INVESTIGATION OF FOUNDRY WASTE SAND RECLAMATION PROCESS FOR SMALL AND MEDIUM SCALE INDIAN FOUNDRY

G. S. PATANGE¹, M. P. KHOND², H. J. RATHOD³ & K. B. CHHADVA⁴

¹,³,⁴Charotar University of Science and Technology, Changa, Gujarat, India
²College of Engineering, Pune, Maharashtra, India

ABSTRACT

A by Product of making a foundry casting is waste Sand. Waste sand is major problem for Indian Small and medium scale Foundry.

Metal casting process generate several kinds of waste, foundry sand is the main waste. Since foundry make intensive use of sand as primary direct material, the regeneration of this sand can be considered as main factor in environmental performance to achieve sustainable development.

In India small and medium scale foundry industries are not aware of this fact. They are ignoring problems, since last decade. But now a day it is essential to focus on sand regeneration, re recycling, re-use and disposal for sustainable development in foundry industries.

This paper focus on Scope of implementation of these techniques in small and medium scale foundry industries in India, considering some environmental, technical and economical aspects depending upon type of opportunities.

KEYWORDS: Foundry, Foundry Sand, Sand- Regeneration, Sand- Re-Recycling, Sand Re-Use

INTRODUCTION

In recent years the foundry industry has been showing an increased interest in reclamation of system sands. One problem that confronts every foundry is that of processing an adequate supply of sand which has the properties to meet the many requirements imposed upon it in molding and core making. The volume of sand required presents a major handling problem.

REASONS OF RECLAMATION

The basic reasons for reclaiming sand are:

• Economical
• Environmental
• Technical

Economically, the foundries desire to reduce the total sand cost which includes purchase cost, freight cost, and disposal costs. While the purchase cost of sand has gone up by more than 40% in the last 10 years, freight costs have gone up by well over 125%. The cost of 1 ton of sand is made up of purchase price, freight, unloading cost, transport cost in the foundry, and finally disposal cost. In some foundries they must not only pay for loading and unloading discard sand, but after a long distance haul they must pay a dumping fee [4].

Environmentally, it is becoming more and more difficult to dispose of great quantities of material into the ground. Different agencies and Governments want to know what chemicals are in all refuse and what amount might leach out from
the sand. This interest is not only in the public dumps but on the foundry's own property. In addition to the environmental plus of reclamation, the process is of value from the conservation point. The deposits of high quality sand will last longer if they are used more efficiently [4].

Technically, reclamation is of interest in that in some cases binders and catalyst may be reduced in reclaimed sand. There are some indications that better castings can be made when rather large variations in impurity levels and screen analysis are minimized in an enclosed reclaimed sand loop. In many reclaim sand trials, when the sand has been cleaned to a proper level, the casting results are as good, if not better than in all new sand. One explanation for this would be the idea of "survival of the fittest". On consecutive molding/pouring cycles, sand grains receive thermal shock from the pouring of molten metal into the casting cavity. Further mechanical shock is applied when the sand is impacted against the reclaimer target. The scrubbing of the individual grains occurs during transporting of the sand in the reclaimer as it moves from cell to cell. Sand grains with poor chemical structure or poor cleavage planes will fracture and the fragments in turn must be removed by dust collection. There is some data that shows repeated heating and cooling of Silica sand grains will produce a lower grain expansion. In many cases castings with better dimensional control have been made in reclaimed sand [4].

Ideally a sand reclamation plant would process used foundry sand at a maximum yield and return the sand in such a state as to be suitable for reuse with any binder system with no defects on the castings, and do all this at an economical cost. It is not possible in any single system to take all types of binder systems and to reclaim them and use them in any other system. The nearest approach that is economical is to process the sand, classify the reclaimed sand to nearly original distribution, reduce residual binders and contaminants to an acceptable level, and return the sand at an acceptable temperature [4].

