55th Indian Foundry Congress 2007

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GATEWAY TO GLOBAL MARKETS

High Level Sand Reclamation by means of Secondary Attrition – A Viable Alternative to Thermal Reclamation

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INTRODUCTION

The need for maximising the re-use of foundry moulding sand has never been higher. Even in countries such as in India where traditionally there was a cheap local source of sand and dumping could be carried out in some cases virtually for free, this situation is now changing at a dramatic pace.

The requirement for high quality washed and screened silica sands to be compatible with today's modern binder systems has meant that the nearest source of suitable sand could be several hundred miles away from the foundry. In this instance it is the cost of transportation not so much the base cost of the sand that is the inhibiting factor.

Dumping of foundry sand has now been identified by the government as a possible hazardous waste and as such in certain areas punitive measures are now in place to restrict this practice by the imposition of high taxes. Based on increasing environmental pressures placed in foundries and industry in general -this situation will only increase.

In order for the foundry to remain financially viable and technically sound it must aim for as near 100% sand conservation/reclamation as possible.

Why cant sand be re-used 100%

The modern 'no bake' binder systems can be split into several categories; in India the most popular are the following:

- ❑ Phenolic Acid Cured
- ❑ Furan
- ❑ Alkaline Phenolic
- ❑ Phenolic Urethane
- ❑ Silicate

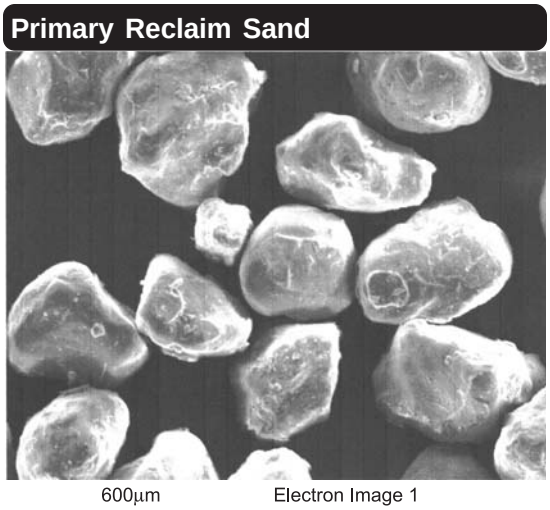


Fig. 1 : *Retained resin on the sand grain after primary attrition*

The limiting factor of reclamation for all these processes is the level of binder initially put onto the sand and the ease that the binder degrades under casting conditions, rate of removal in the

reclamation plant and finally how the residual binder affects the re-bonding with the new binder added at the mixer.

If we take a Phenolic acid cured or furan binder then from a re-bonding standpoint it is quite easy to achieve a high reclamation level, however over time and subsequent cycles of the sand the LOI will build up and could lead to gas defects in the casting coupled with increased VOC's when casting and a deterioration of the working atmosphere.

In-organic binders such as silicate or semi inorganic like alkaline Phenolic have a different set of problems. Firstly the addition rate at the mixer is higher than with furan. Secondly the bond is not as easy to remove through attrition as it tends to be somewhat plastic and in both cases is aggravated by the fact that the binders are hydroscopic and can contain high levels of moisture that compounds the problem.

The other problem area is that due to the alkaline nature of the binder when re-mixed with fresh resin will start the polymerisation process almost immediately and as such the bench life and subsequent strengths are reduced. This normally necessitates an increase in the resin addition to compensate for this, which of course is adding to the overall problem when trying to optimise reclamation levels.

If we take a typical ferrous 'jobbing' foundry running a 4:1 sand to metal ratio with single stage attrition then the reclaim levels will be in the order of 70-85% typically. If we take the same foundry and increase the sand to metal ratio then the reclaim levels will drop proportionately. Change form a ferrous to a non-ferrous operation and the situation becomes even more drastic.

The answer to maximising re-use levels

Because the problems of reclamation lie with the retained binder on the sand, the easiest way to overcome this is to remove the binder by thermal means. This normally involves a fluid bed thermal chamber where the sand is subjected to temperatures normally exceeding 600C. The binder is literally burnt off the sand and fully combusted leaving a typical residual LOI of less than 0.3%. The

Fig. 2 : *Typical thermal reclamation plant*

Fig. 3 : *Hammer mill*

resulting sand then has to be classified and cooled for re-use in the foundry.

