COST EFFECTIVE, HIGH ENERGY EFFICIENT AND ENVIRONMENT-FRIENDLY ADVANCED THERMAL RECLAMATION TECHNOLOGIES

ABSTRACT

Thermal reclamation system is based on the recovery of sand used in foundries. This system is based on the removal of the resin which is used in the mold and coated with resin by heating to approximately 630 ° C. The biggest advantage of the thermal reclamation system is the recovery of the sand, which has to be disposed of at the rate of 90%, to reduce the negative impact on the environment and its contribution to the economy.

1.INTRODUCTION

Reclamation is the re-use of a used product or raw material. It is defined as the process of reclamation of the sand used in the foundry sector. In recent years, the casting industry has shown increasing interest in the reclamation of used molding sands.

• Cost Efffective:

In the last 10 years, the total sand cost used in foundries, raw materials, transportation costs and disposal have increased by 160%. This has led to the development of reclamation systems. The system returns a large amount of sand to the foundry to be disposed of.

• Environment friendly:

The need for environmental protection has increased the minimization of foundry waste and the demand for recycling of recyclable materials. Molding sands that need to be disposed are the most important of these wastes. 90% of the total sand is recovered by mechanical reclamation while the remaining 10% should be discarded continuously and replaced with new sand. The thermal recovery sand recycling rate is 90%, which reduces the amount of waste to 10%. This amount of waste is due to the grain size criterion and the high amount of resin in it. More than 99% of all binders and other organic materials are removed by thermal reclamation.

• Technical(Quality)

In foundries, molding sand is generally used by mechanical reclamation and re-sieving. However, 10% of this used sand should be discarded and replaced with new sand. If new sand is not added, the quality of the production decreases due to the mold quality. Thanks to the elimination of fine-grained sands in the fluidized bed cooling section after thermal reclamation, the grain size is controlled in a precise manner and as a result it decreases the resin consumption in the subsequent molding process and increases the mold strength.

2.THERMAL RECLAMATION – FLUIDIZED BED

Thermal reclamation systems are based on the heating of sand, which is used in the mold with the combustion of natural gas, liquid propane or compressed natural gas and coated with resin, to approximately 630ºC and removal of resin on it. With the thermal reclamation system, the remains of the organic binder in the sand are burned. In Figure-1, the loss of ignition values of the sand samples that are held at certain temperatures according to the waiting time are shown on the graph. As can be seen from Figure-1, temperatures over 600ºC do not have much effect on the result.

