Centac C700

Process Air Solutions ESA

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Basic Frame Description

Ingersoll Rand
Industrial Technologies

1 Introduction

The CENTAC C700 compressor is a reliable and efficient integrally geared multistage centrifugal compressor that is designed to provide oil-free compressed air or nitrogen, for indoor or outdoor under roof installations in non hazardous areas.

CENTAC compressors are designed as fully packaged units including an air end, a driver, an Ingersoll Rand developed state-of-the-art control panel with microprocessor, an air cooling system and a self-contained lubrication systems, all mounted on a common fabricated steel baseplate.

Some of the outstanding features and benefits are:

Standard features	*Benefits*
Compact package on rigid baseplate	No special foundation required
Mounted intercoolers and aftercooler	Compact efficient design
Baseplate mounted control panel	Pre-wired and factory tested
Fewest electrical hook-ups	Minimal installation time and cost

2 CENTAC Principles of Operation

Air enters the compressor through the machine mounted inlet control valve and flows to the first stage where the impeller (1) imparts velocity to the air. The air proceeds through the stationary diffuser section (2) where the kinetic energy (velocity) is converted to static energy (pressure). The built-in inter-cooler (3) removes the heat of com-pression and improves compressor's ef-ficiency. Air then passes through a stainless steel moisture separator (4) in a low velocity zone to remove con-densate. Entrained moisture in the air is reduced when the air is forced through stainless steel moisture separators. This sequence repeats in each succeeding stage until the compressor achieves the desired operating pressure.

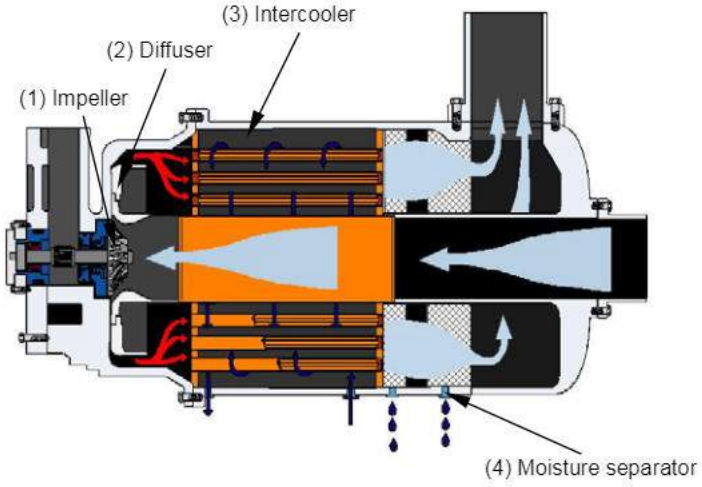

Fig. 1: CENTAC principles of operation

3 General Description

The compressor package contains:

- Two or three high efficiency compression stages, each consisting of an impeller mounted on its own shaft, enclosed within a common cast iron casing.
- A flange or baseplate mounted electric motor coupled to the compressor through a coupling that compensates for angular misalignments between shafts. The motor directly drives a bullgear that is common to all stages.
- Rotors consisting of an integral pinion gear, driven at its optimum speed by the bullgear, and an impeller.
- One or two intercoolers and one aftercooler (except for high pressure units from 12.0 to 18.0 bar(A)).

- A moisture separator and a moisture removal system to remove condensate (not applicable on nitrogen units).

4 Air End

The air end of CENTAC compressor consists of following main components:

- Casing, including:
  - gear casing
  - gear casing cover
  - stage heads
- Gearings
- Rotor assemblies
- Impeller
- Diffusers
- Bearings

