Maximising Sand Recovery in the Foundry

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Abstract

As the disposal of foundry sand becomes more of a worldwide environmental issue and with spiraling costs associated with landfill, the foundry must optimise the sand waste stream by utilising the latest re-processing technology.

An overview of the present options available to foundries to maximise their sand recovery is examined. The primary topics covered are : (i) Primary and Secondary attrition, (ii) Thermal Reclamation, (iii) Chromite and other mineral recovery.

Although primarily aimed at users of No-bake sand systems, the subject of green-sand reclamation, i.e. spent green-sand back to core room is also covered.

Introduction

As the disposal of foundry sand becomes more of a worldwide environmental issue and spiraling costs associated with landfill, the foundry must optimise the sand waste stream by utilising the latest re-processing technology.

Primary Attrition Reclamation

Primary attrition of sands has long been established as a good method of reclaiming spent foundry sand. However the process has its limitations in terms of metal cast and also the type of binder employed.

To maximize reclamation levels using primary attrition only, the foundry must observe the following characteristics:

- Good Sand to Metal ratio – typically 4:1 or less
- Ferrous castings
- Low binder addition rate
- Organic binder, e.g. Furan

With the above criteria in place it is possible for the foundry to reclaim up to 90% of its sand whilst maintain low loss on ignition (LOI) levels that do not impact sound quality and also allow a good working environment in terms of fume liberated in the casting process.

LOSS ON IGNITION BUILD-UP WITH THE NUMBER OF RECLAMATION PASSES

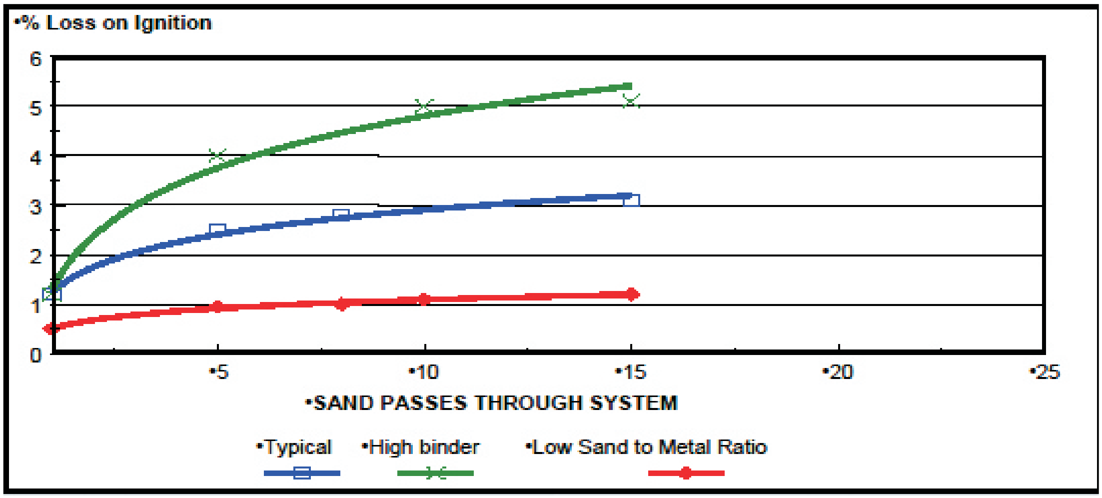

Fig. 1 : *Graph showing effect of number of times cycled versus addition rate of resin and sand to metal ratio*

Fig. 2 : *Good sand to metal ratio. Ferrous casting exhibiting good burnout of the sand*

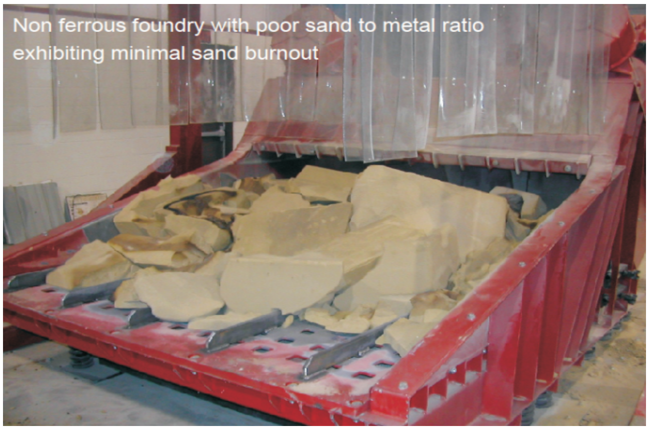

Fig. 3 : *Non-Ferrous foundry with poor sand to metal ratio exhibiting minimal sand burnout*

