HIGH-LEVEL SAND RECLAMATION FOR SODIUM SILICATE AND ALKALINE PHENOLIC-BASED SANDS

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ABSTRACT

Historically due to the chemical nature of these two binders it has proven difficult and costly to attain significant levels of sand reclamation. However due to the recent introduction of a novel method of sand conditioning, it has been proved that upto 90% of the sand can be re-used in the foundry without compromising on casting quality or production.

The system is compact and is easily integrated into the foundry. Because it does not rely on any thermal processing it is more cost-effective to operate compared to the conventional methods.

INTRODUCTION

Historically, due to the chemical nature of these two binders, it has been difficult and costly to attain significant levels of sand reclamation. Due to its inorganic nature and relatively high addition rates of sodium silicate binders, several methods have been previously employed, with varying results.

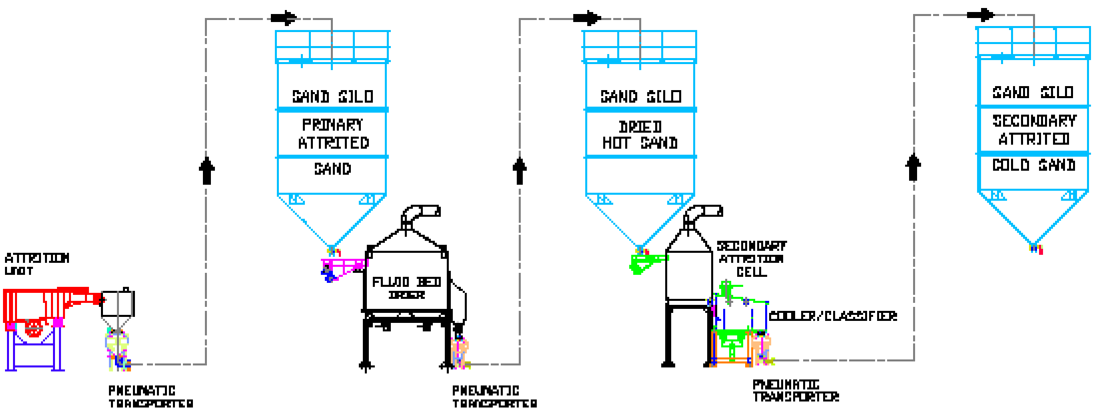
Sodium Silicate – Reclamation by Washing

This method involved various flotation cells whereby the sand was introduced to a counter current of water and by agitation the residual binder was 'washed off'. Unfortunately, the plant was complicated in nature, requiring several processing stages and the resultant wet sand required a subsequent high energy input in order to subsequently dry and classify the media. Other problems were also encountered with the resultant liquid effluent from the process. Due to its caustic nature it was not only difficult to dispose of but also highly corrosive to the plant itself.

Reclamation by Drying and Secondary Attrition

By the late 70's, early 80's, another form of reclaiming silicate-bonded sands became popular which relied on 'drying' of the sand after primary attrition to de-hydrate the binder and thus making it brittle. A secondary attrition cell was then used to impart 'work' or 'energy' in various guises on the sand in an attempt to remove the binder. After this process, the sand would be classified and cooled and ready for subsequent re-use.

The major drawback to this process was the energy required to de-hydrate the sand and then the crude methods of secondary attrition also were hard to control and resulted in varying levels of silicate removal along with the possibility of base sand damage and the creation of fines.



A typical secondary attrition layout with drier.

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An early form of secondary attrition also known as a 'hammer mill'. This was hard to control and could result in sand grain damage.

A 3 cell rotary reclamation plant.

Alkaline Phenolic process

Introduced in the early 80's, this process immediately became popular with steel foundries due to improved casting and knockout properties. This resin being semi-inorganic in nature could be reclaimed by traditional reclamation methods, although levels in the order of 60-70% were of the norm. At the time, this relatively low reclamation level was acceptable when considering the benefits of the process and the low cost of purchasing new sand and dumping of the same. In recent times, due to increased environmental pressure and subsequent increase in tax levies, this level of reclamation is no longer acceptable.