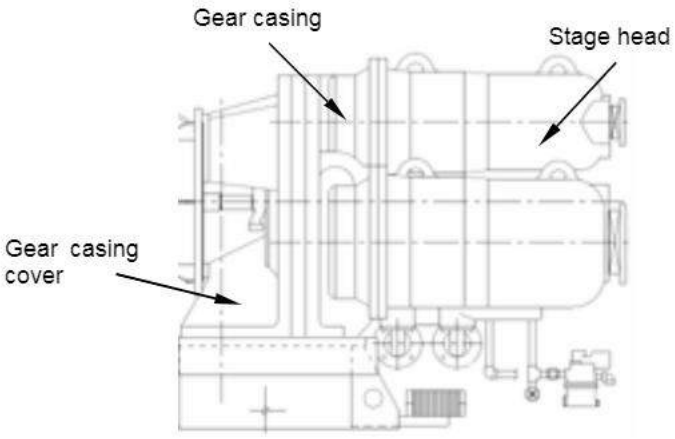

Fig. 2: C700 Air End

4.1 Casing

The casing consists of two halves (gear casing and gear cover) that are bolt together to make-up the linebore. The gear cover is located on the motor side, while the gear casing is located on the compressor side. The vertical split allows an easy insertion and removal of bearings and rotor assemblies without disassembling the gear casing.

Stage heads are bolted to the gear casing and can be easily removed for servicing or inspection. Inlet, discharge and by-pass flanges are integral with the inlet and discharge head covers, providing maximum rigidity and minimum stress on running parts. Inlet and discharge water connection for each cooler are integral with the cooler covers.

On hot discharge units a crossover connects the 2nd stage discharge to the inlet of the 3rd stage head.

4.2 Gearings

Built-in precision helical gearings (AGMA 12) consist of a bull-gear directly coupled to the driver and individual pinion gear for each stage, sized so that each impeller runs at its optimum speed.

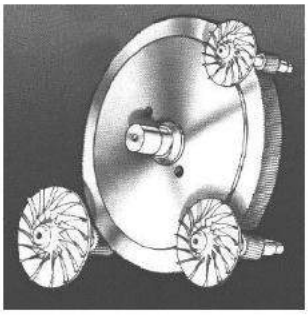

Fig. 4: Bull-gear & impellers

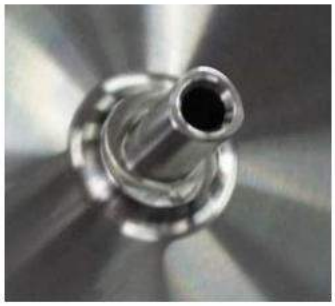

Fig. 3: Polygon profile shaft

4.3 Rotor Assemblies

Each rotor assembly consists of an efficient and high quality stainless steel (15-5 PH) impeller and a removable thrust collar mounted on a helical geared pinion shaft. The thrust collar allows dissipation of aerodynamic thrust loads generated during operations and prevents the transmission of the loads to the main gear train and maximizes gear life.

The impeller and thrust collar are each secured to the shaft by a polygon spline, which tightens under thermal loadings and eliminates the need for stress-producing keyways, and

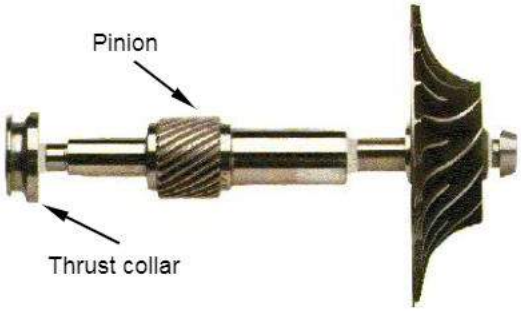

Fig. 5: Rotor assembly

retained with a bolt. The new CENTAC design has the male half on the impeller and the female half in the pinion.

All rotating parts are dynamically balanced as a complete assembly. The correct mechanical behaviour of the rotor assemblies is continuously controlled by radial vibration probes located next to the journal bearing assembly and connected by a cable to a vibration transmitter mounted inside the CMC control panel.

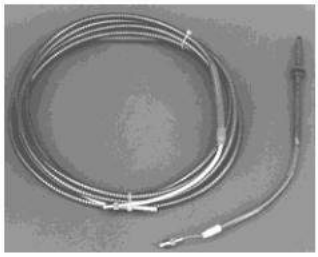

Fig. 7: Vibration probe

Fig. 6: Impeller

4.4 Impellers

Designed to resist corrosion, the impellers are of high quality stainless steel (15-5 PH). Impellers are 5-axis machined and are designed with backward leaning vanes for peak performance and stable operating range.