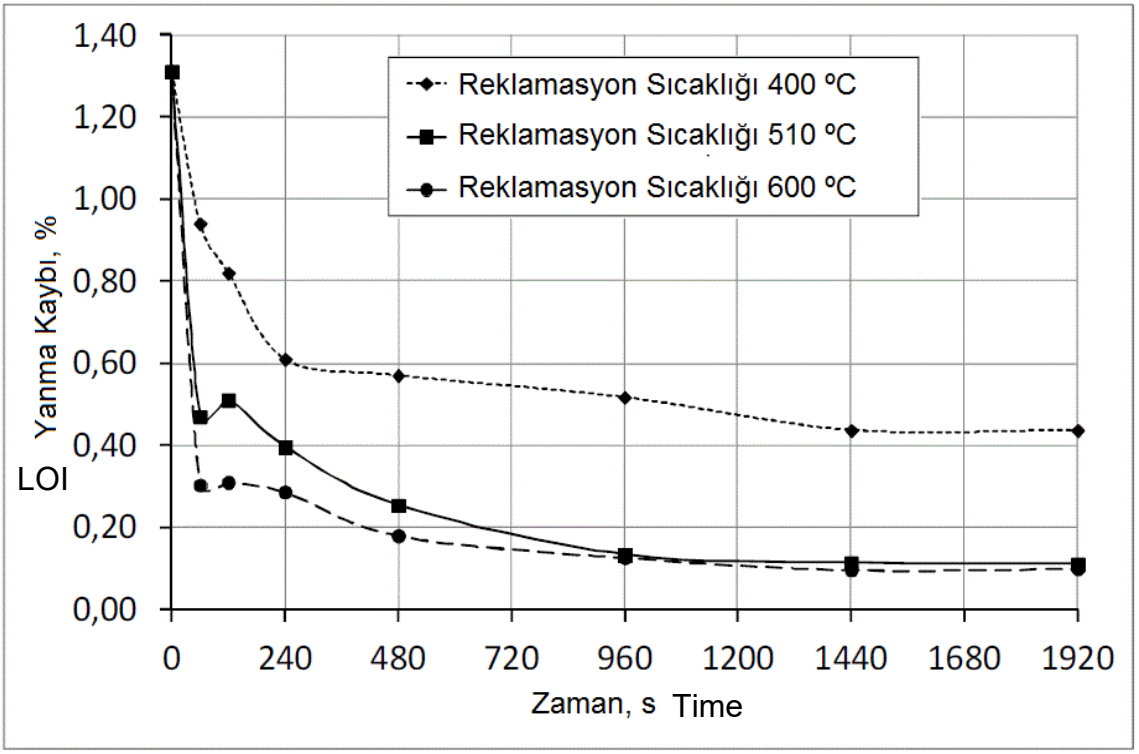

Figure-1: Loss of Ignition (LOI) Time-Temperature

Priort to thermal reclamation, the mold sand is subjected to mechanical reclamation and the bound sand particles are separated from each other. One of the chemical binder systems used in foundries is called alphaset-hardener. If this binder system is used in the foundry, a certain proportion of chemical Kaolin (China Clay) material (eg RecAgent®) must be added before the incoming sand enters the reclamation system, otherwise salt particles may form in the combustion chamber and stop the system's progress.

The new sand shows a large expansion when thermally loaded. Therefore, during casting, dimensional differences occur in the mold contours and consequently imbalance and dimensional errors occur. In Figure 2, the reaction in Formula-1 is described visually. When the sand is heated above 600 ° C, it undergoes phase transformation. If desired, the reclamation temperature is increased to 870 ° C and the alpha quartz phase without sand expansion is transformed to the alpha Tridymite phase.

α-Quarz ----------→ α-Tridymit (Formula - 1

When Thermal Reclamation Sand is used instead of new sand, mold sand expansions, deterioration, imbalance and dimensional errors are eliminated, Figure-2.

