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(54) **Process for the reclamation of foundry sands.**

(57) This invention concerns the reclamation of foundry sands for re-use by removal of the binder by treating the sand in a fluid energy mill. By careful control of the energy imparted to the sand, binder removal can be achieved with minimal particle breakdown.

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PROCESS FOR THE RECLAMATION OF FOUNDRY SANDS

This invention concerns the reclamation of foundry sands.

Foundry sand is used with suitable binding agents for making moulds and cores for casting metal. Various binders, both inorganic and organic, are used to bond the foundry sand and, for many years, the sand after use was discarded.

In an attempt to reduce the running costs of foundries and to reduce environmental pollution, various processes have been suggested in an attempt to enable the foundry to re-use sand, preferably many times over. Problems have always arisen in that the amount of binder to be removed from the used foundry sand to enable it to be re-used is quite critical and, hitherto, it has only been possible to use again some reclaimed sand together with some fresh sand if satisfactory binding is to be achieved and suitable moulds and cores made.

A paper entitled "Trends in Sand Reclamation" was given at the British Cast Iron Research Association International Conference in 1979, by Mr. D.A. Taylor and in this paper reference is made to water washing and

attrition, which can be carried out by various means including crusher units, vibrators, pneumatic impellers and shot blasting. For organic binders incineration has also been proposed. In relation to silicate bonded sands, it is suggested that only intensive attrition and/or water washing can remove sufficient sodium oxide to allow re-use of the sand.

British Patent Specification No. 1,322,864 is also concerned with the problem of sand reclamation and discloses a process in which the used foundry sand is introduced into a blast of fluid under pressure, whereby the sand is projected against lateral walls of a hermetically sealed casing to cause a matrix of the binding agent to burst releasing the sand. The product of this process is then subjected to granulometric selection to remove the fines generated by the high impact.

British Patent Specification No. 1,505,904 discloses a process in which coated sand particles are projected in a current of gas against the interior surface of a rotating drum.

British Patent Specification No. 2,019,274 discloses a similar process in which, again, the coated sand is projected against a solid target.

Other reclamation methods have been disclosed in, for example, British Patent Specification No. 1,593,008, in which used foundry sand is suspended in a fluidised bed and subjected to jets of compressed air whilst in the fluidised state. Japanese Patent Specification No. 51109941, published on 3 April 1978, concerns a similar method in which fluidised sand is subjected to abrasion by stirrer blades rotated at high speed inside the fluidised bed of sand.

The essential problem to be overcome in the sand reclamation process is an adequate balancing of two objectives, namely the effective removal of a hard and tenacious coating and the avoidance of significant particle degradation of the clean sand particles to produce fines which are not useful in the reclaimed sand. The present invention provides a process which effectively balances these two objectives.

Experiments have shown that it is acceptable to have up to a total of 0.8% by weight of soda on sand, including the fresh silicate binder, when reclaimed sand is reused in in foundry core work, without having to add fresh uncontaminated sand to the core mixture. This is equivalent to the removal of 65-70% of the soda coated onto the sand in the the normal carbon dioxide or ester silicate processes.

If less soda is removed a proportion of fresh sand needs to be included to ensure the production of satisfactory cores and moulds. Such removal can be obtained when organic binders are removed from foundry sand by attrition or incineration, but no satisfactory method has hitherto been proposed for the removal of silicate binder to this extent, without causing significant disintegration of the sand, so producing useless fines which merely contaminate the system.

Experiments involving increased fluid energy input into a fluidised bed system have proved unsatisfactory in that the additional energy destabilises the fluidised bed and the higher energy sand merely erodes the surface of the container carrying the fluidised bed.

Accordingly, the present invention provides a process for the reclamation of binder coated foundry sand, in which

the coated foundry sand is fed to a fluid energy mill and fluid energy is imparted to the sand to a sufficient extent to substantially remove the binder coating without causing significant disintegration of the sand particles, and the reclaimed sand is separated from the binder debris.

In a preferred form of the process the specific energy imparted to the sand is less than 1,300 kilojoules per kilogramme of coated sand. In the equipment used for this work, the optimal energy range was from 400 to 1,200 kilojoules per kilogramme of sand. This work was carried out in a micronizer having a diameter of 10 cm and containing 6 1.6 mm diameter inlet nozzles in the periphery of the chamber. The feed rate of the sand varied from 0.33 to 1.54 g per second and the optimum feed rate was of the order of 1 g per second for this apparatus.

Using a commercial production size of fluid energy mill - or micronizer the sand feed rate can be increased in relation to the size of the mill and air throughput. The specific energy imparted to the sand should be of the same order of magnitude as previously defined but applied at a commercially useful sand feed rate.

Fluid energy or jet mills (alternatively known as micronisers) suitable for use in the process of this invention are available from various suppliers in the market and are described in, for example, Chemical Engineering Handbook, Ed. J.H. Perry, 4th ed., McGraw Hill, p.8-42 and 43.