4.5 Diffusers

The diffuser converts kinetic energy to pressure energy and is located between each impeller and cooler. Diffusion and pressure recovery are accomplished in the first row of vanes in the diffuser. A second row of vanes is located in the axial passageway leading to the cooler inlet in order to remove residual swirling of the air for highest overall stage efficiency. Diffusers are machined single-piece aluminium diffusers with Nituff coating on 2nd and 3rd stage for high protection against corrosion.

Fig. 8: Diffuser

4.6 Bearings

Each pinion is supported by a fixed pad journal bearing on impeller side and by a fixed pad journal bearing with integral thrust bearing (pocket type) and a reverse thrust bearing (tapered land type - for operations in unloaded conditions) on collar side. The journal and thrust bearings are hydrodynamic and have a long lifecycle.

The bullgear also uses hydrodynamic bearings for journal and thrust loads.

All bearings are designed to maximize load carrying capacities and babbitt lined to minimize power loss.

Fig. 10: Fixed pad journal bearing

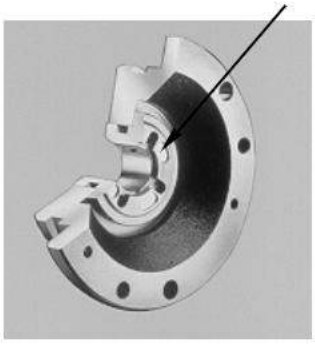

Fig. 9: Thrust bearing

4.7 Seals

There are two types of seals used on CENTAC compressors:

- double lip seals on the bullgear shaft
- a cartridge seal with fully floating non-contact carbon rings on the rotor assembly

The cartridge seal is mounted in the plain bearing housing behind each impeller and consists of three fully floating non-contact carbon rings. One ring is used as an air seal and the remaining two as oil seals. Process air is prevented from being leaked into the compressor casing by the first carbon ring. Seal air is injected between the two oil seal rings at 0.6 bar(G) to prevent oil entering the air stream and to assure that the compressed air is oil-free and environmentally clean for applications such as food, beverage, electronics and pharmaceuticals. A vent to atmosphere is provided between the air and oil seals.

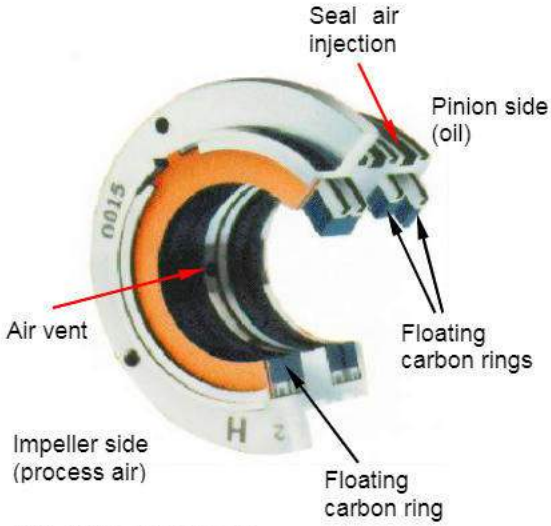

Fig. 11: Cartridge seal

5 Air System

The air system of CENTAC compressor includes following main components:

- inlet air filter
- inlet throttle valve
- air coolers
- moisture separators
- condensate traps
- by-pass valve
- by-pass silencer
- discharge check valve
- instrumentation