However there are some limitations/ drawbacks;

1. Only organic binder systems can be thermally reclaimed. Silicate bonded sand cannot be thermally reclaimed.
2. In the case of Alkaline Phenolic, which is semi-inorganic, it is necessary to add an inhibitor prior to the sand entering the calciner to prevent fusion of the sand. This adds another cost and requires maintenance to ensure correct additions are being metered in.
3. The initial capital cost of the equipment is very high.
4. The running cost of the plant is energy reliant, and as most thermal plants are gas fired is heavily dependant on the price of this commodity.
5. The purity of the base sand is important, as low silica content and can lead to the impurities changing in nature under calcinations leading to a rise in ADV. This is especially important when considering acid cured systems and urethanes.

The Alternative

If the remaining portion of resin can be removed by mechanical means then this has many advantages and the concept of secondary attrition is not new, it has been pioneered many years ago and was especially prevalent when reclaiming silicate for the reasons mentioned previously. However the earlier plants had several drawbacks, probably the greatest is the unintentional damage done to the sand grain itself whilst attempting to remove the binder.

Fig. 4 : *Rotary reclaimer*

Most of these systems relied on impact of the sand grain in various guises from the 'hammer' mill to impact plate and sand upon sand collision. Although binder was removed, the parameters controlling the rate of removal and the option to lessen the impact and subsequent damaging of the sand where just not there.

In more recent times a method generically termed as 'rotary reclamation' has been developed, this system relies on a sand-to-sand 'rubbing'. Normally sand enters the chamber where it falls under gravity on a fast rotating disc. The sand when in contact with the disc is immediately thrown to the outside due to centrifugal force. The sand is retained in the peripheral wall of the disc by a retaining ring allowing a tumbling/ rubbing action to take place as further sand enters the chamber.

The system works well for 'hard' sand such as Furan/Phenolic Acid cured due to the brittle nature of the resin bond. However for other processes such as

Alkaline Phenolic and Silicate the rate of binder removal is lessened due to the problems associated with this system as previously mentioned.

To overcome this, a novel method has been introduced into the reclaimer that allows a more intensive scrubbing action, yet at the same time does not promote the formation of fines or degrade the sand. This is accomplished by two ceramic discs positioned internally and pushing against the sand to increase the level of sand-to-sand contact and hence the binder removal.

What make this method superior to previous systems are the various parameters that can be altered in order to hone and refine maximum binder removal without degrading the sand.

The following parameters can be altered to suit;

- ❑ Sand feed rate
- ❑ Disc speed
- ❑ Retaining ring size to increase/ decrease retention time of the sand
- ❑ Pressure of the ceramic wheels on the sand.

CONCLUSION

There will never be 100% sand reclamation (even with thermal) due to losses on the system such as fines removal etc. These normally equate in the region of 4-7%. However it has been proven that foundries normally operating on single stage attrition and with alkaline Phenolic have increased their reclamation levels from 70 - 90% with the associated cost savings that go with this.

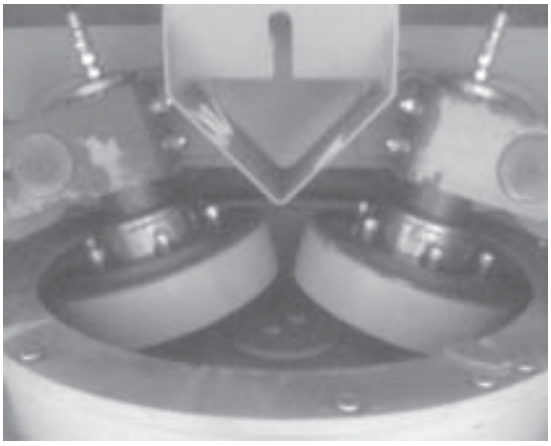


Fig. 5 : *USR Type reclaimer with cermic intensifying wheels*

The use of this type of reclamation offers the foundry an affordable opportunity to maximise the reclamation levels to that approaching thermal yet with a much lower capita1 investment and subsequent running costs. Also due to the fact that there are no thermal calcination of the binder means that hard to reclaim inorganic or semi-inorganic binder systems can be effectively reclaimed using this method.