Unlike Sodium Silicate, Alkaline Phenolic can be thermally reclaimed. In order to counter the negative Effects of the Na and K salts on the sand in a calcine chamber, an additive has to be added to the sand in order to effectively 'neutralise' this effect and allow the sand to be processed. There are various additives in the market; most are clay-based in an aqueous solution. The addition is required to be made in a mixer prior to the sand entering the reclamation unit. Flow monitoring agitation in order to keep the additive in suspension and ensure correct delivery is necessary. Failure to make the correct addition will result in a 'frit' of the bed and significant damage can ensue. This coupled with the extra cost of the additive both in terms of initial costs and subsequent energy to remove the aqueous carrier make this an un-attractive proposition.

The Alternative - USR Sand Reclamation

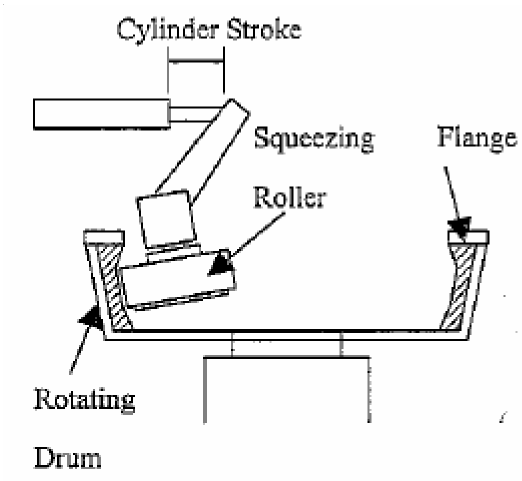
This process developed in Japan addresses the various issues surrounding the drawbacks of previous attempts in reclamation by these two processes. These are:

1. There is no pre-drying of the sand for silicate applications
2. The process is completely controllable and may be adjusted to maximise binder removal without damaging the sand grains
3. The initial capital cost is low when compared to previous methods
4. The running cost is low and there is no requirement for an additive
5. The unit is compact in design
6. There are no exhaust stack emissions to be concerned with.

Operation

Grains of sand enters the unit at a fixed rate and falls into the rotating drum. Due to centrifugal force the sand is thrown to the outside of the drum whereby the two ceramic rollers 'press' against the sand and the ceramic liner of the drum. The sand is retained for a short period of time by the retaining rim on top of the drum. Whilst it is 'rubbed' together, a portion of the resin is removed. The pressure on the sand via the wheels and the width of the retaining rim are adjusted to maximise the resin removal without damaging the sand grains.

USR secondary attrition reclaimer.



Schematic of the system showing the various parts.

Adjustable variables on the USR;

1. Ceramic wheel pressure on sand
2. Sand feed rate
3. Retaining rim width
4. Flow rate of the sand

Initial results

Although the system is well-proven in Japan, it was decided to conduct our own tests on local companies for both Silicate and Alkaline Phenolic sand systems in conjunction with a supplier of resin.

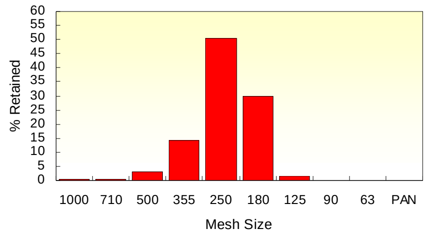
Picture of the ceramic wheels and rotating drum

It shows sand after passing through the cell and subsequent dust removal in the fluid bed classifier.

BINDER SYSTEM :	FENOTEC 260	SAMPLE DATE :	19-Oct-06
PREPARED BY :	M Bradley	REPORT DATE :	24-Oct-06

SIEVE ANALYSIS :-

Mesh Size	% Retained
1000	0.50
710	0.48
500	3.01
355	14.12
250	50.53
180	29.66
125	1.55
90	0.12
63	0.04
PAN	0.00