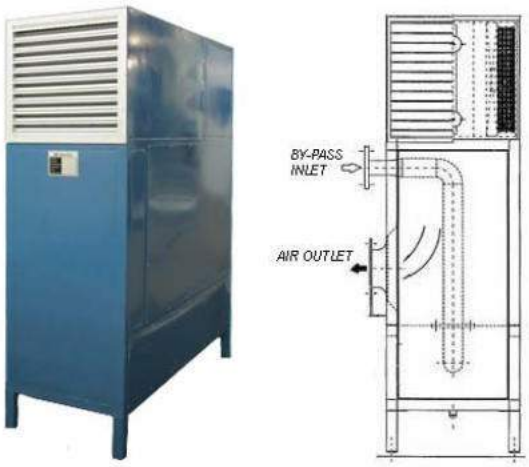

Fig. 12: Inlet air filter with integrated bypass silencer

5.1 Inlet air filter

The inlet air filter is a 2-stage dry type filter with fixed louvre and replaceable elements, with an efficiency >98% at 2 micron. This filter uses a primary and secondary element to filter the incoming air stream. This allows for the removal and cleaning of the first stage filter without shutting down the compressor. The filter includes also an integrated bypass silencer for the blow-off air. The filter is designed for indoor or outdoor under roof installation and covers a variety of flow ranges. The inlet air filter/bypass silencer is shipped loose and is provided with a dirty inlet air filter pressure switch (shipped loose for Customer installation/connection) with related alarm function in the panel.

5.2 Inlet throttle valve

The inlet throttle valve modulates the air intake to the compressor to maintain constant discharge pressure under different air requirement in the down stream system. It is machine mounted, complete with electropneumatic transducer, pressure regulator, pressure gauge, pneumatic actuator and positioner.

Fig. 13: Inlet throttle valve

5.3 Air coolers

CENTAC C700 compressor has one or two intercoolers (depending on number of stages) and one aftercooler.

The air coolers utilize cartridge coolers mounted internal to the compressor casing. The passage of the heat from the air to water is assisted by the internal fins in the air passages, which greatly increase the effective heat transfer area on the air side. The air side fins are lead coated to resist corrosion. The CENTAC air-in-tube/water-in-shell design with counter flow arrangement provides also following important benefits:

- best heat transfer and lowest pressure drop
- air noise damping
- less performance deterioration due to fouling
- low water flow requirement and less cooler maintenance
- back-flushing capability during operation

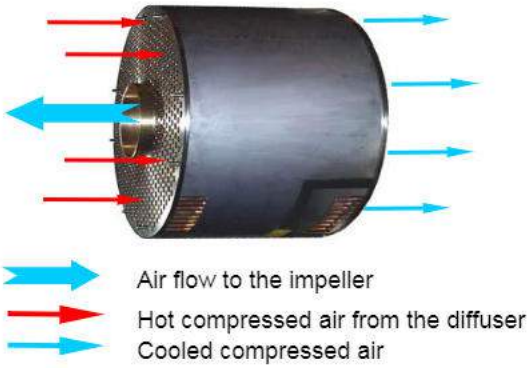

Fig. 19: Intercooler cartridge

Fig. 18: Finned air tube

5.4 Cooling Water Manifold

C700 is provided with a flanged common cooling water manifold that distributes cooling water to each stage and requires a single-point inlet/outlet water connection.

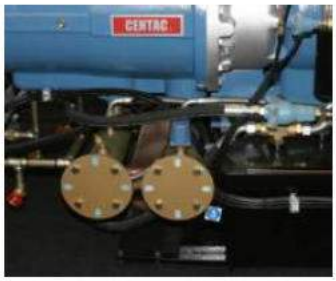

Fig. 14: Cooling water manifold

Fig. 15: Moisture separator

5.5 Moisture Separators

The moisture separator is of stainless steel mesh screen type construction. The thickness of the separator is designed to separate the maximum amount of moisture at a minimal pressure drop. The separators are located at points in the compressor where air velocities are relatively low permitting effective moisture separation.

5.6 Condensate traps

These traps are mounted and piped below each moisture separator for moisture removal. Standard traps (direct ball float type) are furnished complete with a by-pass valve to control the operation of the trap itself.

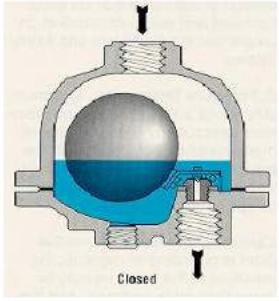

Fig. 16: Condensate trap

5.6 By-pass valve

The by-pass valve is machine mounted, complete with electro-pneumatic transducer, pressure regulator, pressure gauge, pneumatic actuator and positioner. It unloads in the recirculation piping the excess of air when the system's requirements falls below the minimum throttle capacity handled by the inlet valve.

Fig. 17: By-pass valve and check valve

5.7 Discharge check valve

The check valve, machine mounted, is a simple non return valve provided to close the outlet and prevent back-flow of the air from the system to the compressor during off-load periods.