**REQUIREMENTS OF ALL RECLAMATION SYSTEMS**

In any reclamation system the object is to remove a controlled amount of binder layer on the sand grain and by a dust collection system to remove the fines that are created. The requirements of any reclamation system are [4]:

- It must remove all lumps and tramp material. The lumps tend to be high in impurities and of course will add to rough casting surface.

- It must remove both magnetic and non-magnetic metal. The metallic are especially harmful in acid catalyzed binder Systems. The acid will react with the metallic particles and a certain amount of catalyst will be used up in this reaction. This amount of catalyst will of course lower the amount left to react with the resin. The removal of non-magnetics is an especially difficult procedure. Either screening or some type of inertial separation is usually used.

- It must remove the inert and organic material to a low acceptable level. The acceptable level will depend on the sand used, the binder system used, the metal poured, and the sand to metal ratio. Other factors will vary from foundry to foundry.

- It must remove both live and dead clay to a low acceptable level. High residual clay is detrimental in reclaimed sands to be used in an organic binder system. What is acceptable will vary by the use made of the sand in the foundry.

- It must deliver reclaimed sand with a grain distribution that would be similar to the new sand specification used. The new sand was selected to give a certain casting finish. The standard practice should not be materially changed because of the use of reclaimed sand.

- It must remove fines to a uniform level. Fines are very high in impurities, whether they be organic or inorganic.
• It must remove the coating from the sand grain in a uniform manner. For a new coating of binder to be of maximum efficiency the sand grain surfaces must be uniform.

• The reclaimed sand should work near equal to new sand. The casting results must be good as well as the shake-out characteristics of reclaimed sand.

• The appearance and quality of castings made in reclaimed sand is to be equal to or better than new sand.

**RECLAMATION AND ITS TYPES**

Reclamation by definition of the AFS 4S-Sand Reclamation and Re-Use Committee is: The physical, chemical, or thermal treatment of a refractory aggregate to allow its re-use without significantly lowering its original useful properties as required for the application involved.

There are primary reclamation and secondary reclamation of sand.

Primary reclaimed sand is not sufficient quality to be used for core-making and used principally for moulds. The main reclamation techniques are vibration, rotating drums or shot-blasting. Secondary reclamation involves further processing to remove residual binder. The sand returned to similar or better than that of new sand. In foundries using secondary regeneration may not need for new sand [1].

The secondary reclamation are:

− cold mechanical treatment:
  − low energy attrition: friction, impact (for cold-setting resins)
  − high energy attrition: pneumatic chafing, grinding, centrifugal friction

− thermal treatment (usually in a fluidized bed)

− Wet scrubbing.

Sands bonded with cold-setting resins may be regenerated using simple treatment techniques, due to the fragility of the binder layer. Mechanical regeneration systems (e.g. fluidized bed systems) are based on interparticle friction or impact [1].

Sands bonded with gas-hardened and thermosetting resins need more intensive treatment to remove the binder layer. These include grinding, pneumatically chafing and centrifugal friction. Silicate sands can only be regenerated mechanically using pneumatically treatment. Thermal treatment involves the burning of the organic binder. Bentonite is inactivated by the high treatment temperature. For sand flows containing green sand, any thermal treatment should therefore be combined with a mechanical treatment. Wet regeneration involves binder removal through interparticle grinding.

This technique applies only for green sand and silicate or CO2-bonded sands and is not widely applied. Secondary regeneration of green sand as a monosand flow finds limited implementation. The most important mono-sand flows for secondary regeneration are the core sands in nonferrous foundries. Due to the low thermal load they are easily separated from the green sand. Furthermore mono-sands are produced from mould and core-making with purely organic systems such as croning, furan resin and urethane cold-box.

A smaller mono-sand stream is no cured core sand, arising from broken or rejected cores in the core-making shop and the residual sand of core-making machines. Mixed sands generally contain bentonite-bonded sand as well as
chemically-bonded sand. They are mainly generated in iron foundries and represent some 75% of the total waste sand production.