CHEMICAL ANALYSIS

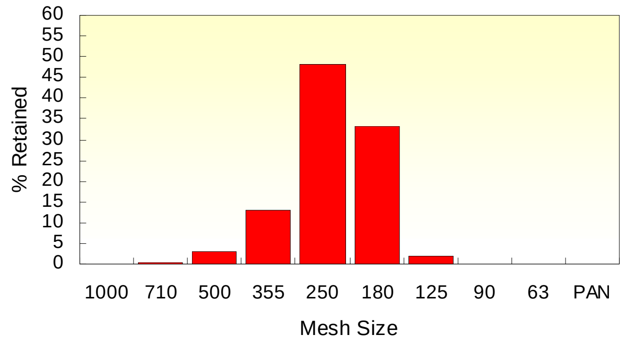
		Low Limit	High Limit			Low Limit	High Limit
Loss on Ignition	2.22%	0.80%	2.00%	AFS	46	44	56
Potassium	0.16%	0.05%	0.20%	FINES	1.67%	0.00%	5.00%
Moisture	0.63%	0.00%	0.90%	DUST	0.04%	0.00%	0.50%
pH	10.28	9.70	11.00				

Sand as received from existing primary attrition.

BINDER SYSTEM :	FENOTEC 260	SAMPLE DATE :	19-Oct-06
PREPARED BY :	M Bradley	REPORT DATE :	24-Oct-06

SIEVE ANALYSIS :-

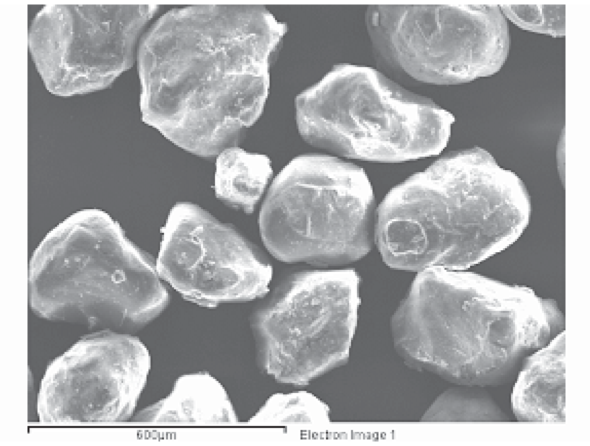
Mesh Size	% Retained
1000	0.12
710	0.36
500	2.93
355	12.89
250	48.26
180	33.30
125	2.08
90	0.06
63	0.00
PAN	0.00



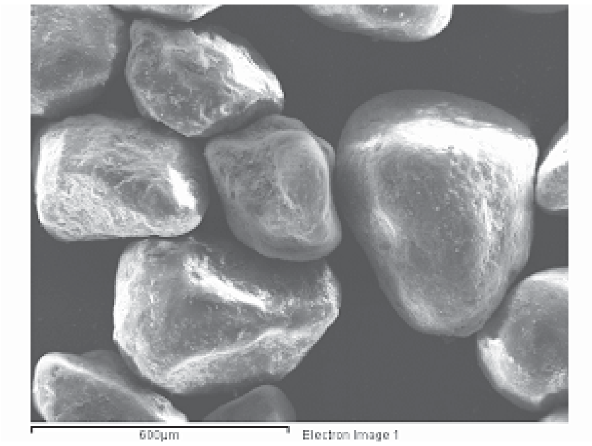
CHEMICAL ANALYSIS

		Low Limit	High Limit			Low Limit	High Limit
Loss on Ignition	0.91%	0.80%	2.00%	AFS	48	44	56
Potassium	0.10%	0.05%	0.20%	FINES	2.13%	0.00%	5.00%
Moisture	0.19%	0.00%	0.90%	DUST	0.00%	0.00%	0.50%
pH	10.17	9.70	11.00				

Sand after first pass through secondary attrition, note LOI reduction and no significant shift in sieve analysis



Sand after primary attrition showing residual resin adhering to the sand grain.



Sand after secondary attrition showing smoothing and rounding of the sand grain without any degradation.

Case Study 1, South Lincs, Foundry - Alkaline Phenolic

Ferrous and non-ferrous foundry casting pieces upto 500kg using Alkaline Phenolic, were reclaiming approximately 60% of their sand and purchasing 1200 Tonnes of new sand per year.

Various aspects of the foundry and castings produced.

Moulds are knocked out directly onto a 3TPH combination shakeout/reclaimer positioned at floor level.

Sand after primary attrition is then fed into the USR secondary attrition unit - note the drum magnetic separator prior to the USR to remove any metallics.

