KAWASAKI

KERMANSHAH PETROCHEMICAL INDUSTRIES CO.
AMMONIA AND UREA COMPLEX

FGC Installation Manual

KAWASAKI HEAVY INDUSTRIES LTD.
MAR. 8.2005
KOBE JAPAN
Power Generation Project Office

Purchaser review and comments shall not be assumed to indicate either responsibility or liability for accuracy and completeness of this document or to alter any contractual terms and conditions.

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C-7101 A/B

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NOTES

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DATE OF ISSUE

KAWASAKI HEAVY INDUSTRIES, LTD.

Power Generation Project Office
Gas Turbine & Machinery Company

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CHECKED BY
DRAWN BY T. Yuhara

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1. INSTALLATION MANUAL (Dwg. No. : 20M-C04346)

2. RUST PREVENTION SPECIFICATION (Dwg. No. : 20S-C14371)

3. PAINTING SPECIFICATION (Dwg. No. : 20S-C13443)

1. INSTALLATION MANUAL

(Dwg. No. : 20M-C04346)

CUSTOMER INQUIRY NO.
JOB NO. 5777
SPEC. NO.
KOBE STEEL EST NO. E2A0995

Messrs. KAWASAKI HEAVY INDUSTRIES,LTD.

INSTALLATION MANUAL (at site)

FUEL GAS COMPRESSOR UNIT

KSL Model No. : KS24SEH

KOBE STEEL, LTD. 神戸製鋼所 MAR. - 7.2005 回転機技術部 ROTATING MACHINERY ENGG DPT.

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KOBELCO | KOBE STEEL, LTD.
ENGINEERING & MACHINERY DIVISION
ENGINEERING DEPARTMENT

CAREER

ISSUED BY 回転機技術部スクリュ室

SEC. CODE 708A

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TOTAL A4-17 SHEETS
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1. GENERAL

1.1 FOREWORD

(1) This document presents necessary installation work, wiring work, and field assembly work.

(2) This document shall be used for site work estimation only. The contents of the work may be changed depending on the installation site condition.

(3) Kobe Steel can not take any responsibility for any price discrepancy between the estimation based on this document and the actual installation site work.

1.2 GENERAL REQUIREMENTS FOR WORK

(1) Since foreign matters in the compressor or the system may cause significant damage, take care not to leave tools, waste cloths or foreign materials in the compressor or piping.

(2) When carrying and installing the equipment, handle it carefully not to injure.

(3) Kobe Steel Service Department is available for assistance relating to problems encountered in installation of the compressor.
In addition, Kobe Steel Supervisor is available for on-site requirements. To avoid problems with your warranty, Kobe's Service Department must be informed immediately of any visible damage to the compressor and the auxiliary equipment after unpacking and before initial start-up.
If any problems arise during the warranty period, no repair should be made without any approval of Kobe's Service Department before starting the work.
Unauthorized disassembly or repair within the warranty period may void the warranty.

1.3 OVERVIEW OF COMPRESSOR ERECTION AND RE-ASSEMBLY WORK

(1) The compressor unit was completely assembled at KHI-Kobe Works.
Piping and wiring work within the skid also carried out.

(2) Wiring work within the skid had been completed at KHI-Kobe Works.

(3) Wiring work between the skid and DCS are to be carried out at installation site.

(4) Maintenance deck, ladders, hangers and supports may be required around the compressor skid. But the design, material and manufacturing of the deck and ladders are out of KSL scope.

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2. RELATED DOCUMENTS AND DRAWINGS

The documents and drawings should be prepared and referenced for the erection work of the compressor and the auxiliary equipment.

	KHI Dwg. No.	DWG.NO.
Operation & Maintenance Manual	X9E20-48102	(20M-C04347)
Schematic Drawing	X9E20-02030, X9E20-02031	(00028282, 00028291)
General Arrangement Drawing	X9E20-42100	(00028281)
Foundation Drawing	X9E20-05207	(00028283)
Painting Specification (at work)	X9E20-48101	(20S-C13443)
Rust Prevention (at KHI-Kobe Works & site)	X9E20-48101	(20S-C14371)
Lubrication Schedule	X9E20-48102	(20S-C13764)
Spare Part List	X9E20-48102	(20S-C13785)
Special Tool List	X9E20-48102	(20W-C06393)
Termination and Wiring Diagram	X9E20-8802	(03S-K24880)
Control Panel Specifications	X9E20-8811	(03S-K25938)

NOTE: Please refer to the latest revision documents and drawings.

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3. CONDITION OF UNIT SHIPPED FROM KHI-KOBE WORKS

3.1 It is essential for planning erection work to be aware of the delivering condition of products. The shipped parts are described in PACKING LIST that is submitted together with the products. The products are shipped in the following condition:

(1) Rust Prevention
Rust preventing treatment is performed before shipping at KHI-Kobe Works according to "RUST PREVENTION" to prevent rusting until installation.

(2) External Painting before Shipping
Primer and finish painting is applied as specified in "PAINTING SPECIFICATION".

(3) Packaging and Shipping
Packing and marking is performed.
Detailed packing items are described in PACKING LIST.

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4. UNPACKING

(1) Unload the packed products with utmost care.
Be sure to positively secure hanging wire ropes to marked places or hanging hooks.

(2) The compressor unit is assembled before shipment so that installation can be performed immediately after unpacking.
It is recommended to unpack just before the installation.

(3) The unpacking should preferably be performed as near foundation as possible.

(4) Take due care not to injure unpacked parts.

(5) Inspection on Unpacking

(a) Check for injuries that may arise during transportation.

(b) Check that all the required parts are supplied without damage according to Packing List.

(6) Measure to be Taken After Unpacking

(a) Keep the parts, especially small parts, in a good order so as not to lose.

(b) Take proper measures to store and to prevent rust depending on the duration of installation work.

(7) Rust Preventing Treatment
Rust preventing treatment is performed at KHI-Kobe Works as described in "RUST PREVENTION ".
The rust preventive should not be removed until the machine is operated.
Moreover, if defective rust prevention is found, perform rust preventing treatment again according to "RUST PREVENTION ".

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5. INSTALLATION WORK

5.1 PREPARATION

(1) Prior to starting the installation work, the person in charge of construction of the foundation should be requested to check whether the strength of the foundation is sufficient.

(2) The check the pitches and angles of the anchor holes according to the foundation drawing. (See Attachment 1)

(3) Determine the accurate centerlines for the installation of the compressor train, etc., referring to the reference point which has been set during the construction.
As this time, deviations and distortions of the anchor holes should be taken into consideration.

(4) Mark the centerlines on the side of the foundation.

(5) Flatness and level should be measured at the points where liners are to be placed.

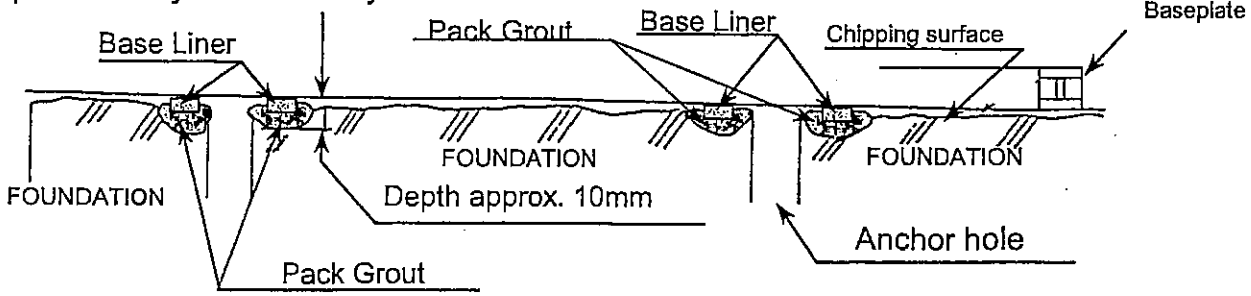
(6) In order to obtain a satisfactory bonding effect, the top surface of the foundation, which is to be grouted, is sufficiently chipped to remove completely hair cracks, parasites , etc. Chipping must be done to the specified level indicated on the foundation drawing.
It is desirable to carry out chipping by using a cold chisel in order to obtain a finer roughed surface. Coarse roughing by means of air chisel should be avoided as it may damage the foundation concrete.
The grouting thickness is shown as a liner thickness on the foundation drawing.

(7) After chipping of the foundation, clean the surface of the foundation and the anchor holes.

(8) In order to set the base liners in the specified position, the pack grout shall be 100mm wider than the base liner and more than 30mm thickness. The base liners height shall be fixed at the indicated position on the foundation drawing and base liners shall be fixed at the indicated position on the liner layout drawing. (See Attachment 2)

- Accuracy of the horizontal : within 0.5mm/m
- Accuracy of the height : within −3 ~ 0 mm
- Accuracy of the position : within ±3mm

The grout should be left for at least 2 to 3 days so that it dries thoroughly. In cold weather, longer periods may be necessary.



Note: At the end of the installation work, the inside of the baseplate shall be filled with epoxy grout to reduce the vibration of the skid. (Refer to attached base plate drawing.)
(See Attachment 5)

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5.2 INSTALLATION OF THE COMPRESSOR UNIT

5.2.1 GENERAL

The procedure of installing the compressor unit is described herein.

5.2.2 INSTALLATION OF THE COMPRESSOR UNIT

(1) Lift up the compressor unit by crane, and bring near above the foundation. Take care that the compressor unit should not pull up by any equipment or supports except for lifting lug. (see Attachment 8)
(2) Set anchor bolts into the hole of the base plate with double hex thick nut.
(3) Then lift down the base plate on the foundation so as to insert the anchor bolts ends into the anchor holes.

5.2.3 TEMPORARY ALIGHNMENT

(1) By adjusting the thickness of the temporary liners or shims, adjust horizontally and height.
(2) Adjust the horizontally within 0.2 mm/m with a level put on the machined surface of compressor suction flange.

5.2.4 ALIGNMENT OF COMPRESSOR

(1) On installation, the compressor unit should be checked for alignment, and it should be corrected, if necessary.
(2) Alignment should be done with the rotors of the compressor and the driver shifted to the operating position.
(3) On the coupling hubs, measure shaft misalignment and parallelism of surfaces by a dial gauge. Correct the alignment, if it doesn't fall within the range shown in Appendix A.
(4) Correction of alignment should be done by adjusting the shims inserted between the base plate and the machines. The jackscrews equipped to the compressor and the driver are available on inserting shims.
(5) Record the final values of the alignment measurement.

NOTES

1. Adjusting shims for alignment must be placed evenly on both sides of the compressor or the driver.
2. Check and record the alignment both before and after piping to the compressor unit. If too large difference is found, adjust the piping.
   The difference must be within 0.1mm in T.I.R. with a dial gauge.

5.2.7 FIXING THE ANCHOR BOLTS

(1) Pour grout into the anchor holes of the foundation. Churn the grout and eliminate any air pockets using pushing tools. Press the grout sufficiently until a clearance of about 50-mm is made between the baseplate and the grout.
The grout should be left for about 4 to 6 days so that it dries thoroughly. In cold weather, longer periods may be necessary.

(2) The baseplate and the anchor bolts should be set at as right angle as possible to avoid uneven contact of nuts with tightening faces.

(3) Tighten the nuts for the anchor bolts the proper torque.

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6. GENERAL INSTRUCTION FOR PIPING WORK

6.1 GENERAL

This chapter shows the minimum requirements for the piping work which is performed by the customer or others.
It is the most important on the piping work to arrange in accordance with the schematic diagrams without giving any excessive load to the machines or leaving any foreign matters in the piping.

6.2 PIPING WORK

At the installation work, the piping should be connected correctly in accordance with Schematic Drawing. (The piping of within FGC is connected. The piping of FGC connections should be connected.) △1

6.3 SPECIAL REQUIREMENT FOR OIL PIPING

(1) Check the conditions of inner rust prevention of piping. Clean and pickle it and apply the rust preventive, if necessary. For additional rust prevention, refer to "Rust Prevention".

(2) When mounting of the piping, check the flange surfaces and inside of the piping, and confirm they are thoroughly clean.
And assemble them without causing any undue forces to them.
If any adjustment work is done during the assembling, be sure to repair with a grinder and conduct the pickling whenever required.

(4) Majority of the compressor troubles are caused by the damage of the bearings due to the foreign matters in the oil piping.
Therefore, take the best care to clean thoroughly in the piping.

(5) After mounting the oil piping, perform the oil flushing in accordance with Chapter 8.

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6.5 SPECIAL REQUIREMENTS FOR MAIN PROCESS GAS PIPING

The followings are the general requirements and the recommendation for the main process gas piping which is fabricated at installation site by the customer or others:

(1) In order to remove the suction piping and clean the inside, as a minimum, a flanged connection should be provided in the suction line of the compressor.

(2) Prior to the tack welding of the piping, the compressor nozzles should be covered by the thin plates secured by cloth-backed duct tape.
The blind plates should not be removed to prevent foreign matters from entering until completion of welding work.

(3) On the welding work, take the best care of the edge preparation for the welding parts.
An employment of argon gas tungsten welding to the first layer is effective to reduce the cleaning work of the pipe inside surface.

(4) Grind the inner welded parts of the flanges to eliminate any spatters, scales, etc. especially the inside of the piping downstream of the suction gas filter/strainer.

(5) Perform hammering and air blasting, and confirm that no dust or foreign matters remain inside the piping. The suction piping should be treated especially carefully.
Perform pickling, if required, according to Chapter 7 of this manual.

(6) On the connection pipes to the compressor, take special care so that no excessive strains are placed on the compressor nozzles by neither weight nor expansion forces.
So, adequate piping supports are required. The piping loads and moments for the nozzles of the compressor should be proper within the allowable values.
And the following notes should be considered for the installation of the main piping:

a) Fit the main pipes to the compressor nozzles without pulling the nozzles with chain block, etc.
The bolts should be smoothly set by the hand. If not, adjust the piping and supports.

b) Adjustment is also required if the flange surfaces are slant or the face-to-face distances are too large even when the bolts of the flanges can be inserted smoothly.

c) After checking of items a) and b), connect the piping and tighten the bolts.
At the same time, attach a dial gauge to the shaft coupling to check a resultant misalignment. If the misalignment exceed 0.1 mm, loosen the bolts and retighten them.
In case the re-tightening of the bolts still results in an excessive misalignment, adjust the piping and supports.

d) Record the shaft alignment of the compressor shaft coupling both before and after mounting the main piping.

7. RECOMMENDED PROCEDURE OF PICKLING

7.1 GENERAL

This chapter presents the recommended pickling procedures of the piping and the equipment made of the carbon steel or the low-alloy steel to remove scales. On performing the pickling, follow the procedures presented in this chapter or other equivalent methods ensuring the same result.

7.3 PREPARATION OF PICKLING

(1) Since it is difficult to clean off the scales or the foreign matters by pickling only, the mechanical methods should be employed prior to the pickling with the grinders, the file or the pipe cleaners, etc. Hammering is effective as well.
Sufficiently hammer the butt-welded portions of the piping prior to the pickling so that the foreign matters will be removed easily.
When the piping flanges are welded, spatters may remain on the surface deep inside. So, remove them thoroughly.

(2) The oil attached on the inner surface reduces the effects of the pickling. therefore, remove the oil with the organic solvent such as tri-chloro-ethylene, thinner or gasoline, etc.

(3) To prevent rusting after the pickling, apply the anti-rusting paint to the machined surfaces of welded valves, nipples and screws, etc.

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7.4 PROCEDURE OF PICKLING

(1) Immerse pipes in detergent acid solution with a concentration of about 30% to 40%, or pour it into the pipes.

(2) If mixed acid detergent solution is not available, mix rust inhibitor with hydrochloric acid in the following weight proportion:

Hydrochloric acid	:	1(for industrial uses, having a concentration of 35%)
Water	:	3 to 4
Rust inhibitor	:	0.001

(3) It is more effective to use warm solution with a temperature of about 40 C to 50 C heated by steam, etc.

(4) After pickling, sufficiently wash the pickled pipes with water and neutralize with neutralizing agent (1% to 3% water solution of sodium phosphate or sodium carbonate). Then, perform sufficient water washing.

(5) After water washing, blow the pipes with steam, and hammer the welded parts. After that, quickly dry them with compressed air blow.

(6) Apply the rust preventives to the oil pipes and cover their ends to prevent foreign matters from entering, after completion of drying.

(7) The result of the pickling should be checked by Kobe's supervisor whether the pipe surfaces are free from the rust and the inherent metal surfaces are obtained.
If the result is unsatisfactory, repeat the pickling.

(8) Agents for Pickling

For the customer's reference, the recommended pickling agents and rust preventives are as follows:

Brand	Manufacturer	Purpose
Rosin	Nippon Paint Co., Ltd.	Rust Inhibitor
Ibit	Sumitomo Chemical Co.	Rust Inhibitor
Kuranodine 45	Nippon Paint Co., Ltd.	Phosphate Chemical Treating Agent
Bondilite M70	Nippon Parkerizing Co.	Phosphate Chemical Treating Agent
Trichlene	Toagosei Chemical Industry	Oil Removing Agent
Rusper M-7	Maruyo Kasei Co.	Pickling Agent
Dioxidine	Nippon Paint Co., Ltd.	Pickling Agent
Furonmask	Nippon Token Shizai Co.	Rust Preventing Agent
Antirusting oil #816	Valvoline	Rust Preventing Agent
Verzone 220	Daiwa Kasei Co.	Rust Preventing Agent

8. OIL FLUSHING

The lube oil system should be flushed with high velocity circulating oil to remove loose material that may have entered the system during assembly.

(1) FILLING OIL

Fill the Oil recovery tank with low viscosity lube oil for flushing. ISO VG32 turbine oil is applicable. Usage of the lube oil charge pump as follows.

Connect the lube oil drum can and oil supply nozzle with flexible hose. The vent nozzle should be returned to the drum can. After the pump is started, initially the air will come out from the vent nozzle. After the air is purged, close the vent valve(V-283) and open the isolation valve(V-281), then the oil will go into the lube oil line and Oil recovery tank. Required oil level is just near the low limit of Oil recovery tank .

After flushing, it is necessary to drain out the flushing oil and charge the recommended oil for the compressor.

(2) TEMPORARY PIPING AROUND THE COMPRESSOR

To circulate the flushing oil, temporary minor modification is necessary as follows.

- Fully open LO shut-off valve (V-212).
- Fully close the isolation valve (V-211).
- Fully close the vent valves (V-252, V-253) of LO Filter and isolation valve (V-301) on the hydraulic line for the compressor slide valve.

(3) VALVES

Valves shall be exercised from fully closed to fully open, slowly and repeatedly. This will create turbulence in the valve bonnet cavities, which will help to flush them.

(4) FLUSH TIME

The flush shall be continued for at least 4 (four) hours in each circulation loop.

(5) THERMAL SHOCKING

During each circulation, alternately heat and cool the oil in the oil cooler, if required.

(6) HAMMERING PIPING

Weld joints, fittings, and other areas that can trap material shall be hammered frequently during all flushing cycles.
Cement vibrators and impact hammers do not normally provide enough sharp impact force to loosen foreign material that adheres to the piping.

(7) DRAINING

Drain the oil from the system, including retention points such as coolers, strainers and filter vessels, as completely as possible.

(8) OTHERS

① Lube oil filter elements to be used at flushing are included in construction spare parts.
② After completion of flushing, lube oil filter elements should be replaced for compressor start up.
③ For cleanliness inspection, wire mesh screens and rubber gaskets are required.
The wire mesh screen should be 100mesh, and its material should be is made of stainless steel.
Ordinary sheet gaskets may be used. (Valqure #6501 Non-Asbestos) Four sets for one point are required as minimum.

(9) INSPECTION OF OIL FLUSHING

Inspection screens shall be installed on the compressor bypass line for initial checks and at compressor for final check.

The inspection screens shall be No.100 plain weave, 0.004-inch diameter, stainless steel wire with 0.0059-inch openings. (As per API614). These screens shall be sandwiched between a pair of rubber gaskets and installed between flanges.

If slag, scale, paint, rust or other abrasive or adhering material continues to appear on the inspection screen during the circulation, circulation shall be stopped. The suspect parts of the system shall be mechanically or chemically re-cleaned, Extra screens may be necessary to isolate and identify the contaminated sections.

(10) SCREEN INSPECTION

Very careful supervision is required for screen inspection.

A careful record of contaminates found on each screen shall be kept. This record shall include a description of the contaminant, the amount present, and the length of time oil was circulated through the screen.

If the first inspection of the screens shows only minor contamination, repeat the circulation and inspection.

(11) RE-CLEAN SYSTEM

If significant contamination is found or if the minor contamination does not clean up in a reasonable period (3-4 hours), the source of contamination shall be located and identified. Extra screens may be installed to help isolate the source. The source area shall be disassembled and thoroughly re-cleaned mechanically or chemically.

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(12) FINAL CLEANLINESS CHECK

KOBE STEEL Supervisors shall certify that the lube oil system is clean. They may request additional circulation.

If KOBE STEEL Supervisors do not require additional circulation or test, the systems are acceptable if the number of particles caught in inspection screens after a 1-hour circulation at design flow rate and operating temperature does not exceed the level specified in the following table. Particles grouped in one areas of the screen will indicate insufficient flow and be cause to re-circulate at higher flush rates.

MAXIMUM NUMBER OF PARTICLES (API614)

NOMINAL PIPE SIZE (INCHES)	SCHEDULE40 OR LESS	SCHEDULE80	SCHEDULE160
1 or less	6	5	4
1-1/2	15	10	10
2	20	20	15
3	45	40	35
4	80	70	60
6 and up	180	160	130

The above particles must not exceed 0.010 inch (greatest dimension) or be abrasive in nature.

9. ELECTRICAL INSTALLATION

9.1 WIRING WORK

At the installation work, the wiring should be connected correctly in accordance with Wiring Diagram.

Earth wires of FGC should be connected to Earth lug of FGC's base plate. △2

(Refer to attached base plate drawing.)

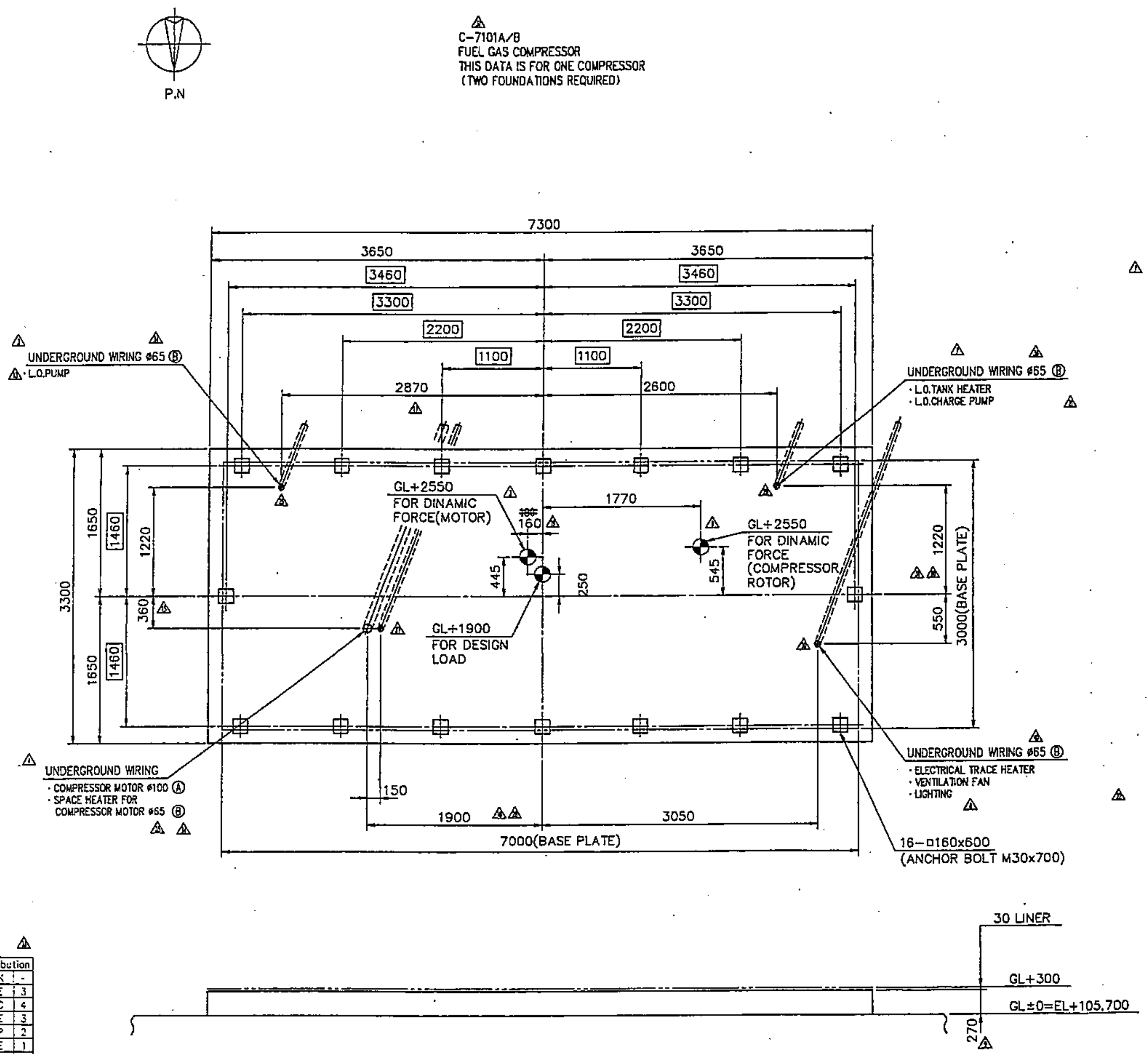
B008014

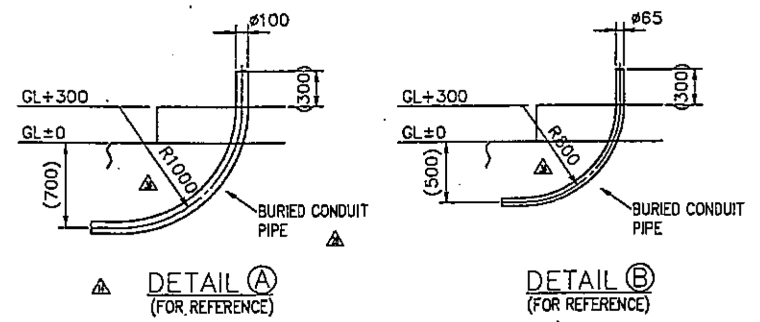
ATTACHMENT

1. Foundation drawing
2. Arrangement drawing for Liner
3. Liner Drawing for the compressor base plate
4. Anchor Bolt Drawing for the compressor base plate
5. Base plate Drawing (showing grout filling space)
6. Shaft Alignment Check
7. Temporary piping around the compressor for oil flushing
8. Lifting Plan for FGC

B018227

Attachment .1





DESIGN LOAD		
EQUIPMENT NAME	STATIC LOAD (kgf)	EQUIVALENT LOAD (kgf)
COMPRESSOR UNIT	24800 ~~23000~~	41000 ~~42000~~

DYNAMIC FORCE					
		ROTOR WEIGHT (kg)	SPEED (RPM)	DYNAMIC FORCE (kg)	TORQUE (N·m)
COMPRESSOR	MALE ROTOR	145	2950	90	1780
	FEMALE ROTOR	105	2107	50	—
MOTOR		700 ~~300~~	2950	440 ~~300~~	1780

FREQUENCY			
		ROTATION(Hz)	PULSATION(Hz)
COMPRESSOR	MALE ROTOR	49.1	245
	FEMALE ROTOR	35.1	
MOTOR		49.1	

REMARKS:

1. THIS DRAWING SHOWS THE RELATIVE LOCATIONS OF COMPONENTS AND FOUNDATION DIMENSIONS.
2. THE ABOVE TABLE SHOWS STATIC LOAD, EQUIVALENT LOAD, ROTOR WEIGHT, ROTOR SPEED, DYNAMIC FORCE, AND TORQUE OF EQUIPMENT OR MACHINES.
   - 2-1 EQUIVALENT LOAD IS USED FOR DESIGN OF STRENGTH OF THE FOUNDATION. EQUIVALENT LOAD WAS CALCULATED FROM STATICALLY EQUIVALENT MACHINE LOAD CONVERTED FROM DYNAMIC LOAD.
   - 2-2 DYNAMIC FORCE IS USED FOR CALCULATION OF AMPLITUDE OF FOUNDATION.
   - 2-3 DOUBLE AMPLITUDE OF THE FOUNDATION PLANE VIBRATION MUST BE LESS THAN 6μ.
   - 2-4 STATIC LOAD IS USED FOR CALCULATION OF NATURAL FREQUENCY OF THE FOUNDATION.
   - 2-5 NATURAL FREQUENCY OF THE FOUNDATION SHALL BE 30% MORE OR LESS THAN NORMAL ROTOR SPEED.
   - 2-6 THE FOUNDATION SHALL BE DESIGNED TO BE RIGID ENOUGH FOR TORQUE IN THE ABOVE TABLE.
3. PILE DRIVING, RUBBLE WORKING AND BAR ARRANGEMENT WORKING SHOULD BE CARRIED OUT ACCORDING TO GROUND AND SOIL CONDITION.
4. DISCONNECT THE FOUNDATION BLOCK OF COMP. WITH THE HOUSE OR THE FLOOR OF OTHER EQUIPMENTS IN ORDER TO AVOID TRANSMISSION OF VIBRATION.
5. CONTACT WITH KSL WHEN ALTERNATION OF DIMENSIONS MAY OCCUR.
6. KSL DISCLAIMS ALL THE RESPONSIBILITY FOR DESIGN OF STRENGTH OF THE FOUNDATION.
7. TOLERANCE OF DIMENSIONS SHALL BE AS FOLLOWS:
   - 7-1 DIMENSION OF FOUNDATION BOLT HOLE :0~+10mm
   - 7-2 DEPTH OF FOUNDATION BOLT HOLE SHALL NOT BE LESS THAN THE INDICATED ONE IN THIS DRAWING.
   - 7-3 INCLINATION ANGLE OF FOUNDATION BOLT HOLE :2 DEG. OR LESS
   - 7-4 HEIGHT OF THE FOUNDATION :-20~+10mm
   - 7-5 DIMENTIONS ENCLOSED IN □ MUST BE ESPECIALLY EXACT.
8. MARK ⊕ INDICATES CENTER OF GRAVITY.
9. THE DIRECTION OF UNDERGROUND WIRING BE CASE AS SOUTH SIDE.

Distribution	
MWK	-
NCE	3
PBC	4
KHE	3
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PGE	1

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R5	△-△	602	'04.9.1	M.H		H.O	H.O
R4	△-△	602	'04.6.18	M.H	M.H	H.O	H.O
R3	△-△	602	'04.6.16	FTE	M.H	H.O	H.O
R2	△-△ Compressor Size Change	602	'04.5.17	M.H	M.H	H.O	H.O
R1	△·△	602	2004 Feb.20	M.H	H.O	T.O	T.O
	ISSUED		2004 Feb.10	M.H	H.O	T.K	T.K

ENGINEERING DEPT. / REVIEWED QA DEPT.

KAWASAKI HEAVY INDUSTRIES, LTD.
GAS TURBINE & MACHINERY COMPANY
POWER GENERATION PROJECT OFFICE

OWNER 注文主: KERMANSHAH PETROCHEMICAL INDUSTRIES Co.

PROJECT: AMMONIA & UREA COMPLEX IN KERMANSHAH, IRAN

TYPE 名称: GTG/HRSG UNIT
FOUNDATION & LOADING DATA
(Fuel Gas Compressor Package/KS24SEH)

RULE 規格 — | MAX. WORKING TEMP. 最高使用温度 — | MAX. WORKING PRESS. 最高使用圧力 — | WATER TEST PRESS. 水圧試験圧力 — | SCALE 尺度 1/30 | DATE 作成日 | ORIGINAL 元図 —

APPROVED 承認 | CHECKED 審査 | DRAWN 作成

JOB NO. / SHOP ORDER / DRAWING NO.: 31X9E200100X9E20-0520705

IP MK	ITEM	PART NO.	NAME	MATERIAL	QTY	kg MASS/PIECE	TP	PRT

CAREER: ACAD:J/WET/D 00028283

KOBELCO
KOBE STEEL, LTD.
MACHINERY COMPANY

TITLE: FOUNDATION DRAWING (Fuel Gas Compressor Unit/KS24SEH)

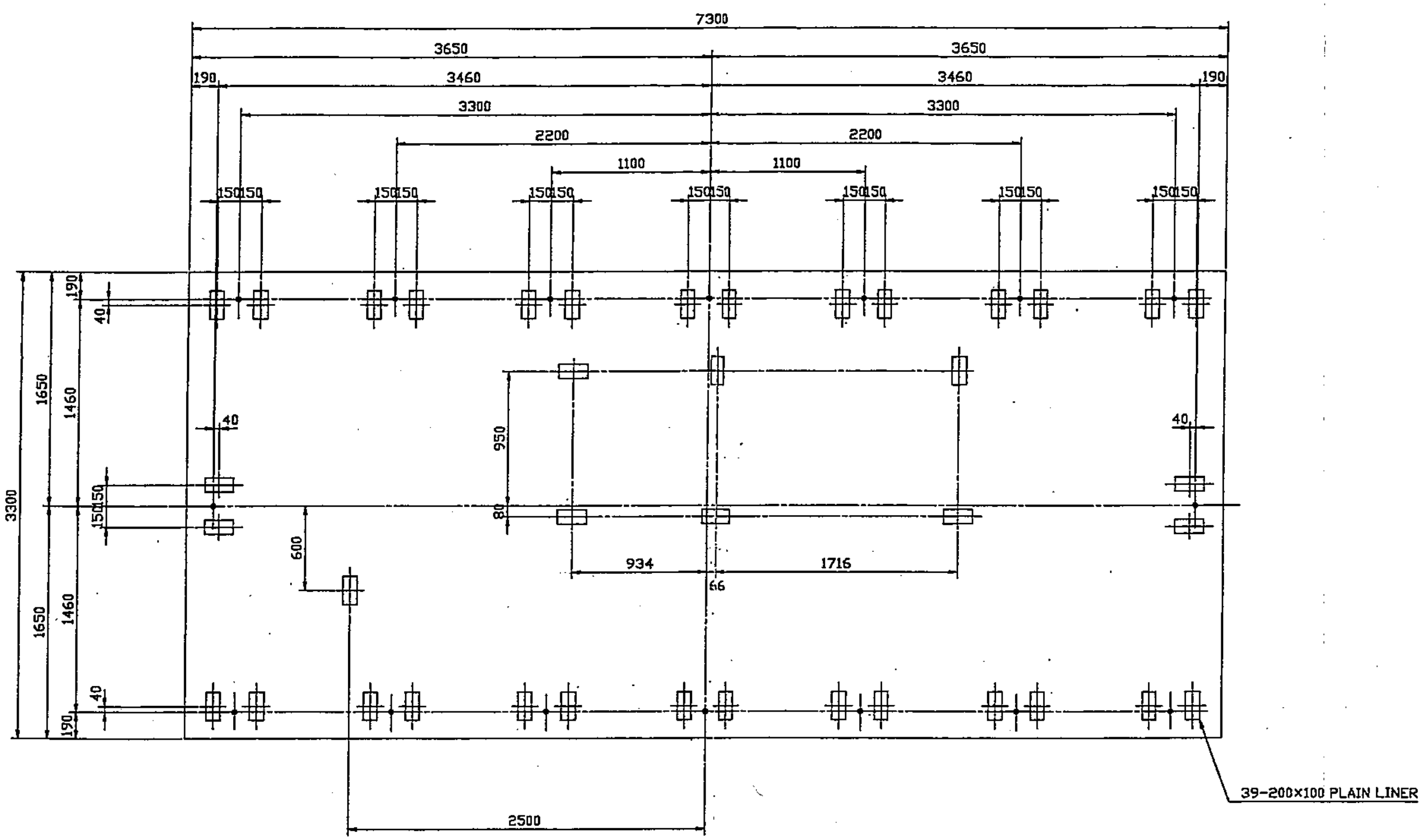
DWG NO. 00028283 REV R5

SCALE 1/30 | ENG C. CODE 708A | STD DWG O.NO. 03-00974-G | T.NO. 1 | C62616

16

(P.16)

Attachment.2



R							
R							
R							
	ISSUED	04.10.05	FTE				
REV NO.	REVISION NOTE	DATE	DRAWN	DESIGNED	CHECKED	APPROVED	REVIEWED
			ENGINEERING DEPT.				QA DEPT.