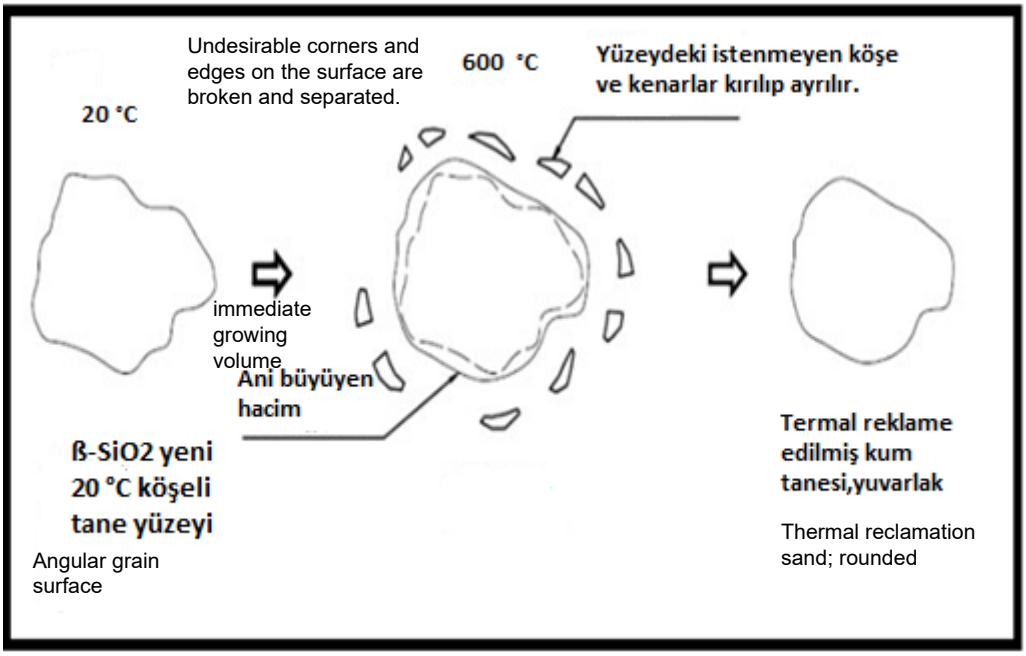

Figure-2: Transformation of sand particles by thermal reclamation

New sand and mechanically reclamation sand contain a considerable amount of dust. The thermal reclamation sand passes through the fluidized bed cooling (Unique to LMA) section to remove fine particles and obtain a more homogeneous grain size, Figure 3 and Figure -4. In addition, as can be seen in Figure 2, Figure 3 and Figure 4, the sand subjected to thermal reclamation with fluidized bed is exposed to abrasion and sharp corners decrease and more rounded grains are formed.

Figure-3: Sand particles before reclamation (x8)

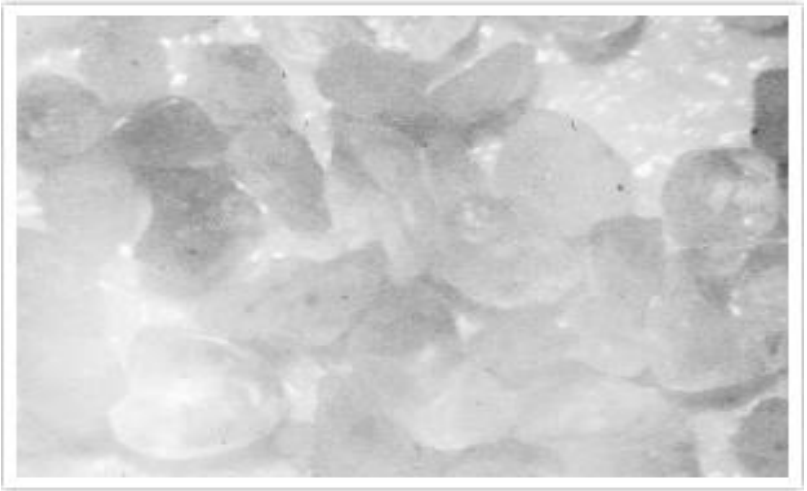

Figure-4: Sand particles after reclamation (x10)

3.THERMAL RECLAMATION SYSTEM & PERIPHERAL EQUIPMENT

The necessary equipment before the general thermal recalamation system are as follows:

1. Mechanical reclamation or lump separator
2. Chromite sand separator
3. Sand Silo
4. RecAgent® storage and homogenization tank
5. Dosing system and mixer to mix sand with RecAgent®

The reclamation system consists of the following parts:

1. Preheating section (Unique to LMA Motif Al. Ltd Şti): It takes cold sand from the silo and gives it to the combustion chamber by heating it (250ºC) by means of waste flue gas. It provides energy saving. Figure-5 hood bottom, upper part.

2. Combustion Chamber (Fluidized Bed- Unique to LMA Motif Al Döküm): It increases the temperature of the incoming sand to 630ºC with the burning of the fuel gas and waits for a while to allow the resin to burn. Figure-5 hood bottom part.

3. Cooling and Dedusting Unit: It ensures that the reclamated sand coming from the combustion chamber is cooled and brought to a suitable temperature for operation. It contains fluidized bed and water exchanger. Figure 6.

4. PLC automation system: It measures, controls, monitors and warns in case a malfunction for the system to function properly.