Omega Foundry Machinery
Sand Analysis Report

OMEGA FOUNDRY MACHINERY LIMITED

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CUSTOMER: SOUTH LINCS **IDENT** SA 117

CUSTOMER CONTACT: PAUL **SAMPLE DATE** 13/12/2007

TYPE SECONDAY ATTRITION

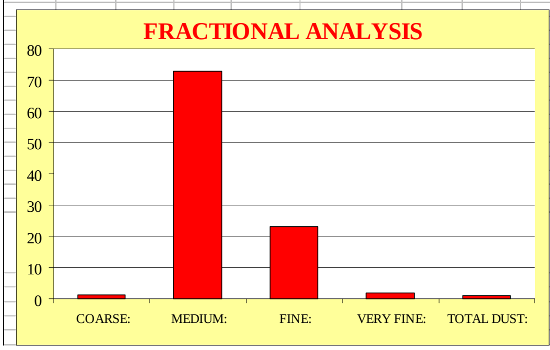
Mesh size (microns)	Mesh Number	Weight Retained
1000.00	16.00	0.03
710.00	22.00	0.09
500.00	30.00	1.06
355.00	44.00	6.89
250.00	60.00	40.39
212.00	72.00	25.49
180.00	85.00	16.17
150.00	100.00	7.05
125.00	120.00	1.80
90.00	170.00	0.81
63.00	240.00	0.21
	PAN	0.05
	TOTAL	100

LOI: 0.72 %
MOISTURE: 0.27 %

AFS FINENESS NO: 56.25

FRACTIONAL ANALYSIS

COARSE:	1.19	%(16-30 MESH)
MEDIUM:	72.79	%(44-72 MESH
FINE:	23.22	%(85-100 MESH)
VERY FINE:	1.80	%(120 MESH)
TOTAL DUST:	1.06	%(>120 MESH)

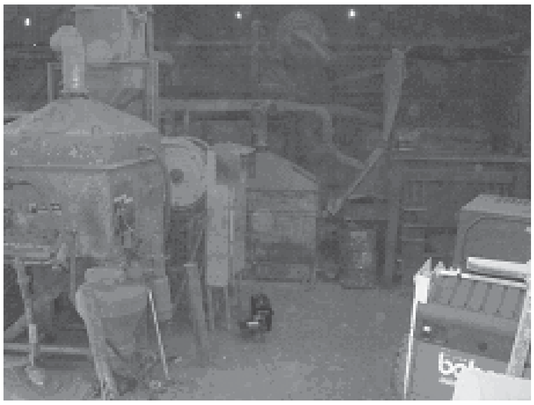


Sand results show a significant decrease in LOI after the USR unit allowing the foundry to reclaim at 90% levels with Alkaline Phenolic binder.

Overall view and with USR protected from the elements.

Results

The foundry has successfully increased their reclamation level from 60% to 90% without any detrimental effect on the quality of the sand, and/or casting quality. The annual savings in purchased sand and dumping costs alone are in the region of £42,000.00 per annum.



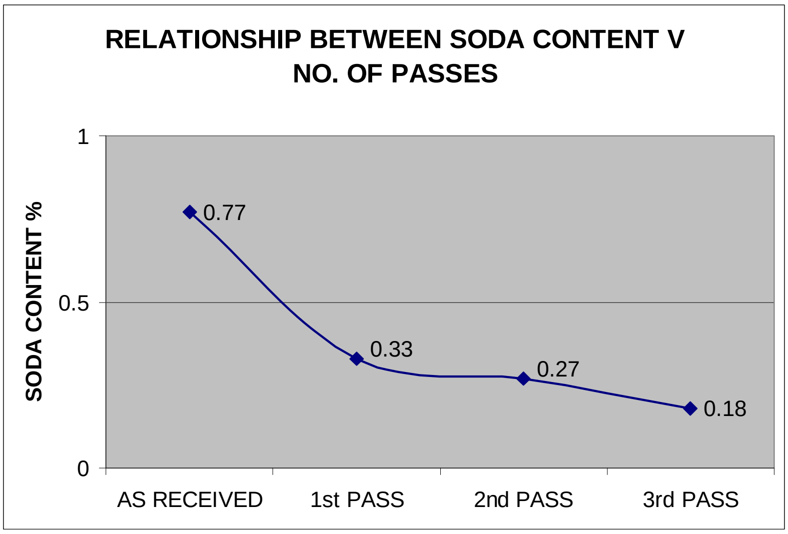
The original plant had a fluid bed gas fired drier for the sand after primary attrition and prior to secondary to increase removal rate of the Silicate.