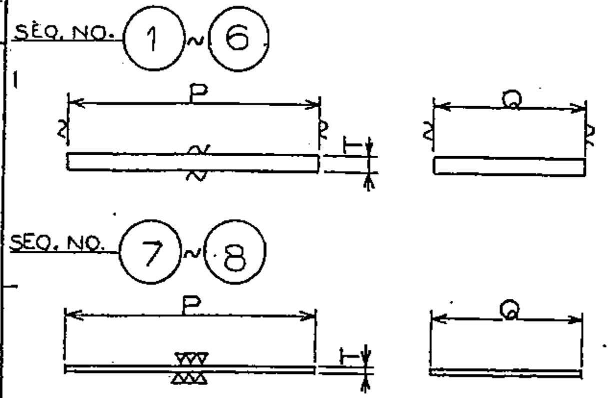
M				DWG	1			
IP MK	ITEM	PART NO.	NAME	MATERIAL	QTY	MASS/PIECE	TP	PET

CAREER ACAD: J/WET/D	KOBELCO KOBE STEEL, LTD. MACHINERY COMPANY	TITLE	ARRANGEMENT DRAWING FOR LINER / FGC(KS24SEH)
		DWG NO.	REV
SCALE 1/20	ENG G. CODE 708A	STD DWG O.NO. 03-00974-G	T.NO. 1-

(Attachment 3)

3RD ANGLE PROJECTION

THE DRAWING(S) AND THE INFORMATION CONTAINED HEREIN ARE THE PROPERTY OF KOBE STEEL, LTD. THEY SHALL NOT BE DISCLOSED, REPRODUCED OR USED IN ANY MANNER WITHOUT PRIOR WRITTEN CONSENT OF KOBE STEEL, LTD.



ITEM NO.			P	Q	T
01/11	A.D	A	200	100	30/12
		B			6
		C			3.2
		D			1.6
		E			0.6
		F			0.4
		G			0.2
	A.D	H			0.1
02/12	B.E	A	150	80	30/12
		B			6
		C			3.2
		D			1.6
		E			0.6
		F			0.4
		G			0.2
	B.E	H			0.1
03/13	C.F	A	100	50	30/12
		B			6
		C			3.2
		D			1.6
		E			0.6
		F			0.4
		G			0.2
	C.F	H			0.1
14	G	A	250	100	12
		B			6
		C			3.2
		D			1.6
		E			0.6
		F			0.4
		G			0.2
	G	H			0.1

RECOMMENDED LINER ITEM NO.

ANCHOR BOLT	ITEM NO.	
M30~42	01	11
M24	02	12
M22	02	14
M12~20	03	13

MARK	SEQ. NO.	PART CODE	ITEM	PART NAME	MATERIAL	QUANT.	kg CALC. MASS/PIECE	REMARKS
MS	8	0100368	# G H	PLANE LINER	SUS304	1	.020	250x100xt0.1
	7		G G		SUS304	1	.040	t0.2
	6		G F		SS400	1	.080	t0.4
	5		G E			1	.110	t0.6
	4		G D			1	.320	t1.6
	3		G C			1	.640	t3.2
	2		G B			1	1.300	t6
	1		# G A		SS400	1	2.400	250x100xt12
MS		01003681 #14		PLANE LINER	—	1s	4.020	
MS	8	01003681	# F H	PLANE LINER	SUS304	1	.004	100x50xt0.1
	7		F G		SUS304	1	.008	t0.2
	6		F F		SS400	1	.016	t0.4
	5		F E			1	.020	t0.6
	4		F D			1	.060	t1.6
	3		F C			1	.130	t3.2
	2		F B			1	.240	t6
	1		# F A		SS400	1	.470	100x50xt12
MS		01003681 #13		PLANE LINER	—	1s	.984	
MS	8	01003681	# E H	PLANE LINER	SUS304	1	.010	150x80xt0.1
	7		E G		SUS304	1	.020	t0.2
	6		E F		SS400	1	.040	t0.4
	5		E E			1	.060	t0.6
	4		E D			1	.150	t1.6
	3		E C			1	.300	t3.2
	2		E B			1	.570	t6
	1		# E A		SS400	1	1.130	150x80xt12
MS		01003681 #12		PLANE LINER	—	1s	2.280	
MS	8	01003681	# D H	PLANE LINER	SUS304	1	.016	200x100xt0.1
	7		D G		SUS304	1	.032	t0.2
	6		D F		SS400	1	.060	t0.4
	5		D E			1	.080	t0.6
	4		D D			1	.250	t1.6
	3		D C			1	.500	t3.2
	2		D B			1	.940	t6
	1		# D A		SS400	1	1.980	200x100xt12
MS		01003681 #11		PLANE LINER	—	1s	3.758	
MS	8	01003681	# C H	PLANE LINER	SUS304	1	.004	100x50xt0.1
	7		C G		SUS304	1	.008	t0.2
	6		C F		SS400	1	.016	t0.4
	5		C E			1	.020	t0.6
	4		C D			1	.060	t1.6
	3		C C			1	.130	t3.2
	2		C B			1	.240	t6
	1		# C A		SS400	1	1.260	100x50xt30
MS		0100368 #03		PLANE LINER	—	1s	1.738	
MS	8	01003681	# B H	PLANE LINER	SUS304	1	.010	150x80xt0.1
	7		B G		SUS304	1	.020	t0.2
	6		B F		SS400	1	.040	t0.4
	5		B E			1	.060	t0.6
	4		B D			1	.150	t1.6
	3		B C			1	.300	t3.2
	2		B B			1	.570	t6
	1		# B A		SS400	1	3.010	150x80xt30
MS		01003681 #02		PLANE LINER	—	1s	4.160	
MS	8	01003681	# A H	PLANE LINER	SUS304	1	.016	200x100xt0.1
	7		A G		SUS304	1	.032	t0.2
	6		A F		SS400	1	.060	t0.4
	5		A E			1	.080	t0.6
	4		A D			1	.250	t1.6
	3		A C			1	.500	t3.2
	2		A B			1	.940	t6
	1		# A A		SS400	1	5.020	200x100xt30
MS		01003681 #01		PLANE LINER	—	1s	6.898	
M				PLANE LINER	—			

REV. NO.	REVISION NOTE	DRAWN	DESIGNED	CHECKED	APPROVED	APPROVED
			有賀	有賀	有賀	森川 藤
		ENGINEERING DEPARTMENT				QA DEPARTMENT

NAME: PLANE LINER

KOBE STEEL, LTD. Engineering & Machinery Division ENGINEERING DEPARTMENT

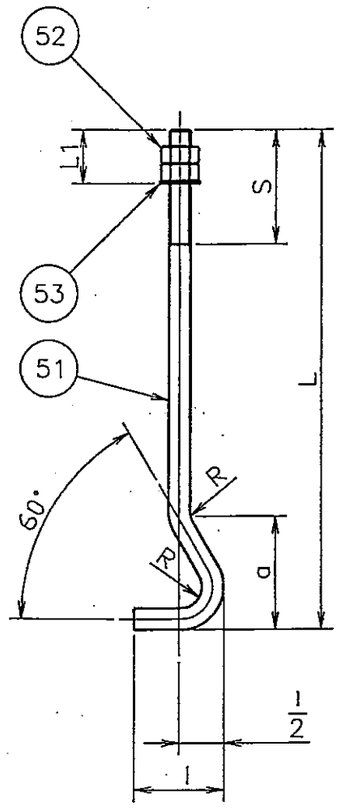
DWG. NO. 01003681

SCALE | SECT. CODE 747B | SUB ASS'Y. INDEX | OUT PUT | O. NO. SCR | T. NO. 2-420413

MF 1回 94.1.27

Attachment 4

ITEM NO.	SIZE	L	S	L1	l1	a	R
01	M30	700	160	75	125	158	30
02	M24	630	125	60	100	127	24
03	M20	500	100	55	80	102	20
04	M16	400	80	45	63	81	16
05	M12	315	63	35	50	64	12



IP MK	ITEM	PART NO.	NAME	MATERIAL	QTY	MASS/PIECE (kg)	TP	PRT
MS	53	BWME-FB-012	PLAIN WASHER	SS400	1			12-W1
MS	52	BNMD-SZ-M012	HEX THICK NUT	SS400	2			M12
MS	51	00327540 #05#51	ANCHOR BOLT	SS400	1			M12×315
MS		00327540 #05	ANCHOR BOLT	———	1s			
MS	53	BWME-FB-016	PLAIN WASHER	SS400	1			16-W1
MS	52	BNMD-SZ-M016	HEX THICK NUT	SS400	2			M16
MS	51	00327540 #04#51	ANCHOR BOLT	SS400	1			M16×400
MS		00327540 #04	ANCHOR BOLT	———	1s			
MS	53	BWME-FB-020	PLAIN WASHER	SS400	1			20-W1
MS	52	BNMD-SZ-M020	HEX THICK NUT	SS400	2			M20
MS	51	00327540 #03#51	ANCHOR BOLT	SS400	1			M20×500
MS		00327540 #03	ANCHOR BOLT	———	1s			
MS	53	BWME-FB-024	PLAIN WASHER	SS400	1			24-W1
MS	52	BNMD-SZ-M024	HEX THICK NUT	SS400	2			M24
MS	51	00327540 #02#51	ANCHOR BOLT	SS400	1			M24×630
MS		00327540 #02	ANCHOR BOLT	———	1s			
MS	53	BWME-FB-030	PLAIN WASHER	SS400	1			30-W1
MS	52	BNMD-SZ-M030	HEX THICK NUT	SS400	2			M30
MS	51	00327540 #01#51	ANCHOR BOLT	SS400	1			M30×700
MS		00327540 #01	ANCHOR BOLT	———	1s			
M		00327540	ANCHOR BOLT	———				

配布先		
工場内	Gr	
	事2F	
	加工	
	組立	
	検査	
	計装	
	製缶・船艤	
工場外	購入品	
	加工品	
合計		

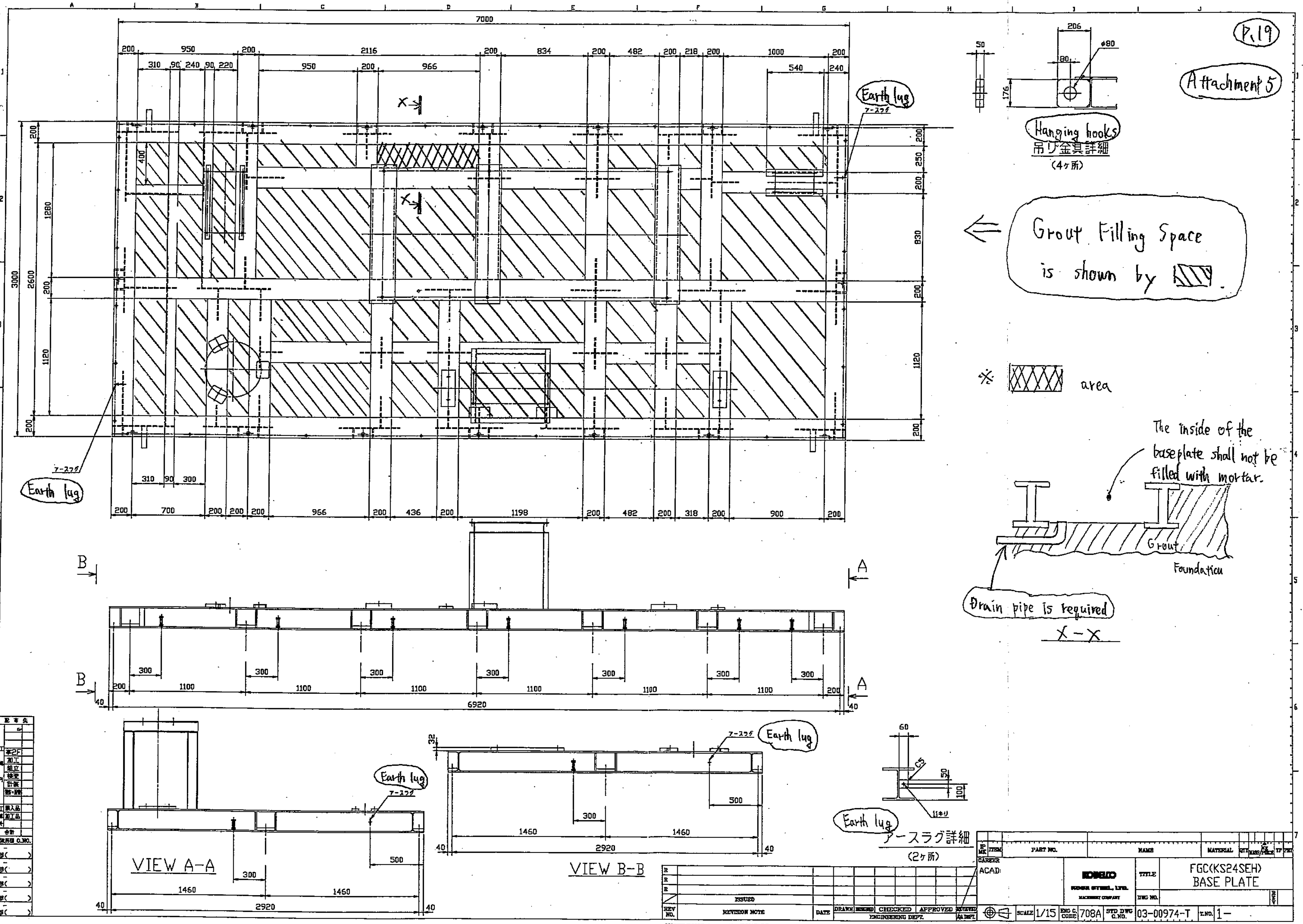
流用図 O.NO.
– 部( )
– 部( )
– 部( )
– 部( )
– 部( )

CAREER
ACAD: WET/D/00327540
S IS LONGER THAN JIS

KOBELCO
KOBE STEEL, LTD.
ENGINEERING & MACHINERY DIV.

TITLE: ANCHOR BOLT(LA TYPE)
DWG NO.: 00327540 REV
SCALE | ENG G. CODE | STD DWG O.NO.: 00-00578-P | T.NO.: 3- C64622

REV NO.	REVISION NOTE	DATE	DRAWN	DESIGNED	CHECKED	APPROVED	REVIEWED
R							
R							
R							
	ISSUED	01.09.04	FTE	牧田	尾崎博	大浜	
			ENGINEERING DEPT.				QA DEPT.



P.19
Attachment 5
Earth lug
アースラグ
Hanging hooks
吊り金具詳細
(4ヶ所)
Grout Filling Space is shown by
※ area
The inside of the baseplate shall not be filled with mortar.
Grout
Foundation
Drain pipe is required
X-X
VIEW A-A
VIEW B-B
アースラグ詳細
(2ヶ所)
ISSUED
REVISION NOTE
DATE
DRAWN
CHECKED
APPROVED
ENGINEERING DEPT.
PART NO.
NAME
MATERIAL
ACAD
KOBELCO
TITLE
FGC(KS24SEH)
BASE PLATE
SCALE 1/15
708A
03-00974-T

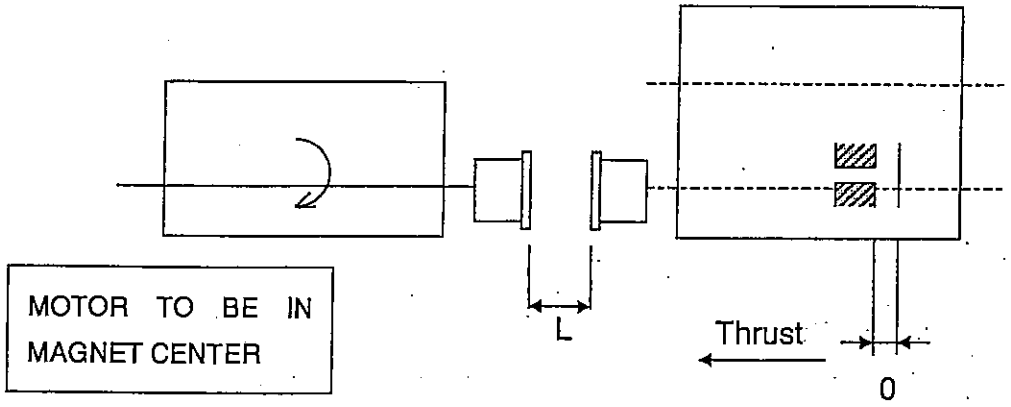
Attachment 6. Shaft Alignment Check

Alignment value is not larger than following value.

unit:mm

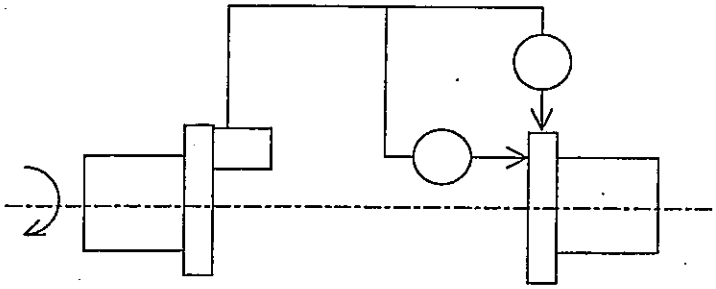
	Parallel Offset	Angular Misalignment	Length
Compressor	±0.1	±0.1	$186_{0}^{+0.1}$

*Parallel Offset and Angular Misalignment shall be measured by TIR.



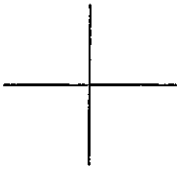
Main Motor Compressor

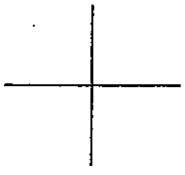
B008014



Main Motor side

Compressor





parallel Offset Angular Offset

Distance : mm

Attachment, 7

Close the isolation valve

Close the valve for Hydraulic Line

Open the shut-off valve

Wire mesh screen to be installed

Close the vent valves

19EKH10AT003 (C-7101A-F2)
SUCTION FILTER
- TYPE: CONE TYPE STRAINER
- FILTRATION: 150MESH (WIRE-MESH)

19EKH10AE001 (C-7101A(M))
COMPRESSOR MOTOR
- OUT PUT: 550kW, 2P
- VOLTAGE: 6000V, 3PH, 50Hz

19EKH10AN001 (C-7101A)
COMPRESSOR
- MODEL: KS24SEH
- SPEED: 2950RPM
- BHP: 498kW

19EKH10BB001 (C-7101A-T1)
OIL RECOVERY TANK
- TYPE: HORIZONTAL
- MATERIAL: CARBON STEEL (SHELL)
- CODE: ASME SECTION VIII Div.1 WITHOUT STAMP

19EKH10AT004 (C-7101A-F3)
OIL MIST SEPARATOR
- TYPE: VERTICAL
- ELEMENT: BOROSILICATE MICRO FIBER
- MATERIAL: CARBON STEEL (SHELL)
- CODE: ASME SECTION VIII Div.1 WITHOUT STAMP

19EKH10AN002 (C-7101A-C1)
VENTILLATION FAN
- OUT PUT: 1.5kW, 6P
- SPEED: 1000 rpm
- MOTOR: 400V, 3PH, 50Hz

19EKH10AP002 (C-7101A-P2)
OIL CHARGE PUMP
- TYPE: VANE
- DISCHARGE PRESSURE: 28barG
- SPEED: 1450rpm

19EKH10AP002 (C-7101A-P2)
OIL CHARGE PUMP MOTOR
- OUT PUT: 3.7kW, 4P
- VOLTAGE: 400V, 3PH, 50Hz

19EKH10AT001/002 (C-7101A-F1A/B)
LUBE OIL FILTERS
- FILTRATION: 10MICRON NOM
- ELEMENT TYPE: FIBER GLASS
- CODE: ASME SECTION VIII Div.1 WITHOUT STAMP

19EKH10AP001 (C-7101A-P1)
LUBE OIL PUMP
- TYPE: GEAR
- DIFFERENTIAL PRESSURE: Approx. 6bar
- SPEED: 1450rpm

19EKH10AP003 (C-7101A-P1)
LUBE OIL PUMP MOTOR
- OUT PUT: 11kW, 4P
- VOLTAGE: 400V, 3PH, 50Hz

19EKH10AH001 (C-7101A-E1)
LUBE OIL COOLER
- TYPE: SHELL & TUBE HORIZONTAL LOW-FINED TUBE
- CODE: ASME SECTION VIII Div.1 WITHOUT STAMP TEMA C

NOTE:
L (EL) DENOTES OPERATING/DESIGN CONDITIONS AS BELOW

	MEANING	UNIT
P	PROCESS DESIGN PRESS.	barG
T	PROCESS DESIGN TEMP.	℃
F	FLOW RATE	m³/hr
DP	MECHANICAL DESIGN PRESS.	barG
DT	MECHANICAL DESIGN TEMP.	℃

2. NUMBERS SHOWN ○ ARE CONNECTION NUMBERS OF TERMINATING POINTS
3. NUMBERS SHOWN □ ARE PIPING NUMBERS.
4. It's FGC-A and FGC-B zone contents. TAG No. of FGC-B is as follows 19EKH20*

SYMBOL LIST	
SYMBOL	NAME
	ACTUATOR, CYLINDER
	ACTUATOR, DIAPHRAGM
	ACTUATOR, MOTOR
	ACTUATOR, SOLENOID
	FLAME ARRESTOR
	LIMIT SWITCH
	LINE, ELECTRICAL
	LINE(GAS,L.O,WATER)
	HEAT INSULATION(LINE)
	HEAT INSULATION (LINE WITH TAPE HEATER)
	SOUND INSULATION(LINE)
	LINE, PNEUMATIC
	CAPILLARY (FILLED SYSTEM)

	LINE STRAINER (CONE-TYPE)
	LINE STRAINER (Y-TYPE)
	FLOW RESTRICTION ORIFICE
	SIGHT GLASS
	RESTRICTION ORIFICE
	SPECTACLE BLIND
	VALVE, BUTTERFLY
	VALVE, CHECK (LIFT/SWING)
	VALVE, CHECK (WAFER, BUTTERFLY)
	VALVE, GATE
	VALVE, BALL
	VALVE, GLOBE
	VALVE, NEEDLE
	VALVE, SAFETY (RELIEF)
	VALVE, SIX-PORT CONTINUOUS-FLOW TRANSFER, MANUALLY OPERATED
	VALVE, THREE-WAY
	VALVE, FLOW CONTROL
	VALVE, FOUR-WAY SPOOL
	PRESSURE, REGULATOR
	OPEN NORMALLY
	CLOSED NORMALLY
	ELECTRIC HEATER
	FAIL CLOSE
	FAIL OPEN
	LOCK CLOSE
	LOCK OPEN
	TRANSMITTER
	OIL PUMP
	OIL ELEMENT

Distribution	
MWK	-
NCE	3
PBC	4
KPE	3
PGP	2
PGE	1

ABBREVIATIONS		ABBREVIATIONS	
SYMBOL	NAME	SYMBOL	NAME
GE	GAS LEAK DETECTOR	PIT	PRESSURE TRANSMITTER
GI	GAS LEAK MONITTOR	TC	TEMPERATURE CONTROLLER
GIS	SLIDE VALVE SENSOR	TE	THERMOCOUPLE
HC	HAND CONTROLLER	TI/TG	TEMPERATURE INDICATOR
LI	LEVEL INDICATOR	TIA	TEMPERATURE ALARM SWITCH
LIC	LEVEL-INDICATING CONTROLLER	TIC	TEMPERATURE-INDICATING CONTROLLER
LA	LEVEL ALARM	TIZA	TEMPERATURE ALARM AND TRIP SWITCH
LS	LEVEL SWITCH	VE	VIBRATION PROBE/PICK-UP
LT	LEVEL TRANSMITTER	VI	VIBRATION INDICATOR
PCV	DIRECT-ACTING PRESSURE CONTROL VALVE	XE	AXIAL POSITION PROBE
PDIA	DIFFERENTIAL PRESSURE ALARM SWITCH	XIZA	AXIAL POSITION ALARM AND TRIP SWITCH
PDIC	PRESSURE DIFFERENTIAL-INDICATING CONTROLLER		
PDIZ	DIFFERENTIAL PRESSURE TRIP SWITCH	H	HIGH (ALARM)
PDT	DIFFERENTIAL-PRESSURE TRANSMITTER	HH	VERY HIGH (TRIP)
PI/PG	PRESSURE INDICATOR	L	LOW (ALARM)
PIZA	PRESSURE ALARM SWITCH AND CONTROLLER	LL	VERY LOW (TRIP)
PRV	PRESSURE-REGULATING VALVE		
PT	PRESSURE TRANSMITTER	○	WITHOUT DATA TRANSMISSION
SV	PRESSURE SAFETY (RELIEF)	⊖	TRANSMITTING DATA TO FIELD PANEL
PIA	PRESSURE ALARM SWITCH	⊖	TRANSMITTING DATA TO DCS

EQUIPMENT LIST	
ITEM NO.	NAME
19EKH10AN001	COMPRESSOR
19EKH10AE001	MAIN MOTOR
19EKH10AT003	SUCTION FILTER
19EKH10AT001/002	L.O. FILTER
19EKH10BB001	OIL RECOVERY TANK
19EKH10AT004	OIL MIST SEPARATOR
19EKH10AN001	L.O. COOLER
19EKH10AP001	L.O. PUMP
19EKH10AP002	O.C. PUMP

CONNECTION LIST					
NO.	PIPE SIZE	RATING	QTY		LINE SERVICE
G-1	6"	ANSI 300#	SORF	1	GAS INLET
G-2	4"	ANSI 300#	SORF	1	GAS DISCHARGE
G-3	8"	ANSI 150#	SORF	1	TO FLARE OR ATM
W-1	4"	ANSI 150#	SORF	1	C.W. SUPPLY
W-2	4"	ANSI 150#	SORF	1	C.W. RETURN
W-3	2"	ANSI 150#	SORF	1	C.W. SUPPLY (MAIN MOTOR)
W-4	2"	ANSI 150#	SORF	1	C.W. RETURN (MAIN MOTOR)
IA-1	3/4"	ANSI 150#	SORF	1	I.A. SUPPLY

F.G.C. / L.C.P.
Fuel Gas Compressor Unit / Local Control Panel

SUPPLIED BY.
KHI—GT (KSL) / KHI—PLANT

REV NO.	REVISION NOTE	DATE	DRAWN	DESIGNED	CHECKED	APPROVED	REVIEWED	QC DEPT.
R 9	Compressor Size Change	602	2004 Dec.15	M. H	M. H	H. O		H. O
R 8	ISSUED	602	2004 Nov.02	M. H	M. H	T. K		T. K
R 7		602	2004 Sep.16	M. H	M. H	T. K		T. K
R 6		602	2004 Aug.09	M. H	M. H	T. K		T. K
R 5		602	2004 July.23	M. H	M. H	H. O		H. O
R 4		602	2004 July.07	M. H	M. H	H. O		H. O
R 3		602	2004 May.14	M. H	M. H	H. O		H. O
			2004 Feb.10	M. H	H. O	T. K		T. K

ENGINEERING DEPT.

Purchaser review and comments shall not be assumed to indicate either responsibility or liability for accuracy and completeness of this document or to alter any contractual terms and conditions.

Item Numbers: C-7101 A/B

Purchasers Disposition: ☐No Comments ☐Comments as Noted ☐Rejected ☐Not Reviewed

Date / Company / Initial

SDRL Code	REQ. No.	Purchaser Order No.
A30	5777-20D1-J520-01	03AAET10

KAWASAKI HEAVY INDUSTRIES, LTD.
GAS TURBINE & MACHINERY COMPANY
POWER GENERATION PROJECT OFFICE

OWNER: KERMANSHAH PETROCHEMICAL INDUSTRIES Co.
PROJECT: AMMONIA & UREA COMPLEX IN KERMANSHAH, IRAN
TYPE: GTG/HRSG UNIT
P&ID
(Fuel Gas Compressor UnitA)

RULE	
APPROVED	
MAX. WORKING TEMP.	
MAX. WORKING PRESS.	
CHECKED	
WATER TEST PRESS.	
SCALE	
DRAWN	
DATE	
JOB NO.	
SHIP'S No.	
DRAWING NO.	3 1 X 9 E 2 0 0 1 0 0 X 9 E 2 0 - 0 2 0 3 0 0 9
REV. NO.	
ORIGINAL	

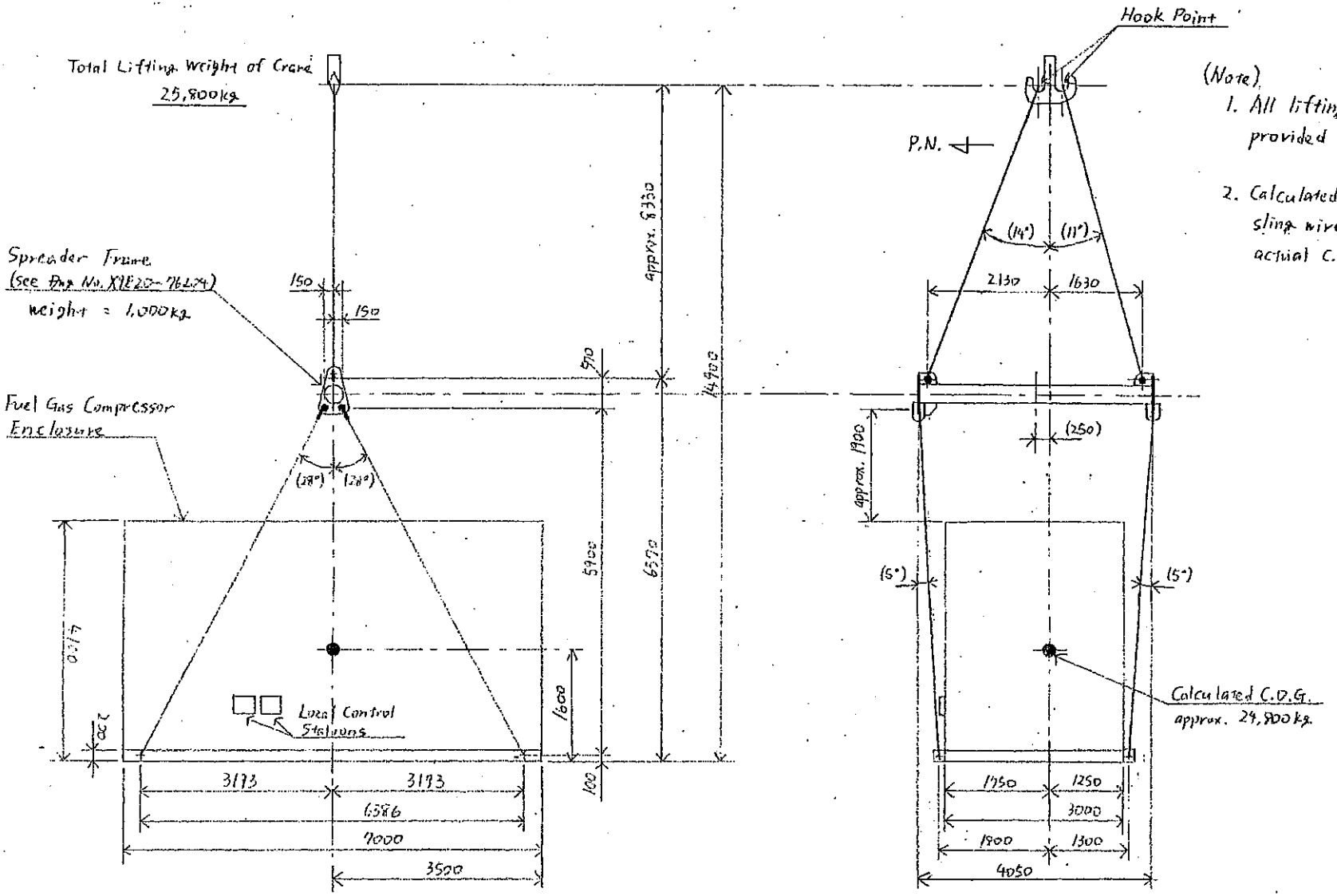
ITEM	PART NO.	NAME	MATERIAL	QTY	MASS/PIECE	TP	PRT

CAREER: ACAD: J/WET/D 00028282

KOBELCO — KOBE STEEL, LTD. MACHINERY COMPANY

TITLE: SCHEMATIC DRAWING (Fuel Gas Compressor UnitA)
DWG NO.: 00028282 REV. R9
SCALE: -/- ENG'G CODE: 708A STD DWG NO.: 03-00974-G T.NO. 1-C62615

GTG/HRSG UNIT Lifting Plan for FGC



Attachment. 8

2. RUST PREVENTION SPECIFICATION

(Dwg. No. : 20S-C14371)

CUSTOMER INQUIRY NO.
JOB NO. 5777
SPEC. NO.
KOBE STEEL EST NO. E2A0995

FINAL

Messrs. KAWASAKI HEAVY INDUSTRIES,LTD.