Alternatively, if we now look at what makes up poor reclamation characteristics, these can be identified as follows:

- Poor Sand to Metal ratio – typically above 4:1
- Non-ferrous metal cast, especially Aluminium and its alloys
- High Binder content at the mixer
- In-organic binder, e.g. Sodium Silicate or partially in-organic such as Alkaline Phenolic

With one or more of these criteria in place primary attrition may only warrant reclamation levels approaching 50-70% level.

Every foundry should evaluate their 'Sand Balance Diagram' to truly understand the amount of sand they are actually reclaiming.

As can be seen from the example above *(Fig. 4)* it is necessary in order to increase the amount of sand

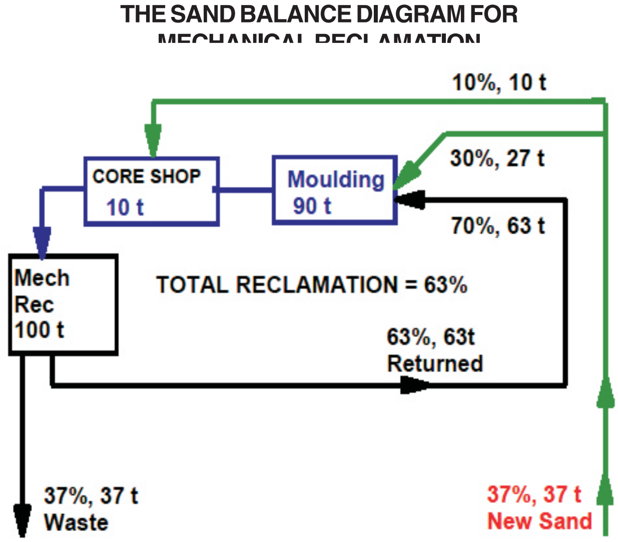

Fig. 4 : *Typical Sand Balance Diagram showing total sand reclamation of 63%*

reclaimed in the foundry to have some form of secondary processing carried out.

Thermal Reclamation

When considering this type of reclamation the plant should be sized according to the amount of sand that is presently being thrown away, and not the total amount that is being consumed. By doing it this way allows the foundry to use a combination of mechanical and thermal reclamation, thereby reducing the size of the thermal plant needed and the associated capital and running costs.

However it should be noted that although the sand, post thermal reclamation or 'calcination', is typically less than