Sand Physical/Chemical Data

Mesh	*As Received Retained*	*Pass 1 Retained*	*Pass 2 Retained*	*Pass 3 Retained*
16	0.15	0.04	0.00	0.00
22	0.49	0.22	0.16	0.10
30	21.57	13.78	10.95	9.02
44	39.41	41.46	35.88	34.25
60	23.21	31.33	33.12	34.35
72	6.96	8.52	11.19	12.70
85	3.16	2.93	4.56	5.35
100	2.52	1.31	2.88	3.16
122	1.28	0.33	0.96	0.97
168	0.91	0.08	0.28	0.19
237	0.30	0.00	0.01	0.01
Pan	0.17	0.00	0.00	0.00
AFS	38.88	38.06	41.54	42.72
Fraction				
Coarse	22.21	14.04	11.11	9.12
Medium	69.58	81.31	80.19	81.30
Fine	5.68	4.24	7.44	8.51
Very Fine	1.28	0.33	0.96	097
Dust	1.38	0.08	0.29	0.20
Moisture	0.39	0.14	0.10	0.10
LOI	1.20	0.49	0.33	0.25
Alkali	0.093	0.062	0.051	0.039
ph	9.26	9.41	9.49	9.40

Fig. 6 : *LOI V number of passes showing decrease in LOI*