RUST PREVENTION SPECIFICATION

(at KHI Kobe Works & Site)

FUEL GAS COMPRESSOR UNIT

KSL Model No. : KS24SEH

KOBE STEEL, LTD. 神戸製鋼所 FEB. 18 2005 回転機技術部 ROTATING MACHINERY ENG'G DEPT.

REV NO.	REVISION NOTE	DESIGNED	CHECKED	APPROVED	REVIEWED
R1	⚠ 602	'04 11.19 M. Hasegawa	11/19 H.Ogata	11/19 H.Ogata	
		'04 11.11 M. Hasegawa	11/11 H.Ogata	11/11 H.Ogata	
		ENGINEERING DEPARTMENT			QA DEPARTMENT

O. NO. 03-00974-G

S. NO. 20S-C 14371

T. NO. B015881

KOBELCO | KOBE STEEL, LTD.
ENGINEERING & MACHINERY DIVISION
ENGINEERING DEPARTMENT

CAREER

	事務	品保	加工	組立	検査	計装	製缶		合計
C									
B									
A									
配布先									

ISSUED BY 回転機技術部スクリュ室

SEC. CODE 708A

TOTAL A4-13 SHEETS

O. NO. / ( ) / 外注 / 承認 / 部品表 頁 (repeated)

RUST PREVENTION PROCEDURE

Contents

1. Rust Prevention Treatment Specification
2. Application of Rust Preventives
3. Notes for Storage of Equipment until Installation
4. Data of Rust Preventives

1. General

This manual presents rust prevention specifications for the KOBELCO Compressors and their auxiliary equipment.

Requirements for Rust Prevention

Period of storage : **6 months**

Place of storage : **Indoors**

If any defective rust prevention is found after unpacking, or if longer period of storage is required, perform additional rust prevention treatment.

For anti-corrosive materials such as stainless steel or copper, or nickel-plated surfaces, no special rust prevention treatment will be performed.

2. RUST PREVENTION TREATMENT SPECIFICATION

Spec. No. (JIS)	Rust Inhibitor	Method of Application	Method of Removal	Opening	Remarks
1 (NP-18)	VERZONE MA10 (solution)	Spray	By water cleaning or air blow	Plugged, Capped or Blind Flanged	
2 (NP-18)	VERZONE 270 (powder)	In the bag(s)	Remove the bag(s)	do.	
3 (NP-20)	VERZONE 220 (10%) & Turbine oil (90%)	Brush or Circulation with oil	By oil flushing (Specific removal not required)	do.	
4 (NP-10)	RUST VETO MEDIUM	do.	do.	do.	
5 (NP-19)	TECTYL 506	Brush	By solvent	do.	If applied inside of equipment, inhibitor removal requires disassembling of equipment.
6 (NP-2)	TECTYL 502C	do.	do.	do.	
7	N_2	Enclosed	Purge	do.	
8	VERZONE 220 (10%) & Turbine oil (90%)	Enclosed with cover sheet	—	—	
9	N_2	Enclosed in a tin plate box	—	With N_2 supply nozzle	With desiccant inside

Notes :

1. TECTYL 506 must be removed with petroleum solvent, kerosene, chlorinated solvent or vapor phase degreaser.

2. TECTYL 502C must be removed with petroleum solvent, kerosene, chlorinated solvent, hot alkali or vapor phase degreaser.

3. VERZONE 220 in the oil system will be washed away in oil flushing.

4. The volatile corrosion inhibitor VERZONE 270 need not be removed, unless they adversely affect the process.
   The volatile corrosion inhibitor VERZONE 270 will not be applied to stainless steel or nickel plated casings, and stainless steel rotors.

2. Application of Rust Preventive

Item	Specification No		REMARKS
	Inner Face	Flange Face	
Fuel Gas Compressor Lube Oil Cooler Lube Oil Filter Oil Piping / Component	3 + 7	5	
Coupling	-	5	
Oil Recovery Tank	7	-	Carbon Steel
Oil Separator	7	-	Carbon Steel
L.O.Unit for Driver(Motor)	3	5	
Fuel Gas Piping	7	-	Carbon Steel
Water Piping / Component	1	5	Carbon Steel
Instrument Air Piping	-	-	Stainless Steel
Spare Parts	-	3 + 8	
Special Tool	-	5	
Electrical Equipment	Vendor's Std.	Vendor's Std.	
Instruments	Vendor's Std.	Vendor's Std.	

Compressor Unit (1), Compressor Unit (2) are N2 purged when the shipping from KHI.

Nitrogen blankets shall be maintained at a positive pressure. Each nitrogen blanket package shall have pressure gauge and the valve for nitrogen charge. The pressure gauge and the valve shall be accessible from outside of shipping package.

3. Notes for Storage of Equipment Until Installation

3-1 Place of Storage

The following conditions shall be satisfied:

(1) No exposure to weather, rain or wind.
(2) No exposure to direct sun rays.
(3) Concrete floor, free from moisture and water.
(4) Relative humidity below 70 percent.
(5) No corrosive gas
(6) No vibration or shock
(7) Moderate temperature (0 ℃ ~ 40 ℃)

If the package may be stored outdoor, following care should be taken;

(1) To avoid the rain water, package should be laid on water free floor, then be covered with waterproof vinyl sheet.

Notes:

Keep the delivered cargo packed until installation work.

3-2 Rust prevention treatment for more than 6 months would require check of the compressor for startup to remove anti-corrosive coating. Therefore, only 6-month rust prevention treatment is applied, for the convenience of the installation work.

3-3 Long Term Storage

In case a long term storage of the delivered cargo is required, unpack the cargo to check the conditions of the compressors and other components 6 months after the shipment. If any rust, corrosion or poor rust prevention is found, perform additional rust prevention treatment in the following procedures :

(1) Compressor
Remove the end covers of the compressor to inspect the conditions of the inside. When the film of rust inhibitor is sufficient, only application of volatile corrosion inhibitor is required.
But if any rust, corrosion or poor rust prevention is found, apply additionally rust inhibitor to the compression chamber, bearing and shaft seal portions.

(2) Vessels, and other components
Remove blind covers, and apply rust inhibitor or charge nitrogen gas, if necessary.

(3) Pipes
Remove blind covers, and apply rust inhibitor, if necessary.

Notes:

(1) For the rust inhibitor to be used and methods of application, refer to Paragraph 1 and 2 of this manual. Repeat these processes every 6 months thereafter, if the storage period is further extended.

(2) Stainless steel materials do not require rust prevention treatment additionally.

(3) According to the equipment filled with N_2, check N_2 pressure(0.2~0.5barG) appropriately, and when pressure dropped, re-fill N_2.

4. Data of Rust Preventives

1. VERZONE 270 (MA10) ··· P.7
2. VERZONE 220 ··· P.8-9
3. VERZONE 506 ··· P.10-11
4. TECTYL 502C ··· P.12

VERZONE MA-10

VERZONE MA - 10
(VERZONE -crystal # 270)

Verzone MA - 10 is a solvent type cleaner with temporary rust prevention and finger print neutralizer serving as finger print neutralizer, remover of rost machining oil in processing and of dust, producing temporary rust prevention before final rust prevention treatmont.

Composition

A solution of Verzone crystal No. 270 in nonharmful refined alcohol. Spocial care is given to stability, added with unique stabilizers. Thus, it is a volatile corrosion inhibitor with neutralization effect on finger print.

Special Properties

1. High effect of finger print neutralizsation and of cloaning.
2. Quick drying up.
3. No influence upon after-processing.
4. No change to be produced on the composition of metal surface nor making it dirty.
5. Easy application.
6. Attention to be given to fire and good ventilation in case of using big quantity.
7. No influence upon human body even in contact with the produot.

Application

Any application method of spraying, brushing (with soft brush hair), dipping, wiping off with oloth etc.is possible. In case of dipping two stages should be preferred for extremely dirty parts, i.e. clean solution has always to be used for the finish. Otherwise, dirt may be redeposited, causing not good effect.

NATURE OF PROPERTY	
Speific Gravity	0.80
Flash Point	12 C (54 F)
Ignition Temperature	470 C(878 F)

DAIWA RESEARCH LABORATORY

Technical Report

VERZONE ORIGIN OIL NO.22o

Oily compatible additive to vapor rustpreventor

Verzone Origin Oil No.22o is an oily vaporous additive(VCI Element) with good amphoteric character, is an oily additive which ,in its small quantity addition to normal rustpreventing oils or those basic oils, produces an oil with vaporous rust-preventin function.

The commercial vapor rustpreventing oil (NP-2o) has scarce compatibility with general rustpreventing oils (f.i.NP 7-1o), tendency to cause reaction or gelling, thus is not suitable to the use, may deteriolate rustpreventing effect.

We have developed Verzone Origin Oil No.22o with the aim to provide normal rustpreventing oils with vaporous rust preventing effect and at the same time to produce amphoterous additive to increase synergism.

Application:

1) To add the product 1-1o%, according to the purpose of the object , to general rustpreventing oils or those basic oils an to mix up well.
2) According to objects or purpose free selection of base oils is possible.
3) Basic oils need not to be highly refined ones, but those with richt sulphur, or unclean ones with imigrated dirts, water, swimming matters, eliminates rust preventing effect as well as regenerated or degenerated oils.
4) The product is a vaporous rust preventing additiv especially under consiceration of compatibility with general rust preventing oils. In case a normal vaporous rustpreventing oil additive is required, an daughter product Verzone Origin Oil No. 21o is recommended.

DAIWA RESEARCH LABORATORY

Technical Report

Characteristics:

1) Appearance.	browny clear oily
2) Sp. Weight.	o.91o - o.94o (at 25°C)
3) Viscosity.	70 - 75 Cps (at 37.8°C)
4) Flow point.	below ≒ 25°C.
5) Reaction.	Ph 7.5 - 8.5
6) Water Solution.	Milky
7) Oil Solution.	Clear

Application Field:

Iron and steel materials, iron and steel construction materials and parts.

DAIWA FINE CHEMICALS CO., LTD.
V.C.I. Producer and Distributor

Head Office : 3-18, Tsukamoto-dori, 3-chome, Hyogo-ku, Kobe 652
Tel. 078 (577) 1345

Tokyo Branch Office : Kyodo Building, 2-2, 4-chome, Hattyobori, Chuo-ku, Tokyo 104
Tel. 03 (551) 1801 , 1806

Factories & Laboratories : ~~529, Aza-Shimogawara, Ohhata, Hirano-cho, Tarumi-ku, Kobe 673-02~~
~~Tel. 078-(961)-0282-3~~

220-2/2

PRODUCT INFORMATION

Tectyl RUST PREVENTIVES

A PRODUCT OF VALVOLINE OIL COMPANY DIVISION OF ASHLAND PETROLEUM COMPANY

TECTYL 506

Description

TECTYL 506 is a solvent cutback, wax base, corrosion preventive compound. The dry film is firm, amber, waxy and translucent. TECTYL 506 is excellent for long term protection of metallic surfaces against corrosion in either indoor or outdoor exposure and during domestic and international shipments.

Laboratory Data

	Typical Properties English	Metric
Flash, PMCC, Minimum	100°F	37.8°C
Specific Gravity @ 60°F (15.6°C)	0.88	0.88
Recommended Dry Film Thickness	1.3 Mils	32.5 Microns
Theoretical Coverage	650 sq. ft./ U.S. Gallon	16 sq. meters/ liter
Non Volatile % by Weight	53-57	—
Approximate Air Dry Time @ 77°F (25°C)	1 hour	1 hour
High Temperature Flow Point	300°F	149.5°C
Low Temperature Flexibility, (90° bend-No flaking or cracking)	-10°F	-22.5°C
Volatile Organic Content V.O.C.	3.24 lbs./ U.S. Gallon	400 grams/ Liter
Accelerated Corrosion Tests: 5% Salt Spray (Hours) (A) *ASTM B-117 @ 1.3 mils, (2x4x1/8 in. Polished Steel Panels)	2000	—
(B) **DIN 50021 @ 32.5 microns (125x200 mm. DIN 1623 Panels)	—	168

*ASTM (American Society for Testing and Materials)
**DIN (Deutsche Industrie Normen)

Benefits

Easy Application

TECTYL 506 is formulated for easy application by spray, dip or brush.

Low-Cost Protection

TECTYL 506 is a one coat rust preventive. The thin film provides high coverage and low cost protection.

Long-Term Protection

TECTYL 506 provides outstanding external protection of machinery, machinery, machine rolls, machine tools, automotive parts, dies, tubing, and spare parts. TECTYL 506 has a dielectric (insulating) strength of approximately 1000 volts per dry mil of film thickness and therefore protects electrical connections and helps prevent galvanic corrosion.

Surface Preparation

The maximum performance of TECTYL 506 can only be achieved when the metal surfaces to be protected are clean and dry. Remove dirt, rust, scaling paint and other contaminants before applying 506.

Application

Ensure uniform consistency prior to use. Continuous stirring or thinning is generally not required. If product thickens due to cold storage or loss of solvent during use, add only aliphatic mineral spirits and only if necessary to restore consistency. Do not apply heat; fire or explosion may result. Apply at 50-95°F (10-35°C) by spray, dip or brush.

Coverage

The theoretical coverage is 650 sq. ft./gallon (16 sq. meters/liter) at the recommended dry film thickness of 1.3 mils (32.5 microns). Material losses during application will vary and must be considered when estimating job requirements.

Removal

TECTYL 506 can be removed if necessary with mineral spirits, or any similar petroleum solvent or vapor degreasing. TECTYL 506 can be removed from fabrics by normal dry cleaning procedures. Avoid using chlorinated or highly aromatic solvents when removing from painted surfaces as these solvents may adversely affect paint.

Caution:

TECTYL 506 cures by solvent evaporation. Keep away from heat, sparks and open flames. Use with adequate ventilation. If applied to the interior of an enclosed vessel adequate ventilation is required for cure and to ensure against formation of an explosive atmosphere. For further information, consult Technical Bulletin #34. Refer to Ashland Oil Inc.'s Material Safety Data Sheet for health and safety instructions.

7015

Tectyl RUST PREVENTIVES

Product Information

A product of Valvoline Oil Company Division of Ashland Petroleum Company

TECTYL 502C

What It Is

TECTYL 502C is a solvent cutback, soft wax base, corrosion preventive compound.

Benefits

Easy Application

TECTYL 502C is suited for application by either spray, dip or brush.

Low-Cost Protection

TECTYL 502C is a one-coat rust preventive. The thin film provides greater coverage and low-cost protection.

Long-Term Protection

TECTYL 502C is designed for long-term indoor and limited outdoor protection of pipe, machinery, instruments, bearings and spare parts. TECTYL 502C can be used as a preservative for lubrication and fuel systems of gasoline and diesel engines for storage or export. The dry film is transparent, soft and self healing.

Surface Preparation

The maximum performance for TECTYL 502C can only be achieved when the metal surfaces, to be protected, are clean and dry. However, TECTYL 502C is effective on lightly rusted surfaces.

Application

Agitate well to ensure uniform consistency prior to use. Continuous stirring or thinning are generally not required. If product thickens due to cold storage or loss of solvent during use, add only aliphatic mineral spirits and only if necessary to restore consistency. Apply at 10-35 °C (50-95 °F) by spray, dip or brushing.

Coverage

The theoretical coverage is 900 sq. ft./gallon (22.1 sq. meters/liter) at the recommended dry film thickness of 1.0 mils (25 microns). Material losses during application will vary and must be considered when estimating job requirements.

REMOVAL

TECTYL 502C can be removed with mineral spirits or any similar petroleum solvent, vapor degreasing or chemical cleaning. TECTYL 502C can be removed from fabrics by normal dry cleaning procedures. Avoid using chlorinated or highly aromatic solvents when removing from painted surfaces as these solvents may affect paint.

3. PAINTING SPECIFICATION

(Dwg. No. : 20S-C13443)

CUSTOMER INQUIRY NO.
JOB NO. 5777
SPEC. NO.
KOBE STEEL EST NO. E2A0995

FINAL

Messrs. KAWASAKI HEAVY INDUSTRIES,LTD.

PAINTING SPECIFICATION (at Work)

FUEL GAS COMPRESSOR UNIT

KSL Model No. : KS24SEH

KOBE STEEL, LTD. 神戸製鋼所 FEB.18.2005 回転機技術部 ROTATING MACHINERY ENG'G DPT.

REV NO.	REVISION NOTE	DESIGNED		CHECKED		APPROVED				REVIEWED		
R2	2 602 Color [illegible]	'04 6.11	M. Hasegawa	6/11	H.O.	6/11	H.O.					
R1	1 2 602	'04 4.27	M. Hasegawa	4/27	H.O.	4/27	H.O.			5/14	K. [illegible]	—
		'04 3.29	M. Hasegawa	3/29	H.O.	3/29	H.O.			3/31	K. [illegible]	—
		ENGINEERING DEPARTMENT								P.E. SECTION		

O. NO. 03-00974-G

S. NO. 20S-C 13443

T. NO. P310757

KOBELCO | KOBE STEEL, LTD. ENGINEERING & MACHINERY DIVISION ENGINEERING DEPARTMENT

CAREER

C																	
B																	
A	3	1	1				1	3	1		1	1	1		2	25	39
配布先	客先	3Fスクリュ	3F回転				回品管	回製造	回生管		設備計装	資材部	検査サービス		ウェイズ	外注	合計

ISSUED BY 回転機技術部スクリュ室

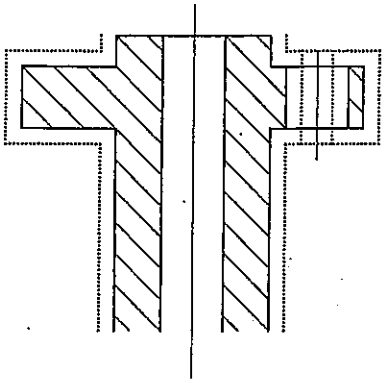
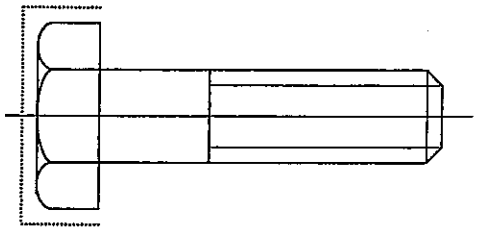
SEC. CODE 708A

TOTAL A4-1 SHEETS

O. NO. ( ) 外注 承認 部品表 頁
O. NO. ( ) 外注 承認 部品表 頁
O. NO. ( ) 外注 承認 部品表 頁
O. NO. ( ) 外注 承認 部品表 頁

日本語 (Japanese)	English (英語)
1. 緒言 本要領書は塗装について遵守すべき仕様について規定する。	1. Introduction This specification covers the procedures for shop painting.
2. 適用範囲 2-1. 本仕様書はステンレス，銅合金，アルミ，メッキ，機械加工面（防錆面）を除く金属面の工場塗装における素地調整，塗料，塗装について規定する。（機械加工面塗装の場合は仕様表示膜厚は適用せず。） 2-2.製品の基礎据付面及び他部品との接触面は塗装不要とする。	2. Range of application 2-1. This specification covers surface preparation, paint materials and painting procedures of metal goods except for stainless steel, copper alloy, aluminum, plating surface gilding and machined surface (only be applied rust preventive). (Specified film thickness is not applied to machined surface.) 2-2. The parts which contact with the mortar of foundation or connecting surface to the other part need not to be painted
3. 素地調整 被塗装面の錆・スケール・その他油水分は塗料の付着や乾燥、塗料のフクレ，ワレ，ハガレの原因となる為、下記の通り素地調整を行うこと 3-1.錆・スケールの除去 3-1-1. 物理的方法 処理に先立って厚い錆層をチッピングにより除去する。目で見える油，グリースや泥土も除去する。 (a)ISO-Sa $2^1/_2$：ﾌﾞﾗｽﾄ処理 拡大鏡なしで表面には目に見える油，ｸﾞﾘｰｽ，泥土,及びﾐﾙｽｹｰﾙ,錆,塗膜,異物がないこと。汚れの残存している痕跡は、斑点あるいはすじ状の僅かな染みとしてのみ認められること。 "ISO 8501-1"の写真 A Sa 2.5,B Sa 2.5,C Sa 2.5 及び D Sa 2.5 により素地調整後の表面を検査する事。 (b)ISO-St 3：動力工具によるケレン 拡大鏡なしで表面には目に見える油，グリース，泥土，及び殆どのミルスケール，錆，塗膜，異物がないこと。更に、素地の金属光沢を呈するまで充分な処理を行うこと。"ISO 8501-1"の写真 B St 3C St 3 及び D St 3 により素地調整後の表面を検査する事。	3. Surface preparation Rust, scales, oil, water, etc. on the surface will cause deposition, drying, or swells, crack and strip-off of the paint. Hence, the surface shall be prepared as follows. 3-1. Removal of rust and scales 3-1-1. Physical method Prior to cleaning, any heavy layers of rust shall be removed by chipping. Visible oil, grease and dirt shall also be removed. (a)ISO-Sa $2^1/_2$: Blast Cleaning When viewed without magnification, the surface shall be free from visible oil, grease and dirt, and from of mil scale rust paint coating and foreign matter. Any remaining traces of contamination shall show only as slight stains in the form of spots or stripes. Check the surface by photographs on "ISO 8501-1" as A Sa 2.5, B Sa 2.5, C Sa 2.5 and D Sa 2.5. (b)ISO-St 3 : Power tool cleaning When viewed without magnification, the surface shall be free from visible oil, grease and dirt, and from poorly adhering mill scale, rust, paint coatings and foreign matter. And the surface shall be treated much more thoroughly to give a metallic sheen arising from the metal substrate. See photographs on "ISO 8501-1" as B St 3,C St 3 and D St 3.

日本語 (Japanese)	English (英語)
3-1-2. 酸洗（炭素鋼）SSPC-SP-8： 10～15%塩酸又は２０%燐酸にオーバピックリング阻止剤及びスマット除去剤を添加した液に浸漬するか塗布して、完全に除錆し水洗中和を確実に行う。	3-1-2. Pickling (Carbon Steel) SSPC-SP-8 : Rust shall be removed completely by immersing in hydrochloric acid(10～15 %) or phosphoric acid(10～15 %) with check agent of over pickling and smut remover, or by applying of that liquid. Then the surface should be completely neutralized by water.
Note (備考)； ISO : International Organization for Standard "ISO 8501-1-1988" SSPC : Steel Structure Painting Council "Steel Structure Painting Manual" Vol. 2 Chapter-2 –1982	
3-2. 脱脂 油脂類の付着は肉眼では充分見分けることが出来ない為、塗装前に塗装シンナー，ラッカーシンナー等の石油系溶剤で被塗装面を洗浄又は清拭し乾燥後速やかに防錆塗料を塗ること。 尚、ステンレス材料は石油系溶剤で洗浄を行うものとし、トリクレン等塩素系溶剤の使用は絶対さけること。 3-3.除塵 空気中の塵埃が被塗装面に付着したもの、又は機械的に行った脱錆の工程中についた塵埃は圧縮空気，刷毛，ウェス等で清浄すること。	3-2. Removal of oil As oil on the surface cannot be seen with the naked eye, the surface shall be washed by the solvent such as mineral turpentine thinner, trichloroethylene before painting and rust preventive paint shall be applied as soon as the surface is dried. Stainless steel should be washed by only the petroleum solvent. Chloric solvent, such as trichloroethylene must not be used. 3-3. Removal of dust Dust, which adheres on the surface from air or during the rust removal process, should be removed by compressed air, brush, rags, etc..
4.塗装 塗装における基本的注意事項 塗装を完全に行う為に、基本的には次の事項に注意して作業すること。 4-1. 塗装条件により最も適した塗装用具を使用すること。 4-2. 塗料の品質を調べ使用法を誤らないこと。 4-3. 塗料は使用前に必ず撹拌して均一な状態にして用いること。 4-4. 多湿時(85%以上) 又は低温時(5℃以下)における塗装は避けること。又、被塗装物の表面温度が結露点プラス３℃以上で無い場合塗装は避けること。 4-5. 塵埃の多い時は塗装を避けること。	4. Painting Fundamental cautions on painting For the best painting, painting work shall be done with taking care of the following items. 4-1. Use the most suitable painting tool in accordance with the condition of paint. 4-2. Check the quality and the usage of the paint. 4-3. Paint shall be used after stirring and uniforming. 4-4. Painting shall not be done under high relative humidity (more than 85%) or low temperature (less than 5℃). And surface temperature of material to be painted less than "dew point +3℃". 4-5. Painting shall not be done under a lot of dust.

日本語 (Japanese)	English (英語)
4-6. 最初の塗装は素地調整後4時間以内に行うこと。天候，工程等の都合によりその当日に塗装ができなかった場合には、再度素地調整を行ってから塗装すること。	4-6. Surfaces which have been blast cleaned shall be prime coated within 4 hours. If the prime paint is impossible due to the bad weather, etc., surface preparation shall be applied again before the prime painting.
4-7. 塗り重ねは前回の塗膜の乾燥を確認し傷，塗装異状，塗り忘れた部分，異物の付着等があればこれを充分に補修した後に行うこと。	4-7. Successive paints shall be applied after confirming the dryness of the former paint and also repairing the part where it is injured, abnormal film of paint, omitted to be painted or deposition of foreign matter.
4-8. 塗装の塗膜は塗料指定膜厚に塗ること。	4-8. The paint shall be applied with the specified dry film thickness.
4-9. エッジ部，コーナー部，接続部，ボルト止め部等、複雑な形状の部分は指定膜厚を確保する様、特に注意すること。	4-9. Special attention shall be paid for the specified dry film thickness to complicated parts such as edges, corners, welded point bolted points, etc.
4-10.組み付け後塗装の困難な場所には、組み付け前に塗装すること。	4-10. Parts which are difficult to paint after assembly shall be applied with specified painting before assembly.
Ex. 1) flange surface or bolt hole フランジ面及びボルト穴  Apply rust preventive oil on the flange seat. フランジシート面は防錆油を塗布。	Ex. 2) bolt ボルト  Apply rust preventive oil on the screw. ネジ部は防錆油を塗布。
Apply to the part (.....) prior to assembly. (.....) 部は組立前に塗装の事。	
4-11.直射日光による乾燥は避けること。	4-11. The painted surface shall not be dried under direct sun rays.

日本語 (Japanese)	English (英語)
5.検査 5-1. 膜厚の測定は、塗膜乾燥後に正確な膜厚測定器を用いて測定すること。 5-2. 外観検査は、上塗りを塗り終えた後、目視にて行うこと。 6.塗装色	5. Inspection 5-1. When thoroughly cured, Dry film thickness shall be checked with properly calibrated Thickness gauge. 5-2. After completion of finish coat, Appearance of painting shall be visually checked. 6. Paint Color

Color Standard ;
色　規　格

- ☐ Munsell
- ☐ J.P.M.A. (Japan Paint Manufacturers Association) 日塗工(日本塗料工業会)
- ■ RAL
- ■ BS. (British Standard) ■ 381C, ☐ 2660, ☐ 4800, ☐ 5252
- ☐ FS (Federal Standard 595B)
- ☐ ANSI. (American National Standards Institute, Inc.)
- ☐ Others ☐
- ☐

7.塗装要領に付いて 本塗装要領書と異なる塗装を行う場合は必ず文書にて KSL.に承認を得る事。	7. Painting Procedure Any deviations or changes in this PAINTING PROCEDURE must be in writing by KSL. for approval.

Color Schedule (塗装色指示書)

Equipment 機器区分	Painting Schedule 塗装仕様	Painting Area (m²) 塗装面積	Color Munsell Values or Other Standard 塗装色
圧縮機本体 Compressor Body	Spec. -A	4.5	RAL7035 LIGHT GRAY
油回収器 Oil Tank	Spec. -A	15	RAL7035 LIGHT GRAY
油分離器 Oil Separator	Spec. -A	3.5	RAL7035 LIGHT GRAY
油冷却器 Oil Cooler	Spec. -A	6.5	RAL7035 LIGHT GRAY
油濾過器 Oil Filter	Spec. -A	2.3	RAL7035 LIGHT GRAY
ｶﾞｽ配管，弁 Gas Piping, Valve	Spec. -A ※	3.6	Basic Color RAL 1021 (Yellow) Code Color RAL 6024 (Green)
油配管，弁 (CS 材) Oil Piping, Valve	Spec. -A ※	3.5	Basic Color RAL 8016 (Brown) Code Color RAL 1023 (Yellow)
油配管，弁 (SS 材、保温材) Oil Piping, Valve (SS, Insulation)	Spec. -C	2.5	—
水配管，弁 (CS 材) Water Piping	Spec. -A ※	3	Basic Color RAL 6024 (Green) Code Color RAL 9006 (Aluminum)
計装空気配管，弁 (SS 材) Instrument Air Piping	Spec. -B ※	0.5	Basic Color RAL 7001 (Grey) Code Color RAL 3020 (Red)
油ﾎﾟﾝﾌﾟ Oil Pump	Spec. -A	1	RAL7035 LIGHT GRAY
油補給ﾎﾟﾝﾌﾟ Supply Oil Pump	Spec. -A	0.3	RAL7035 LIGHT GRAY
防音カバー Noise Arrest Cover (Acoustic Enclosure)	Spec. -A	160	RAL7035 LIGHT GRAY
圧縮機台板 Base Plate	Spec. -A	25	RAL7035 LIGHT GRAY
ｶｯﾌﾟﾘﾝｸﾞｶﾊﾞｰ (圧縮機、油ポンプ用) Coupling Cover	Spec. -A	1	RAL1006 GOLDEN YELLOW
主電動機 Main Motor	KHI SUPPLY		
油ﾎﾟﾝﾌﾟ、換気扇用電動機 LV Motor	メーカ仕様 Maker Spec.	---	メーカ標準色 Maker's STD. Color
スピルバック弁 Spill Back Valve	Spec. -A	0.2	RAL7035 LIGHT GRAY

Color Schedule（塗装色指示書）

Equipment 機器区分	Painting Schedule 塗装仕様	Painting Area (㎡) 塗装面積	Color Munsell Values or Other Standard 塗装色
その他計装品 Other Instrument	メーカ仕様 Maker Spec.	---	メーカ標準色 Maker's STD. Color
計器ｽﾀﾝﾄﾞ、ﾗｯｸ、ｻﾎﾟｰﾄ類 Instrument Stand, Rack, Support	Spec.-A	3	ＲＡＬ７０３５ LIGHT GRAY
制御盤 Control Panel	メーカ仕様 Maker Spec.	---	ＲＡＬ７０３２ PEBBLE GLAY
ローカルスタンド（非常停止スイッチ） Local Stand (with Emergency Stop Switch)	メーカ仕様 Maker Spec.	---	BS381-C 216
ジャンクションボックス Junction Box	Spec.-A	1	ＲＡＬ７０３５ LIGHT GRAY

※REMARKS

・Pipe Work

The width of the basic color band shall be 240mm, plus the width of the code color Band. The width of the code color band shall be 50mm.

Top Coat Color Sample (上塗り色見本)

Painting Schedule (塗装仕様)	Color No. (塗装色 No. 又は記号)	Color Order No. (塗料メーカー色番号)	Top Coat Color (上塗り塗装色)
Spec - (仕様)	RAL 7035	F/No. 04-CAS-12773	
Spec - (仕様)	RAL 1021	F/No. 04-CAS-11542	
Spec - (仕様)	RAL 6024	F/No. 97-217-16483	
Spec - (仕様)	RAL 8016	F/No. 04-CAS-16259	
Spec - (仕様)	RAL 1023	F/No. 03-CAS-17636	
Spec - (仕様)	RAL 7001	F/No. 02-MTJ-11835	
Spec - (仕様)	RAL 3020	F/No. 04-CAS-16260	
Spec - (仕様)	RAL 1006	F/No. 04-CAS-14831	
Spec - (仕様)	RAL 7032	F/No. 04-CAS-16261	
Spec - (仕様)	BS381C-216	F/No. 04-CAS-14832	

Color samples are not attached about N-1(BLACK), N-9.5(WHITE), and silver.
Please use" Color Order Number" by all means when you order these paint.
N-1(黒), N-9.5(白), シルバー色については色見本を付けません。
塗料発注の際は、必らず塗装色 No.又は記号と塗料メーカ番号にて発注のこと。

Spec. (仕様) - A

Painting Schedule (塗装仕様)

	Process (工程)	Paint (塗料)	Dry Film Thickness (乾燥膜厚) (μm)	Painting Method (塗装方法)	Coverage (塗布量) (g/m²)	Painting Interval (塗装間隔) (20℃)	Thinner (うすめ液)	
1	Surface Preparation	ISO. - St 3 or SSPC - SP - 8						
2	1st. Coat	ESCO	40	SPRAY	460	8 Hr～1 Month	EPOMARINE	(0～10%)
				BRUSH	140		Thinner 20	(0～10%)
3	2nd. Coat	ESCO	40	SPRAY	460	8 Hr～1 Month	EPOMARINE	(0～10%)
				BRUSH	140		Thinner 20	(0～10%)
4	3rd Coat	RETAN 6000	35	SPRAY	170	16Hr～	RETAN	(0～10%)
				BRUSH	130		Thinner	(0～5%)
5	4th Coat	RETAN 6000	35	SPRAY	170	16Hr～	RETAN	(0～10%)
				BRUSH	130		Thinner	(0～5%)
6	5th Coat							
Total Dry Film Thickness (T.D.F.T.) (トータル膜厚)			150 μm (Min.)					