6 Lubrication System

The lubrication system of the compressor is completely self-contained and mounted on the baseplate. The oil reservoir is built into the compressor baseplate and coated with epoxy to resist corrosion.

The C700 uses a low pressure lubrication system to provide oil for the gears and the hydrodynamic bearings. The design uses two oil pumps:

- a motor driven pre and post lubrication oil pump (screw type)
- a compressor shaft driven main oil pump

CENTAC lubrication system includes also:

- a suction strainer on oil line inlets
- check valves on the discharge line of the pre and post lubrication oil pump and on the suction line of the main oil pump to prevent reverse flow through the pumps
- a cast-iron adjustable relief valve to control oil pressure to the compressor bearings
- a single element oil filter
- an oil level indicator
- a demister to condition oil vapour and to eliminate pressure build-up in reservoir
- a shell and tube oil cooler designed for a maximum cooling water temperature of 35°C

Fig. 20: Demister

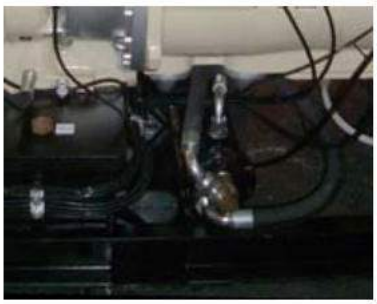

Fig. 21: Oil cooler

- an oil reservoir electric heater to insure adequate oil temperature for compressor start-up
- a temperature detector mounted downstream of oil cooler for low oil temperature and high oil temperature with analogic functions on control panel
- a pressure transducer mounted downstream of oil cooler for low oil pressure with analogic function on control panel
- SAE "dry-tech" compression fittings to avoid oil leakage from oil connections
- First fill of Techtrol Gold (shipped loose), Ingersoll Rand's synthetic fluid that guarantees superior performances and long durability

For the schematic oil flow see also the Process & Instrumentation Diagram.

Fig. 22: Electric heater

6.1 Pre and post lubrication oil pump

The pre and post lubrication oil pump lubricates the compressor bearings and gears and fills the oil lines before the compressor starts and maintains lubrication after the compressor has been shutdown.

Fig. 23: Pre/post lube oil pump

It is driven by an electric motor and starts when the control panel is energized and runs until the compressor is up to speed and the main oil pump increases oil pressure.

The pre and post lubrication oil pump shuts down automatically when the main oil pump is supplying the required system pressure. When the compressor trips on the shutdown cycle, the pre and post lubrication oil pump will start immediately and will continue to run until the panel is de-energized, cooling down the compressor.

A seal air pressure transmitter interlock prevents the pre and post lubrication oil pump from operating if seal air pressure is not established.

6.2 Main oil pump

The main oil pump is oversized and is driven by the main motor to supply oil during operation and to protect the bearings during an electrical shutdown. In the event of a main driver or power failure, the main oil pump will continue to supply oil to the bearings and gears during coast down. The main oil pump is mounted on the main compressor shaft.

Fig. 24: Main oil pump

7. Control System

Centac compressors are equipped with a IP 54/400 V/3 Phase/50 Hz microprocessor control panel (CMC), mounted and wired on the baseplate, that provides complete integration of compressor, motor and all auxiliary instruments. The CMC allows complete adjustment of all electrical parameters, alarm and trip set points from the front faceplate and can be customized to individual customer requirements. 23 analogue and 16 digital inputs and 4 analogue and 16 digital outputs are available as standard. The CMC is fitted with multi-language liquid crystal display providing the necessary information to determine compressor's operating status with Event Log of last 224 events and includes prelube oil pump motor starter and contactor, lube oil heater contactor and control panel transformer.