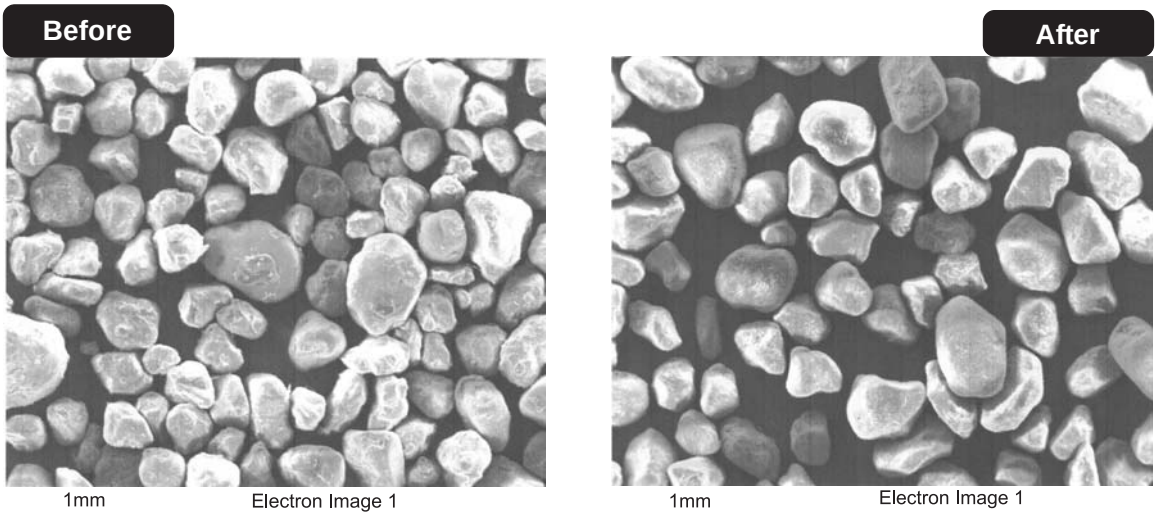


Fig. 7 : *Before and after sand*

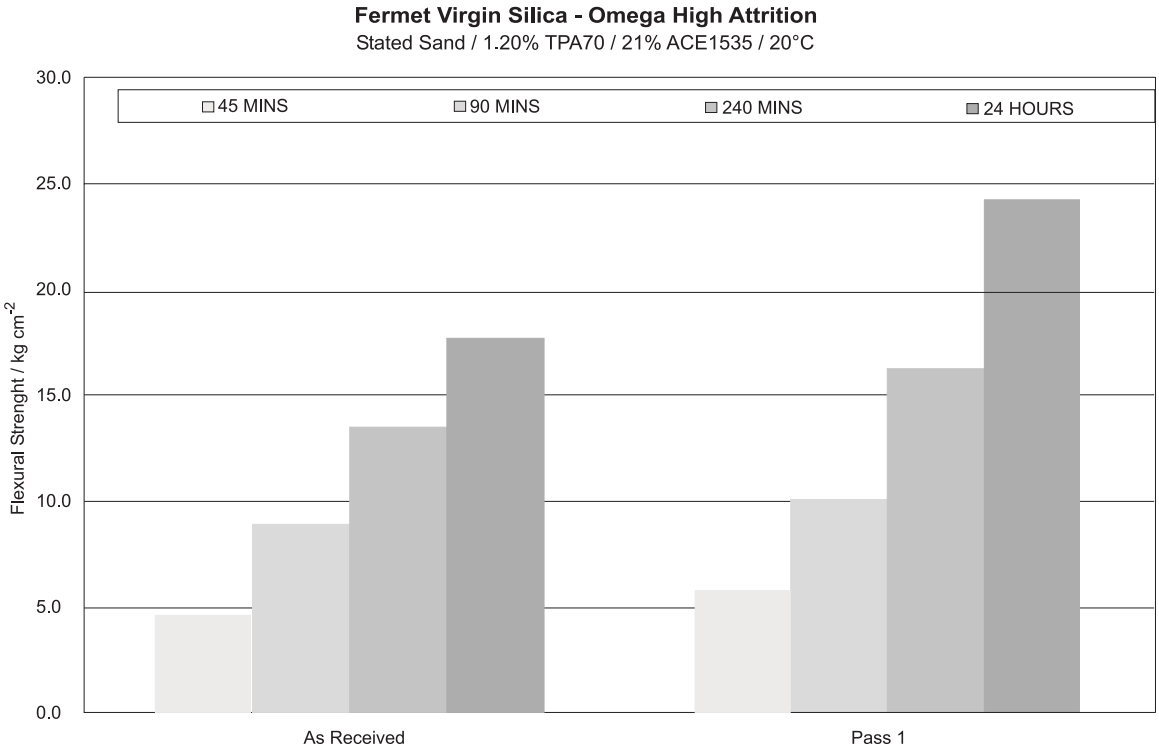


Fig. 8 : *Re-bonding strength figures on alkaline Phenolic*

Hexion Specialty Chemicals
Sand Analysis Results

HEXION™
Specialty Chemicals

Hexion Specialty Chemicals UK Ltd,
Sully, South Glamorgan, Wales, UK. CF64 5YU
Tel: + 44(0)845 310 9200 Fax: +44(0)845 310 9201

CUSTOMER: Omega
CUSTOMER CONTACT:
SALES REPRESENTATIVE

INDENT: RK102.1
SAMPLE DATE: Nov-06
SAND TYPE: Fermet Reclaimed Sand
As Received

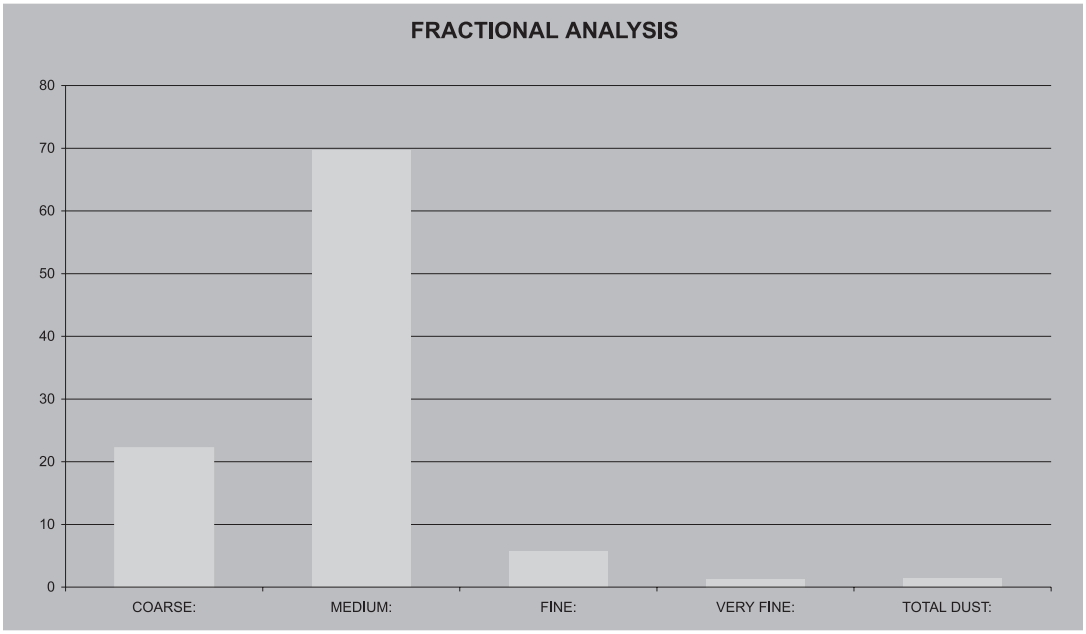
Mesh Size (microns)	Mesh Number	Weight Retained
1000	16	0.15
710	22	0.49
500	30	21.57
355	44	39.41
250	60	23.21
212	72	6.96
180	85	3.16
150	100	2.52
125	122	1.28
90	168	0.91
63	237	0.30
	PAN	0.17
	TOTAL	