1 TPH THERMAL UNIT, HEAT EXCHANGER & COOLER PACKAGE

Fig. 5 : *Typical Thermal Reclamation Plant*

INTERNAL FURNACE COMBUSTION ZONE

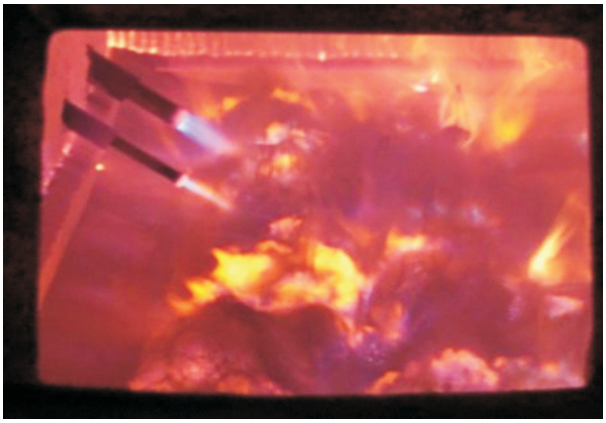

Fig. 6 : Inside the Furnace Combustion Zone

THE 'USR' SECONDARY RECLAIMER

Fig. 8 : Secondary Attrition Unit

SAND BALANCE DIAGRAM FOR A THERMO/MECHANICAL RECLAMATION SYSTEM

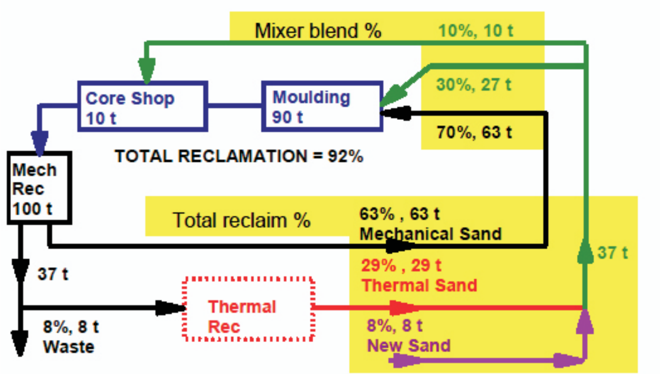

Fig. 7 : Sand Balance Diagram showing Thermal Reclamation in place and total sand conservation of 92%

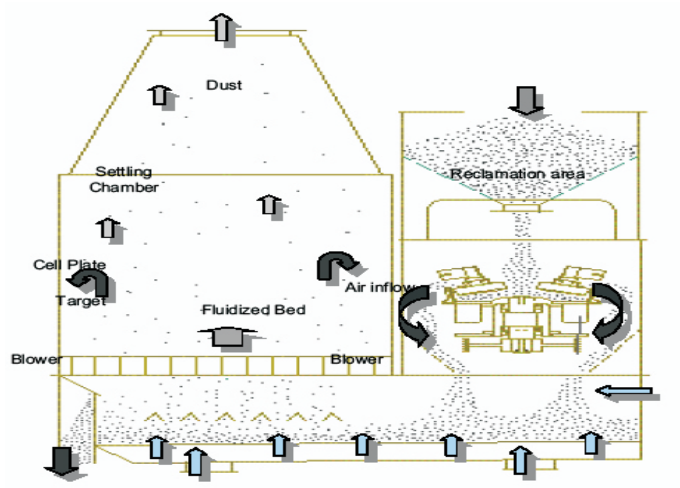

Fig. 9 : Schematic of the unit in operation

0.1% LOI, it does not mean that the system is 100% efficient as there will be losses of approx. 5-8% in the system when processing the sand.

Secondary Attrition Reclamation

An alternative to thermal reclamation is secondary attrition. The purpose of this is to impart further 'work' onto the sand after primary attrition in an attempt to remove more of the binder and hence, in turn, to re-use a higher amount within the foundry.

There are several models of secondary attrition units in the market, however most have some issues regarding control and when considering secondary attrition the plant should be able to:

- Remove a portion of the resin without damaging the sand grains

THE SAND BALANCE DIAGRAM FOR MECHANICAL PRIMARY & SECONDARY RECLAMATION

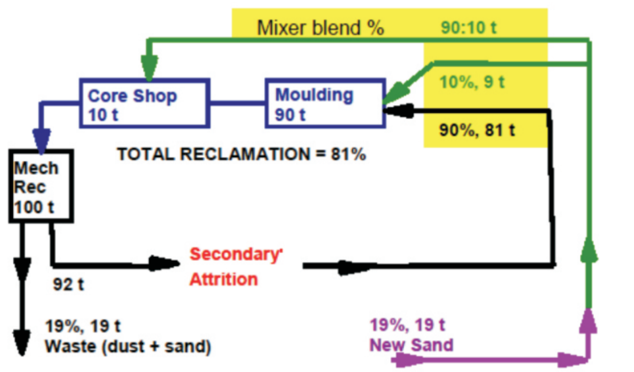

Fig. 10 : Sand Balance Diagram showing the use of Secondary Attrition and total sand conservation of 88%

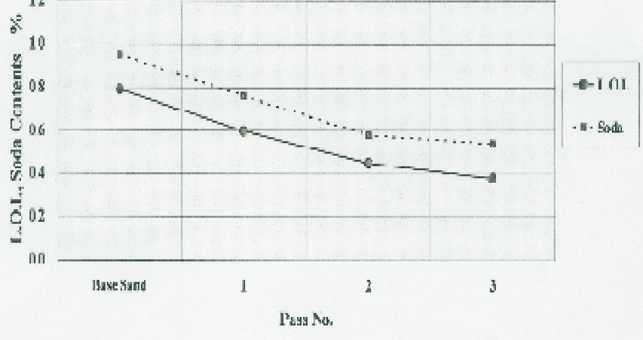

Fig. 11 : Graph showing relationship between number of passes and reduction in LOI/Soda content