5. Sand Conveyor System: It allows the cooled ready-to-use sand to be sent to stock silos.

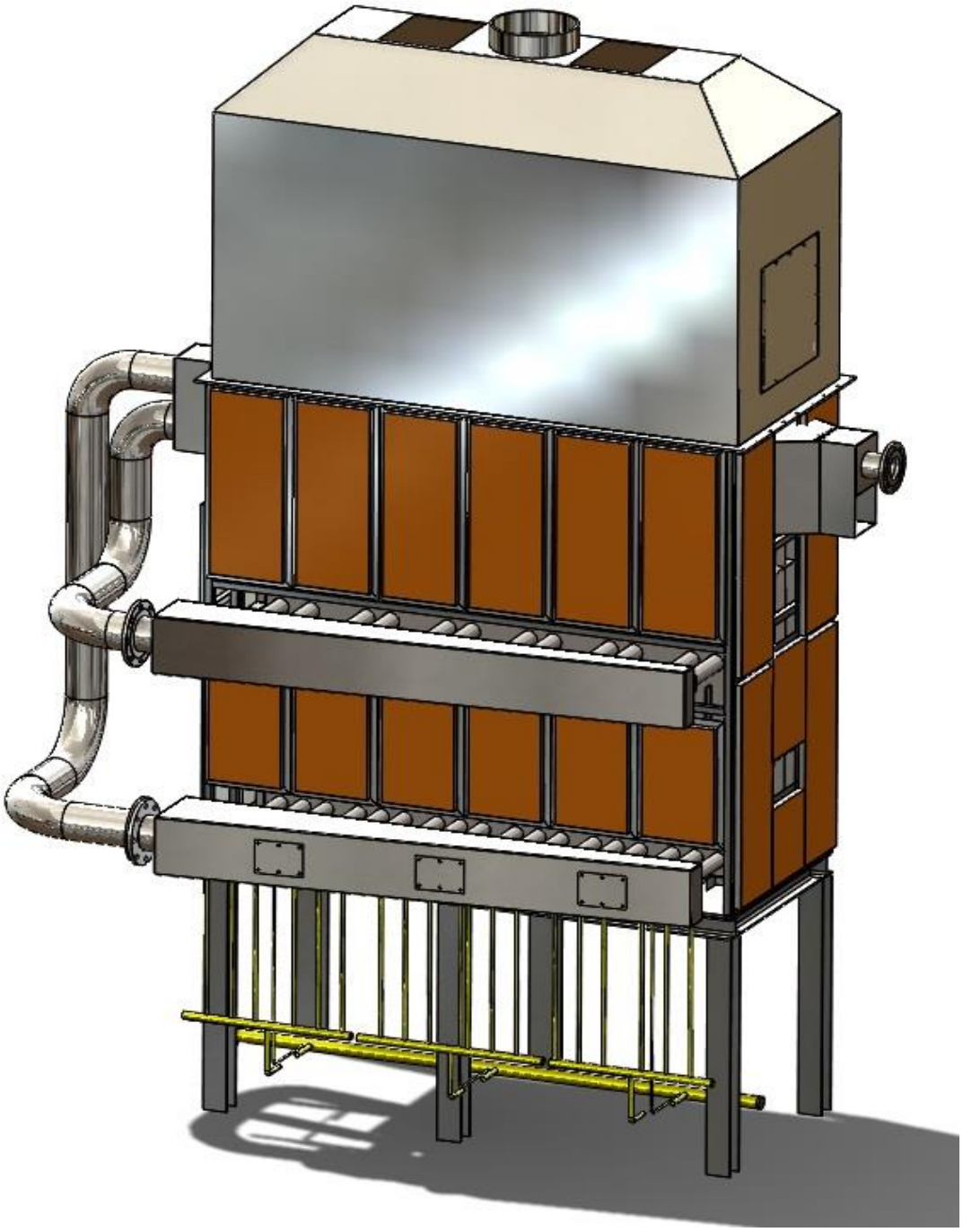

Figure-5: Thermal reclamation preheating and combustion unit

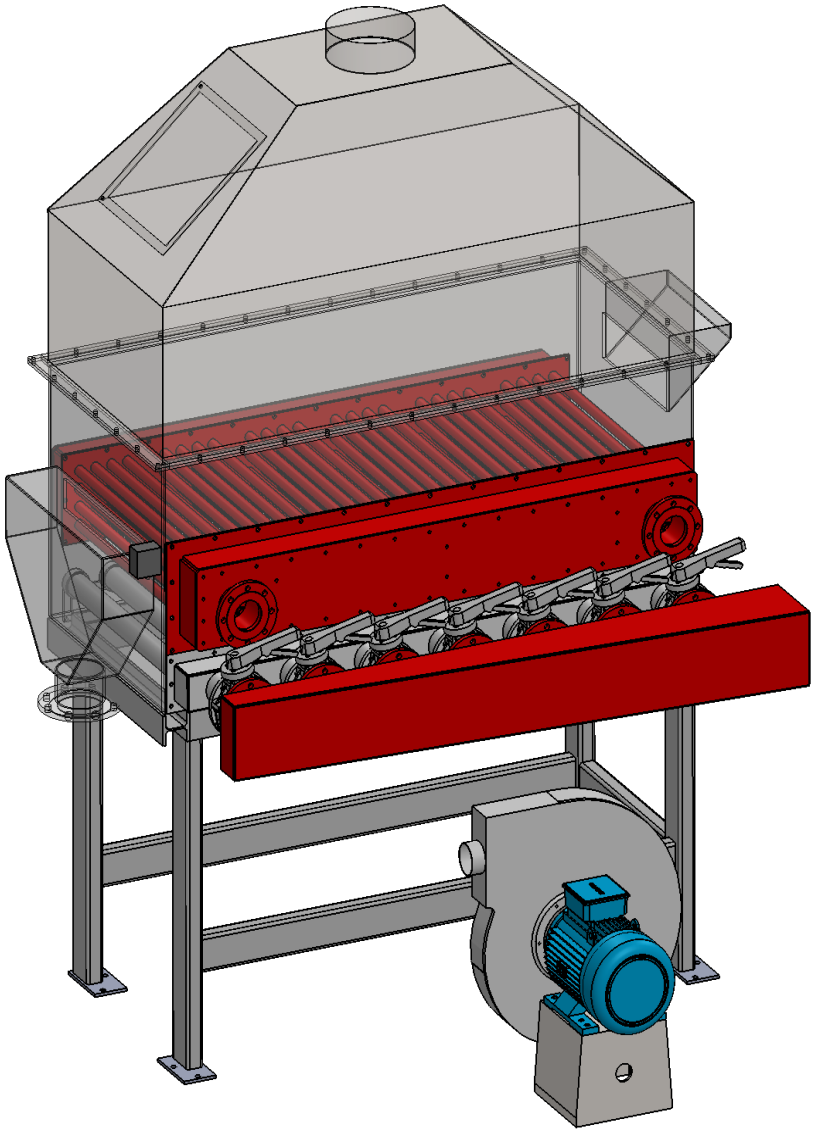

Figure-6: Fluidized Bed Cooling & Dust Separation Unit

You can find an example sand reclamation system in Figure-7. System in order:

1. Lump Separator
2. Pneumatic sand conveyor, 1. level
3. Thermal reclamation feeding silo
4. Mixer/Feeder
5. Combustion Unit
6. Fluidized Bed Cooler
7. Pneumatic sand conveyor, 2. level
8. Sand storage hopper,