Remark (備考)　KANSAI PAINT CO., LTD. 『㈱扇商会 神戸営業所 Tel 078-651-7411』

ESCO(エスコ)　→　Two(2) Pack High Performance Coating Based on Epoxy Resin and Moisture-Curing Ketimine type Hardener
RETAN 6000 (レタン 6000)　→　2-PACK POLYURETHANE HIGH GLOSS FINISHING COAT

Spec. (仕様) – B

Painting Schedule (塗装仕様)

ｽﾃﾝﾚｽ鋼用
Spec. for Stainless Steel

	Process (工程)	Paint (塗料)	Dry Film Thickness (乾燥膜厚) (μm)	Painting Method (塗装方法)	Coverage (塗布量) (g/㎡)	Painting Interval (塗装間隔) (20℃)	Thinner (うすめ液)	
1	Surface Preparation	Grinning by emery paper, cleaning for removing oil. ペーパ目荒らし，脱脂洗浄						
2	1st. Coat	EPOMARINE GX	40	SPRAY	230	8 Hr～	EPOMARINE	(0～5%)
				BRUSH	100	1 Month	Thinner 20	(0～5%)
3	2nd. Coat	EPOMARINE GX	40	SPRAY	230	8 Hr～	EPOMARINE	(0～5%)
				BRUSH	100	1 Month	Thinner 20	(0～5%)
4	3rd Coat	RETAN 6000	35	SPRAY	170	16Hr～	RETAN	(0～10%)
				BRUSH	130		Thinner	(0～5%)
5	4th Coat	RETAN 6000	35	SPRAY	170	16Hr～	RETAN	(0～10%)
				BRUSH	130		Thinner	(0～5%)
Total Dry Film Thickness (T.D.F.T.) (トータル膜厚)			150μm (Min.)					

Remark (備考)　KANSAI PAINT CO., LTD. 『㈱扇商会 神戸営業所 Tel 078-651-7411』

EPOMARINE GX(エポマリン GX)　→　Two(2) Pack Epoxy Resin Primer for Galvanized Surface
RETAN 6000 (ﾚﾀﾝ 6000)　→　2-PACK POLYURETHANE HIGH GLOSS FINISHING COAT

Spec. (仕様) - C

Painting Schedule (塗装仕様)

	Process (工程)	Paint (塗料)	Dry Film Thickness (乾燥膜厚) (μm)	Painting Method (塗装方法)	Coverage (塗布量) (g/m²)	Painting Interval (塗装間隔) (20℃)	Thinner (うすめ液)	
1	Surface Preparation	Grinning by emery paper, cleaning for removing oil. ペーパ目荒らし，脱脂洗浄						
2	1st. Coat	BISCON No. 1000 ビスコン No. 1000	75	SPRAY BRUSH	190 160	16 Hr～5 Day	ビスコン Thinner	(0～5%) (0～2%)
3	2nd. Coat	BISCON No. 1000 ビスコン No. 1000	75	SPRAY BRUSH	190 160	16 Hr～5 Day	ビスコン Thinner	(0～5%) (0～2%)
Total Dry Film Thickness (T.D.F.T.) (トータル膜厚)			150μm (Min.)					

Remark (備考)　CHUGOKU MARINE PAINTS, LTD.『中国塗料㈱ 神戸営業所 Tel 078-331-0861』

BISCON No. 1000 → Tar Epoxy Resin Paint With Poly-Amide Amine Curing Hardener
ビスコン No. 1000 → (ポリアミド硬化形タールエポキシ樹脂系塗料)

塗装完了より通水までの養生期間は７日以上(20℃)必要とする。
養生期間中に通水を行うと塗膜異常を引き起こすので厳守する事。

KAWASAKI

KERMANSHAH PETROCHEMICAL INDUSTRIES CO.
AMMONIA AND UREA COMPLEX

FGC Operation & Maintenance Manual

KAWASAKI HEAVY INDUSTRIES LTD
FEB. 28. 2005
KOBE JAPAN
Power Generation Project Office

Purchaser review and comments shall not be assumed to indicate either responsibility or liability for accuracy and completeness of this document or to alter any contractual terms and conditions.

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1. OPERATION & MAINTENANCE MANUAL

(Dwg. No. : 20M-C04347)

CUSTOMER INQUIRY NO.
JOB NO. 5777
SPEC. NO.
KOBE STEEL EST NO. E2A0995

FINAL

Messrs. KAWASAKI HEAVY INDUSTRIES,LTD.

OPERATION & MAINTENANCE MANUAL

KSL Model No. : KS24SEH

KOBE STEEL, LTD. 神戸製鋼所 FEB. 18.2005 回転機技術部 ROTATING MACHINERY ENG'G DPT.

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KOBELCO KOBE STEEL, LTD. ENGINEERING & MACHINERY DIVISION ENGINEERING DEPARTMENT

CAREER

	事2部	品保	加工	組立	検査	計装	製缶		合計
C									
B									
A									
配布先									

ISSUED BY 回転機技術部スクリュ室

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TOTAL A4-169 SHEETS A3-6

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O. NO. ( ) 外注 承認 部品表 頁
O. NO. ( ) 外注 承認 部品表 頁
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FOREWORD

This manual contains instructions for operation and maintenance of KOBELCO compressors. The compressors and the auxiliary equipment have been manufactured and undergone strict shop inspections and tests. We believe that all our machines function well, but no machine can work perfectly unless operated and maintained correctly.

If they are improperly installed, handled or operated, not only malfunction but also fatal damage to the machines may be brought about. Therefore, prior to starting the operation, please read through to understand the whole contents of this manual, and operate the compressor unit in the best conditions to get the most of them.

It should be understood that the information contained herein will not relieve the operators of the responsibility of exercising normal good judgment in the care and operation of the machine.

SAFETY PRECAUTIONS FOR COMPRESSORS AND EQUIPMENT

To be read attentively before starting the unit

Safety Signs

Whenever you see Safety Signs in this manual it means as follows :

WARNING : **Personal danger**

Warning notes indicate any condition or practice, which if not strictly observed, could result in personal injury or possible

CAUTION : **Possible damage to equipment**

Caution notes indicate any condition or practice, which if not strictly observed or remedied, could result in damage or destruction of the equipment.

NOTE : Notes indicate an area or subject of special merit, emphasizing either the product's capabilities or common errors in operation or maintenance

General

It is important that all personnel observe safety precautions to minimize chances of injuries. The following should particularly be noted :

Read and understand the contents of this manual before installing, operating or maintaining this compressor.

Installation, operation, maintenance and repair shall be performed by authorized, trained personnel only.

Take care and follow appropriate procedures in handling, lifting, installing, operating and maintaining the equipment.

Installation

Apart from general engineering practice conform with the regulations of local authority, the following directives are specially stressed :

1. Any blanking flanges, plugs or caps as well as eventual desiccant bags shall be removed before connecting up the pipes.
2. This compressor and associated piping have been protected with a rust preventative against internal corrosion during shipment and possible storage just prior to operation, the rust preventive should be removed according to the manual.
3. This unit was aligned at our factory prior to shipment. However, misalignment may occur during shipment and a check of alignment is mandatory during installation before starting.
4. Vibrations during transportation may result in some fasteners becoming loose. So, all fasteners should be checked for proper tightness during installation.
5. In compressor systems manual valves shall be installed to isolate each compressor. Check valves shall not be relied upon for isolating pressure systems.
6. Never remove or tamper with the safety devices, guards or insulation fitted on the compressor unit.
7. Lifting tools such as eye bolts are designed to lift individual parts only. So, unless specially instructed, never lift the assembled parts with the tools.
8. If longer period of storage is required (a year over) , it is necessary to give compressors an overhaul.

Operation

1. Before the first starting of the equipment after installation, be sure to check its condition. Sometimes, the compressor may be provide with special parts for shipping to secure the parts during transportation. They should be removed before the operation or turning of the rotor by referring to RUST PREVENTION PROCEDURE (20S-C14371).
2. KOBE STEEL, LTD. will not be responsible for any damages that may result from operation out of design and/or stated operating conditions for which this compressor was intended. (Refer to design operating conditions included as part of this manual)
3. In the event that compressor shuts down automatically, DO NOT RESTART until cause of shut down has been determined and corrected. Severe damage to compressor and/or auxiliary equipment may result.
4. People staying in compressor rooms where the sound pressure level exceeds 90dB(A) shall use ear protectors. Noise level could be partially larger than estimated valve because of reflection by the wall or the other sound source.
5. Never operate the equipment without protective guards such as a shaft coupling guard attached.
6. The compressor casing and associated piping or accessories may become hot enough to cause skin burn on contact. Care must be taken where such surfaces are exposed.
7. Never attempt to work on machine or removal guards, covers, shields, etc. while machine is in operation.
8. Never operate the compressor for inflammable gas service on air, once it has been put into the actual gas service. This may cause a fire due to possibly remaining inflammable impurities.
9. When a person enters into the acoustic enclosure of the compressor other than air service, never fail to check the concentration of oxygen and other gases, and to secure the ventilation. If the compressor is running, be sure to wear ear protector.
10. Critical ratings (pressures, temperatures, flow, etc.) shall be durably marked and maintained.
11. Other potential hazards to safety may also be associated with operation of the equipment. All personnel working in or passing through the area should be warned by signs and trained to exercise adequate general safety precautions.

Maintenance

Maintenance and repair work shall be carried out by adequately trained personnel only, if required, under supervision of someone qualified for the job.

1. Use only the correct tools for maintenance and repair work.
2. Use only genuine spare parts.
3. Disconnect power sources prior to doing any work, and avoid bypassing or disabling any safety or protective devices, unless noted specially.
4. Before removing any pressurized component, effectively isolate the unit from all sources of pressure and relieve the related system from pressure.
5. The suction and discharge gas line service valves must be closed and the compressor relieved of all internal pressure. DO NOT rely on the gas line check valve.
6. Piping systems and compressor containing toxic or combustible gases should be purged before attempting maintenance.
7. Never use flammable solvents or carbon tetrachloride for cleaning parts.
   Take safety precautions against toxic vapors of cleaning liquids.
8. Observe scrupulous cleanliness during maintenance and repair.
   Keep dirt away by covering the parts and exposed openings with a clean cloth paper or tape.
9. Never weld or perform any other operation generating heat near the oil system.
   Oil tanks must be completely purged e.q. by steam-cleaning, before carrying out such operation.
   Never weld or in any way modify any pressure vessel.
10. Make sure that no tools, loose parts nor rags are left in or on the compressor, piping, prime mover or gear unit.
11. When starting the unit for use after maintenance or overhaul, check that operating pressures, temperatures and time-settings are correct so that the control and shutdown devices function correctly.
12. Protect the motor, electrical and regulating components, etc., to prevent moisture from penetrating these parts when doing steam-cleaning.
13. Never leave oily substances on the operation deck of the equipment to avoid slipping. Take due care when working on the oil console deck.
14. Lifting tools such as eye bolts are designed to lift individual parts only. So, unless specially instructed, never lift the assembled parts with the tools.
15. Periodically check that :
    a. All guards are in place and secure
    b. There are no leaks
    c. All electrical leads are secure and in good order
    d. Pressure relief devices are not obstructed by dirt, paint or isolating valves.
    e. Confirm that all safety and shutdown devices are functioning properly.

Troubleshooting

If an abnormality occurs during operation, the safety devices are designed to issue an alarm for protective actions. In the instance, set about executing due countermeasures according to the "Trouble shooting Manual" attached to this manual. Use the table effectively in finding the cause and troubleshooting quickly.

SERVICE INFORMATION

1. When detailed information on installation, operation, maintenance and parts service, etc. are desired, please contact.

   KOBE STEEL, LTD.
   Rotating Machinery Marketing Department

   KOBELCO Building
   5-9-12 Kita-Shinagawa, Shinagawa-Ku, Tokyo, Japan

   Phone :81-3-5739-6772
   Fax : 81-3-5739-6991 or 6992

2. In all correspondence concerning the compressor and especially on ordering spare parts, the following information should be provided to facilitate handling:

   Shop Order Number (Work Number) : 03-00974-0
   Compressor Model : KS24SEH

   For inquiry and ordering of spare parts, the following additional information should be accompanied:

   - Name of part
   - Input Key Number (if not indicated, Part Dwg. No. and Part No.)
   - Quantity required

3. KOBE STEEL Service Department is available for assistance relating to problems encountered in installation or operation of your compressor.
   In addition, KOBE STEEL's Supervisor is available for on-site requirements. To avoid problems with your warranty, the Service Department must be informed immediately of any visible damage to the compressor and its auxiliary equipment after unpacking and before initial start-up.
   If problems are encountered during the warranty period, no repair should be made without specific approval through KSL's Service Department in advance.
   Unauthorized disassembly or alteration within the warranty period may void the warranty.

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- Schematic Diagram — See Dwg. No. X9E20-02030, X9E20-02031
- General Arrangement — See Dwg. No. X9E20-42100
- Piping Drawing (1/2)(2/2) — See Dwg. No. X9E20-42112
- Foundation Drawing — See Dwg. No. X9E20-05207

INSTRUCTION MANUALS FOR ACCESSORIES — See Dwg. No. X9E20-48111

Related Documents

Following documents and drawings are to be referred.

	(KHI Dwg. No.)
1. Schematic Drawing	X9E20-02030, X9E20-02031 (00028282, 00028291)
2. General Arrangement	X9E20-42100 (00028281)
3. Foundation Drawing	X9E20-05207 (00028283)
4. Piping Drawing	X9E20-42112 (00028591, 00028592)
5. Site Commissioning Procedure	X9E20-48102 (20M-C04353)
6. Installation Manual (at site)	X9E20-48101 (20M-C04346)
7. Rust Prevention Specification (at KHI work & Site)	X9E20-48101 (20S-C14371)
8. Drawings of screw compressor & accessories	X9E20-42111 (20W-06395)
9. Lubrication Schedule	X9E20-48102 (20S-C13764)
10. Utility List	X9E20-01130 (20S-C13495)
11. Spare Part List	X9E20-77102 (20S-C13785)
12. Spare Part List of Compressor	X9E20-48102 (20W-C06394)
13. Spare Part List of Accessories	X9E20-48102 (20W-C06443)
14. Special Tool List	X9E20-48102 (20W-C06393)
15. Electrical Specification	X9E20-42113 (03S-K25900)
16. Interlock table	X9E20-42108 (03S-K25261)
17. Outline drawings of Instrument	X9E20-8023 (03S-K25974)
18. Termination and Wiring Diagram	X9E20-8802 (03S-K24880)
19. Logic Diagram	X9E20-48102 (03S-K25937)
20. Instruction Manual for Instrument & electrial	X9E20-48852 (03S-K27789)

NOTE: Please refer to the latest revision documents and drawings.

Chapter I EQUIPMENT DATA

KOBELCO

OIL-INJECTED SCREW COMPRESSOR DATA SHEET

MODEL : KS24SEH
NO. OF STAGE : 1

ITEM NO. : 19EKH10,19EKH20
TYPE OF DRIVER : ELECTRIC MOTOR
NO. REQUIRED : 1

ALL DATA ON PER ONE UNIT BASIS

		Design			
		Full Load	Unload		
GAS HANDLED					
FLOW RATE	kg/h WET	6514	5921		
(1.0132bar & 0 Deg.C)	Nm3/h WET	8889	8080		
(1.0132bar & 0 Deg.C)	Nm3/h DRY	8889	8080		
ATM PRESSURE	bar	0.878	0.878		
SUCTION CONDITIONS					
PRESSURE AT TERMINAL POINT	barA	10.0	10.0		
TEMPERATURE	deg.C	45.0	45.0		
RELATIVE HUMIDITY	%	0.0	0.0		
MOLECULAR WEIGHT		16.423	16.423		
SPECIFIC HEAT RATIO (K1=Cp/Cv)		1.328	1.328		
COMPRESSIBILITY(Z1)		0.9814	0.9814		
INLET VOLUME	m3/h	1030	935.8		
DISCHARGE CONDITIONS					
PRESSURE AT TERMINAL POINT	barA	27.5	27.5		
TEMPERATURE	deg.C	85.0	83.8		
TEMP. COOLER OUTLET	deg.C	------			
PRESSURE RATIO		2.75	2.75		
BHP AT COMP. INLET SHAFT	kW	498	-		
SEPARATE GEAR LOSS	kW	0	-		
TOTAL BHP(GEAR LOSS INCL.)	kW	498	474		
SPEED	rpm	2950	2950		
DRIVER RATED	kW	550	-		
DRIVER SPEED	rpm	2950	-		
SLIDE VALVE VOLUME RATIO	%	100.0	90.9		
COOLING WATER QUANTITY	m3/h	38	38		
TEMPERATURE	deg.C	32.0	32.0		
TEMPERATURE RISE	deg.C	7.0	6.7		

(*1) FLOW RATE SHALL NOT BE LESS THAN 0% OF SPECIFIED FIGURE AT DESIGN.
(*2) BHP SHALL NOT EXCEED 104% OF QUOTED FIGURE AT DESIGN.

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OIL-INJECTED SCREW COMPRESSOR DATA SHEET

MODEL : KS24SEH
NO. OF STAGE : 1

ITEM NO. : 19EKH10,19EKH20
TYPE OF DRIVER : ELECTRIC MOTOR
NO. REQUIRED : 1

ALL DATA ON PER ONE UNIT BASIS

		Full Load	Unload		Unload
GAS HANDLED					
FLOW RATE	kg/h WET	6627	5921		5921
(1.0132bar & 0 Deg.C)	Nm3/h WET	9043	8080		8080
(1.0132bar & 0 Deg.C)	Nm3/h DRY	9043	8080		8080
ATM PRESSURE	bar	0.878	0.878		0.878
SUCTION CONDITIONS					
PRESSURE AT TERMINAL POINT	barA	10.0	10.0		17.0
TEMPERATURE	deg.C	40.0	40.0		40.0
RELATIVE HUMIDITY	%	0.0	0.0		0.0
MOLECULAR WEIGHT		16.423	16.423		16.423
SPECIFIC HEAT RATIO (K1=Cp/Cv)		1.328	1.328		1.328
COMPRESSIBILITY(Z1)		0.9814	0.9814		0.9814
INLET VOLUME	m3/h	1031	921.1		541.8
DISCHARGE CONDITIONS					
PRESSURE AT TERMINAL POINT	barA	27.5	27.5		27.5
TEMPERATURE	deg.C	85.0	83.7		67.1
TEMP. COOLER OUTLET	deg.C	-----			
PRESSURE RATIO		2.75	2.75		1.62
BHP AT COMP. INLET SHAFT	kW	498	-		-
SEPARATE GEAR LOSS	kW	0	-		-
TOTAL BHP(GEAR LOSS INCL.)	kW	498	470		249
SPEED	rpm	2950	2950		2950
DRIVER RATED	kW	550	-		-
DRIVER SPEED	rpm	2950	-		-
SLIDE VALVE VOLUME RATIO	%	100.0	89.4		49.5
COOLING WATER QUANTITY	m3/h	38	38		38
TEMPERATURE	deg.C	32.0	32.0		32.0
TEMPERATURE RISE	deg.C	6.4	6.2		3.4

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ALL DATA ON PER ONE UNIT BASIS

		Design			
GAS COMPOSITION(Mol.%)					
Carbon Dioxide	CO2	0.242			
Carbon Monoxide	CO	0			
Hydrogen	H2	0			
Nitrogen	N2	1.09			
Methane	CH4	96.85			
Ethane	C2H6	1.23			
Propane	C3H8	0.216			
n-Butane	n-C4H10	0.085			
i-Butane	i-C4H10	0.054			
n-Pentane	n-C5H12	0.042			
i-Pentane	i-C5H12	0.041			
Hexane & Heavier	C6H14	0.15			
Ethylene	C2H4	0			
Propylene	C3H6	0			
Butene	C4H8	0			
Sulfer as organic		20ppm			
Sulfer as inorganic		20ppm			
Water		150ppm			
Hydrogen Sulfide	H2S	0			
Ammonia	NH3	0			
Oxygen	O2	0			
TOTAL	%	100.000			
RELATIVE HUMIDITY	%	0.00			
AVERAGE MOL. WEIGHT		16.423			

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SCREW COMPRESSOR DATA SHEET

NOTE : ■ Applicable
□ Not applicable

1. COMPRESSOR CONTROL
2. Method ■ Slide valve
3. ■ Bypass □ Blow-off
4. □ Variable speed
5. □ No
6. Slide valve capacity control range From approx. 25 % to 100 %
7. Bypass~~/blow-off~~ valve capacity control range From 0 % to 100 %
8. Speed control range From ____ % to ____ %
9. Control ■ Disch. press □ Suc. press. □ Interstage press.
10. □ Flow rate □
11. □ Control signal by customer
12. Operated by ■ Automatic □ Manual
13. ■ Electric □ Pneumatic □ Hydraulic
14. ■ Remote □ Local
15. Duty ■ Continuous □ 1 year □ 2 years □
16. □ Intermittent □ Daily □ Weekly □
17. □ Stand by □
18.
19.
20.
21. Remarks
22. Oil mist carry over : Less than 5 ■ ppm
23. □ cc/Nm³ □ cc/Sm³ □ cc/SCFM
24. □ Expected ■ Guaranteed
25. Estimated sound level : AVG. 85 dB(A) at 1 m from Unit/Equipment
26. Acoustic enclosure installed ■Yes □No
27. Enclosing ■ Compressor~~/Gear~~ □ Driver
28. ■ L.O./C.O. system
29. ■ Aux. equipment
30.
32.
33.
34.
35.
36.
37.
38.
39.
40.
41.
42.
43.
44.
45.
46. Remarks:
47. (1)
48.
49.
50.
51.
52.
53.
54.
55.

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SCREW COMPRESSOR DATA SHEET

NOTE : ■ Applicable
□ Not applicable

				Remarks
1.	MATERIALS AND FEATURES			
2.	Compressor stage			
3.	Type	■ OIL-FLOODED	□ OIL-FLOODED	
4.		□ OIL-FREE		□ Water inject
5.	Rotational direction viewed	■ CW □ CCW	□ CW □ CCW	
6.	from comp. coupling end			
7.	Casing			
8.	Casing split	■ Vertical	□ Vertical	
9.		□ Horizontal		
10.	Casing material	□ Cast Iron	□ Cast Iron	
11.		■ Cast Steel	□ Cast Steel	
12.		□ Cast Steel		□with S.S.Lining
13.		□Stainless Steel		
14.	Safety valve set press. □ MPaG □ kPaG ■ barG □ kg/cm²G □ PSIG			
15.		33.0		
16.	Mech. design press. □ MPaG □ kPaG ■ barG □ kg/cm²G □ PSIG			
17.		33.0		
18.	Mech. design temp. ■ ℃ □ °F	120		
19.	Hydro. test press. □ MPaG □ kPaG ■ barG □ kg/cm²G □ PSIG			
20.		49.5		
21.	Casing thickness ■ mm □ inch	33/30		
22.	Corrosion allow ■ mm □ inch	3		
23.	Casing cooling jacket	■ No □ Yes	□ No	
24.				
25.	Rotors & shafts			
26.	Rotor lobe type - Helical	Asymmetric	Asymmetric	
27.	No. of lobes (Male/Female)	5 / 7	/	
28.	Rotor diameter (M) ■ mm □ ft	249		
29.	Tip speed (M) ■ m/s □ ft/s	38.5		~~DGN. /MAX. /RATED~~
30.	Length to diameter ratio (L/D_W)	0.99		
31.	Materials-Rotor	■ Carbon Steel	□ Carbon Steel	
32.		□ Ductile Iron	□ Ductile Iron	
33.		□Stainless Steel		
34.	-Shaft	Same as rotor	Same as rotor	
35.	Rotor construction	■Solid □Welded	□ Solid	
36.	Shaft sleeves at seals	■Yes(S.S.) □No	□Yes(S.S.) □No	
37.	Shaft end	Cylindrical	Cylindrical	with keyed
38.				
39.	Radial bearings			
40.	Housing	Integral	Integral	
41.	Type	□ Anti-friction	□ Anti-friction	
42.		■ Babbit-sleeve	□ Babbit-sleeve	
43.				
44.	Thrust bearings			
45.	Housing	Integral	Integral	
46.	Location	Dis. side	Dis. side	
47.	Type	□ Anti-friction	□ Anti-friction	
48.		■ Tilting pad	□ Tilting pad	MICHELL
49.				
50.				

51. Remarks:
52. (1)
53.
54.
55.

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SCREW COMPRESSOR DATA SHEET

NOTE : ■ Applicable
□ Not applicable

					Remarks
1.	MATERIALS AND FEATURES				
2.	Compressor stage				
3.	Casing connections				
4.	Gas inlet nozzle	Rating-size	600# 8"		
5.		Facing	■ FF □ RF	□ FF □ RF	
6.		Position	■ Top □ Down	□ Top	
7.	Gas outlet nozzle	Rating-size	600# 6"		
8.		Facing	■ FF □ RF	□ FF □ RF	
9.		Position	□ Down ■ Side	□ Down □ Side	
10.			□ Top		
11.					
12.	Auxiliary connections		Refer to outside view drawing. (20W-C06395)		

46. Remarks:
47. (1)

KOBELCO

SCREW COMPRESSOR DATA SHEET

NOTE : ■ Applicable
□ Not applicable

1. MATERIALS AND FEATURES
2. Shaft seals ~~(□ Low stage □ High stage)~~
3. Type ■ Mechanical seal ■ Single □ Double □ Tandem
4. □ Carbon rings and bearing oil film seal □
5. Seal/Buffer gas ■ No □ Yes □ Nitrogen □ Self-delivered gas □
6.
7. Shaft seals (□ Low stage □ High stage)
8. Type □ Mechanical seal □ Single □ Double □ Tandem
9. Seal/Buffer gas □ No □ Yes □ Nitrogen □
10.
11. Shaft couplings

	Driver/~~Gear~~-comp.	Driver/Gear-comp. (Low)	Driver/Gear-comp. (High)
12. Location			
13. Type/MFR	■ Flexible multi-disk NIPPON PILLAR (THOMAS)	□ Flexible multi-disk NIPPON PILLAR (THOMAS)	□ Flexible multi-disk NIPPON PILLAR (THOMAS)
15.	□ Diaphragm EAGLE INDUSTRY	□ Diaphragm EAGLE INDUSTRY	□ Diaphragm EAGLE INDUSTRY
17.	□ Gear	□ Gear	□ Gear
18. Lubrication	■ No □ Yes	□ No □ Yes	□ No □ Yes

19.
20. Coupling guard ■ Steel □ Non-spark material (Aluminum alloy) □
21.
22. Mounting plate
23. □ Baseplate □ Soleplate
24. ■ Open construction □ Oecked
25. □ Mounted on oil recovery tank
26. ■ Common to □ Gear ■ Driver ■ Oil system ■ Aux. equipment
27.
28. Weight □ N ■ kgf □ lbf
29. Assembly Compressor ~~1st stage~~ approx. 2900 2nd stage approx. —
30. Gear approx. — Driver approx. _____
31.
32. Max. for maintenance _____
33.
34. Remarks
35. Material
36. Casing ~~(□ Low □ High stage)~~ : JIS □ FC250 □ FC300 □ FC350 □
37. ■ SCW480 □ SCPL1 □ SCS13 □
38. □ with SUS316L Lining
39. Casing (□ Low □ High stage) : JIS □ FC250 □ FC300 □ FC350 □
40. □ SCW480 □ SCPL1 □
41. Rotor ~~(□ Low □ High stage)~~ : JIS □ S30C ■ S45C □ FCD700 or equivarent
42. □ SUS405 □
43. SAE □ 1137 □ 1141 □
44. ASTM □ A350 LF2 □
45. Rotor (□ Low □ High stage) : JIS □ S30C □ S45C □ FCD700 or equivarent
46. SAE □ 1137 □ 1141 □
47. ASTM □ A350 LF2 □
48. Mechanical seal : □ Cast Iron + Carbon
49. ■ SiC + Carbon
50. □ SiC + SiC □
51. "O"ring □ NBR ■ FPM □
52.
53. Remarks: _____
54. (1) _____
55. _____

KOBELCO

SCREW COMPRESSOR DATA SHEET

NOTE : ■ Applicable
□ Not applicable

1. ACCESSORIES
2. ■ Vibration detector □ API 670 □ with deviations
3. Manufacturer ■ Shinkawa □
4. Type ■ Seismic □
5. Monitoring ■ Casing vibration (■ Acceleration □ Velocity □ Amplitude)
6. No. Required □ Mounting provision only ■ 1 per casing Total 1
7. Kobe supply ■ Sensor ■ Oscillator-Demodulator □
8. □ Electric Cable □ Safety Barrier □
9. □ Monitor
10. Setting ■ Alarm at 2 ■ g □ m/s^2 RMS □ mm/s RMS □ μm P-P
11. □ Shutdown at ____ □ g □ m/s^2 RMS □ mm/s RMS □ μm P-P
12.
13. ■ Axial position detector □ API 670 □ Not available in high pressure/corrosive gas
14. Manufacturer ■ Shinkawa □
15. Type ■ Non-cotact
16. No. Required □ Mounting provision only ■ 1 for male Total 1
17. Kobe supply ■ Sensor □ Oscillator-Demodulator □
18. □ Electric Cable □ Safety Barrier □
19. □ Monitor
20. Setting ■ Alarm at 300 ■ μm □ mil
21. ■ Shutdown at 500 ■ μm □ mil
22.
23. □ Phase reference detector/Speed sensor
24. Manufacturer □ Bently nevada □
25. Type □ Non-cotact
26. No. Required □ Mounting provision only □ ____ per shaft Total ____
27. Kobe supply □ Sensor □ Transducer □
28. □ Electric Cable □ Safety Barrier □
29. □ Indicator
30.
31. □ Radial bearing temperature detector
32. Type □ Thermocouple □ RTD □
33. Mount □ Compression fitting □ Spring loaded □ Embedded
34. No. Required □ Mounting provision only □ ____ per BRG. Total ____
35. Setting □ Alarm at ____ □℃ □°F
36. □ Shutdown at ____ □℃ □°F
37.
38. □ Thrust bearing temperature detector
39. Type □ Thermocouple □ RTD □
40. Mount □ Compression fitting □ Spring loaded □ Embedded
41. □ Oil exhaust
42. No. Required □ Mounting provision only □ ___ on active side per BRG. Total ____
43. □ Mounting provision only □ ___ on inactive side per BRG. Total ____
44. Setting □ Alarm at ____ □℃ □°F
45. □ Shutdown at ____ □℃ □°F
46.
47.
48.
49.
50. Remarks: _____
51. (1) _____
52. _____
53. _____
54. _____
55. _____

UTILITY CONSUMPTION

NOTE : ■ Applicable
□ Not applicable
All data on per unit basis

■ Electricity for Motor/Heating

Service	Voltage V	Phase	Hertz Hz	Rated ■kW □PS □HP	Set(s)	Remarks
■ Main motor	AC 6000	3	□60 ■50			
■ For Compressor ~~(Low stage)~~				550	1	
□ For Compressor (High stage)						
□						
■ Auxiliary motor	AC 400	3	□60 ■50			
■ For L.O. Pump ~~(Low stage)~~				11.0	1	
□ For L.O. Pump (High stage)						
■ For L.O. Charge Pump				3.7	1	
□ For C.O. Pump						
□ For Separate L.O. Pump						
■ For Ventilation Fan ~~(Low-stage enclosure)~~				1.5	1	
□ For Ventilation Fan (High stage enclosure)						
□ For Cooling Water Pump						
□ For Cooling Tower Fan						
□ For Radiator						
□ For Barring Gear (Turning device)						
□						
□ Auxiliary motor	AC 400	3	□60□50			
□						
■ Heating	AC 400	3	□60 ■50			
■ For Oil Recovery Tank				3.0	1	
■ For Tape heater (AC230、3、50)				10.0	1	

■ Electricity for instrumentation

Service	Voltage V	Phase	Hertz Hz	Consumption kVA	Remarks
■ Instrument	■AC □DC □100 ■110 □	1	■50 □60	1.0	
■ Control	■AC □DC □100 ■110 □	1	■50 □60		
■ Inter-lock	■AC □DC □100 ■110 □	1	■50 □60		
■ Solenoid valve	■AC □DC □100 ■110 □	1	■50 □60		
■ Lighting	■AC □DC □100 ■110 □	1	■50 □60		
□	□AC □DC □100 □110 □	1	□50 □60		

■ Instrument air

Kind	■ Dry and oil free □	
Supply press.	Max. 700 Nor. Min. 350	■ kPaG □ barG □ kgf/cm²G □ PSIG
Supply temp.	Max. Nor. Min.	□ ℃ □ °F ■ Ambient
Dew Point	0 ■℃ □°F or lower at 700	■ kPaG □ barG □ kgf/cm²G □ PSIG
Consumption	Max. Nor. Approx. 6	■ Nm³/h □ Sm³/h □ SCFM □

■ Cooling water

Service	■ L.O. cooler	□ C.O. cooler □ Gas cooler □
	□ L.O. cooler for	□ Compressor/Transmission gear □ Driver
	□ Driver	□ Low stage casing
Source	□ Industrial water	□ Cooling tower □ Sea water ■ Demineralized water
Fouling factor	0.0002	□ m²·°K/W ■ m²·h·℃/kcal □ ft²·h·°F/BTU
Supply press.	Max. Nor. 400 Min. 300	■ kPaG □ barG □ kgf/cm²G □ PSIG
Supply temp.	Max. Nor. 32 Min.	■ ℃ □ °F
Press. drop	Max. 50	■ kPa □ MPa □ bar □ kgf/cm² □ PSI
Temp. rise	≦ 10.0	■ ℃ □ °F
Circuration	38	■ m³/h □ GPM US □ GPM UK

UTILITY CONSUMPTION

NOTE : ■ Applicable
☐ Not applicable
All data on per unit basis

■ Cooling water
Service ☐ L.O. cooler ☐ C.O. cooler ☐ Gas cooler ☐
☐ L.O. cooler for ☐ Compressor/Transmission gear ■ Driver
Source ☐ Industrial water ☐ Cooling tower ☐ Sea water ☐
Fouling factor 0.0002 ☐ $m^2 \cdot °K/W$ ■ $m^2 \cdot h \cdot ℃/kcal$ ☐ $ft^2 \cdot h \cdot °F/BTU$
Supply press. Max. Nor. 400 Min. 300 ■ kPaG ☐ barG ☐ kgf/cm^2G ☐ PSIG
Supply temp. Max. Nor. 32 Min. ■ ℃ ☐ °F
Press. drop Max. ☐ MPa ☐ kPa ☐ bar ☐ kgf/cm^2 ☐ PSI
Temp. rise ☐ ℃ ☐ °F
Consumption 10.8 ■ m^3/h ☐ GPM US ☐ GPM UK

■ Lubricant (☐ Refer to lubricant list)
■ Lube oil
Service ■ Compressor ~~(Low/High stage)~~ ■ Combined L.O. & C.O. system
Quality ■ JIS additive turbine oil or equivalent
☐ Vacuum pump oil --- KSL recommendation: IDEMITSU DN. SUPER ACEBACK
☐ Rotary compressor oil
☐ Polyalphaolefin synthetic hydrocarbon oil (PAO)
☐ Polyglycol lubricants (PAG) CPI 1515-150 or equivalent
☐
■ ISO VG ☐ 32 ■ 46 ☐ 68 ☐ 100 ☐ 150 ☐ 220 ☐
☐ Informed later
Initial charge Approx. 1200 ■ ℓ ☐ gal US ☐ gas UK
Renewal interval 16000 h or 2 year, whichever is shorter

☐ Control oil
Service ☐ Slide valve ☐ Mechanical seal ☐ Combined separate lube oil system
Quality ☐ Same as Lube oil
☐ JIS additive turbine oil or equivalent
☐ Vacuum pump oil --- KSL recommendation: IDEMITSU DN. SUPER ACEBACK
☐ Rotary compressor oil
☐ Polyalphaolefin synthetic hydrocarbon oil (PAO)
☐ Polyglycol lubricants (PAG)
☐
☐ ISO VG ☐ 32 ☐ 46 ☐ 68 ☐ 100 ☐ 150 ☐ 220 ☐
☐ Informed later
Initial charge Approx. ☐ ℓ ☐ gal US ☐ gas UK
Renewal interval h or year, whichever is shorter

☐ Separate lube oil (☐ Informed later)
Service ☐ Compressor (Low stg.) ☐ Transmission Gear ☐ Driver
☐
Quality ☐ Same as Lube oil ☐ Same as Control oil
☐ JIS additive turbine oil or equivalent
☐
☐ ISO VG ☐ 32 ☐ 46 ☐ 68 ☐
☐ Informed later ☐ By customer or others ☐
Initial charge Approx. ☐ ℓ ☐ gal US ☐ gas UK
Renewal interval 16000 h or 2 year, whichever is shorter

■ Grease (☐ Informed later)
Service ■ Main motor
■ Auxiliary motor
☐
Quality ☐ Informed later ■ Refer to Lubrication Schedule (20S-C13764)

Chapter II System Design Discription of the Fuel Gas Compressor

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      5.1.1. Programmable Controler
      5.1.2. Bypass Valve
      5.1.3. Slide Valve

1. Fundamental Mechanism of Screw Compressor

1.1 Overall Construction

The screw compressor is a sort of rotary positive displacement compressor, and a machine in which successive volumes of gas are confined within a closed space formed by two rotors and casing, and elevated to a higher pressure as the volume of the closed space is decreased by rotation of rotors.