SAND AFTER PRIMARY ATTRITION

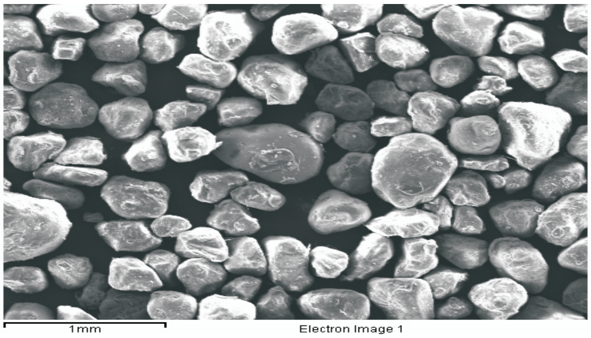

Fig. 12 : Sand after primary attrition

SAND AFTER SECONDARY ATTRITION

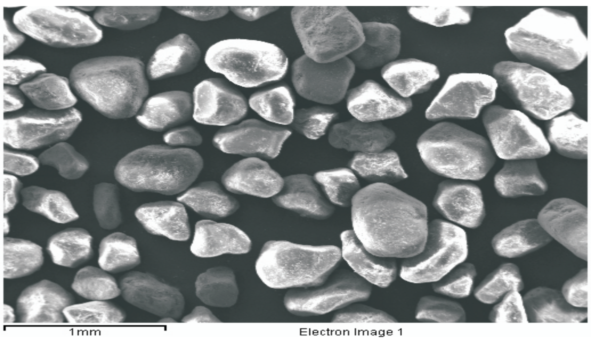

Fig. 13 : Sand after secondary attrition

- Be easy to maintain and have high wear resistant parts due to the sand abrasion
- Be able to control the work put into the sand and monitor accordingly.

One such unit is the USR, that due to its patented design allows the foundryman to control exactly the attrition process, thereby maximising resin removal without damaging the sand grains.

Secondary attrition is suitable for the following binders:

- Organic, e.g. Furan, Phenolic,
- In-organic e.g. Sodium Silicate
- Semi-Inorganic e.g. Alkaline Phenolic

Secondary attrition is not suitable for the following binders or applications:

- Resin-coated sand
- Phenolic-urethane cores in a non-ferrous die casting application

Probably the major difference in the use of secondary attrition is that because the LOI is only reduced and not taken to very low levels as in the case of thermal reclamation, all the sand is processed through the plant to give an overall reduction in the LOI.

Green Sand Reclamation

The normal question everyone asks when this subject is mentioned is: “Why?”. As greensand is naturally reclaimed, however, we can split this topic into two subjects:

Green Sand back to Mill-room : Depending on the type of castings the foundry is making it may be necessary to control the volatiles at the mill room, and the only way this can be readily achieved is by the addition of new sand. Typical addition of new sand at the mill room can range from 5-10%, and in greensand reclamation a portion of the volatile matter is scrubbed form the sand thereby reducing the volatiles – typically