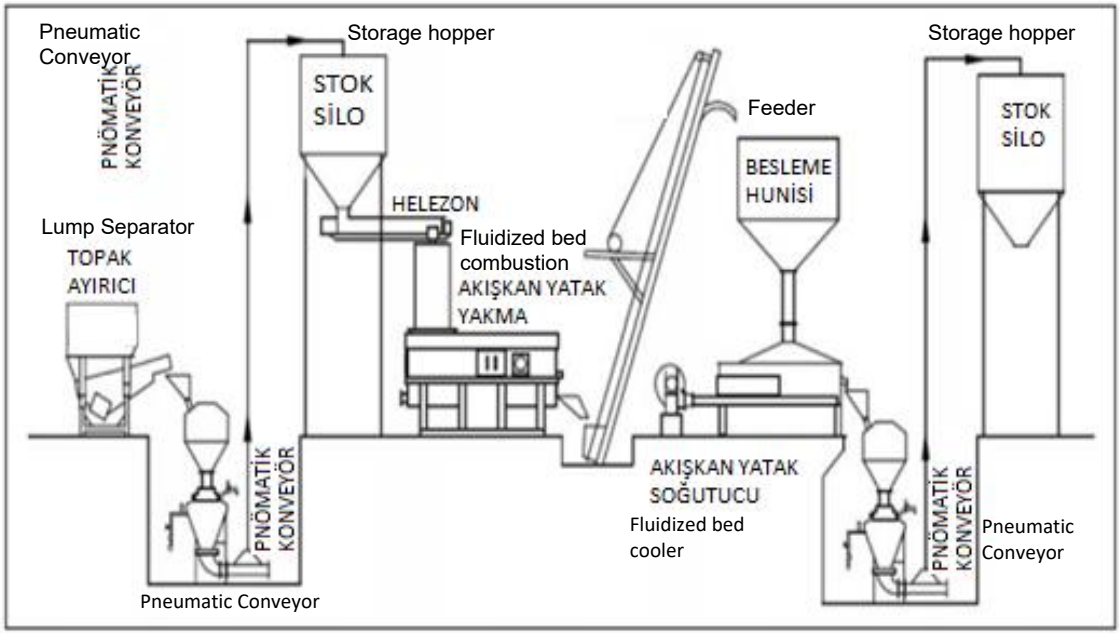

Figure-7: An exemplary thermal reclamation system

4.AUTOMATION CONTROL SYSTEM

An automation mechanism that controls the sand flow rate, chemical feed dosage, process temperatures, and fault conditions of the thermal reclamation system is required. As can be seen from Figure-8, the control panel provides the necessary corrections and activities to keep the system under control.

4.1) If there is no air or gas in the pilot burner, the system automatically resets and stops alarm within 5 minutes.

4.2) The sand guide tube counter determines the capacity by controlling the delivery time. When it sends sand, it detects the transfer and closes the valve according to the pressure.

4.3) The sand mixer sets the capacity in advance and gives the sand and silo empty warning if the desired amount does not emerge from the machine. If the Kaolin (China clay) pump does not work and the kaolin does not come to the mixer, the machine alarms and stops. The system is programmed for fully automatic operation.

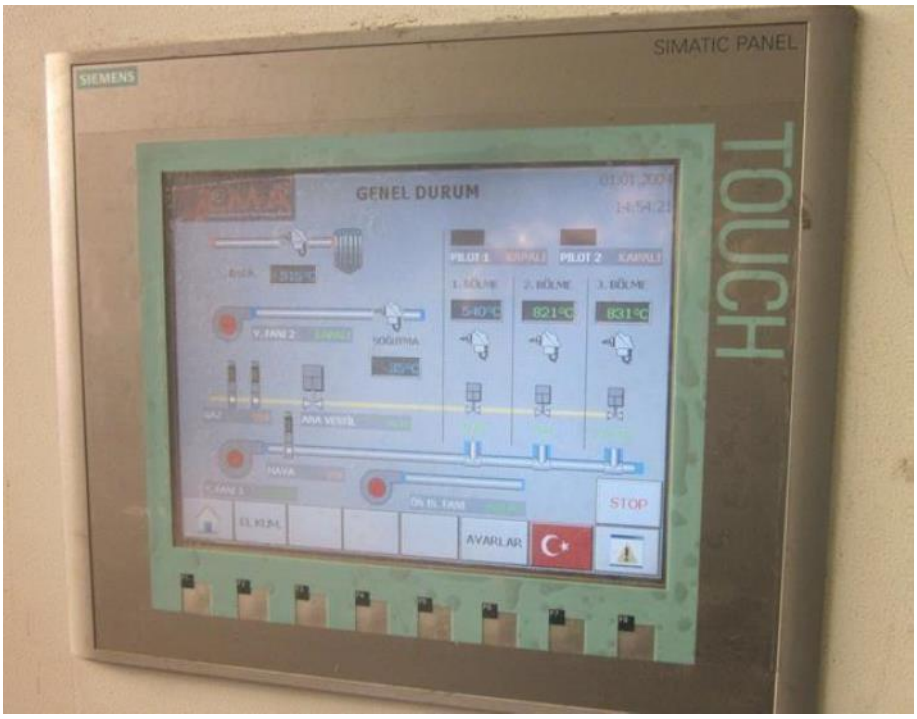

Figure-8 : Control Panel

5. THERMAL RECLAMATION SYSTEM - OPERATING COST AND GAIN

Sample cost study based on data obtained in applications;