LOI: 1.20 %
MOISTURE: 0.39 %
TOTAL ALKALI: 0.093 %K

AFS FINENESS NO: 38.88
GFN NO: 401.98

FRACTIONAL ANALYSIS

COARSE: 22.21 %(16-30 MESH)
MEDIUM: 69.58 %(44-72 MESH)
FINE: 5.68 %(85-100 MESH)
VERY FINE: 1.28 %(122 MESH)
TOTAL DUST: 1.38 %(>122MESH)



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CUSTOMER: Omega
CUSTOMER CONTACT:
SALES REPRESENTATIVE

INDENT: RK102.2
SAMPLE DATE: Nov-06
SAND TYPE: Fermet Reclaimed Sand Pass 1

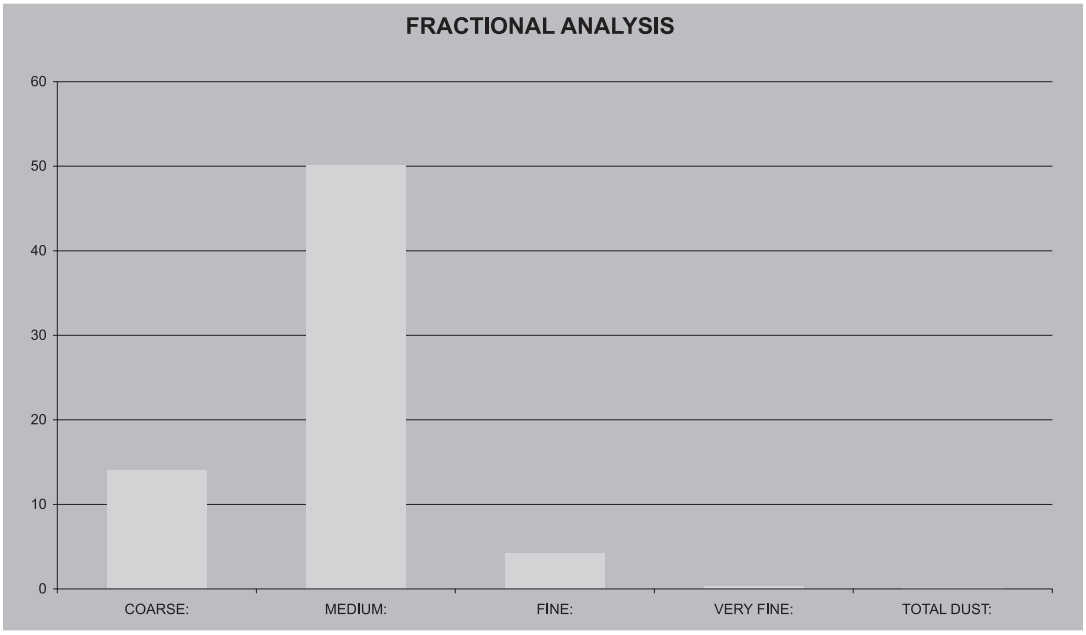
Mesh Size (microns)	Mesh Number	Weight Retained
1000	16	0.04
710	22	0.22
500	30	13.78
355	44	41.52
250	60	
212	72	8.52
180	85	2.93
150	100	1.31
125	122	0.33
90	168	0.08
63	237	0.00
	PAN	0.00
	TOTAL	68.73

LOI: 0.49 %
MOISTURE: 0.14 %
TOTAL ALKALI: 0.062 %K

AFS FINENESS NO: 35.34
GFN NO: 420.52

FRACTIONAL ANALYSIS

COARSE: 14.04 %(16-30 MESH)
MEDIUM: 50.04 %(44-72 MESH)
FINE: 4.24 %(85-100 MESH)
VERY FINE: 0.33 %(122 MESH)
TOTAL DUST: 0.08 %(>122MESH)



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CUSTOMER: Omega
CUSTOMER CONTACT:
SALES REPRESENTATIVE