CMC standard features/functions:

- Spike voltage protection
- Motor current reading
- Motor Amp limits (low/high)
- Main motor thermal overload relay
- Hour meter
- Vibration probe (radial "Y" on each stage) reading and alarm/trip
- Interstage air temperature reading and alarm/trip
- Interstage air pressure reading
- Discharge air temperature reading and alarm/trip
- Discharge air pressure reading
- Oil temperature reading and low/high alarm/trip
- Oil pressure reading and low alarm/trip
- Surge detection
- Low seal air pressure contact (on/off)
- High motor temperature contact (on/off) (on CV&CH line with low voltage motor only)
- High inlet air filter pressure drop (alarm)
- Horn (alarm/trip)

7.1. Modulate Control Mode

Modulate maintains the system discharge pressure at the system pressure set point as entered into the CMC by the user (set point stability ± 0.1÷0.2 bar as standard, can be improved through fine tuning of valves). Once loaded, the compressor will operate along the constant pressure line until the user switches to Unload or presses the stop button. Control is accomplished by modulating the inlet valve within the compressor's throttle range. When system demand is less than the minimum throttled capacity, the discharge pressure is maintained by modulating the bypass valve and venting some of the air to atmosphere. This valve is opened just prior to reaching the surge line. Whenever the bypass valve is open, the inlet valve maintains its position

at the minimum throttled capacity setting. Modulate provides a constant discharge pressure with variable capacity from design to zero. This control method is used when stable control of the discharge pressure is required. Modulate is the most commonly used control method for Centac compressors.

7.2. Autodual Control Mode

Autodual automatically loads the machine when demand is high and unloads the machine when demand is low. When the compressor is controlling to pressure setpoint and demand is within the inlet valve throttle range, constant pressure is maintained in the same manner as Modulate. When the machine is controlling to the pressure setpoint and system demand is low, the compressor is operated in the bypass valve throttle range. Autodual automatically unloads the machine when the bypass valve is opened beyond the Unload Point for a programmed time period called the Unload Delay Time. The Bypass Valve Unload Point is selected to correspond with the check valve closing since at this point the machine is not supplying the system. The Unload Delay Timer should be set to prevent unloading during short excursions through the Unload Point. The Reload Percent determines the System Pressure at which the machine will automatically load into the system.

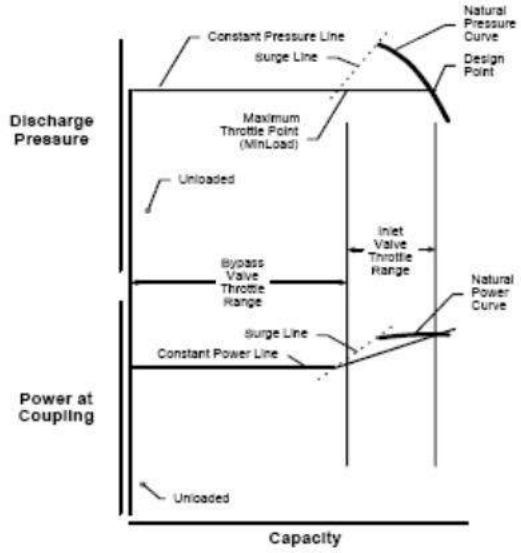

Fig. 26: Modulate Control Mode

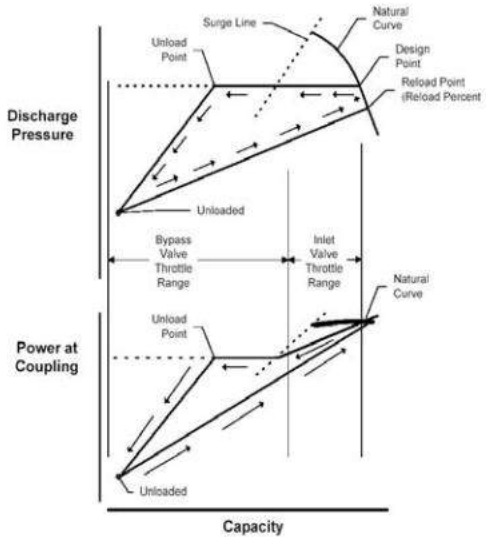

Fig. 25: Autodual Control Mode

8. Motor

Insert here motor details as appropriate.

Note: motor starter is not included in the motor scope of supply and is Customer supply, unless otherwise specified. Customer starter to include current transformer for current reading (0 to 5 Amps).

Low voltage motors are provided as standard with motor stator protection by PTC thermistors connected to the CMC panel with discrete trip function.

9. Standard Documentation

- General Arrangement
- P&I Diagram