90% of the total 250 tons / month of new sand is supplied from the thermal reclamation system. This means the recovery of 250 x 0.9 = 225 tons of sand.

Waste sands must be disposed of in a licensed waste company. If the reclaim sand in thermal reclamation was assumed to be waste, 225 tonnes of 250 tonnes of sand would be disposed of as waste each month according to 90% system efficiency. Assuming that the monthly waste transportation cost is 400 ₺ / 20 tons, waste cost for 225 tons of sand:

Transportation Cost: 225 ton /month x 400 ₺ / 20 ton = 4.500₺ /month (1)

New Sand Cost: 225 ton/month x 160 ₺/ton = 36.000 ₺/month (2)

Total :40.500 ₺/month (3)

Cost calculations in an enterprise with an alphaset-hardener binder system for 250 tons of sand (approx.):

Table-1:

UNIT	COST	AMOUNT (₺/ton)
1	15-25 m^3/ton Natural Gas	17
2	24 kwh/ton electric power	6,72
3	Cooling water requirement from general furnace system	2
4	17 kg/ton Kaolin (China Clay)	45
	TOTAL	70,72 ₺/ton

Reclamation Cost: 225 ton/month x 70,72₺/ton = 15.912 ₺ /month (4)

Savings based on all these data:

The difference between the current cost of new sand and the cost of running thermal reclamation is:

-225 ton / month sand cost= 40.500 ₺/month (3)

-225 ton / month thermal reclamation cost = 15.912 ₺/month (4)

Savings = (3) - (4]) (5)

Thermal reclamation system - SAVINGS:

Saving = 40.500 ₺/month - 15.912 ₺/month = 24.588 ₺/month

= approx. 5.854 €/month

6.LMA MOTİF AL. LTD.ŞTİ. THERMAL RECLAMATION DIFFERENCE

What distinguishes our thermal reclamation system is:

- Fluidized bed,
- Preheating section,
- Air economizer

Thus, as can be seen in Figures 9-10-11,

Figure-9: New Silica Sand (x2)

- The inert and organic components in the sand are reduced to trace amounts
- Recycled sand granulation is obtained similar to new sand properties
- The sand grain surfaces are rounded with maximum efficiency.
- Optimum heat and material transfer with ensures minimum wear on the sand surface.
- Recycled sand shows the same of new sand or better properties.
- Pre-heat and air economizers ensure a minimum energy saving of 12%.
- The flue gas is washed in the liquid flushing system or the dry dust holding system and the emission of the flue gases are zero wherever.

Figure-10: Mechanical Silica Sand (x2)

Figure-11: Thermal Silica Sand (x2)

7. LMA THERMAL RECLAMATION & PERIPHERAL EQUIPMENT SAMPLES

Figure-12: Mechanical reclamation system

Figure-13: Thermal reclamation system

Figure 14:LMA Thermal reclamation systems

SUMMARY

It has taken many years to realize that industrialization, its negative interaction with the environment, and the harm it causes to human life. In an effort to minimize irreversible environmental damages, it is an important step not to contaminate the atmosphere with industrial gases. At this stage, the negative effects on the environment are minimized by the thermal reclamation system. The system contributes to the protection of natural resources by eliminating water pollution chemically from the discarded sand. It performs a more efficient process to obtain oxygen-enriched air. It is an economic system which provides huge savings to companies in terms of reducing the amount of new sand usage and consequently reducing waste cost in foundries operating with air-hardening chemical binder system.