**CASE-STUDY ON SAND RECLAMTION AT ABC PVT LTD, GUJARAT**

ABC Private limited (Name is kept indicative as per request from company) is a incorporated Under company act 1956, engaged in business of manufacturing heavy duty cast iron, S G iron castings ranging from 400 kg to 700 kg single piece. The company had installed mechanical sand reclamation system. The current situation as shown in figure bellow shows Sand proportion:-

![Fig. 1: Present Mechanical Sand Reclamation System at ABC Pvt. Ltd.](image)

The 75% reclamation rate reduced the volume of sand purchased to 2.5 tonnes per hour; 10 tonnes was processed through the reclamation unit hourly to maintain the rate of production.

The volume of spent sand going to beneficial reuse was reduced to 7.5 tonnes per hour. It is realized that company is not saving a significant proportion of sand, the company have 75% reclamation rate, and they are using both new and old sand for making of core and mould, Here 2.5 tonnes/ hr. Sand is wasted and this increases the cost of waste disposal and cost of new Sand. For investigation purpose Why-Why analysais is used;

**WHY-WHY ANALYSIS**

<table>
<thead>
<tr>
<th>PROBLEM 1</th>
<th>Sand was wasted</th>
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<tbody>
<tr>
<td>WHY</td>
<td>Sand mixture prodused nore sand</td>
</tr>
<tr>
<td>WHY</td>
<td>Because only one mould was there</td>
</tr>
<tr>
<td>SOLUTION</td>
<td>Filling of two or more moulds to reduce the waste</td>
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<tr>
<th>PROBLEM 2</th>
<th>Wastege of sand in mould making for larger casting</th>
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</thead>
<tbody>
<tr>
<td>WHY</td>
<td>Entire mould was made up of new sand</td>
</tr>
<tr>
<td>WHY</td>
<td>Old sand was not able the fill the voids in the mould cavity</td>
</tr>
<tr>
<td>WHY</td>
<td>Due to its distoration to small size</td>
</tr>
<tr>
<td>SOLUTION</td>
<td>To use concrete blocks instead of sand to fill the voids</td>
</tr>
</tbody>
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<tr>
<th>PROBLEM 3</th>
<th>Wastage of sand in mould making in smaller casting</th>
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<tbody>
<tr>
<td>WHY</td>
<td>The mould box was very large as compared to casting</td>
</tr>
<tr>
<td>WHY</td>
<td>There was only one mould box</td>
</tr>
<tr>
<td>SOLUTION</td>
<td>To use smaller mould box for small casting</td>
</tr>
</tbody>
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<th>PROBLEM 4</th>
<th>Sand spilling throughout process</th>
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<tr>
<td>WHY</td>
<td>No awareness</td>
</tr>
<tr>
<td>WHY</td>
<td>No house-keeping training</td>
</tr>
<tr>
<td>SOLUTION</td>
<td>Development of clener production awareness program</td>
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</table>
After implementing new process improvement the new model suggested to company showing the sand proportions is shown Bellow.

![Propsoed Reclamtion System with Process Improvement](image)

**Fig. 2: Propsoed Reclamtion System with Process Improvement**

**RESULTS OF PROCESS IMPROVEMENT**

By implementing above process improvement, company Can Save \((2.5 - 2.1 = 0.4\) ton\(= 400\)kg\) of sand per hour.

**CONCLUSIONS**

Reclamation of sand can be under taken using number of techniques, most of the foundries in India uses mechanical reclamation. By proper investigation of mould making, mould box size, sand mixture, better process control, sand spilling throughout the process, General house keeping foundry management can enhance performance of their system by critical examination.

Also There is scope for thermal reclamation system in small and medium scale fonderies in India, due to some advantages such as: Stronger molds and cores with less chemical additives, Better surface finish and less porosity, More dimensionally accurate castings, Far less odor and smoke in the foundry during pouring because less chemical binder is needed. With fewer chemical additives and a Superior quality of sand grain, casting defects such as finning and burn in are reduced.

**ACKNOWLEDGEMENTS**

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