INDENT: RK102.3
SAMPLE DATE: Nov-06
SAND TYPE: Fermet Reclaimed Sand Pass 2

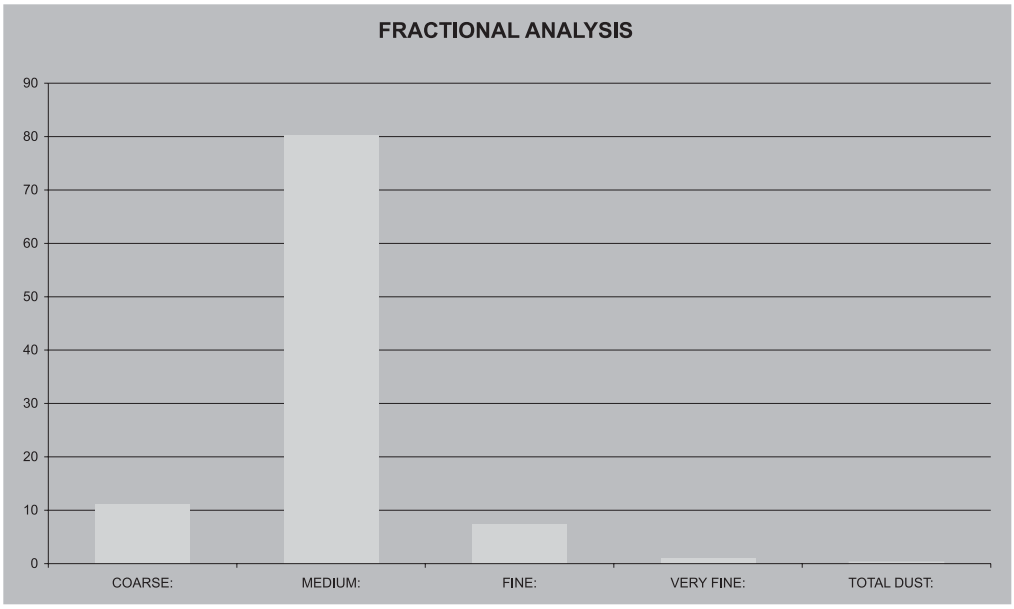
LOI: 0.33 %
MOISTURE: 0.10 %
TOTAL ALKALI: 0.051 %K

AFS FINENESS NO: 41.54
GFN NO: 358.93

Mesh Size (microns)	Mesh Number	Weight Retained
1000	16	0.00
710	22	0.16
500	30	10.95
355	44	35.88
250	60	33.12
212	72	11.19
180	85	4.56
150	100	2.88
125	122	0.96
90	168	0.28
63	237	0.01
	PAN	0.00
	TOTAL	99.99

FRACTIONAL ANALYSIS

COARSE: 11.11 %(16-30 MESH)
MEDIUM: 80.19 %(44-72 MESH)
FINE: 7.44 %(85-100 MESH)
VERY FINE: 0.96 %(122 MESH)
TOTAL DUST: 0.29 %(>122MESH)



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CUSTOMER: Omega
CUSTOMER CONTACT:
SALES REPRESENTATIVE

INDENT: RK102.4
SAMPLE DATE: Nov-06
SAND TYPE: Fermet Reclaimed Sand Pass 3

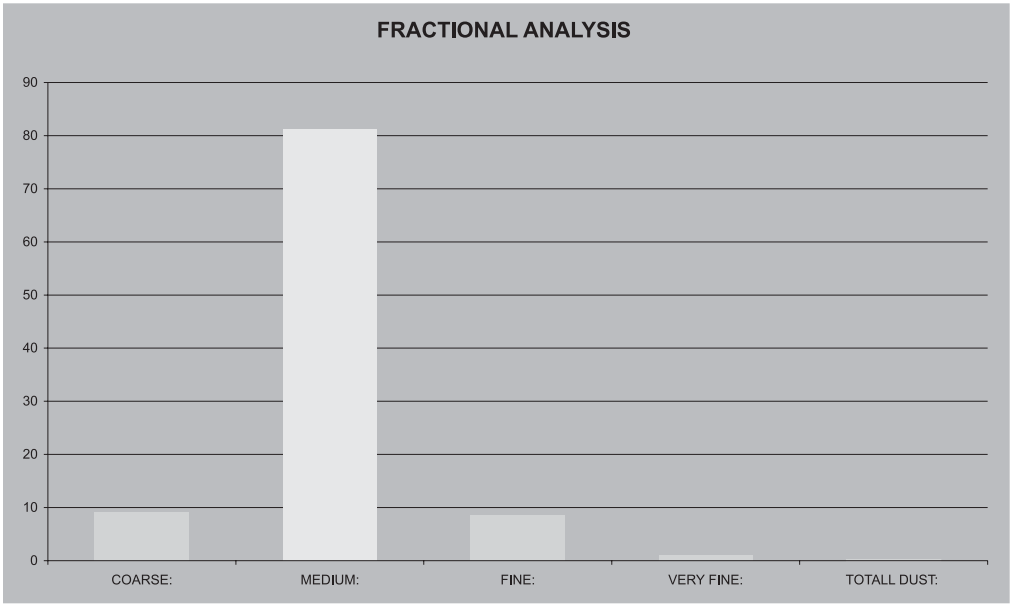
Mesh Size (microns)	Mesh Number	Weight Retained
1000	16	0.00
710	22	0.10
500	30	9.02
355	44	34.25
250	60	34.35
212	72	12.70
180	85	5.35
150	100	3.16
125	122	0.97
90	168	0.19
63	237	0.01
	PAN	0.00
	TOTAL	100.10

