

Sand Reclamation

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.

Grain shape, screen analysis, chemical characteristics, as well as thermal characteristics, must be uniform to get uniform properties in today's sand mixes. These requirements can be further complicated if the use of a sand from a particular geographical location is required. Many steel foundries require the high purity of an Ottawa or New Jersey Silica. While the purchase price of the sand may be the same as the local sand, the delivered cost becomes a major consideration. When transporting sand for a considerable distance, the foundry must allow for delays by maintaining a considerable stock or having a number of railcars in the circuit between the foundry and the pit.

RECONDITIONING VS RECLAIMING

One of the problems that have arisen in the area of sand processing has been semantic in nature. The words reclaiming and reconditioning have often been interchanged. Reconditioned sand has received some degree of cleaning work, but not enough to make the sand suitable for use as a new sand replacement throughout the foundry whether it be in cores or molds. Reconditioning of sand, that is crushing, magnetic separation, screening, air classification and possibly some cleaning, treats the sand as a mass. The compound grains are not necessarily broken and coatings of dehydrated clay or resin residue are not removed from the individual sand grains.

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. A true reclamation system works on the individual sand grains and re-establishes the near original screen analysis. In reclamation we are interested in the removal of the accumulated coatings from around the sand grain and the removal of excessive fines, dust, and other impurities that have made the sand unusable.

BACKGROUND

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.

Environmentally, it is becoming more and more difficult to dispose of great quantities of material into the ground. Agencies of the Local, State, and Federal 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. If the foundry is in a flood plain, materials they dump can have an effect on water supplies many miles away. 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.

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.

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.

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:

- 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 metallics 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 a 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.

SAVINGS TO BE MADE FROM A RECLAMATION UNIT

The savings to be made from a reclamation unit are:

- New sand purchases consider delivered price of the sand, not just the purchased price. Delivered price = purchase price + freight + unloading charges.
- Sand disposal cost - surveys have shown that disposal costs have ranged from .75 to over 5.00 dollars per ton. This cost includes a portion of the truck driver's time, a portion of pay-loaders time, and a portion of truck cost. Cost is affected by distance to the dump area and whether the foundry must pay for dump privileges.
- Better control in the foundry - variation in sand properties is less then when using all new sand. The screen analysis is more consistent in reclaimed sand in a closed system as are chemical characteristics of the sand.
- New sand storage can be reduced - new sand storage can be cut by up to 75% with most sand reclamation systems. This storage space can be converted to some other productive use.
- Binder or catalyst reduction - binder reduction can be made if the new sand used is very angular. The reclaiming process tends to round the grains. When this more rounded sand is used, an appreciable binder reduction can be made. In some cases an acid build-up can be a problem due to the cumulative nature of some of the catalysts. Less new catalyst may be needed, but if residual catalyst level is too high then poor bonding of the sand becomes a problem.

BASIC STEPS IN RECLAMATION

Every reclamation system has 5 basic steps:

- Shake-out
- Crushing or lump reduction
- Cooling
- Scrubbing
- Classification

All of the reclamation units on the market are combinations of these five steps. The difference in the designs of the various systems is basically due to the order and manner in which these units are put together. Each manufacturer makes the greatest application of their specialty.

Shake-out is the method of separating the casting from the mold and/or the sand from the flask. It can be done by manual knockout, high energy impact vibrating shake-out, or by shot-blasting. The shake-out is usually the primary lump breaking unit. In the flaskless molding process there is no requirement to break the sand loose from the flask, but the casting must be broken loose from the sand.

Although it is not considered a separate step, magnetic separation must be considered. Magnetic pulleys or magnetic overhead separators are required to remove rods, chills, and other magnetic metal. One of the areas of trouble has been the removal of non-magnetic material.

Crushing or lumpbreaking can basically be done by three different actions:

- The first method is by impact, in which a sharp instantaneous impingement of one moving object against another. The hammer mill and cage mill would be examples of this type of lumpbreaker.
- Attrition or reduction of material by rubbing action. The horizontal vibrating conveyor, with louvered plate sections

- that allow the sand to fall through, is an example of this type of lumpbreaker.
- Compression or the process of compressing material between two surfaces. Jawcrushers are an example of this type of lumpbreaker.

Because of the residual heat from the casting process some type of cooling is often required in a sand reclamation system. Heat is the most potent catalyst in any chemical reaction; therefore, heat will speed up the cure in the chemically cured binder systems. The cooling unit can be placed before or after the scrubber and its location will effect the final design of the reclamation system. If the sand reclaimed is to be controlled closely, no residual moisture can be present in the reclaimed product. Some reclamation systems cool the sand by exhausting air through the various stages and transfer points such as elevators and belt conveyors.

Scrubbing is a function in all reclamation systems, although the degree of scrubbing does vary considerably from unit to unit. Although some scrubbing is done on the sand in the shake-out and lumpbreaking process, further work is required. The form in which the scrubbing action takes place will effect the design of the equipment. Pneumatic sand scrubbers were designed to do further cleaning on the sand grains, by use of pneumatic power to transport the sand at a target and to use the impact for further binder removal. This impacting is controlled to be violent enough to knock binder loose from the sand grain surface but not hard enough to break good sand grains.

Classification is a very important step in a sand reclamation system. The reclaimed sand screen analysis should be similar to the new sand used originally. If the screen analysis varies a great deal, all the properties of the sand will vary. The coarse grains must be removed or rough casting surfaces will be produced. The fines must be removed to an acceptable level because they require high binder content for bonding and they also lower the permeability of the sand very rapidly.