The oil-injected type of screw compressor is characterized by the oil-injection into gas which is closed in rotor grooves and under compression for the purpose of cooling, sealing and lubricating.

The mechanism of the screw compressor consists of two screwed teeth rotors which are intermeshed in parallel within the casing.

The rotor which has five (5) lobes is called " male rotor" , and the other which has seven (7) lobes is called " female rotor" .

The two (2) rotors are supported by bearings at each ends so that they can rotate with keeping a constant small clearance between the rotor tip and the casing as well as the rotor and face end of the casing. These bearings are type of sleeve and are required durability against the radial or thrust load forced by the compressed gas to the rotors.

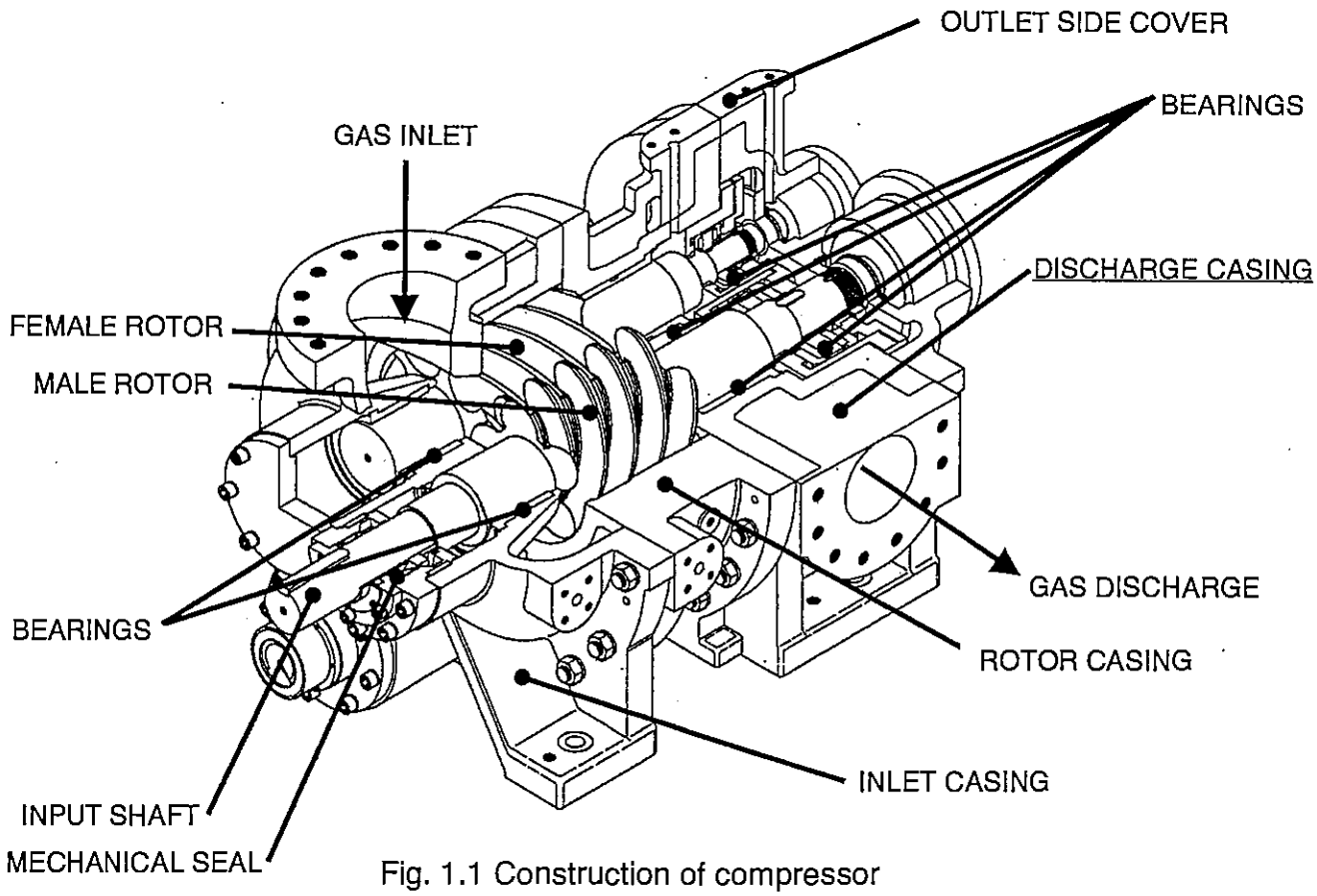


Fig. 1.1 Construction of compressor

The torque is transmitted from a driver to the input shaft through a flexible shaft coupling and further to the male rotor.

The male rotor drives the female rotor directly their gearing of lobes and grooves, therefore the timing-gears are of no use. The input shaft is fitted with the mechanical seal to check of a gas leakage and an air penetration.

The oil drain from bearings and mechanical seal is sucked into rotor grooves and discharged together with the injected oil.

1.2 Rotor

In its construction the screw compressor closely resembles the well-known rotary lobe blower. It differs, however, in its peculiar rotor profile and its very large helix angle (the wrap angle of a mail rotor is 300 degrees in most cases).

The rotor profile is the unsymmetrical type as shown in Fig. 1.2 having both convex and concave faces.

At the root of the lobe in the male rotor and the tip of the lobe in the female rotor a pitch circle is found. Both male and female rotor have the same outer diameter, yet the number of lobes are five (5) and seven(7) respectively. Therefore it follows that the male rotor is rotating 1.4 times as fast as the female rotor.

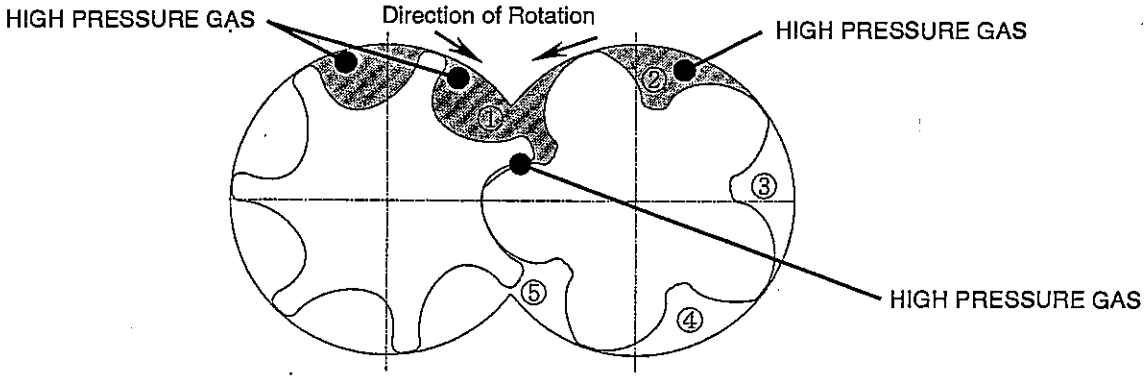


Fig. 1.2 Rotor profile of KOBELCO COMPRESSOR

In the male rotor, the four(4) grooves,②,③,④,⑤, not intermeshed are approximately symmetrical respective to a straight line running through the rotor center. Therefore, force due to gas pressure is directed toward the center.

Simultaneously, at the intermeshed groove ①, a pressure difference occurs on both sides of the sealing point and an unbalance force is caused due to gas pressure. This unbalanced force works in opposition to the rotational direction of male rotor, and it is necessary to supply power for rotating the mail rotor against this force.

As for the female rotor, the intermeshing point is found at the tip of the lobe, and all gas pressure is directed toward the rotor center.

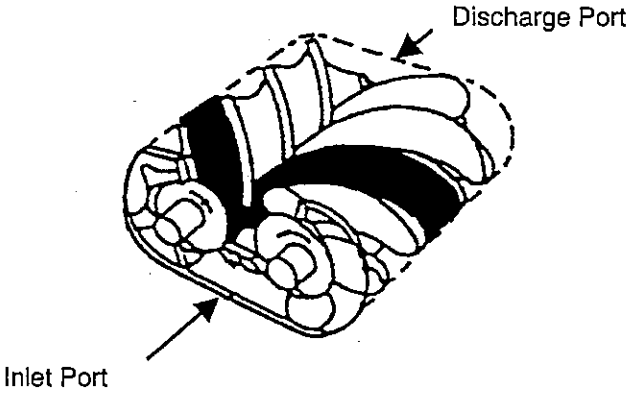
Therefore the torque due to gas pressure is very slight in the female rotor. Thus, the female rotor seems to be acting as only a rotary seal device for the male rotor.

The required torque for the rotation of the female rotor is about 10% of the total input torque.

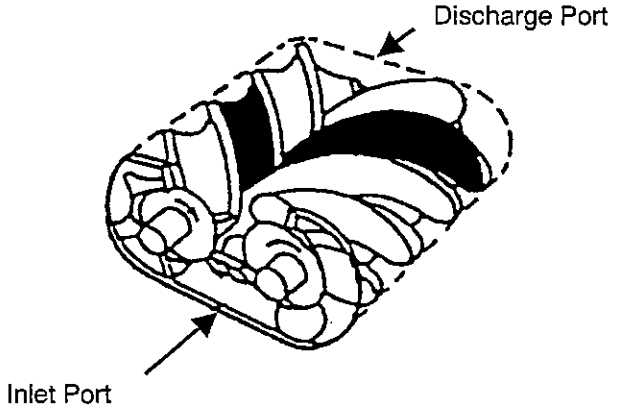
Because of this reason, under the lubricated condition, the torque transmission from male to female rotor is very smooth with their direct contact of rotors, and the rotors are free from wear or pitching.

1.3 Mechanism of Compression

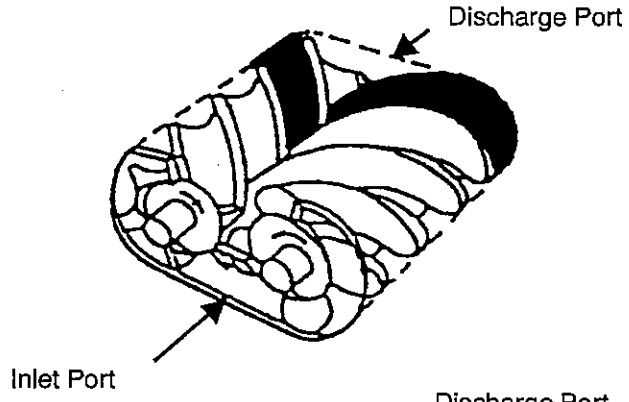
Gas is drawn through the suction port into grooves of rotors.



As rotation continues, the groove spaces are cut off from the suction port and gradually reduce, thus starting compression of entrapped gas.



Compression continues until the groove space becomes exposed to the discharge port.



Compressed gas flows smoothly out of the compressor.

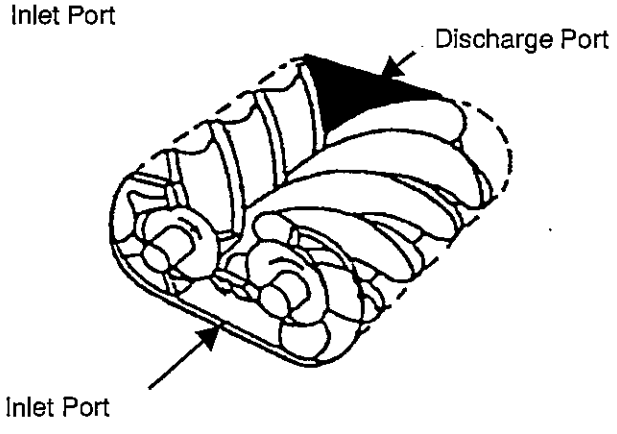


Fig.1.3

1.4 Capacity Control System

KOBELCO oil-injected screw compressor is furnished a slide valve device as a standard specification, for a continuous and stepless capacity control.
The principle of this mechanism is shown in Fig. 1.4 .

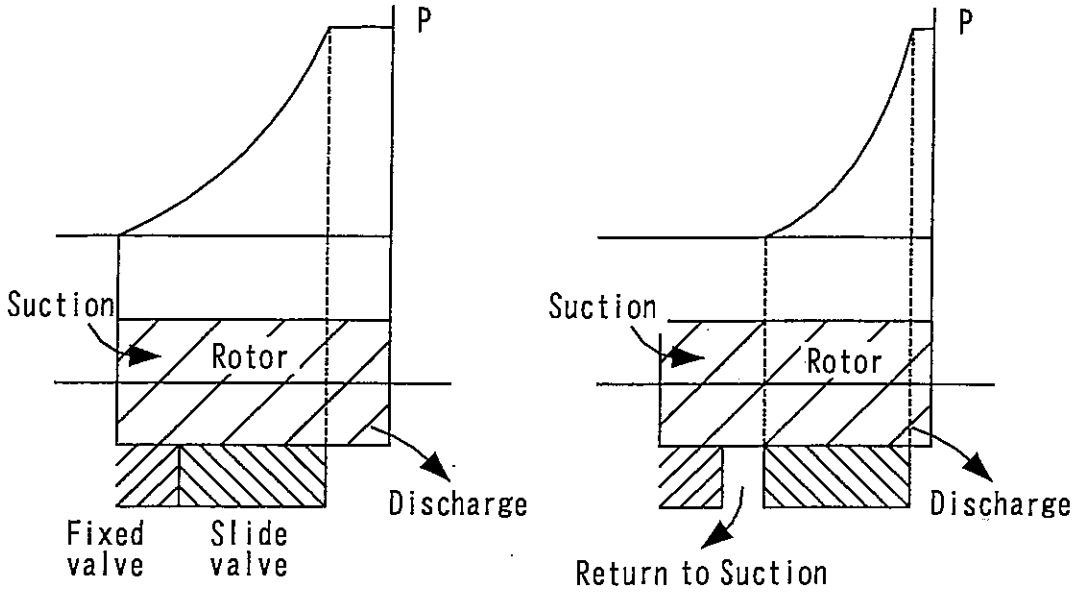


Fig. 1.4 Mechanism of slide valve

(A) shows the case of 100% operation, where all of gas drawn into the rotor grooves is discharged.
(B) shows the case of part load operation, where the slide valve has been moved toward the discharge side to produce a gap between the fixed portion. When there is a gap, the gas within the rotor grooves is not compressed and returns to the suction side through the gap, until the intermeshing part of the rotor (sealing point) reaches the end of the slide valve.
Compression will begin after the formation of closed space by the rotor lobes and the slide valve. This means that the effective length of the rotor has been reduced and the stroke volume decreased, resulting in regulation of the capacity. Therefore, when the capacity is decreased, absolutely no superfluous compression takes place, and as the position of the discharge port moves in accordance with the slide valve, the internal compression ratio can be kept constant approximately.

This means that when the capacity is regulated, the power consumption of compressor decreases in proportion to the capacity.
Fig. 1.5 shows the characteristic of capacity control on KOBELCO oil-flooded compressor with slide valve.

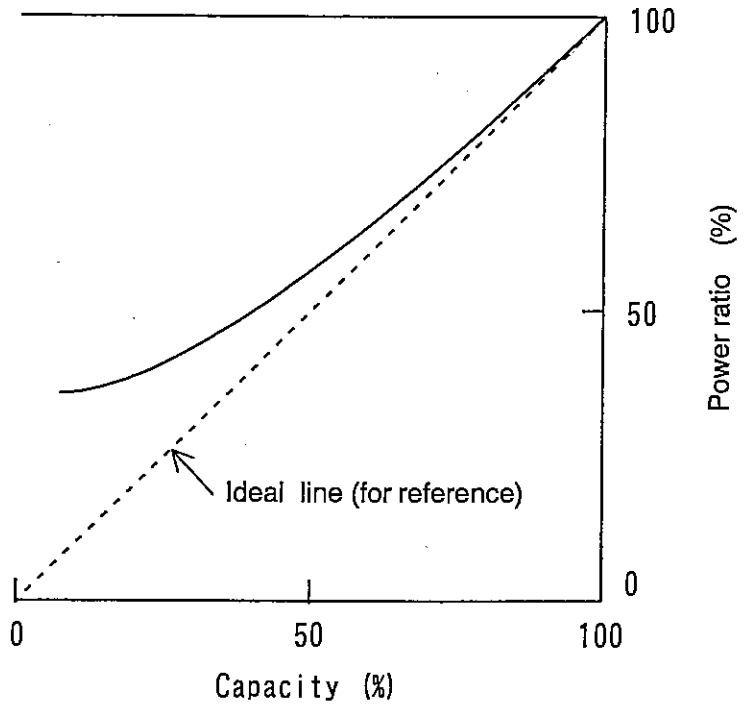


Fig. 1.5 Characteristic of capacity control

The slide valve can be operated by a hydraulic actuator furnished in a compressor, and the pressure for actuating power is conducted from a lube oil header of the compressor. This actuator is usually linked with a controller circuit of suction or discharge pressure.
These unique capacity control system of KOBELCO oil-injected compressor will realize the most economical, stabilized and authentic operation in all types of compressor.

2. Detailed Explanation of Compressor Components

2.1 Outlines of the Construction

As is shown in the drawings, compressor casing consists of inlet casing, rotor casing, discharge casing and outlet side cover.
Within the rotor casing, two rotors having twisted teeth are engaged with each other. Gas from suction port is compressed within rotor casing and then is sent to discharge port.
The rotor, connected to the main motor, is male rotor, and the rotor which engages with it is the female rotor.
The rotors are supported by the main bearing so as not to contact the casing.
To support the thrust load generated in the rotor, is used an tilting pad bearing. The part where the male rotor shaft penetrates the casing has a mechanical seal for preventing a gas leak. A balance piston is installed between the thrust bearing and the main bearing, in order to generate by oil pressure a thrust load counter to the rotor-generated thrust load so as to decreased the load imposed on the thrust bearings.
The bottom of casing has a capacity control valve (slide valve).
The capacity control valve can be moved in the axial direction by the oil hydraulic piston to control the volume to approx. 35%.
Oil is injected into rotor engagement, thus seals tightly the clearance of rotors and cools the gas.
As for the compression method of a compressor, it sucks the gas into the groove of rotor profile from suction end of rotors, and sends the gas to the discharge port of the other end of rotors by engagement of teeth, then compressed the gas to discharge pressure by reducing of volume of groove.
So the KOBELCO-SCREW compressor does exactly the same method for compression as the reciprocating compressor.
For above reasons, KOBELCO-SCREW compressor is possible to operated stably in spite of the fluctuation of discharge and suction pressure and rotating speed.

2.2 Casing

The compressor casing consists of mainly four(4) blocks.
They are vertically split type.
Casing is made of cast steel, and the suction port locates at side and the delivery port at the bottom and is designed to discharge the gas when the gas pressure has become a discharge pressure. Casing has no water jacket because the compressor is cooled by injected oil.

2.3 Rotor

The rotor is made of forged steel and the tooth profile is carefully and precisely machined. The machined rotor is well dynamically balanced so it has no vibration during a high-speed rotation.
The male rotor has 5 and female rotor has 7 twisted teeth.
The input power is transmitted to male rotor.
The two rotors are engaged with each other for operation, so entry of large and hard dirt into the gas should be prevented.

2.4 Bearings

Main bearings (Journal bearing) consist of forged steel bush lined with white metal. The thrust load generated by the pressure difference between suction and discharge side is supported by the tilting pad bearing.

2.5 Shaft Seal

The mechanical shaft seal is used at the part where the shaft penetrates the casing, to prevent the leakage of gas.
Single mechanical seal is adopted as a shaft seal. The seat, which is made of silicon-carbide, rotates with the shaft and shaft sleeve. The washer made of carbon is fixed to the casing with retainer. The washer is pushed to the seat by spring of retainer, and the sealing face is formed. Owing to the excellent lubricating performance and good affinity of the combination of carbon and silicon-carbide excellent sealing performance can be achieved.

2.6 Slide Valve

At the bottom of the casing, the slide valve is provided. The slide valve consists of a sliding valve, drive shaft, hydraulic cylinder, piston, slide valve indicator, etc. The slide valve is moved axially by the hydraulic force acting on the piston. As the valve moves to the discharge side, a path from compression chamber to suction is formed between the sliding valve and valve stopper. As the compression of the gas starts when the edged of robes pass through the edge of suction port, the new path makes delay of the compression, i.e., as the slide valve moves to the discharge side, the trapped gas volume is reduced.
The axial movement of the slide valve is measured by potentio meter.

2.7 Shaft Coupling

A steel flexible coupling " Thomas type" is used for the shaft coupling to avoid the expansion of shaft due to thermal expansion and strain due to deflection.

3. Gas System

3.1 System

Supplied fuel gas goes through the EMERGENCY SHUT DOWN VALVE, SUCTION PRESSURE CONTROL VALVE and SUCTION GAS FILTER, then the gas is sucked by the compressor. The compressed gas is discharged together with oil through the discharge nozzle. Next, the gas is sent to OIL RECOVERY Tank where the gas and the oil are separated by the demister and coalescing filter element. And then the gas flows out through the nozzle at the top of Tank. At last, the gas is sent to final OIL SEPARATOR where the oil contained in the gas is thoroughly removed down to less than 5ppm by weight.

3.2 Attached Equipment

3.2.1 SUCTION STRAINER

A gas Strainer is provided on the compressor suction line to protect the compressor from the dust in the gas. The element is made of 150 mesh stainless steel wire cloth.

3.2.2 OIL RECOVERY TANK

This vessel services both as an oil separator and an oil tank. The gas and oil mixture flows into the vessel through the nozzle on the side. Most of oil falls down and is accumulated at the bottom by gravity.
But the residual oil flows upward with the gas is caught by the stainless steel demister and the coalescing fitlters near the top of the vessel. These coalescing fileters,which are made of borosilicate microfibre, are also used in the next Oil Separator
The gas flows out through the nozzle at the top.
The level gauge with alarm contact L for luburicaton oil is provided.

3.2.3 OIL SEPARATOR

Most of the oil mist in the gas is caught by the Oil Recovery Tank. The oil mist passing through the Oil Recovery Tank is further more removed by OIL SEPARATOR. The gas and oil mist flows into the filter through the nozzle at the top side and pass through the filter elements which are made of borosilicate microfibre.

The oil mist caught by the coalescing filters is accumulated at the bottom of the elements and falls as droplets to the bottom of the tank. The oil accumulated at the bottom of the tank flows out through the oil return nozzle to the compressor suction. The gas flows out through the nozzle on the side.

4. Lube Oil System

4.1 System

The oil pressure in OIL RECOVERY TANK and the compressor discharge are the same.
The oil is fed to the compressor as lubricating oil for bearings and mechanical seal, injection oil to the compressor chamber. All the oil is discharged through the discharge nozzle together with process gas.The oil is supplied by the differencial pressure(ΔP) depending on the compressor inlet pressure(P_s) and discharge pressure(P_d).
The system is furnished with an oil cooler, two oil filters for each compressors to assure uninterrupted long term operation. And also one lubirication oil pump for each compressor is furnished and used during starting-up and in case of Ps increase. The pump gives approx.6 bar to the differencial pressure to supply enough oil.

4.2 Attached Equipment

4.2.1 LUBE OIL COOLER

Oil cooler is a water cooled, horizontal shell and tube type. Oil flows shell side whereas cooling water flows tube side. Tube bundle type is fixed tube sheet (BEM type).

4.2.2 LUBE OIL FILTER

Lube Oil filter is duplex type. The filter elements' fineness is 10 microns.

4.2.3 LUBE OIL PUMP

Lube oil pump is postive displacement gear type.
The oil regulating valve (relief valve) is integrated in the pump to control the differential pressure across the pump.

4.2.4 LUBE OIL CHARGING PUMP

Lube oil charging pump is provided on the skid to charge oil for initial or during operation.

5. Control System

The commpressor discharge pressure is controled by manipulating the slide valve,which is integrated in the compressor, and the bypass valve, which is connected between compressor discharge line and the inlet line.

The bypass valve is controled to keep a specified discharge pressure. And the valve is controlled so as to keep a slight openning, within approximately 4-6%, by manipulating the flow capacity.

By the above control system, the screw type compressor has flexibility and stability at the variable condition even though in case of changing the compressor inlet pressure and/or fuel gas flow rate.

5.1 Components

The control system consists of the following components.

5.1.1 Programmable controler

The controler has a function of feed-forward control which operates at the time of gas turbine tripped or load rejection. The feed-forward control gives the minimum fluctuation of discharge pressure.

5.1.2 Bypass valve

Bypass valve gives the quick and stable response during normal operation.
The valve has a capacity to bypass the full flow rate.

5.1.3 Slide valve, integrated in the compressor

Slide valve actuated by hydraulic cylinder gives the capacity control to manipulate the its position. Oil pressure cylinder is actuated by compressor lubrication oil.
Traveling speed of the slide valve is controled by throttles and check valves.
"LOAD SPEED" is generally adjusted to be approximately 60~90 seconds per full stroke, traveling position 0-100%, and "UNLOAD SPEED" to be approximately 90~120 seconds.
Traveling direction of the valve is controled by spool valve actuated by pneumatic.

In case of the gas turbine load decrease and/or compressor inlet pressure increase, in order to decrease the compressor inlet volume, the oil pressure cylinder is actuated toward the "UNLOAD" direction(100→0%).
On the other hand, in case of the gas turbine load increase and/or compressor inlet pressure decrease, the oil pressure cylinder is actuated toward the "LOAD" direction(0→100%) in order to increase the compressor inlet volume.

Chapter III TEST & PREPARATION PROCEDURE BEFORE OPERATION

1. General

The test operation should be carried out after initial installation or overhaul based on this chapter.
It is very important to prepare the treatment for the abnormal results during test operation.
The test operation shall be carried out under the supervisor of KOBE STEEL, LTD. until the operators are experienced.

> CAUTION
> 1. Never operate the compressor with air, once it has been put into an actual gas service, because possible remaining flammable impurities could cause a fire.
>
> 2. When the compressor is operated with nitrogen, minimum 1 % of oxygen shall be mixed in the nitrogen.
> Pure nitrogen operation casues rotor surface damage on our experiences. The cause is thought that the oxidized film is not formed on the rotor surface.

2. Leakage Test

After installation or overhaul, leak test of each jointed part should be performed before charging oil.
Dry nitrogen gas should be used.
The test pressure is 39barG .

1) Joint all the piping lines to be fully closed system.
2) Block or shut the inlet side of safety valves.
3) Open all the stop valves, but only the valves that communicate with the atmosphere such as air vent valves and drain valves should be fully closed.
4) Introduce the dry nitrogen gas into the equipment to pressurize to 1.0~2.0 barG.
5) Check the leakage of each jointed part by means of soapsuds.
6) If there is no leakage, more gas is introduced to pressurize to the leak test pressure.
7) Check the leakage of each jointed part by means of soapsuds.

3. Pre-Start Up Check Points (refer to "Site Commissioning Procedure (20M-C04353))

The following check points must be completed before the compressor operation.

(1) Pre-confirmation
Compressor unit is completely flushed and leakage tested.

(2) Turning of the Compressor Rotor
Confirm the free rotation of the compressor and all oil pumps by rotating them by hand. Turn oil pumps in proper direction.

Gas compressor	CW	(View from motor)
L.O. Pump	CCW	(ditto)
L.O. Charge Pump	CW	(ditto)

If these machines do not turn freely, determine the reason and eliminate the problem before going any further.

(3) Alignment
Confirm proper coupling alignment after replacing the coupling center.

(4) Piping
Confirm that correct piping flow is carried out and orifice with correct diameter is installed.

(5) Wiring Check
Confirm all field wiring connections have been made per electrical drawings and that all instruments are operating.

(6) Oil Level Check
Confirm oil level of the oil recovery tank.

(7) Lube Oil Supply Pressure
Confirm that lube oil pressure is enough higher than the required pressure.

(8) Valve Position Check
Confirm all positions of valves. Refer to the Schematic diagram.

(9) Slide Valve Position
Activate the slide valve from 0% to 100% and confirm that slide valve position indicator indicates correct position.
Lube Oil shall be supplied before activating the slide valve to form oil film.
Confirm that Slide Valve is in 0% position at starting.

(10) Slide Valve Speed Adjustment
Adjust slide valve LOAD speed to be 30 seconds per full stroke and Unload speed to be 90 seconds.

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(11) Cleanliness
Confirm cleanliness at lube oil inlet nozzle.
Recommended cleanleness criteria is as follows,

Recommended Cleanliness	As per API 614 4.3.3.7

(12) Cooling Water Quality Check
Confirm the quality is fitted.

(13) Fuel Gas Introduction
Introduce the fuel gas to the compressor unit. (refer to Site Comissioning Procedure (20M-C04353)).

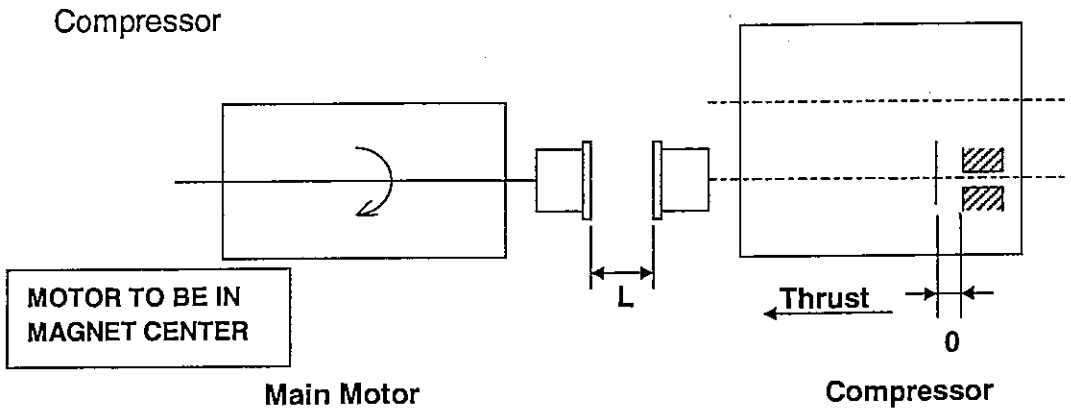
CAUTION
The starting current of induction motor is several times of the normal running current. During the starting, INSTRUCTION MANUAL FOR MAIN MOTOR should be refered to for the starting.

Shaft Alignment Check

unit : mm

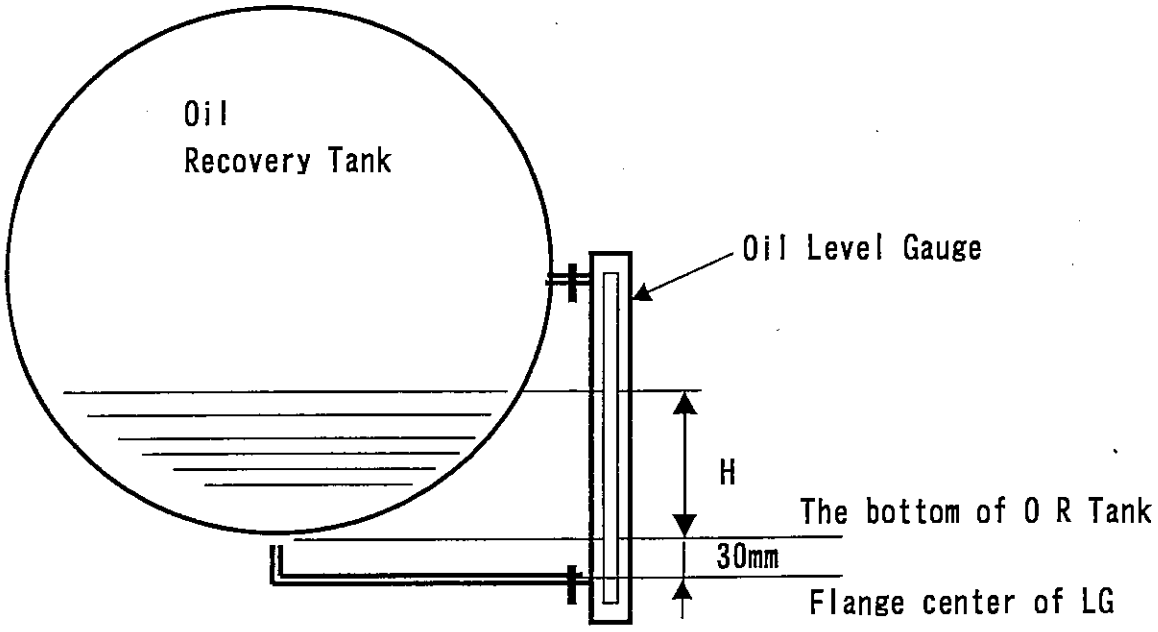
	Parallel Offset	Angular Misalignment	Length
Compressor	±0.1	±0.1	$186_{0}^{+0.1}$

*Parallel Offset and Angular Misalignment shall be measured by TIR.