THE SAND BALANCE DIAGRAM FOR GREEN SAND RE-USE

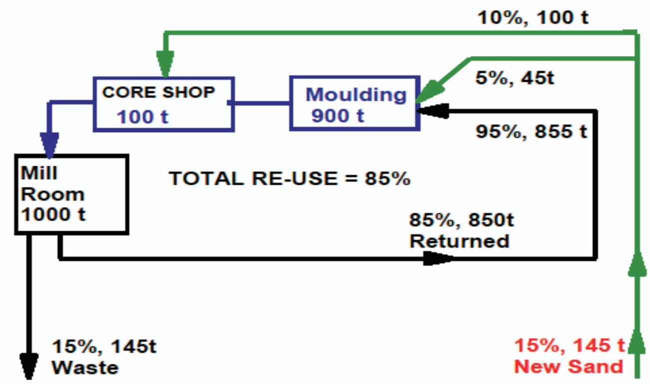

Fig. 14 : Sand Balance Diagram for green sand re-use

GREEN SAND (THERMAL) SYSTEM BACK TO CORE ROOM

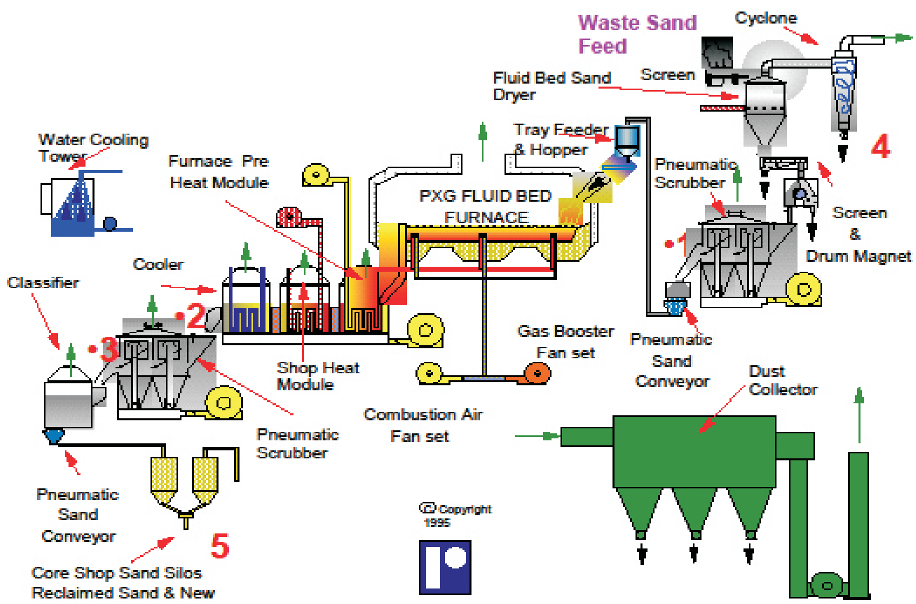

Fig. 15 : Schematic diagram for green sand returned to the core room

THE SAND BALANCE DIAGRAM FOR GREEN SAND RECLAMATION

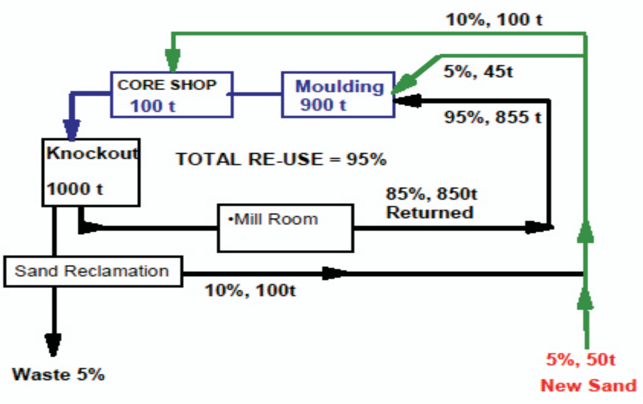

Fig. 16 : Sand balance diagram for green sand back to core room

by at least 50% – and it is this portion that is blended back into the mill room, thereby significantly reducing the amount of new sand required.

Green Sand back to Core-room : This is perhaps the most exciting area to look at – especially for a large automotive foundry that is producing heavily cored castings, typically cylinder blocks and heads would have a very high proportion of core sand in the mould package.

At the shakeout a lot of this core sand, because it is heavily burnt out, is mixed back into the greensand. If the equivalent amount of greensand is not dumped then the total amount of sand in the system will keep on