Sand after knockout being fed into the primary attrition mill by payloader.

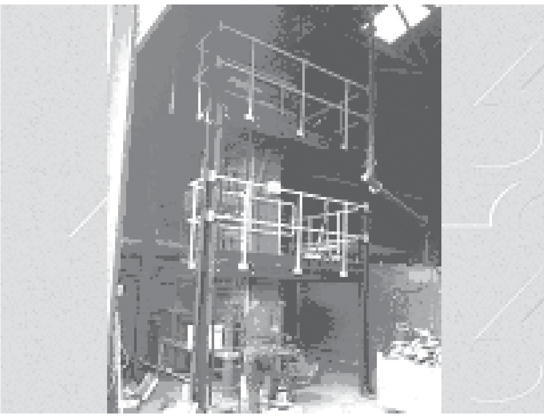
Case Study 2 – Sodium Silicate - Swan Foundry

Ferrous foundry casting from 50-2000kg using Sodium Silicate processes with CO_2 curing. The foundry uses approximately 6000 tonnes of sand per year. The foundry was using a two-stage attrition system with drier as previously outlined in the beginning of this paper. Levels of sand re-use at the mixer were in the order of 80% and the addition of silicate was 5%.

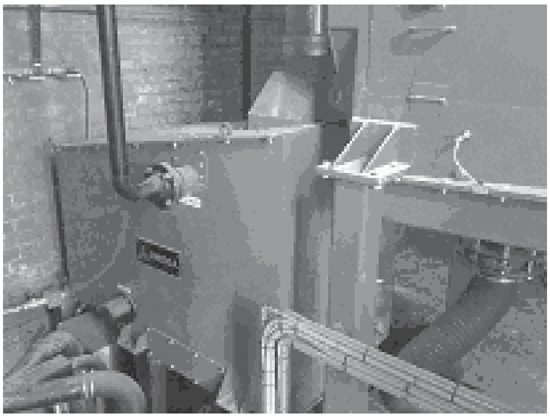
The original plant was over 20 years old and as the sand needed to be pre-dried prior to entering the secondary attrition, it was estimated that the gas consumption in the drier alone was costing an amount of £50,000.00 per annum.



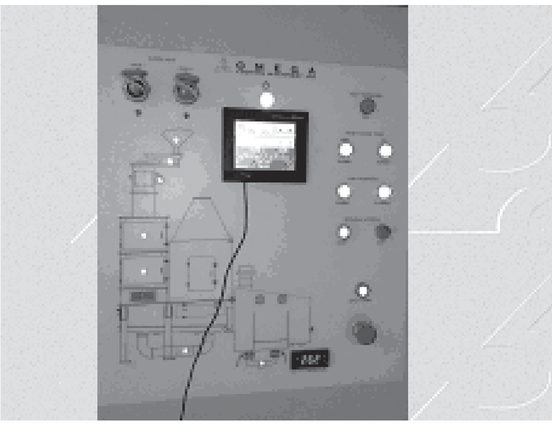
Graph showing the rate of Silicate removal as expressed in % soda versus number of passes through the USR.



Double cell USR being fed by primary atritted sand.



Sand after the USR being cooled and classified prior to re-use.



The control panel of the USR monitors the current of both cells and will give warning alarms should the Amperage go outside of preset levels.

Following initial test on the customer's sand and the resulting Soda content reduction, it was decided to install a two-cell USR system without pre-drying for processing the sand.

Results

Soda levels were reduced to a level that allowed re-bonding of the sand at 90% at the mixer with a concurrent reduction in Silicate addition rate from 5 to 4%. Apart from the commercial savings, the foundry also noted a significant improvement in the flowability and compactability of the sand.

The annual savings, taking into account the reduction in gas consumption; new sand purchase; dumping and silicate addition amounted to £84,000.00.

Conclusion

The USR is capable of increasing the reclamation levels of these two predominantly difficult processes to a level that increases the viability of their utilisation.

Acknowledgements

Foseco International, Tamworth, UK.

South Lincs Foundry, Spalding, UK.

Swan Foundry, Banbury, UK.