Oil level of the Oil recovery tank

		Oil level (mm)	Amount(ℓ)	Remarks
Normal level (During operation)	Maximum(H)	450	1,500	
	Initial	370	1,200	
	Minimum(L)	310	1,000	
Visible Level	Maximum	770	---	
	Minimum	0	---	



Manual Valve List

TAG.NO. * *	VALVE NAME/PLACE/PURPOSE	TYPE	SIZE	Open/Close ○/●	Note
V 105	SUCTION LINE CHECK VALVE / P	BU	6	–	
V 127	OIL RETURN CHECK VALVE / OIL RECOVERY TANK / P	CH	3/4	–	
V 128	OIL RETURN CHECK VALVE / OIL MIST SEPARATOR / P	CH	3/4	–	
V 129	OIL RETURN CHECK VALVE / OIL MIST SEPARATOR / P	CH	3/4	–	
V 130	OIL RETURN GLOVE VALVE / OIL MIST SEPARATOR / P	GL	3/4	○	
V 131	OIL RETURN GLOVE VALVE / OIL MIST SEPARATOR / P	GL	3/4	○	
V 132	OIL RETURN GLOVE VALVE / P	GL	1	○	
V 135	OIL RETURN GATE VALVE / OIL RECOVERY TANK / P	GA	3/4	○	
V 155	OIL VENT GATE VALVE / P	GA	3/4	○	
V 164	CP001 ROOT GATE VALVE / P	GA	1/2	○	
V 165	CP007 ROOT GATE VALVE / P	GA	1/2	○	
V 169	CP002 ROOT GATE VALVE / P	GA	1/2	○	
V 170	CP002 ROOT GATE VALVE / P	GA	1/2	○	
V 171	CP003 ROOT GATE VALVE / P	GA	1/2	○	
V 172	CP002 ROOT GATE VALVE / P	GA	1/2	●	
V 184	LS ROOT GATE VALVE / P	GA	3/4	○	
V 187	LI ROOT GATE VALVE / P	GA	3/4	○	
V 185	LS ROOT GATE VALVE / LO	GA	3/4	○	
V 186	LS DRAIN ROOT GATE VALVE / LO	GA	3/4	●	
V 188	LI ROOT GATE VALVE / LO	GA	3/4	○	
V 189	DRAIN ROOT GATE VALVE / OIL RECOVERY TANK / LO	GA	1	●	
V 190	LI DRAIN ROOT GATE VALVE / LO	GA	3/4	●	
V 201	BYPASS GLOVE VALVE / OIL COOLER / LO	GL	4	●	
V 202	ROOT GATE VALVE / OIL RECOVERY TANK / LO	GA	4	○	
V 210	LO LINE CHECK VALVE / LO	BU	3	–	
V 211	LO LINE GATE VALVE / LO	GA	2	○	
V 212	OIL RETURN GATE VALVE / OIL RECOVERY TANK / LO	GA	1	●	
V 221	N5 GLOVE VALVE / LO	GL	1	○ Adjusted	
V 222	N5 CHECK VALVE / LO	CH	1	–	
V 224	N8 CHECK VALVE / LO	CH	1	–	
V 225	N8 GLOVE VALVE / LO	GL	1	○ Adjusted	
V 226	N9 CHECK VALVE / LO	CH	1	–	
V 227	N5 CHECK VALVE / LO	CH	1	–	
V 229	N9 GLOVE VALVE / LO	GL	1	○ Adjusted	
V 231	VENT CHECK VALVE / OIL COOLER / LO	CH	3/4	–	

TAG.NO. * *	VALVE NAME/PLACE/PURPOSE	TYPE	SIZE	Open/Close ○/●	Note
V 244	VENT GATE VALVE / OIL COOLER / LO	GA	3/4	●	
V 245	DRAIN GATE VALVE / OIL COOLER / LO	GA	3/4	●	
V 246	DRAIN GATE VALVE / OIL FILTER / LO	GA	3/4	●	
V 247	DRAIN GATE VALVE / OIL FILTER / LO	GA	3/4	●	
V 248	VENT GATE VALVE / OIL FILTER / LO	GA	3/4	●	
V 249	VENT GATE VALVE / OIL FILTER / LO	GA	3/4	●	
V 250	DRAIN GATE VALVE / OIL FILTER / LO	GA	3/4	●	
V 251	DRAIN GATE VALVE / OIL FILTER / LO	GA	3/4	●	
V 252	VENT GATE VALVE / OIL FILTER / LO	GA	3/4	○	
V 253	VENT GATE VALVE / OIL FILTER / LO	GA	3/4	○	
V 254	VENT GATE VALVE / OIL FILTER / LO	GA	3/4	○	
V 264	PdIA ROOT GATE VALVE / LO	GA	1/2	○	
V 265	PdIA ROOT GATE VALVE / LO	GA	1/2	○	
V 266	PI ROOT GATE VALVE / LO	GA	1/2	○	
V 267	PI ROOT GATE VALVE / LO	GA	1/2	○	
V 270	PdIZ ROOT GATE VALVE / LO	GA	1/2	○	
V 281	LO CHARGE PUMP GATE VALVE / LO	GA	3/4	●	
V 282	LO CHARGE PUMP CHECK VALVE / LO	CH	3/4	-	
V 283	LO CHARGE PUMP GATE VALVE / LO	GA	3/4	●	
V 298A	VENT GATE VALVE / OIL COOLER / LO	GA	3/4	○	
V 298B	LO PUMP DRAIN GATE VALVE / LO	GA	3/4	●	
V 301	GATE VALVE / CONTROL OIL MANIFOLD / LO	GA	3/4	○	
V 302	GATE VALVE / CONTROL OIL MANIFOLD / LO	GA	3/4	○	
V 861	GLOVE VALVE / IA	GL	1/2	○	
V 862	GLOVE VALVE / IA	GL	1/2	○	
V 541	VENT GATE VALVE / OIL COOLER / CW	GA	3/4	●	
V 542	DRAIN GATE VALVE / OIL COOLER / CW	GA	3/4	●	

TYPE : GATE(GA), GLOBE(GL), CHECK(CH), BALL(BA), BUTTERFLY(BU), NEEDLE(NE), MINITURE(M), DI(DIAPHLAGM), TH(THREE WAY VALVE)

FLUID : PROCESS GAS(P), LUBE OIL(LO), COOLING WATER(CW), INSTRUMENT AIR(IA)

Chapter IV NORMAL OPERATION PROCEDURE

1. Preparation for Start

1.1 Preparation

Prior to start-up of the compressor, check the following items.

1) Set up parameters of instruments
   Confirm the set points and parameters of instruments as per Interlock Talbe
2) Confirm the chapter III TEST & PREPARATION PROCEDURE BEFORE OPERATION as guide.

1.2 Starting Condition

After following starting condition items are settled, compressor can be started. (refer to LOGIC DIAGRAM (03S-K25937))

1. Not COMPRESSOR RUNNING
2. Not HEAVY FAULT
3. MAIN MOTOR AVAILABLE
4. LUBE OIL PUMP RUN
5. MOTOR LUBE OIL PUMP RUN
6. SLIDE VALVE MINIMUM POSITION
7. L.O. SUPPLY DIFFERENTIAL PRESSURE HIGH
8. COMPRESSOR INLET VALVE OPEN (Supplied by KHI)
9. Valve V202 Open
10. Valve V211 Open
11. Valve V212 Close

CAUTION

The starting current of induction motor is several times of the normal running current. During the starting, INSTRUCTION MANUAL FOR MAIN MOTOR should be refered to for the starting.

1.3 Function of the LOCAL CONTROL STATION

- Indicating meter for the slide valve position (0 to 100%)
- Indicating meter for the 550kW main motor current (0 to 100A)
- Indicating lamps for the "READY FOR START","COMMON ALARM" and "COMMON TRIP"
- MANUAL-OFF-AUTO selector switches for the "SLIDE VALVE" and "L/O PUMP" operation
- LOCAL-OFF-REMOTE selector switch for the compressor operation mode
- OFF-ON selector swithes for the following items.
  1) Oil tank heater operation
  2) Tape heater operation
  3) Fluorescent lamp operation
- START / STOP push button for the following items.
  1) Compressor operation
  2) Lube oil pump operation
  3) Ventilation fan operation
  4) Oil charge pump operation
- EMERGENCY STOP push button for compressor system

1.4 Function of the SLIDE VALVE operation

Load / Unload manual operation of slide valve is possible from BOP control panel when the "MAN ORDER" signal is ON.
Usually, the slide valve is controlled automatically. Therefore, this signal should be "OFF" to keep the stability condition of compressor.

(note)

As for the discharge pressore controller that received the "STAND-BY" signal from BOP control panel, the pressure setting is raised a 0.5BARG from the normal pressure setting. The purpose is move to unload side of slide valve of stand-by compressor automatically when the compressor change over operation.
The signal is sent from BOP control panel to FGC control panel.

2. Start / Stop

2.1 Start Operation

The compressor is started at DCS.

1) When the start signal is sent from DCS, if the starting conditions are settled, the compressor will start. At first, LUBE OIL Pump will start. And the L.O. differential pressure is more than set pressure, and more than 15 sec. passes, the compressor will be started automatically.

2) Starting Failure
If the LUBE OIL Pump runs more than 30 seconds while the compressor is not starting, LUBE OIL Pump will be stopped as heavy fault "START FAILURE".

2.2 Stop Operation

Stop operation is normally done at DCS.

1) At first, LUBE OIL Pump will be started. The compressor will be stopped 5minutes or the slide valve position(≦5%) after stop opertion..
2) LUBE OIL Pump will be stopped 30 sec after the compressor stop.

3. Shut Down / Emergency Stop

3.1 Shut Down
The compressor will stopped immediately as per trip conditions of Interlock Table. In this case, the auxiliary equipments will be stopped 30 sec. after the compressor stop. At the same time, stand-by compressor will be started immediately.

3.2 Emergency Stop
The compressor can be stopped emergency stop at DCS. When the compressor is emergency stopped, the auxiliary equipments will be stopped immediately same as the compressor.

Note: After the emergency stop of the compressor, manual turnning should be executed (refer to Chapter V-5).

Chapter V MAINTENANCE

1.Recommended Maintenance Schedule

In this chapter, suggestions of routine checks and records and overhaul schedules are presented . However, these schedules should be modified or adjusted in intervals and contents to suit Customer's specific requirements depending on service and environment conditions. At the early stages of operation, rather frequent checks should be performed to grasp the proper characteristics of the equipment and the system.

The check items basically required are lubrication, cleanliness, and increase of vibration. Also, inlet and discharge pressures and temperatures should be observed frequently to avoid troubles resulting from excessive operating conditions.

Shaft seals, the rotating mechanical type, are subject to deterioration as well as wear. They may require replacement at varying periods.

Make sure that the machine should be operated within the specifications.
The suggested general requirements and a schedule for maintenance are shown on Table 5.1.

WARNING
Enter the vessel after the gas discharged completely.
Never enter the vessel unless you are certain that it is free of explosive gasses and toxic substance and that the breathing atomosphere is adequate.

Table 5.1 Recommended Maintenance Schedule

○ : CONSTRUCTED BY USER
● : CONSTRUCTED BY MANUFACTURER (SUPERVISING)

ITEM		INTERVAL							Remarks
Name	Measure	-	-	-	4000Hrs	8000Hrs	16000Hrs	32000Hrs	
		Every day	every week	Every Month	every 6 months	every year	Every 2years**	Every 4 years	
1. Compressor									
(1) Rotor	Check						●		
(2) Radial Bearing	Check						●*		Replace when wear exceeds criteria.
(3)Thrust Bearing	Check						●*		Replace when wear exceeds criteria.
(4) O-rings	Replace						●		
(5) Blance Piston	Check						●		Replace when wear exceeds criteria.
(6) Oil Injection Nozzle	Check						●		Replace when wear exceeds criteria.
(7) Mechanical Seal	Replace						●		Replace even if flawless.
(8) Overhaul							●		
2. Coupling	Alignment						○		

NOTE : * If the one of all the bearings excees the crteria, all bearing shall be replaced.

** 16000Hr compressor running or 2years whichever earlier.

Table 5.1 (Continued)

ITEM		INTERVAL							Remarks
Name	Measure	- every day	- every week	- Every Month	4000Hrs every 6 months	8000Hrs every year	16000Hrs Every 2 years*	32000Hrs Every 4 years	
3. L.O. Pump									
(1) Bushing	Replace						●		
(2) Mechanical Seal	Replace						●		
4. L.O. Cooler									
(1) Tube(C.W.) Side	Cleaning						○		
(2) Shell (Oil) Side	Cleaning						○		
5. Oil Recovery Tank									
(1)Oil	Leakage Oil Level Sample Quality Replace	○ ○		(○) First time	○		○**		
6. Oil Sepalator	Check	○							
(1) Separator Elements	Replace					○**		●	**Replace when Diff.P. exceeds 0.1MPa

* 16000Hr compressor running or 2years whichever earlier.

** The lube oil shall be sampled regularly and changed whenever it exceeds the criteria, which is recommended by lube oil manufacturer, regardless of the scheduled interval between oil changes.

Table 5.1 (Continued)

ITEM		INTERVAL							Remarks
Name	Measure	- every day	- every week	- Every Month	4000Hrs Every 6 months	8000Hrs every year	16000Hrs Every 2 years *	32000Hrs Every 4 years	
7.L.O. FILTER	Check	○							
(1)Filter Element	Replace					○**			**Replace when Diff.P. exceeds 0.1MPa
8. Ventilation Fan									
(1)BEARING	Replace						○		*** Use the temporary maintenance deck for maintenance work.
9. Suction Filter	Cleaning						○		
10.Instruments	Check&Calibrate					○			*** Use the temporary maintenance deck for maintenance work.

* 16000Hr compressor running or 2years whichever earlier.

*** Please refer to "Instruction Manual for Maintenance Deck" for details.
This deck is for temporary maintenance use only.

2. Operating Log and Check Points

2.1 Daily Operating Log

The use of an operating log permits through analysis of the operation of a Compression System by those responsible for its maintenance and servicing. Continual observation and recording of gauge pressures, temperatures, and other pertinent information enables the observer to do the following :

1. To be constantly and at all times familiar with the operation of the system.
2. To immediately recognize any deviations from normal operating conditions.
3. When recognizing any departure from normal operation, rectify the condition at once ; or shutdown the system and service the components causing the malfunction. Suggested DAILY OPERATION LOG is shown in Table 5.5. It is designed for a typical Compression System using a minimum of components.
Depending on the operation, it may be necessary to expand the steps shown in the suggested log.

2.2 Normal Operating Check Points

2.2.1 Filters

1. The oil filters should be changed a few days after start-up, every time the pressure drop across the housing reaches 1.0 bar when measured at normal operating temperatures, and at least once a year. Use the filter transfer valve to switch to the standby filter, and replace the plugged elements.
2. The compressor Suction Gas Strainer and Y type L.O strainer should be repalaced at every overhaul period. These are for mechanical protection use.

2.2.2 Oil Separation system

1. If the pressure drop between the upstream of the 1st coalescing fileters and the downstream of the 2nd coalesscing filters is too high (over 1bar during normal operation), the elements should be changed.
2. These is the possibility that the oil has not returned to the oil recovery tank from the Oil Mist Separation system. This would be caused by the blockage on the 3/4B drain line from the coalescing section. During the nomal operation, check the oil returing with gas to the compressor by looking over the sight glass. If the view looks like a raindrop through the window on the train, the system is working well.

2.2.3 Compressor Lube Oil

Oil Brand

Since the service life of the oil flooded screw compressor depends on the quality of lube oil, the proper oil which satisfies the required conditions shall be applied. (refer to Lubrication Schedule (20S-C13764)).

Standards for Lube Oil Changes

To observe the lube oil is the most important factors since the oil is injected to the compressor.
The lube oil should be changed at least once a shoter period of 2 year or 16,000 hour actual operation.
Sample the oil regularly and change the oil whenever it exceeds the criteria, regardless of the scheduled interval between oil changes.

Decisions about oil changes should be based on an overall consideration of all factors through consultation with the lubricant manufacturer.

(1) Sampling should be carried out within 500 hours after initial start up.
Sampling should be carried out every 1000 hours during normal operation.

(2) Decisions about oil changes should be based on an overall consideration of all factors through consultation with the lubricant manufacturer.

(3) Drain the oil from the system, including retention points such as coolers, strainers and filter vessels, as completely as possible.

(4) Mixing the different type of oils is absolutely prohibited.
Mixing the different type of the brand will make the oil inferior and causes agglutinated material or lacquer.

(5) Sampling oil should be carried out from drain valve of Oil Separator during operation.
Completely drainage should be carried out before sampling.

(6) The service life of the oil depends on the following factors :

a. Thermal stress to the oil proceeds the oil degradation.
b. Higher temperature operation proceeds the oxidation of the oil.
c. Dirty gas such as including dust, rust ,etc defiles the oil.

(7) By the result of oil sampling, KOBELCO may recommend to add the additives to the oil for corrosion prevention.

Table 5.2 General Standards for Changing Compressor Oil

Item	Test Method	Standard	Purpose of Test
Total acid number (TAN) mgKOH/g	ASTM D974 or D664 (JIS K 2501)	1.0 mgKOH/g max	The TAN shows the degree of oil degradation. When the TAN exceeds 0.5mgKOH/g, the rate of oxidation increases. The oil must be managed carefully and sampled regularly.
Kinematic viscosity (40 C) mm^2/s	ASTM D445 or D446 (JIS K 2283)	within ±10% from new oil ※	As the oil degrades the oxidation byproducts cause the viscosity to increase, resulting in sludge formation and poor lubrication.
Moisture content Vol%	ASTM D95 or 4006 E123 (JIS K 2275)	0.1 Vol% max	If the oil contains 0.1% or more moisture after draining, the moisture separation will worsen, thus causing the oil to degrade faster.
Contamination mg/100ml	Millipore filter (0.8 μ)	10 mg/100ml max	This test shows the amount of sludge or carbon resulting from oil degradation or thermal decomposition, as well as the amount of dust, rust, metal particles, etc. in the oil. Contamination is measured in order to monitor the oil's degradation and to prevent bearing damage and device clogging caused by foreign matter.

Note 1 ※ :" NEW oil" refers to the oil at the beginning of operation
(based on sampling 24 hours after the start of actual gas operation).
The new oil values are the base points for oil management.

2 : Kinematic Viscosity of the oil seems to be lower when the gas dissolved.
Therefore degassing should be carried out prior to analysing the oil.

2.2.4 Vibration Analysis

Periodic vibration analysis can be useful in detecting bearing wear and other mechanical failures.

2.2.5 Abnormal Instrument Readings

It is recommended that instrument readings are recorded on a daily basis and compared against previous readings and the initial startup log entries. Any extraordinary deviation in the readings (e.g., high motor amps) should be investigated immediately to prevent potential equipment damage.

2.2.6 High Differential Pressure Across an Oil Filter

When the differential pressure of the filters exceeds 1bar, change the filter into the standby fileter by switching over without interrupting operation.

2.2.7 Oil Quality

Sample oil quality whenever an oil filter or coalescer element is changed. Check the surface of the element and the drain whether it contain solids or oil is degraded, the system must be drained and refilled. If the oil meets the manufacturers specifications, check the oil level and top it off as necessary.

2.2.8 Solid Particles in the Oil

If there is an indication that the oil contains a high amount of solids, drain the oil out of the system and have the solids analyzed. The analysis may indicate the source of the solids and a potential problem with the equipment. It is recommended that prior to refilling the system with fresh oil that the following steps are taken :

1. Locate the source of the solids, and correct it.
2. Flush the entire system with fresh oil.
   Ensure that the oil is circulated through the entire system including all valves, both oil pumps and filters, the oil cooler, and temperature control valve. Minimum 10 minutes contact time through each component is recommended.
3. Drain the oil that was used flush the equipment. Remove all oil filters and coalescer elements(if required). Clean and inspect the filters and elements, if their condition is unsure or cleanliness, replace with new.
4. Refill the system with fresh oil (do not reuse the oil that was used to flush the system).

2.2.9 High Amount of Oil Mist Carryover

If an analysis indicates that the gas contains an abnormally high amount of oil, the following items should be checked :

1. The coalescer elements in the Oil Recovery Tank and the Oil Mist Separator should be examined ; and free passage through an element will allow a greater amount of oil to pass into the gas stream. Although free passage through a coalescer element is usually detectable by a low differential pressure indication across a coalescer, that is not always the case ; therefore, the elements should be visually checked.
2. Check for accumulation of excessive oil in the sight glasses of each Oil Mist Separator.

2.2.10 Differential Oil Pressure between Suction pressure and Oil supply pressure.

During the operation, an alarm will appear and oil pump will start to run if the differential pressure drops to 8bar and a shutdown will occur if the differential pressure drops to 7bar Possible causes are :

1. Pressure differential control valve integrated the oil pump may be out of adjustment, the setpoint is 6bar.
2. When Fuel gas suction pressure increases and exceeds the specified pressure,
3. Oil filters may be dirty. The pressure drop exceeds the allwable pressure. Switch over the valve to exchage into the new filter.
4. Oil pump coupling may be broken. Replace the coupling.

2.2.11 Oil Separator Coalescing Filters Replacement Procedure

The replacement procedure of Oil Separator Coalescing Filters is as follows:

① Coalescing Filters shall be changed whenever the following occurs :
Pressure drop across the coalescers is 1bar or larger.
Operaton time exceeds the spesified period.

② Release all pressure from the vessel by using the vent valve.

③ Remove the manhole cover.

④ Wait five to ten minutes to allow the gas to escape from the vessel.

> Warning:
> Prior to enter the vessel,
> Check the Oxygen concentration in the vessel must be 18% higher.

⑤ Remove the set nut fixing the coalescers.

⑥ Remove the coalescing fileter from the vessel one by one.
The weight of each wet coalescer is approximately 4 kg.

⑦ Wet the end of the coalescer with a small amount of oil to get a better seal.

⑧ Clean the seal surface of the coalescer with a lint-free rag.

⑨ Install the new coalescers into the vessel.
The weight of each dry coalescer is approximately 2 kg.

⑩ Install the set nut on the coalelescer.

⑪ Move the coalescer from side to side to check the tightness of the coalescer, re-tighten if there is any movement in the coalescer.

⑫ Fix the set nut by wiring among the set nuts of the near coalescing filters.

⑬ Make sure that no tools, loose parts nor tags are left in the vessel.

⑭ Place the gasket and close the manhole cover.

NOTE :

If the System with the new coalescing filters show a negligible pressure drop, i.e. less than 0.003 MPa, it may be necessary to re-tighten all the coalescing filters.

2.2.12 Lube Oil Filter Element Replacement Procedure

Lube oil filter element cleaning procedure is as follows :

① Switch over to the standby filter.

② Open the dirty side drain valve first, and then open the vent valve. The oil should be completely drained.

③ Open the top flange and remove the element.

④ Replace the element .

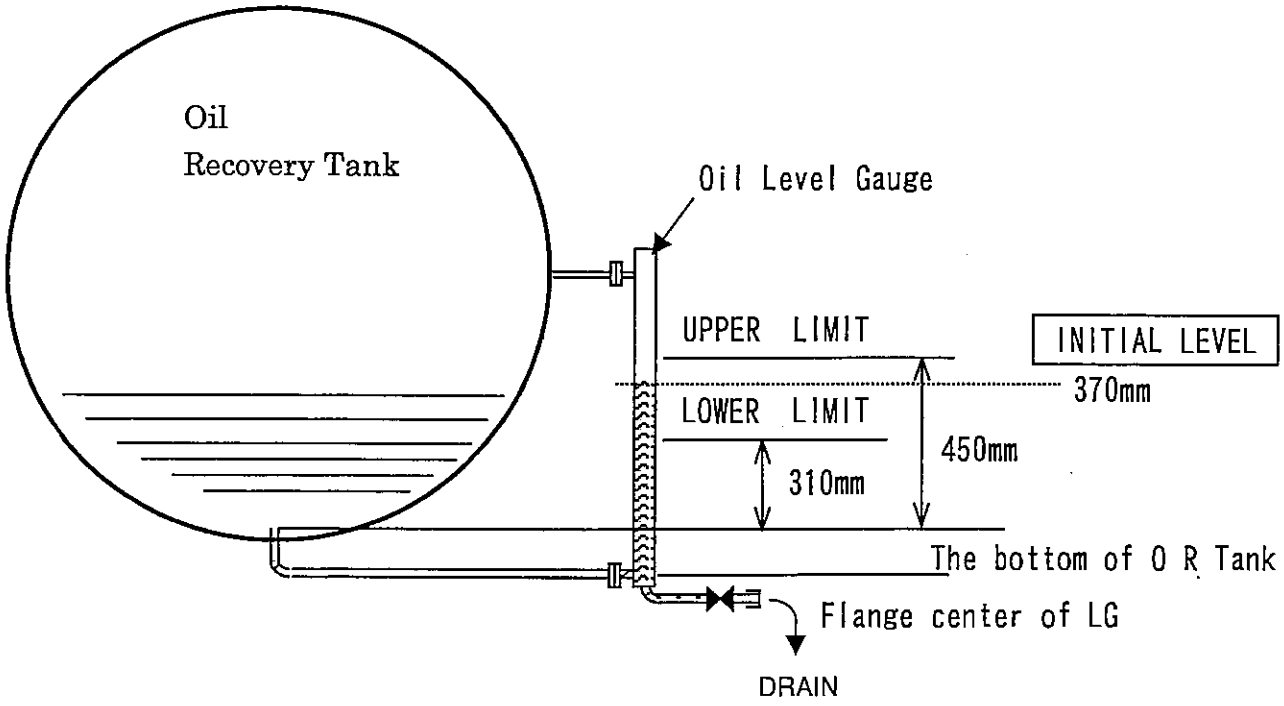
⑤ Replace all of the O-rings and gaskets.

⑥ After replacing the element, the oil should be lead by the equalizing valve and air should be out of the vessel by the vent valve.

⑦ Confirm the drain, the vent and the qualizing valve to be closed.

2.2.13 Oil Level in Oil Recovery Tank

The oil level in the Oil Recovery Tank should be controlled during operation as follows :



2.2.14 Long Term Shutdown

If the compressor will be shutdown for more than one month, the following procedure should be followed.

① Open compressor and oil pumps electric disconnect.

② Close the suction and discharge isolation valves.

③ Install a dry N2 gas 1.0 barG.

④ Run lube oil pumps once per a month for ten minutes.

⑤ Turn the compressor manually once per a month.
(Refer to the manual turning procedure.)

⑥ Sample and analyze the lube oil before restarting.

3. Maintenance of Heat Exchangers

Heat Exchangers should be properly operated and maintained, especially in respect to the quality and quantity of cooling water.

3.1 Quality Control of Cooling Water

Quality of cooling water is desirable to satisfy our recommended standard listed below.

Description	Unit	Operated C.W.	Charged C.W.	Tendency	
				Corrosion	Scale
pH(25℃)	—	6.8 - 8.2	6.0 - 8.0	○	○
Electrical conduction rate(25℃)	μ Ω/cm	< 800	< 300	○	
Cl^-	ppm	< 50	<20	○	
SO_4^{2-}	ppm	<200	<50	○	○
Fe	ppm	< 1.0	< 0.3	○	○
Ca CO_3	ppm	< 100	< 30		○
Total hardness Ca CO_3	ppm	< 200	< 50		○
S^{2-}	ppm	≒0	≒0	○	
NH_4^+	ppm	≒0	≒0	○	
SiO_2	ppm	<50	<30		○

3.2 Treatment

Quality of the water shall be checked once or twice a month and check and take following measurements depending on water condition.

1)Nomalize the water with chemical agents※ ※Consult a specialist of water treatment

2) Add flesh water

3)Wholly change the watr freshwater

3.3 Operation

①Before supplying cooling water to a cooler for the first time after installation, sufficiently clean the inside of piping for cooling water lest foreign materials should come into the cooler.

②Adjust the amount of cooling water to be +5% to –5% of designed value.
Specified water flow rate is shown in the Table 5.3.
Smaller quantity of water makes its flow velocity in the cooler lower resulting in accumulation of foreign materials in the cooler and may form a deposit on the inside of tubes.

Table 5.3

	Flow Rate	Temp. Rise
Unit	m^3 / hr	Degree C
Oil Cooler	38	less than 10
Main Motor	10.8	-

③During the operation, periodically take records of temperature and pressure at both inlet and outlet of gas, oil, and water, if temperature and pressure gauges or instruments are provided.

④After stopping the operation of equipment, drain out the water from the cooler if resting period is fairly long.
Then wash its inside with fresh water and drain out completely.
In case of the stopping for a few days, water may be circulated through the cooler

at approximately a half flow rate of designed value instead of draining out.

3.4 Maintenance

During the early period of operation, pay attention to the condition of a cooler and determine an adequate interval for cleaning after experiencing several times of cleaning.
Afterward, carry out cleaning periodically with the determined interval according to the following procedure.

3.4.1 Cleaning of Water Side for Oil Cooler

① Remove a shell.

② Check the condition of a tube sheet surface and inside surface of the channel. Clean the these surface by high pressure water jet, steam blowing or chemical cleaning agents depending on the condition.
Clean the inside of tubes with nyron blush or something else.

③ Carry out leak test of shell side with N2 gas after cleaning. If, unfortunately, tubes become loose in tube holes to cause leakage by the bad treatment during disassembling, expand the tubes a little more including neighboring tubes.
If plugging of tubes become necessary, apply tapered plugs.

④ At the re-assembling of the cooler, replace all gaskets and O-rings with new ones. Re-assemble the cooler by the reverse procedure of the disassembly.

4. Trouble Shooting

4.1 General

Alarms located at the local control panel provide the indication of problems with the compressor system.

> CAUTION
>
> Only skilled personnel familiar with electrical equipment and the hazards involved should be permitted to operate and service this equipment. Plant personnel should be used only if they have had specific training in safe electrical procedures and training in what to do in an emergency and unusual situation.

Information needed to troubleshoot the system is contained in the following drawings and documents.

1. Schematic Diagram (Piping drawings and Terminaton & Wiring Diagram)
2. Interlock Table
3. Logic Diagram
4. Instruction Manual for Instruments

4.2 Trouble Shooting Guide

When any anomalies, especially abnormal noise are heard and their causes are not easily found, shutdown the compressor as soon as possible.

In case the compressor is shutdown automatically by safety trip devices, check why it has happened. Then, if the compressor rotors are rotated smoothly by manual turning, perform a no-load operation to check the compressor.

It is impossible to anticipate every kind of trouble that is encountered during operation, but the following table may be helpful to work out causes of troubles, and to correct and remedy these troubles.

Table 5.4 Trouble shooting Check List 1/4

Troubles	Possible Causes	Remedy
1. Starting failure (Driver would not start by safety interlock)	a. Too much idling time of LO pump operation before starting compressor (30 sec.)	Stop lube oil pump and carry out manual turning of compressor to drain oil from compressor casing
	b. Slide valve is not at zero position	Return it to zero position by operating pump
	c. Low lube oil supply pressure	See 10, 11.
2. Low capacity	a. Low suction press.	See 5.
	b. High suction temp.	See 8.
	c. Bypass valve opened	Close the valve.
	d. Improper setting of capacity control signal from DCS failure	Check the signal.
3. Excessive power	a. High discharge pressure	See 4.
	b. Excessive load	Reduce load
4. High discharge press. – may cause blow-off of safety valve – may cause excessive power	a. Improper valve operation	Check block valve position. Correct if wrong.
	b. Clogging of 2nd oil separator	Replace elements
	c. Cooling water low flow or high temperature	Check water temperature and / or increase water.
5. Low suction pressure	a. Clogged suction filter	Clean or replace suc. strainer elements.
	b. Improper valve position.	Check suction valve correct if wrong.

Table 5.4 Trouble shooting Check List 2/4

Troubles	Possible Causes	Remedy
6. Popping of safety relief valve in discharge line (SV, 19EKH__AA005)	a. Increased discharge pressure	See 4.
	b. Incorrect setting of safety relief valve	Check setting pressure. Readjust if necessary.
	c. incorrect setting of interlock (CP003)	Check setting pressure. Correct if wrong.
7. High discharge temperature	a. High discharge press.	See 4.
	b. Insufficient injection oil flow	Raise oil pressure Open additional oil supply valve. (V221, V225,V229)
	c. High lube oil supply temperature	See 9.
	d. high suction temp.	Check suction gas temp.
8. Handled gas leakage	a. Loosening connecting bolts	Tighten bolts
	b. Damage of gaskets	Replace gaskets
	c. Safety valve leakage	Check safety valve
9. High lube oil supply temperature — may cause damage of bearings	a. Cooling efficiency of oil cooler reduced due to scale or dirt accumulation	Remove water channel of the cooler to clean inside of tubes.
	b. Low cooling water flow rate	Check temperature rise across a cooler. Increase water if rises too much.
	c. High c.water temp.	See 15.