LOI: 0.25 %
MOISTURE: 0.10 %
TOTAL ALKALI: 0.039 %K

AFS FINENESS NO: 42.72
GFN NO: 348.23

FRACTIONAL ANALYSIS

COARSE: 9.12 %(16-30 MESH)
MEDIUM: 81.30 %(44-72 MESH)
FINE: 8.51 %(85-100 MESH)
VERY FINE: 0.97 %(122 MESH)
TOTAL DUST: 0.20 %(>122MESH)



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Tel: + 44(0)845 310 9200 Fax: +44(0)845 310 9201

CUSTOMER: Omega
CUSTOMER CONTACT:
SALES REPRESENTATIVE

INDENT: RK102.5
SAMPLE DATE: Nov-06
SAND TYPE: Fermet Reclaimed Sand Dust Extracted

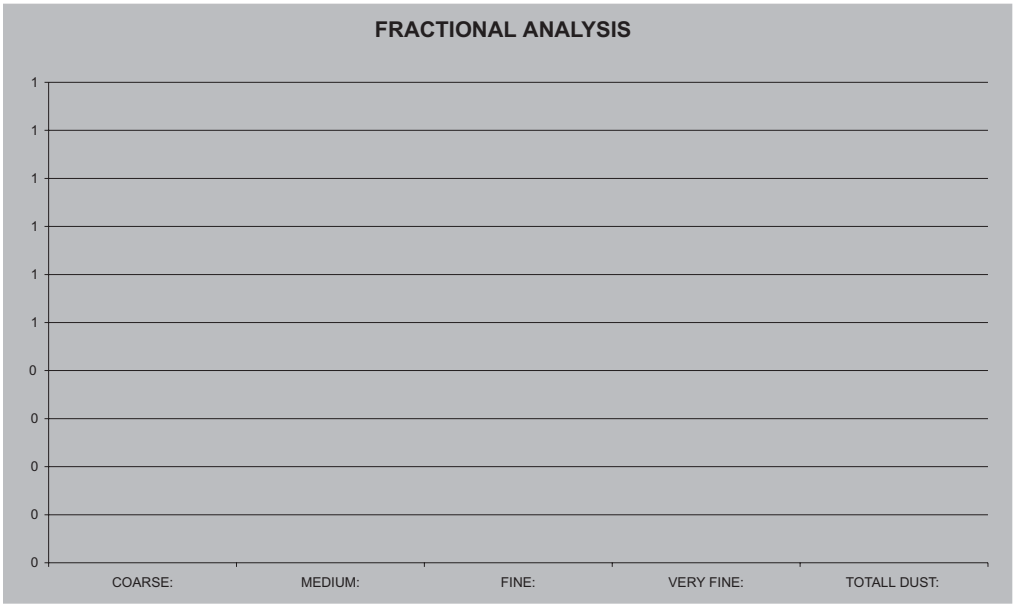
Mesh Size (microns)	Mesh Number	Weight Retained
1000	16	
710	22	
500	30	
355	44	
250	60	
212	72	
180	85	
150	100	
125	122	
90	168	
63	237	
	PAN	
	TOTAL	0.00

LOI: 1.27 %
MOISTURE: %
TOTAL ALKALI: %K

AFS FINENESS NO:
GFN NO:

FRACTIONAL ANALYSIS

COARSE: 0.00 %(16-30 MESH)
MEDIUM: 0.00 %(44-72 MESH)
FINE: 0.00 %(85-100 MESH)
VERY FINE: 0.00 %(122 MESH)
TOTAL DUST: 0.00 %(>122MESH)