ANALYSIS OF TYPICAL SYSTEM KNOCK-OUT SAND

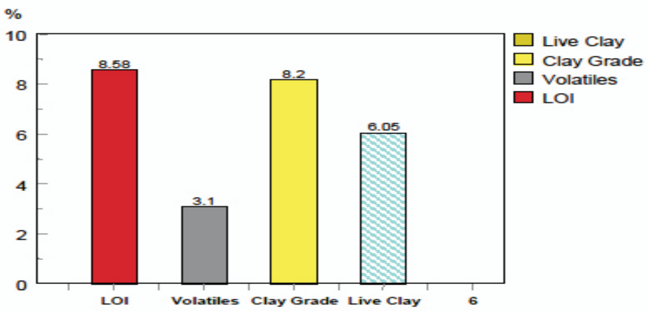

Fig. 17 : Typical green sand analysis prior to reclamation

THERMO/PNEUMATIC RECLAIMED SAND

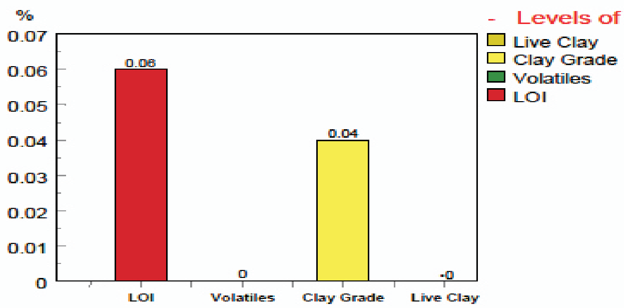

Fig. 18 : Typical green sand analysis after reclamation and back to core shop

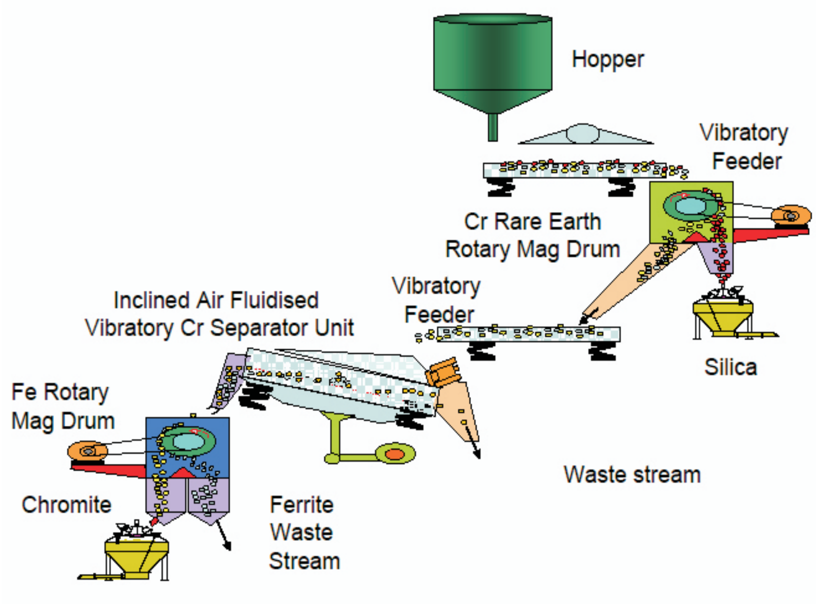

***Fig. 19 :** Schematic diagram showing the recovery of chromite sand*

increasing day by day and the foundry will not be able to function.

In order to 'clean' up the greensand to make it suitable for re-bonding in the core room it has to undergo several stages of scrubbing and thermal processing to ensure that contaminants such as clay do not interfere with the binding properties of the resin system (typically phenolic urethane).

Chromite Sand Recovery

In large steel casting applications it is normal to use Chromite as facing sand, or in certain sections to avoid metal penetration. Due to the high cost of Chromite it makes sense to try and recover as much of this as possible from the system sand.

In order to reclaim the Chromite it must first be attrited to grain size along with the other sand that it is mixed with. As Chromite is 'para' magnetic below 50 °C it must then be cooled prior to the first stage separation which involves a highly magnetic (rare earth) separator that will produce two streams, i.e. magnetic and non-magnetic.

The magnetic portion will then be fed into a fluidised vibratory gravity separator that separates by density the silica portion that is contaminated into the Chromite.

The next step involved is the removal of any 'tramp' metallics that have been carried over with the Chromite, along with any Chromite that has now formed into 'gangue', thereby losing its refractory properties and becoming highly magnetic. Therefore, the last operation involves passing the metallic waste stream over a normal or 'ferrite' separator that will remove the highly magnetic portion and hence purify the Chromite ready to be re-used by the foundry.

Concluding Remarks

The foundry, if it is to be viable, must look at every means to conserve raw materials and maximise the moulding process/core-making process.

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