Table 5.4 Trouble shooting Check List 3/4

Troubles	Possible Causes	Remedy
10. Low lube oil supply pressure — may cause damage bearing	a. Improper function of pressure regulating valve	Check the valve. Readjust if necessary.
	b. Oil leak through oil regulating valve due to incorrect setting or damage seat	Check setting value. Correct if wrong. Replace the valve and seat if necessary.
	c. Oil filter element clogged	Changeover filter. Clean or replace element.
	d. Oil pump failure	Remove pump and inspect parts for wear. See manual of oil pump. (19EKH__AP001)
	e. Low oil level of Oil Recovery Tank	See 14.
	f. Excessive oil flow demand	See 13.
	g. Gas stays at oil line before oil pump(10EKH_AP001)	Purge gas from vent valve.
11. Oil supply differential pressure (PdlZT-19EKH_CP007)	a. Discharge press. low	Check the downstream gas consumption.
	b. Suction press. high	Check upstream pressure control valve
	c. Lube oil supply press. low	See 10.
12. Lube oil pressure fluctuation	a. Improper function of oil press. regulating valve	Check and adjust / repair the valve
13. Excessive oil flow — may cause low lube oil pressure	a. Increase of bearing clearance	Check bearing clearance replace bearings if necessary.
	b. Additional oil supply valve opens	Adjust the valves(V221, V225,V229).
	c. High lube oil temp.	See 9.
14. Oil level decrease of Oil Recovery Tank	a. Oil leakage	Check for leakage. Correct if any.
	b. Deterioration of element in Oil Separator	Replace the element.
	c. Oil return line from Oil Separator to suction is blocked	Open the block valve. (V127,V128,V129,V130,V131 ,V132,V135)
	d. Excess mechanical seal leakage	See 17

Table 5.4 Trouble shooting Check List 4/4

Troubles	Possible Causes	Remedy
15. High cooling water temperature	a. Troubles on cooling water supply system	Check cooling water supply system. Decrease the temperature if possible.
16. Vibration — If serious vibration occurs, spectrum analysis should be made	a. Misalignment	Check alignment. Re-align correctly.
	b. Worn bearings	Check bearing clearances. Replace if necessary.
	c. Loosening of mounting bolts, foundation bolts	Tighten bolts. CAUTION: If the casing vibration alarm happens, please consult KOBELCO soon.
17. Oil leakage of mechanical seal	a. Damage of sealing face by dust etc.	Replacement of mechanical seal.
	b. Damage of O-ring	Replacement of O-ring
18. Abnormal noise — may produce serious accidents	a. Bearing seizure	Replace the bearing.
	b. Loosening of connection into compressor	Stop compressor and tighten them.
	c. Foreign materials come into compressor	Stop compressor and correct internals. Check suction gas filter.
	d. Misalignment or damaged shaft coupling	Stop compressor and correct alignment. Replace the coupling if necessary.
	e. Rotors rubbing with casing inner surface.	Stop and disassemble the compressor to replace bearings. Correct clearance.

5. Manual Turning Procedure

Turn the compressor manually before starting or long term shutdown to check whether the compressor is in good conditions or not, and to form oil film on the journal area.

When the compressor is shut down by emergency trip devices, it is advisable to check the damage of rotors by manual turning.

> WARNING:
> Before the manual turning, circuit breaker of the compressor must be turned off.

① Turning location

The coupling hubs are provided with drilled holes for turning.

② Turning tool

A turning bar is furnished as a special tool.

③ Procedure

Insert the special tool (turning bar) into the drilled hole on coupling hub.

Next turn the shaft slowly in normal direction, checking if there is any rubbing or sticking.

Table 5.5

LOG SHEET(1/1)

OPERATING DATA

DATE :

ITEM	ITEM.NO.	UNIT	DESIGN	RANGE	TIME		
SUCTION PRESSURE	19EKH__CP001	barA (barG)	10 (9)	10-17			
SUCTION TEMPERATURE	19EKH__CT001	℃	45	8-45			
DISCHARGE PRESSURE	19EKH__CP002	barA (barG)	27.5 (26.5)	-			
DISCHARGE TEMPERATURE	19EKH__CT002	℃	85	-			
OIL SEPARATOR DIFF.PRESS.	19EKH__CP002	bar	0.5	<1.0			
L.O. DIFFERENTIAL PRESSURE	19EKH__CP007	bar	17.5	10.5-17.5			
L.O. PRESS. BEFORE L.O. PUMP	19EKH__CP004	barG	26.5	-			
L.O. PRESS. AFTER L.O. PUMP	19EKH__CP005	barG	26.5	26.5-32.5			
L.O. FILTER DIFF. PRESSURE	19EKH__CP006	bar	0.5	<1.0			
L.O. TEMPERATURE	19EKH__CT003	℃	50	-			
L.O. LEVEL OF OIL RECOVERY TANK	-	mm	370	<450			
MOTOR COLD INNER AIR TEMP.	19EKH__AE001	℃	-	-			
MOTOR HOT INNER AIR TEMP.	19EKH__AE001	℃	-	-			
MOTOR POWER CONSUMPTION	19EKH__AE001	kW	498 St@45deg.C	≦550 St@45deg.C			
MOTOR / VOLTAGE	19EKH__AE001	V	6000	-			
MOTOR / CURRENT	19EKH__AE001	A	-	-			
SLIDE VALVE POSITION	19EKH__AS001	%	—	0-100			
SPILL BACK VALVE MV VALUE 1	19EKH__AA004	%	—	100-0			
ROTOR THRUST POSITION	19EKH__CY002	mm	0	<0.3			
CASING VIBRATION	19EKH__CY001	G	—	<2			
MECHANICAL SEAL DRAIN	9EKH__AN001	cc/hr	—	<36			

Chapter VI DISMANTLING AND ASSEMBLING PROCEDURE for KOBELCO SCREW COMPRESSOR (EH TYPE)

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5. Adjustment of Discharge End Plane Clearance between Casing and Rotor P.6- 20
6. Assembling and Dismantling of Mechanical Seal P.6- 22

1. Introduction

A KOBELCO SCREW COMPRESSOR is a precision machine. So, be careful not to make even a slight damage to the machine during overhaul. Especially cleanliness of parts is important.

CAUTION

The procedures presented in this chapter may not cover all requirements in assembly or disassembly. It is highly recommended to perform assembly or disassembly after instruction or under supervision of KOBE STEEL supervisor.

(1) The compressor should be lifted only with the heavy lifting lugs (hook). On lifting, slings should be used to distribute load evenly.

(2) Eyebolts furnished on the covers should not be used for lifting the whole compressor unit.

(3) Uneven tightening of bolts and nuts should be avoided.

Notes:

(1) Be careful not to miss any small parts.

(2) In dismantling the compressor, keep in mind to check how individual parts are assembled and to observe the conditions of the parts.

(3) The parts identification numbers in parentheses in the texts are indicated on COMPRESSOR SECTIONAL ASSEMBLY DRAWING and in COMPRESSOR PARTS LIST.

4. Assembling and Dismantling of Mechanical Seal

1 General Procedure of Dismantling

(1) Remove Labyrinth Ring from Gland Plate.
(2) Remove Gland Plate together with Primary Ring.
(3) Pull out Sleeve and Mating Ring from rotor shaft.
(4) Remove Mechanical Seal Box together with FS Seal.
(5) Pull out Spacer Sleeve from rotor shaft.

2 General Procedure of Assembling

(1) Install Mechanical Seal Box together with FS Seal.
(2) Install Spacer Sleeve, Mating Ring and Sleeve to rotor shaft.
(3) Install Gland Plate together with Primary Ring.
(4) Install Labyrinth Ring to Gland Plate.

APPENDIX

P&ID
GENERAL ARRANGEMENT
Piping Drawing
Foundation Drawing

DISMANTLING AND ASSEMBLING MANUAL FOR KOBELCO SCREW COMPRESSOR

Contents

1. Introduction 1
2. General Procedure of Dismantling 2
3. General Procedure of Assembling 8
4. Adjustment of Thrust Clearance of Tilting Pad Thrust Bearing 17
5. Adjustment of Discharge End Plane Clearance between Casing & Rotor 18

1 Introduction

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(2) In dismantling the compressor, keep in mind to check how individual parts are assembled and to observe the conditions of the parts.

(3) The parts identification numbers in parentheses in the texts are indicated on COMPRESSOR SECTIONAL ASSEMBLY DRAWING and in COMPRESSOR PARTS LIST.

2 General Procedure of Dismantling

(1) Remove the coupling cover.

(2) Loosen the tightening bolts of the coupling and remove the center spool unit.

(3) Disconnect and remove piping, fittings and instruments from the compressor.

(4) Remove the thermocouples for the journal and thrust bearings from the compressor, if any.

(5) Disconnect cables of the vibration and axial displacement detectors, if any.

(6) Remove axial displacement detector, if any.

(7) Disconnect cable of the slide valve position meter.

(8) Prior to dismantling the compressor, record cold shaft alignment.

(9) Dismount the compressor from the baseplate.

(10) Remove End Plate (A09) and pull out coupling hub from the shaft.

(11) Remove Mechanical Seal from Inlet Casing (B01).
See "Assembling and Dismantling of Mechanical Seal" & "Instruction of Mechanical Seal".

(12) Loosen the stud bolts and nuts between 1st stage Side Casing (B04) and 2nd stage Inlet Casing (B01), then divide into 1st stage and 2nd stage.
Dismantle the 1st stage and 2nd stage with the same procedure.

(13) Remove slide valve position meter from Cylinder Head (D31).
See "Slide Valve Position Meter Assembly Drawing".

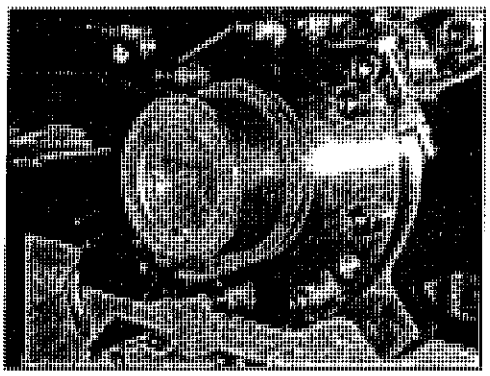

Fig. 2-1

(14) Remove Cylinder Head (D31) together with Ball Bearing (D33) and Spindle (D36) from Inlet Casing (B01).

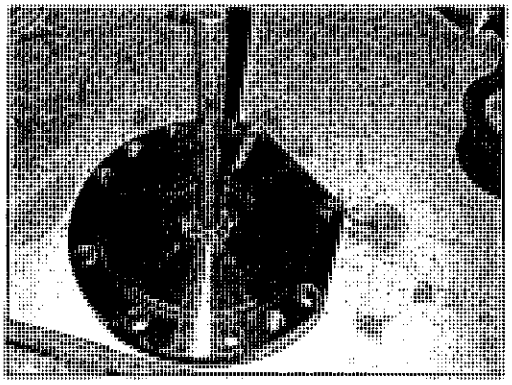

Fig. 2-2

(15) Remove Lock Nut (K33) by the hook spanner (special tool), and remove Piston (D04) and Pin (D06) from Rod (D03).

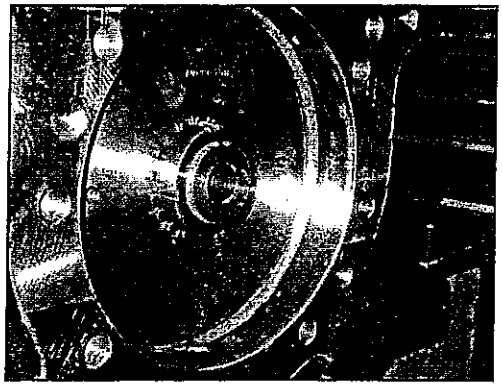

Fig. 2-3

(16) Remove Inlet End Cover (B05) from Inlet Casing (B01).

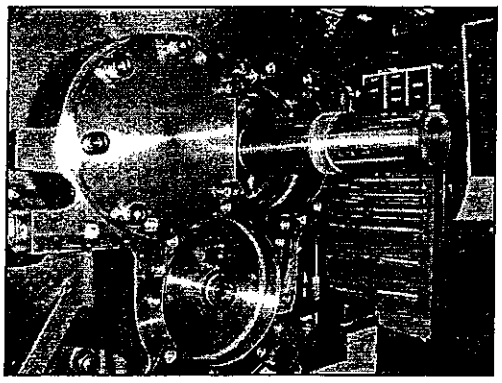

Fig. 2-4

(17) Remove Balance Piston Cover (B06), (B07) and Piston Ring (B08), (B09) from Side Casing (B04).

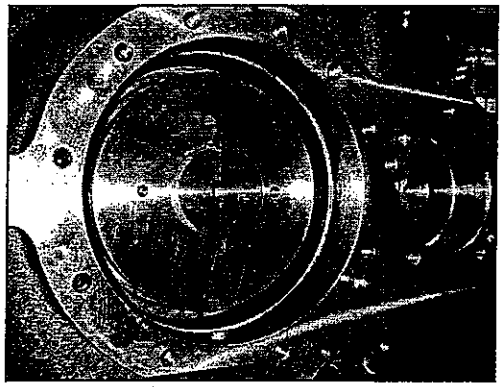

Fig. 2-5

(18) Remove Lock Nut (K34), (K35) by the hook spanner (special tool), and remove Balance Piston (A03), (A04) from rotor shaft.

(19) Remove Bush Retainer (A21), (A22) and Bush (A19), (A20) from Side Casing (B04).

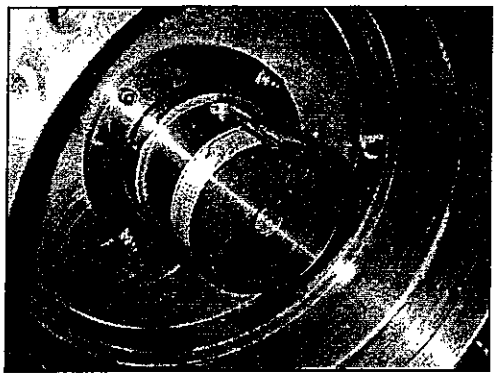

Fig. 2-6

(20) Remove Side Casing (B04) from Discharge Casing (B03).

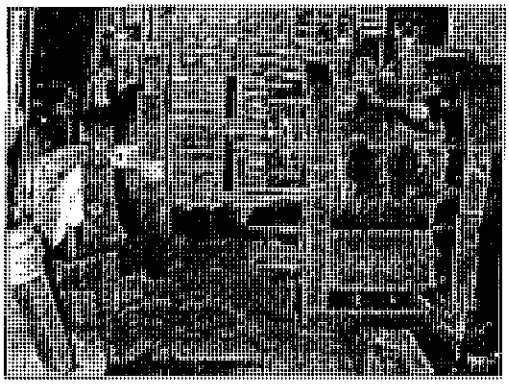

Fig. 2-7

(21) Remove Oil Injection Tube (D10) from Discharge Casing (B03).

(22) Remove Lock Nut (K31), (K32) by the hook spanner (special tool).

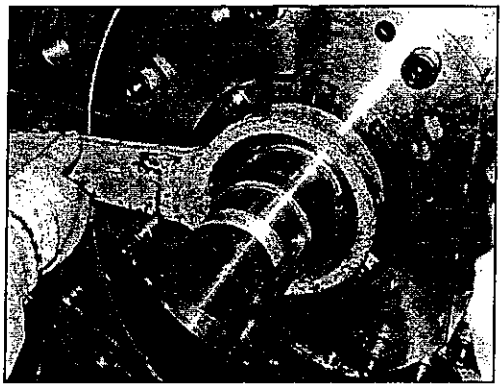

Fig. 2-8

(23) Remove Thrust Bearing Box Cover (C07), (C08) together with Bush (C19), (C20) and inactive side Thrust Bearing (C15), (C16).

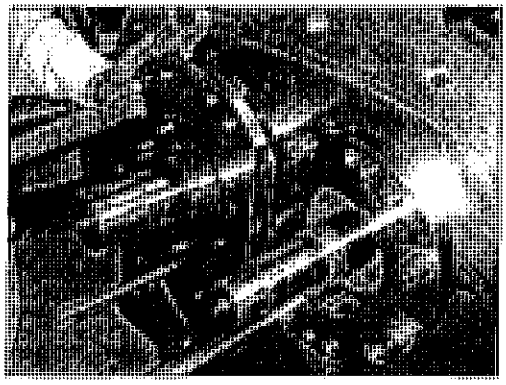

Fig. 2-9

(24) Remove Thrust Adjusting Plate (C11), (C12).

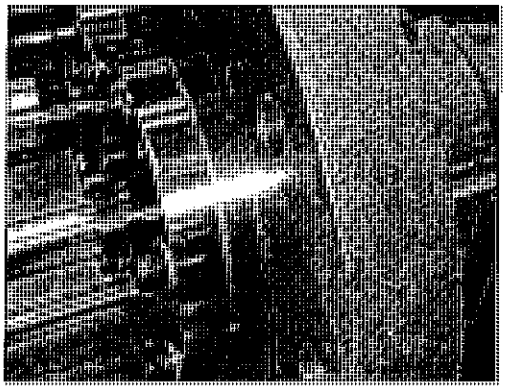

Fig. 2-10

(25) Remove Sleeve (A05), (A06) from rotor shaft.

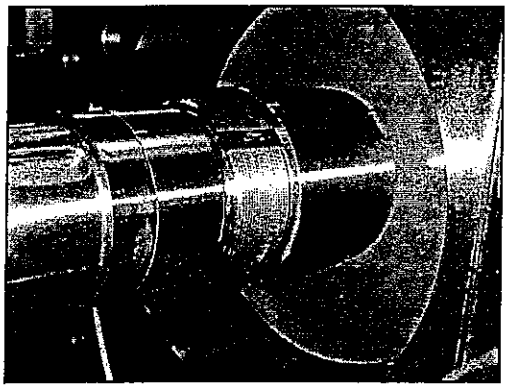

Fig. 2-11

(26) Remove Thrust Bearing Box (C05), (C06) together with Thrust Disc (A07), (A08) and active side Thrust Bearing (C13), (C14) and Bush (C19), (C20).

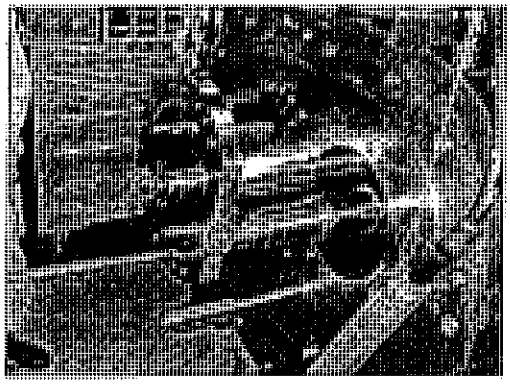

Fig. 2-12

(27) Remove Adjusting Plate (C09), (C10).

(28) Erect the compressor vertically with Inlet Casing (B01) upper side. (Refer to Fig.4-1)

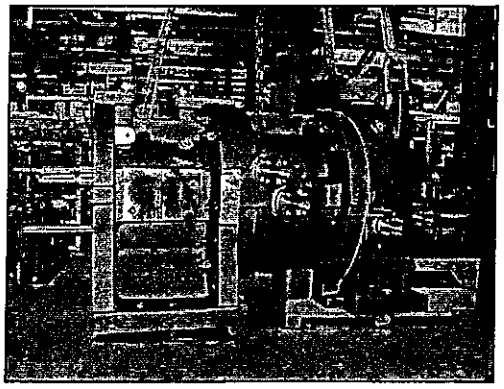

Fig. 2-13

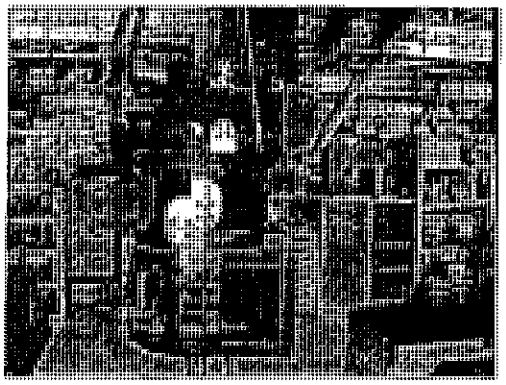

Fig. 2-14

(29) Loosen the bolting and lift up Inlet Casing (B01) from Rotor Casing (B02).

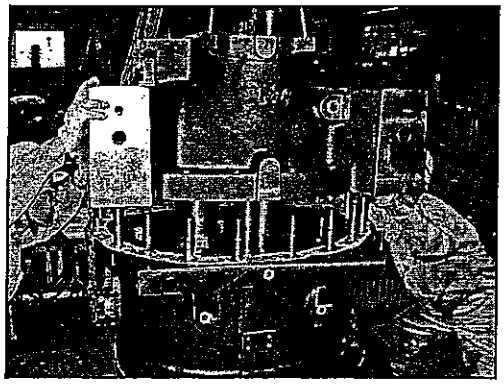

Fig. 2-15

(30) Install eyebolts to the upper end of each Rotors, then lift up Rotors (A01), (A02) from Rotor Casing (B02).

Fig. 2-16

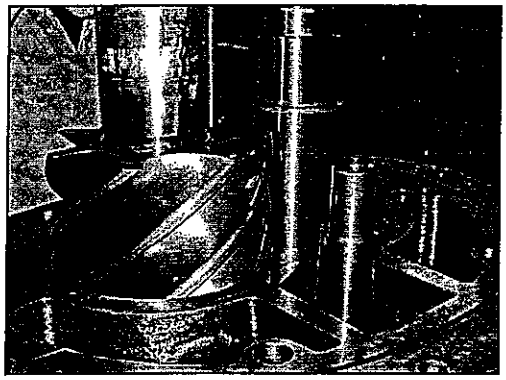

Fig. 2-17

(31) Arrange the compressor horizontally.

(32) Remove Discharge Casing (B03) from Rotor Casing (B02).

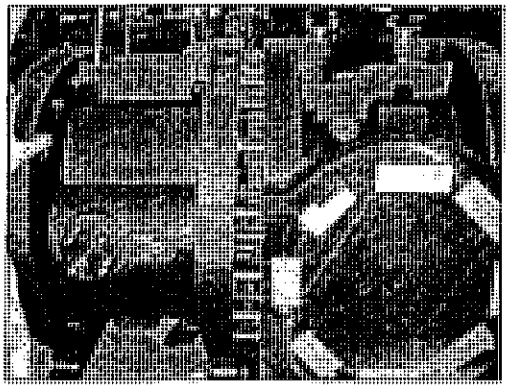

Fig. 2-18

(33) Remove Rod (D03) and Guide Pipe (D11) from Slide Valve (D02).

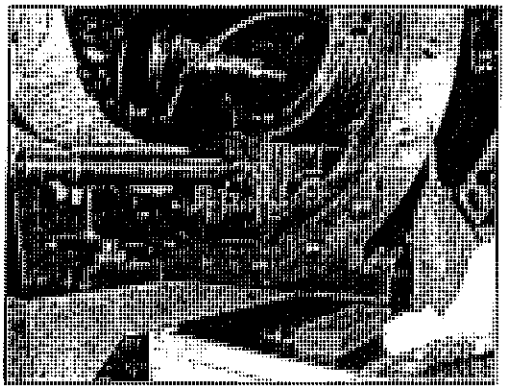

Fig. 2-19

(34) Lifting up Slide Valve (D02) by sling, remove it from Rotor Casing (B02).

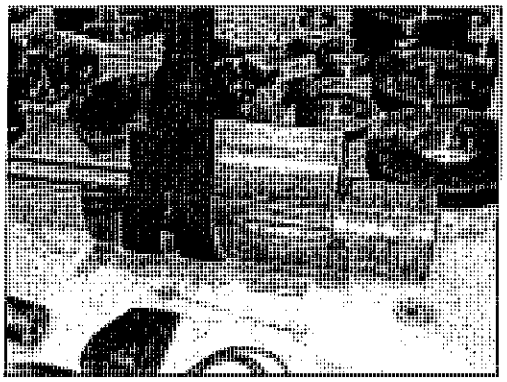

Fig. 2-20

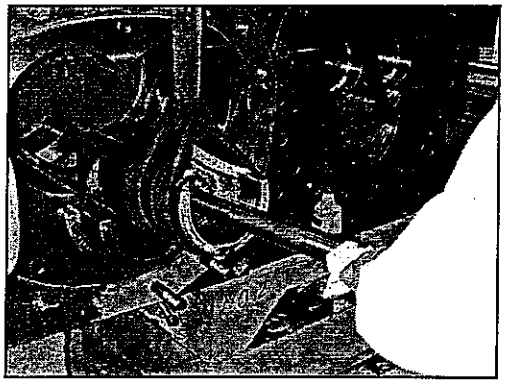

Fig. 2-21

(35) Remove Adjusting Bar Retainer (B13), Adjusting Bar (B12) and Guide Block (B11) from Rotor Casing (B02).

Fig. 2-22

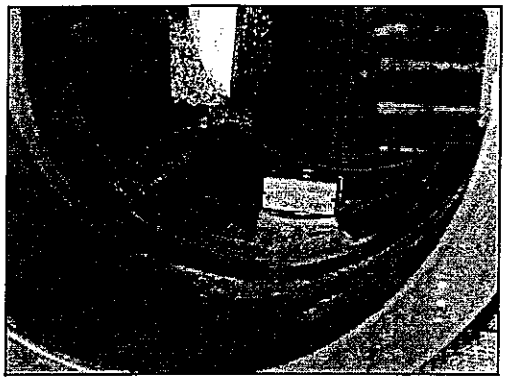

Fig. 2-23

(36) Remove Valve Guide (B10) from Rotor Casing (B02).

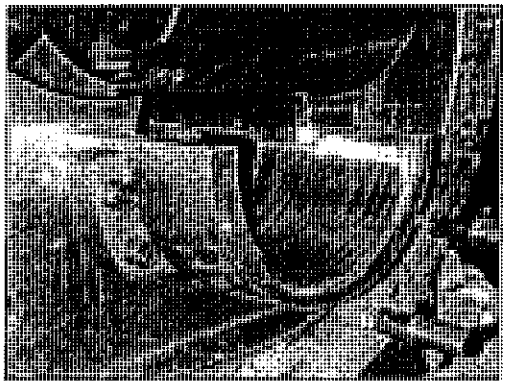

Fig. 2-24

(37) Remove Seal Ring Retainer (D42) and Seal Ring (D41) from Inlet Casing (B01).

(38) Remove Journal Bearing (C01) ~ (C04) from Inlet and Discharge Casing (B01) (B03).
See "Assembling and Dismantling of MS·FS Bearing" and "Assembling and Dismantling of MD·FD Bearing".

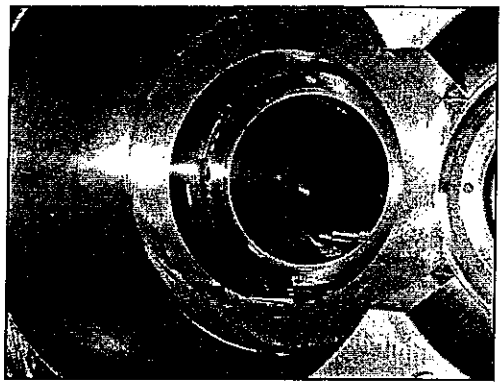

Fig. 2-25

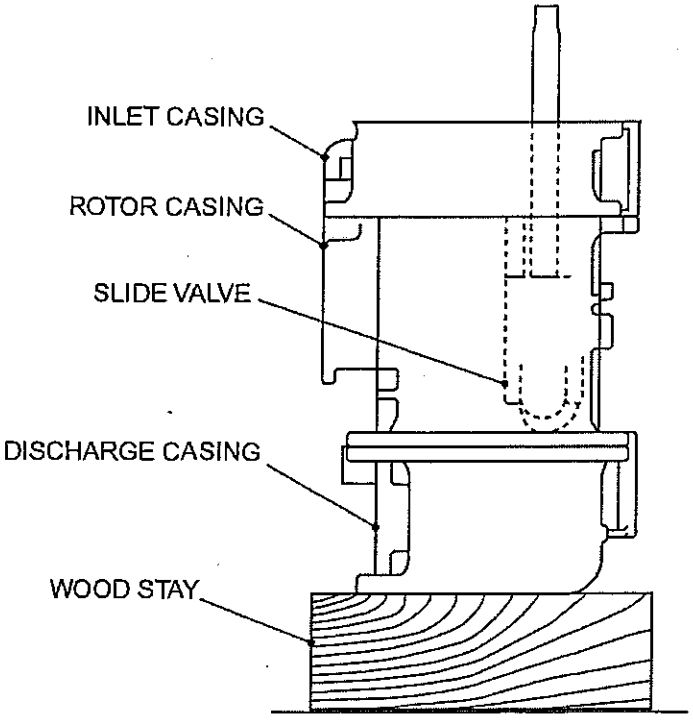

Fig. 4-1

3 General Procedure of Assembling

The compressor should be assembled with dismounted from the common baseplate.

(1) Install the suction side Journal Bearings (C01) (C02) to Inlet Casing (B01) adjusting pin position.
See "Assembling and Dismantling of MS·FS Bearing".

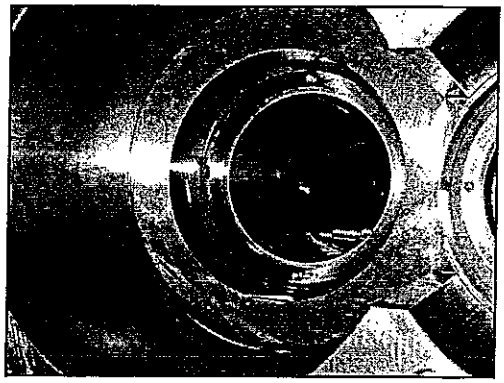

Fig. 3-1

(2) Install the discharge side Journal Bearings (C03) (C04) to Discharge Casing (B03) adjusting pin position.
See "Assembling and Dismantling of MD·FD Bearing". Refer to Fig. 3-1.

(3) Set the Valve Guide (B10) to Rotor Casing (B02) and drive the dowel pin.

NOTE:

Removal of Valve Guide (B10) is not required at dismantling.

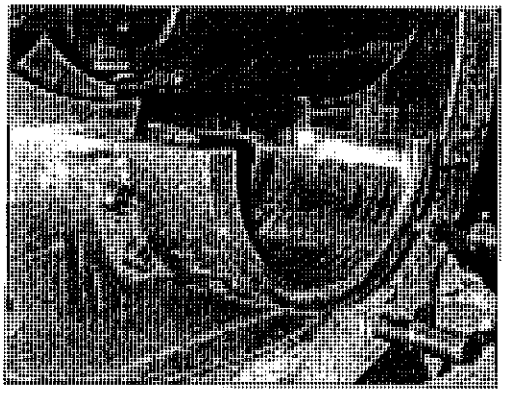

Fig. 3-2

(4) Install Guide Block (B11) (Fig. 3-3), Adjusting Bar (B12) and Adjusting Bar Retainer (B13) (Fig. 3-4) to Rotor Casing (B02).

Fig. 3-3

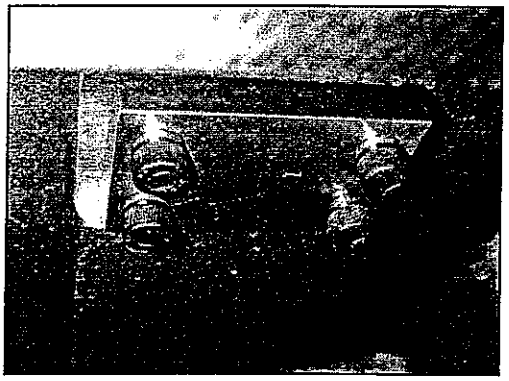

Fig. 3-4

(5) Install Slide Valve (D02) by sling to Rotor Casing (B02).

Fig. 3-5

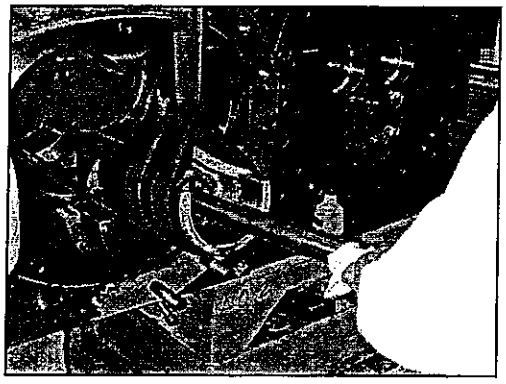

Fig. 3-6

(6) Combine Rod (D03) and Guide Pipe (D11) with Slide Valve (D02) from suction side.

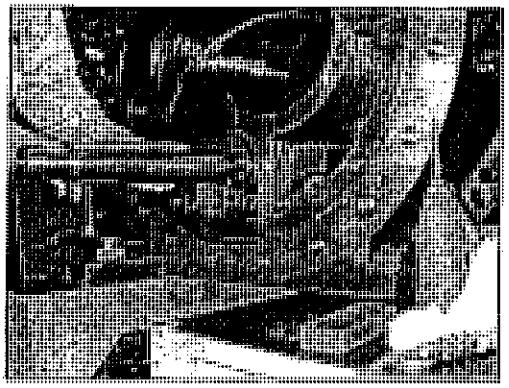

Fig. 3-7

(7) Install stud bolts on Discharge Casing (B03) (Fig. 3-9) and Rotor Casing (B02) (Fig. 3-8). Place O-ring (B15) in the groove and apply Three Bond to the flange surface of Rotor Casing (B02) (Fig, 3-8).

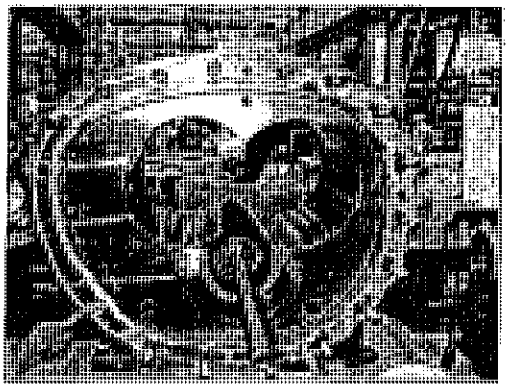

Fig. 3-8

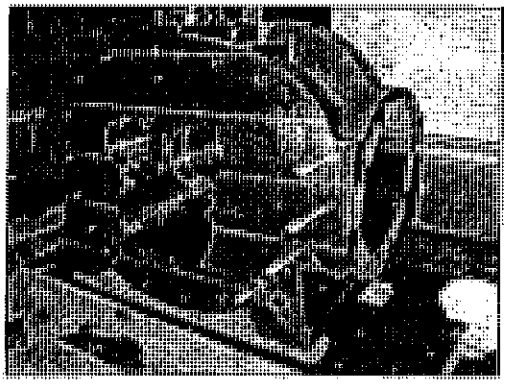

Fig. 3-9

Combine Discharge Casing (B03) with Rotor Casing (B02) (Fig. 3-10).