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Hexion Specialty Chemicals UK Ltd,
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Tel: + 44(0)845 310 9200 Fax: +44(0)845 310 9201

CUSTOMER: Omega
CUSTOMER CONTACT:
SALES REPRESENTATIVE

INDENT: RK102.6
SAMPLE DATE: Nov-06
SAND TYPE: Fermet Virgin Silica
As Received

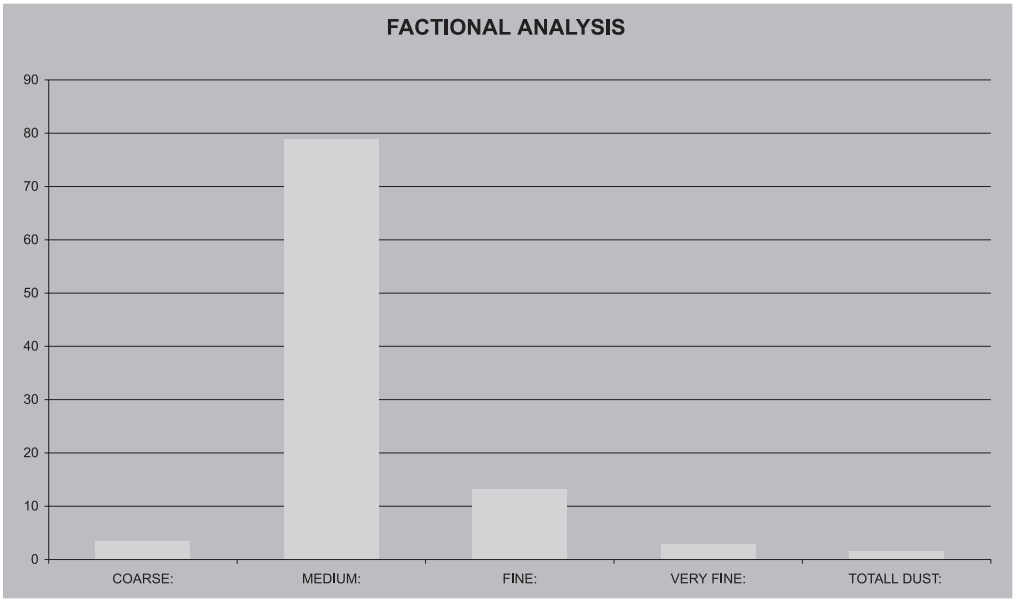
Mesh Size (microns)	Mesh Number	Weight Retained
1000	16	0.00
710	22	0.02
500	30	3.38
355	44	21.72
250	60	39.88
212	72	17.31
180	85	7.17
150	100	6.03
125	122	2.82
90	168	1.28
63	237	0.30
	PAN	0.07
	TOTAL	99.98

LOI: 0.23 %
MOISTURE: 0.04 %
TOTAL ALKALI: - %K

AFS FINENESS NO: 50.62
GFN NO: 299.31

FRACTIONAL ANALYSIS

COARSE: 3.40 %(16-30 MESH)
MEDIUM: 78.91 %(44-72 MESH)
FINE: 13.20 %(85-100 MESH)
VERY FINE: 2.82 %(122 MESH)
TOTAL DUST: 1.65 %(>122MESH)



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Tel: + 44(0)845 310 9200 Fax: +44(0)845 310 9201

CUSTOMER: Omega
CUSTOMER CONTACT:
SALES REPRESENTATIVE

INDENT: RK102.7
SAMPLE DATE: Nov-06
SAND TYPE: Fermet Virgin Silica
Pass 1

Mesh Size (microns)	Mesh Number	Weight Retained
1000	16	0.00
710	22	0.01
500	30	4.54
355	44	27.44
250	60	41.17
212	72	15.65
180	85	5.90
150	100	3.81
125	122	1.24
90	168	0.36
63	237	0.01
	PAN	0.00
	TOTAL	100.13

LOI: 0.17 %
MOISTURE: 0.04 %
TOTAL ALKALI: - %K

AFS FINENESS NO: 45.86
GFN NO: 320.72

FRACTIONAL ANALYSIS

COARSE: 4.55 %(16-30 MESH)
MEDIUM: 84.26 %(44-72 MESH)
FINE: 9.71 %(85-100 MESH)
VERY FINE: 1.24 %(122 MESH)
TOTAL DUST: 0.37 %(>122MESH)