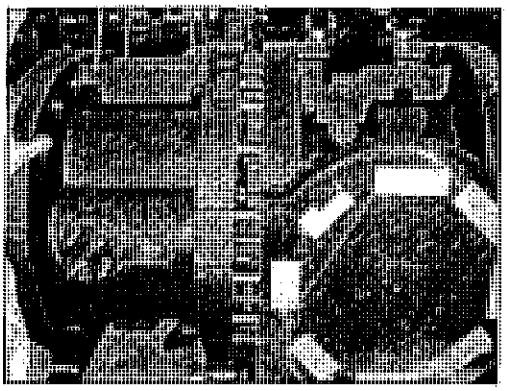

Fig. 3-10

Drive the dowel pin (Fig. 3-11)

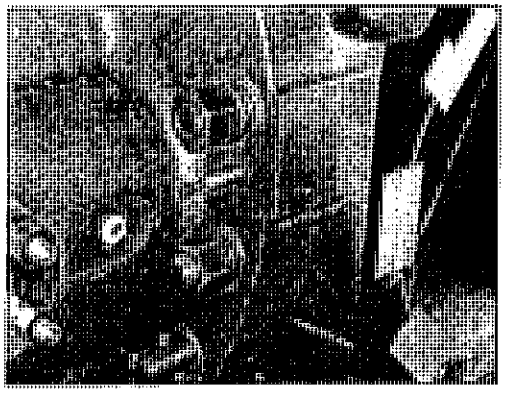

Fig. 3-11

Tighten the nuts (Fig. 3-12).

Fig. 3-12

(8) Erect the compressor vertically with Rotor Casing (B02) upper side (Fig. 3-13), and lift down Rotors (A01), (A02) into the Rotor Casing (B02) (Fig. 3-16, 3-17) aligning the match marks (Fig. 3-14, 3-15) on the discharge end of each rotor.

> **⚠ WARNING**
>
> Be careful not to injure hands due to rotating rotor at assembly.

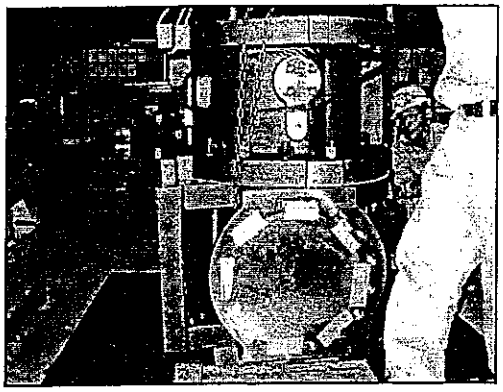

Fig. 3-13

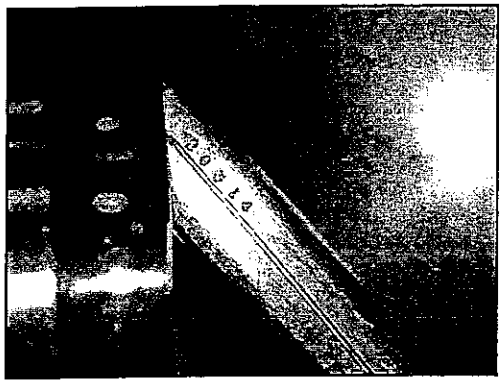

Fig. 3-14

Fig. 3-15

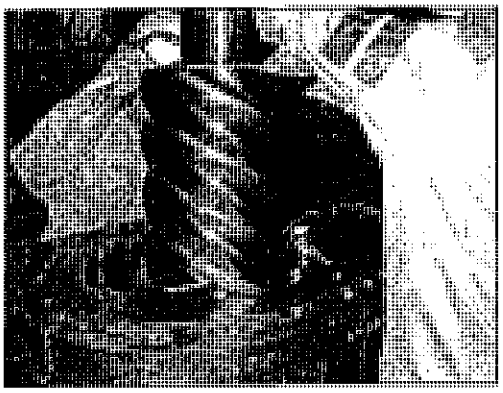

Fig. 3-16

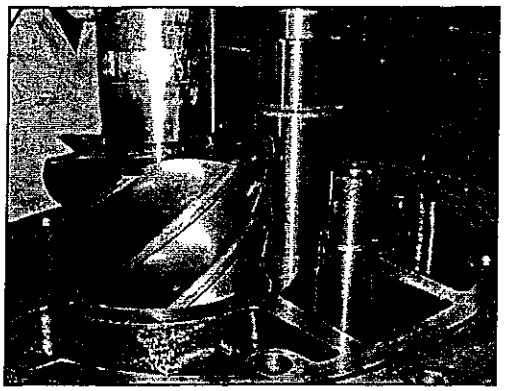

Fig. 3-17

(9) Install stud bolts on Rotor Casing (B02). Place O-ring (B16) in the groove and apply Three Bond to the flange surface of Rotor Casing (B02) (Fig, 3-18).

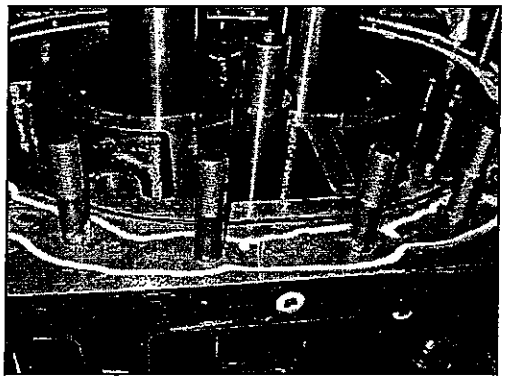

Fig. 3-18

Combine Inlet Casing (B01) with Rotor Casing (B02) (Fig. 3-19).

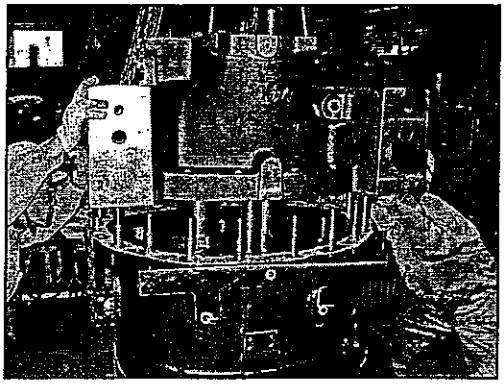

Fig. 3-19

Drive the dowel pin and tighten the nuts (Fig. 3-20).

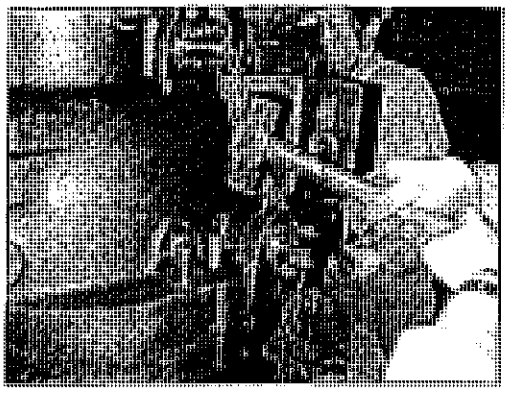

Fig. 3-20

(10) Arrange the compressor horizontally.

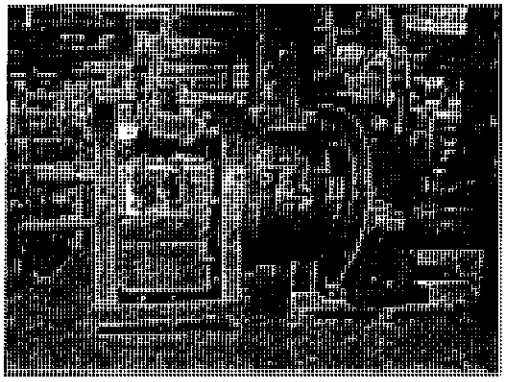

Fig. 3-21

(11) Measure and record each end plane clearance between the rotors and the casing.

(12) Combine Thrust Bearing Box (C05), (C06) with Bush (C19), (C20) and active side Thrust Bearing (C13), (C14).

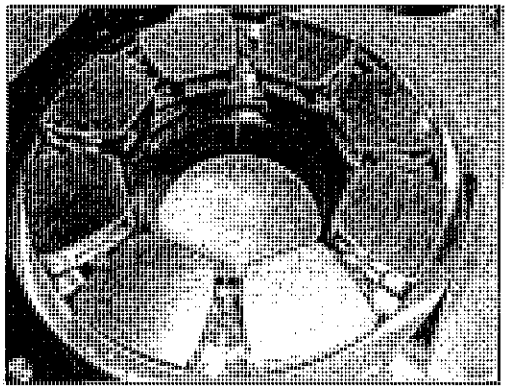

Fig. 3-22

(13) Install Thrust Bearing Box (C05), (C06) together with Adjusting Plate (C09), (C10) to Discharge Casing (B03).

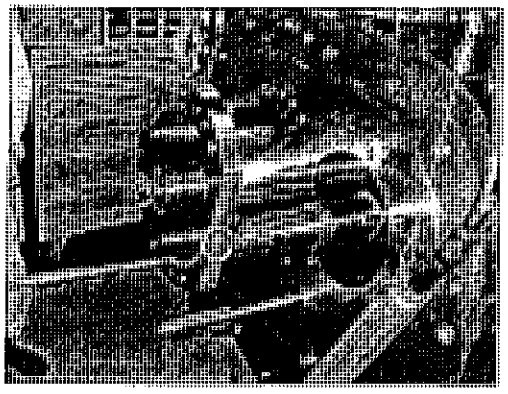

Fig. 3-23

(14) Install Thrust Disc (A07), (A08) (Fig. 3-24) and Sleeve (A05), (A06) (Fig. 3-25) to rotor shaft.

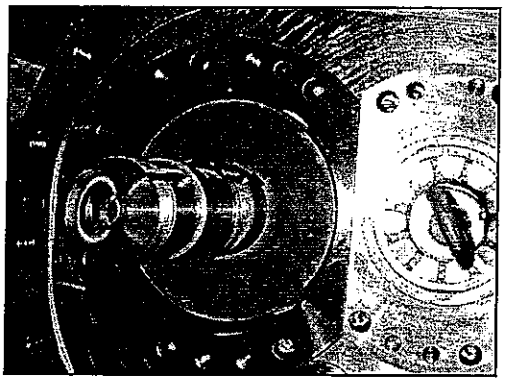

Fig. 3-24

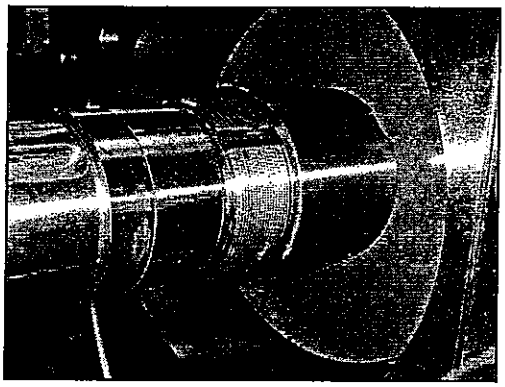

Fig. 3-25

(15) Combine Thrust Bearing Box Cover (C07), (C08) with Bush (C19), (C20) and inactive side Thrust Bearing (C15), (C16).

(16) Install Thrust Bearing Box Cover (C07), (C08) (Fig. 3-27) together with Thrust Adjusting Plate (C11), (C12) (Fig. 3-26) to Discharge Casing (B03).

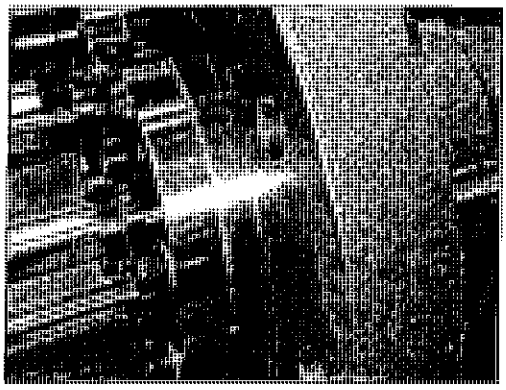

Fig. 3-26

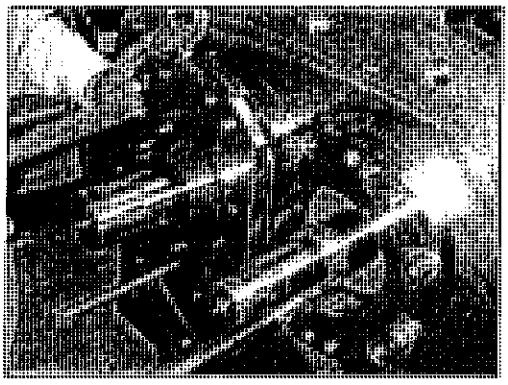

Fig. 3-27

(17) Fix the Sleeve (A05), (A06) by Lock Nut (K31), (K32) (Fig. 3-29) and Lock Washer (L21), (L22) (Fig. 3-28, 3-30) using special tool.

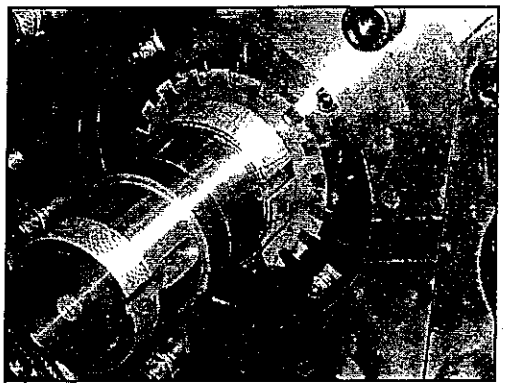

Fig. 3-28

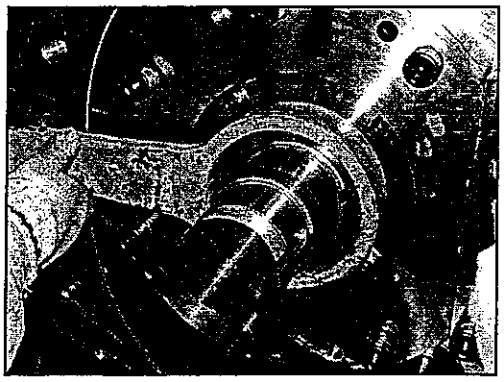

Fig. 3-29

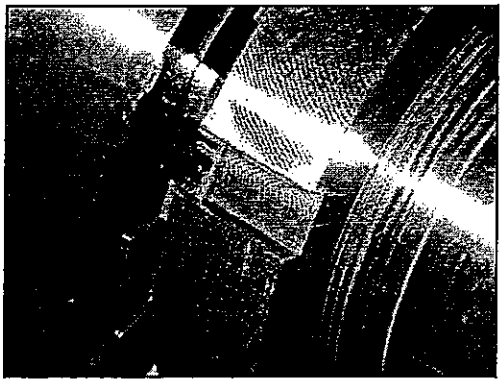

Fig. 3-30

(18) Adjust the thrust clearance and discharge end plane clearance by grinding Adjusting Plates (D09) ~ (C12), if necessary. See "Adjusting Clearance and Dimension" of the compressor sectional assembly drawing.

(19) Install Oil Injection Tube (D10) to Discharge Casing (B03).

(20) Install stud bolts on Discharge Casing (B03). Place O-ring (B17) in the groove and apply Three Bond to the flange surface (Fig, 3-31).

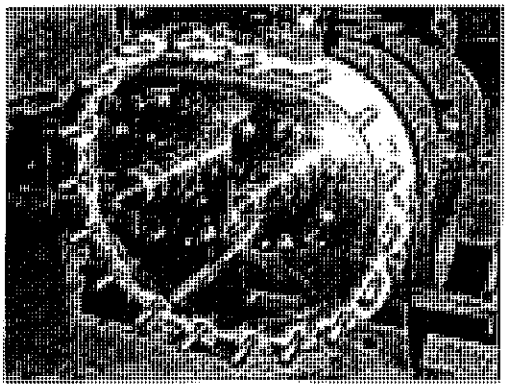

Fig. 3-31

Combine Side Casing (B04) with Discharge Casing (B03) (Fig. 3-32).

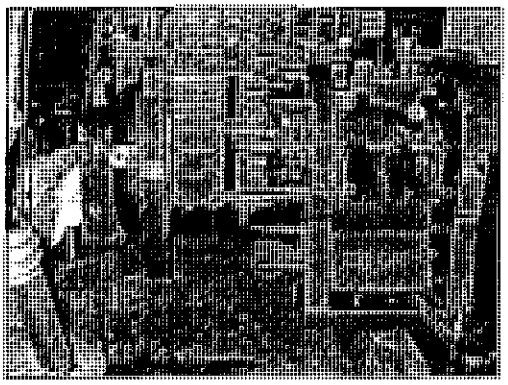

Fig. 3-32

Drive the dowel pin (Fig. 3-33) and tighten the nuts (Fig. 3-34)

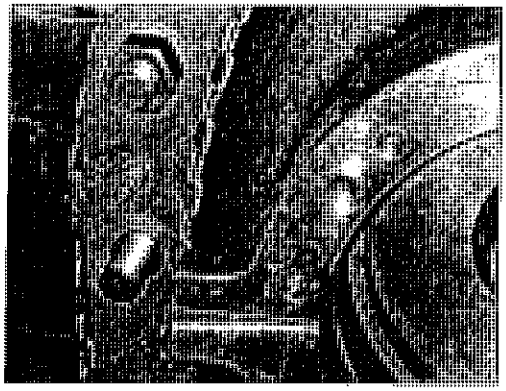

Fig. 3-33

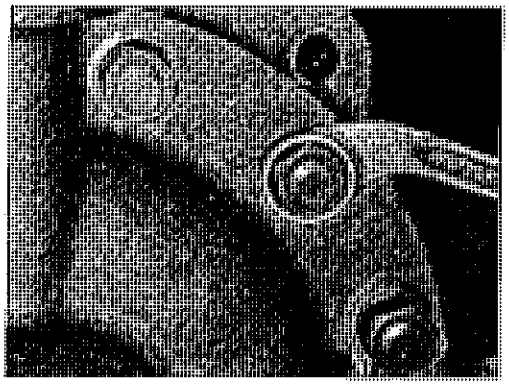

Fig. 3-34

(21) Install Bush (A19), (A20) (Fig. 3-35) and Bush Retainer (A21), (A22) (Fig. 3-36) to Side Casing (B04).

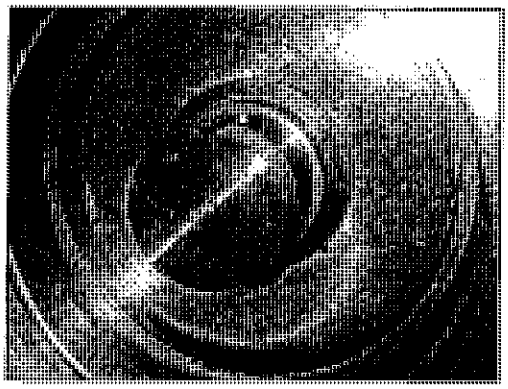

Fig. 3-35

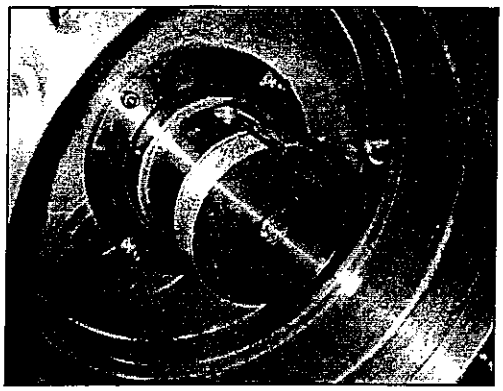

Fig. 3-36

(22) Install Balance Piston (A03), (A04) on the rotor shaft and fix them by Lock Nut (K34), (K35) and Lock Washer (L23), (L25) using special tool.

(23) Install Piston Ring (B08), (B09) (Fig. 3-38) and Balance Piston Casing (B06), (B07) (Fig. 3-37) to Side Casing (B04).

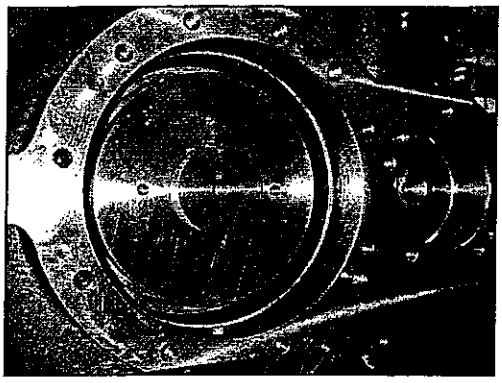

Fig. 3-37

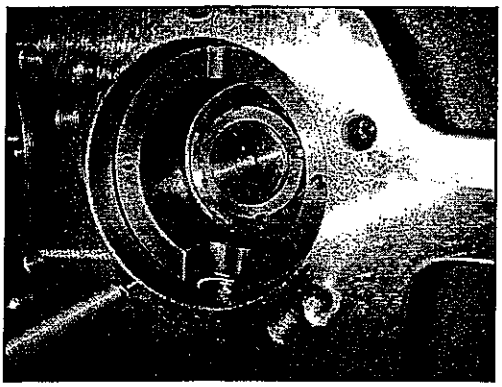

Fig. 3-38

(24) Install Seal Ring (D41) (Fig. 3-40) and Seal Ring Retainer (D42) (Fig. 3-39) to Inlet Casing (B01).

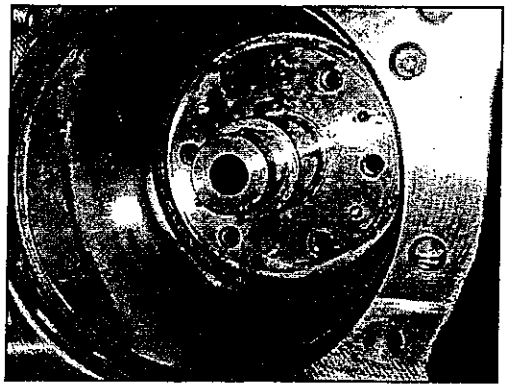

Fig. 3-39

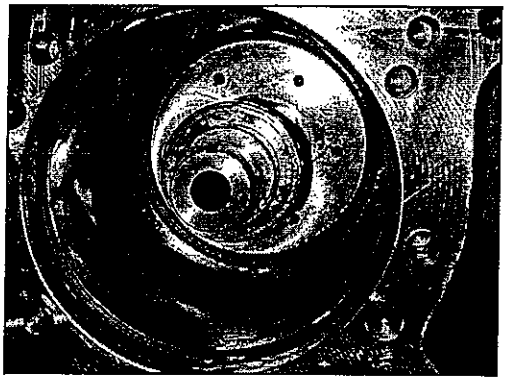

Fig. 3-40

(25) Install Pin (D06) and Piston (D04) with O-ring to Rod (D03) and fix them by Lock Nut (K33) and Lock Washer (L24) using special tool.

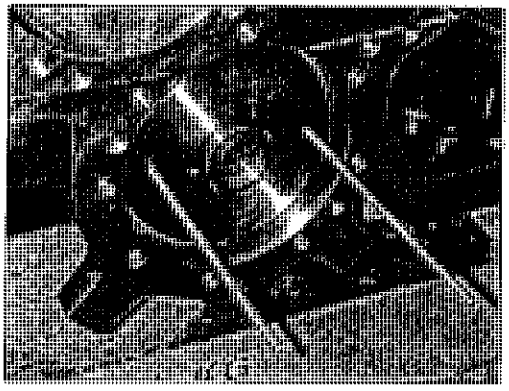

Fig. 3-41

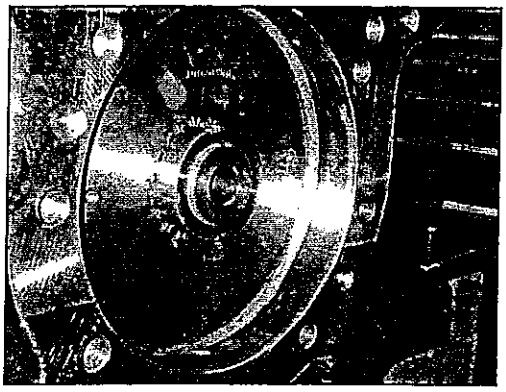

Fig. 3-42

(26) Combine Cylinder Head (D31) (Fig. 3-43) with Ball Bearing (D33) and Spindle (D36).
Fix Ball Bearing (D33) by Snap Ring (L01).

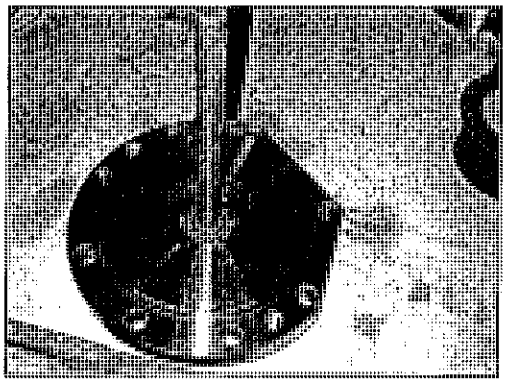

Fig. 3-43

(27) Install Cylinder Head (D31) to Inlet Casing (B01) rotating Spindle (D36) to fit Pin (D06).

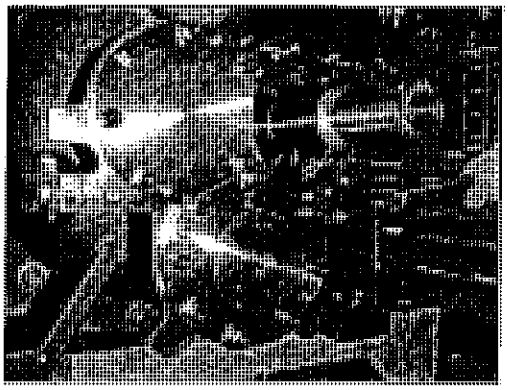

Fig. 3-44

(28) Set slide valve position meter to Cylinder Head (D31).
See "Slide Valve Position Meter Assembly Drawing."

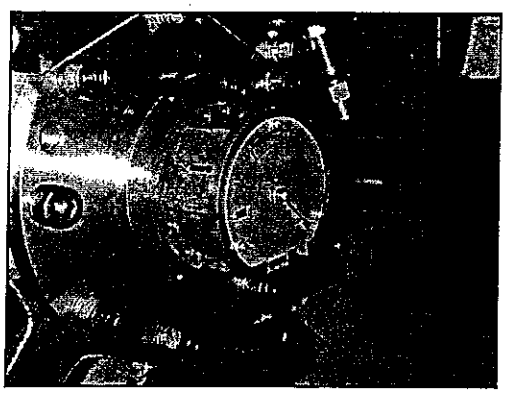

Fig. 3-45

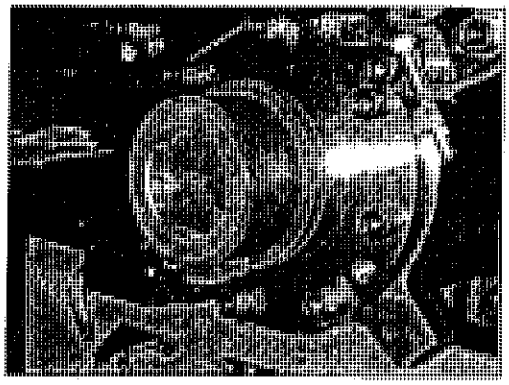

Fig. 3-46

(29) Install Inlet End Cover (B05) to Inlet Casing (B01).

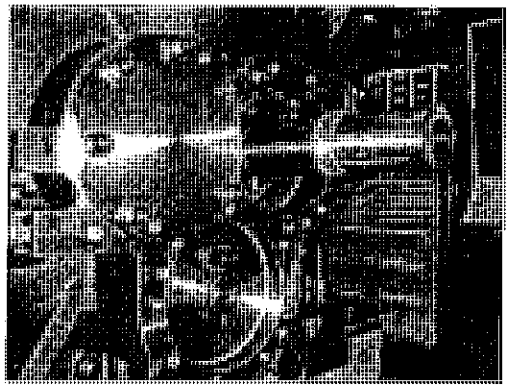

Fig. 3-47

(30) Combine 1st stage and 2nd stage.

(31) Install Mechanical Seal to Inlet Casing (B01).
See "Assembling and Dismantling of Mechanical Seal" & "Instruction of Mechanical Seal".

(32) Fix the Mechanical Seal Sleeve by Lock Nut.

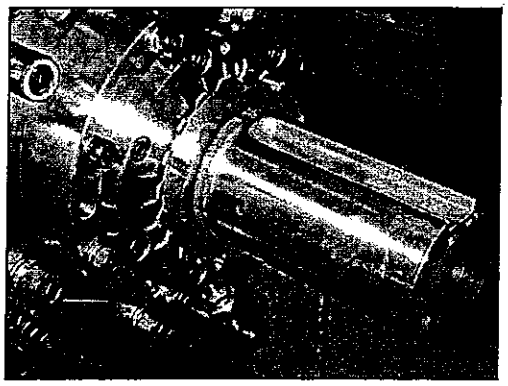

Fig. 3-48

(33) Install coupling hub and End Plate (A09) to the shaft.

(34) Confirm carefully unnecessary onto the baseplate.

(35) Mount the compressor onto the baseplate.

(36) Confirm parallel offset and angular misalignment between the coupling halves, and adjust them to allowable values, if necessary.

(37) Connect cable of the slide valve position meter.

(38) Install the thermocouples for the journal and thrust bearings to the compressor, if any.

(39) Install axial displacement detector, if any.

(40) Connect cables of the vibration and axial displacement detectors, if any.

(41) Connect or install instruments, piping, and fittings to the compressor.

4 Adjustment of Thrust Clearance of Tilting Pad Thrust Bearing

DOUBLE ACTION TILTING PAD THRUST BEARING

Refer to "Adjustment of Discharge End Plane Clearance between Casing and Rotor", as well.

(1) Check the following parts:

a. Thrust disc
Although the thrust disc is finished by polishing and lapping, it is necessary to check that the thrust bearing sliding surface of the thrust disc is sufficiently smooth and free from damage.

b. Thrust Bearing Pad
Check that the thrust bearing pads are free from damage on the surface.

(2) Insert a shim between the outlet casing and thrust bearing box with such a thickness that the rotor keeps clearances from both side casing end planes.
If the rotors are not replaced with new ones, the original adjusting plates may be employed as the shim.

(3) Apply a dial gage to the rotor shaft end.

(4) Move the rotors in both axial directions and measure the displacement of the rotors. This displacement is "thrust clearance of C". (Fig.4-2)

(5) If the measured thrust clearance is found smaller than the required thrust clearance, replace the thrust adjusting plate between the thrust bearing box cover and the thrust bearing box with thicker one. It is allowed to add shims cut into the shape of the thrust adjusting plate to the existing thrust adjusting plate, But it is preferable to use a new thicker thrust adjusting plate.

(6) If the thrust clearance is found larger than the required thrust clearance , polish the surface of the thrust adjusting plate to reduce the thickness.

(7) Replacement of Thrust Pads
When the thrust bearing pads are damaged, replace them with new ones. Loosening Thrust pad stops the thrust pads can be taken out. Be noted that the tilting pad thrust bearings furnished for male active and female active side may be different. Install thrust pads and thrust pad stops with care that they are correctly located and positioned.

5 Adjustment of Discharge End Plane Clearance between Casing and Rotor

DOUBLE ACTION TILTING PAD THRUST BEARING

(1) Place the rotor in the casing, and push the rotor toward the discharge side so that the discharge end plane clearance becomes zero. (See Fig. 4-2)

(2) Then, pull the thrust bearing box ② outboard until the active side thrust bearing comes in contact with the thrust disc.

(3) At this stage, measure the clearance between the thrust bearing box and the discharge casing flange where the adjusting plate ④ is to be inserted. The thickness of the adjusting plate ④ , Y, should be:

$$Y = X - A \text{ mm}$$

where, A is the required discharge end plane clearance, and X is the measured clearance.
Accordingly, grind to adjust the adjusting plate ④ so that its thickness becomes Y mm. Then, insert it into the clearance between the thrust bearing box and the outlet casing.

(4) The final checking should be carried out with the adjusting plate ④ in place as follows:
Sufficiently loosen the bolts that are fastening the thrust bearing box. Push the rotor shaft toward the suction side until it ceases moving, and set the dial gage to zero. Then move the rotor shaft toward the discharge side until it ceases moving, and read the indication of the dial gage. This indication is "DISCHARGE END PLANE CLEARANCE".
If it is found smaller than the required clearance, reduce the thickness of the adjusting plate ④ accordingly. If it is found larger than the required clearance, replace the adjusting plate ④ with thicker one or add shims if replacement on site is impossible. However, in principle, adjustment should be preformed with a new thicker adjusting plate.

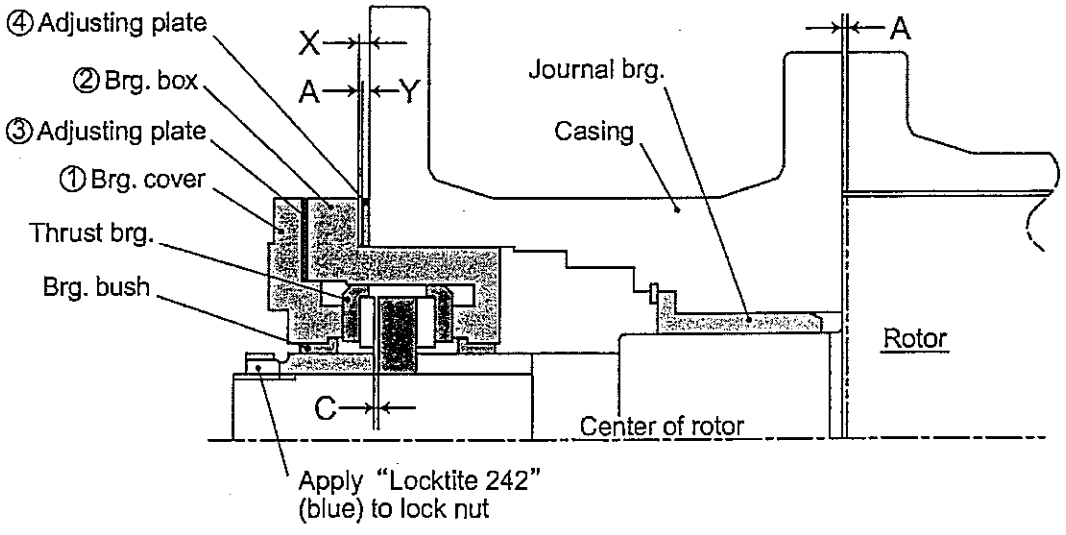

Fig. 4-2

⚠ CAUTION

An excessively large discharge end plane clearance affects remarkably the discharge capacity of the compressor, and an excessively small clearance causes a contact of the rotor end plane with the casing. Therefore, care should be taken.

Then fix the thrust bearing box with the bolts.
Applying a dial gage to the rotor shaft end, fully push the rotor shaft toward the suction side. Then, set the dial gage to zero. And then move the rotor toward the discharge side. The obtained dial gage reading is called "THRUST CLEARANCE".

Assembling and Dismantling of Mechanical Seal

Mechanical Seal Type : 8B1V with segmental bushing