The fluid energy imparted to the sand in the mill is determined by calculating the energy expended by the adiabatic expansion of the compressed fluid through the nozzles, and is given by:

$$E = \frac{\gamma}{\gamma-1} \times W \times R \times T \left[\left(\frac{P_1}{P_0} \right)^{\frac{\gamma-1}{\gamma}} - 1 \right]$$

where E = Energy due to expansion (kw)

R = Universal Gas Constant (8.314 kj/k mol k)

T = Absolute Temperature (K)

W = molal flowrate (k mol/s)

P_1 = Absolute air pressure applied to nozzles (N/m^2)

P_0 = Absolute air pressure after expansion (N/m^2) assumed to be atmospheric pressure

γ = ratio of specific heats (C_p/C_R).

The specific energy input is obtained by dividing by the feedrate of sand (kg/s), i.e.

$$E_s = \frac{E}{M_s} \text{ (kj/kg)}$$

It will be appreciated that the imparted energy figures set out above relate to a specific piece of apparatus, but it is thought that by simple experiment the work can readily be applied to other types of fluid energy mill. To assist in this generalisation and to relate the forces involved to the fluid input stream, Reynolds Number calculations have been carried out.

Reynolds Number is the ratio of inertial force to the viscous force of the flowing fluid. It is a measure of the air fluid velocity in the jet stream which determines the drag force exerted on the individual particles and thus determines their acceleration and their impact velocity.

Reynolds Number can be calculated on the basis of the fluid mass flowrate through a single nozzle (Q_f) of

nozzle diameter, d_n,

$$N_{Re} = \frac{4\ Q_f}{\pi d_n / u}$$ / u = air viscosity

In general, it is preferred that the Reynolds Number does not exceed 6.5×10^4 and is preferably in the range 4.0×10^4 to 6.4×10^4.

Using the 10 cm diameter microniser referred to earlier, a sample of foundry sand which had previously been used in a silicate bonded core was treated in accordance with the invention and the results are set out below.

Sieve Analysis of Original Fresh Uncoated Sand.

	%
< 150 /um	3.0
150 - 180 /um	10.0
180 - 250 /um	43.8
250 - 355 /um	30.8
355 - 425 /um	10.5
> 425 /um	1.9

	EXAMP. 1	EXAMP. 2	EXAMP. 3	EXPT. 1
Sand Feedrate (g/s)	1.54	1.0	1.0	1.0
Injection Air Pressure (KN/m^2)	310	228	310	434
Grinding Air Pressure (KN/m^2)	379	241	379	517
Specific Energy Input, Es (Kj/Kg)	434	421	1000	1783
Sieve Analysis				
<150 /um	11.94	6.96	14.27	35.62
150-180 /um	9.78	11.75	11.63	9.82
180-250 /um	41.92	47.68	42.93	32.71
250-355 /um	27.46	27.15	24.47	17.50
355-425 /um	7.95	5.82	5.97	4.00
>425 /um	0.95	0.64	0.73	0.34
% Na_2O on sand >150 /um (original sand plus silicate binder 0.675%)	0.287	0.355	0.275	0.178
% Na_2O Removal	64.7	53.3	66.7	82.8
Renolds Number	$5.3X10^4$	$3.91X10^4$	$5.73X10^4$	$7.89X10^4$

It can be seen from the Examples that in the preferred range of specific energy and Reynolds number mode of operation of the process of this invention, that more than 60% of the soda on used sand can be removed whilst fines are less than 15%.

If higher energies are used, although even more soda is removed, unacceptably large quantities of fines are produced - see Exp. 1.

As mentioned earlier, if sufficient soda is removed, sand can be reused without any addition of fresh sand, so giving a valuable benefit to the user.

CLAIMS

1. A process for the reclamation of binder coated foundry sand, in which the coated foundry sand is fed to a fluid energy mill and fluid energy is imparted to the sand to a sufficient extent to substantially remove the binder coating without causing significant disintegration of the sand particles, and the reclaimed sand is separated from the binder debris.

2. A process as claimed in claim 1, in which the energy imparted to the sand is less than 1,300 kilojoules per kilogramme of coated sand and in which the Reynolds Number arising from the energy-imparting jet stream does not exceed 6.5×10^4.

3. A process as claimed in claim 2, in which the energy imparted is in the range 400 to 1,200 kilojoules per kilogramme of sand and in which the Reynolds Number is in the range 4×10^4 to 6.4 to 10^4.

4. A process as claimed in any one of the preceding claims, in which the reclaimed sand is separated from the binder debris in a separate classification system.

5. Reclaimed foundry sand prepared by a process as claimed in any one of the preceding claims.

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EUROPEAN SEARCH REPORT

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
X	DE - A1 - 2 921 197 (H.J. LINDER) * claims 1, 3, 4, 6 * --	1	B 22 C 5/00 B 22 C 5/10 B 22 C 5/18
A	DE - A1 - 2 537 259 (BRITISH LEYLAND LTD.) * claims 1, 4 * & GB - A - 1 463 749 --	1,4	B 07 B 4/06
A	DE - A1 - 2 408 981 (A. KLEIN KG) * claims 1, 7, 8 * --	1,4	TECHNICAL FIELDS SEARCHED (Int.Cl. 3)
A	GB - A - 2 061 770 (FUTTANS LTD.) * claims 1 to 4 * --	1	B 22 C 5/00 B 07 B 4/00
A	US - A - 3 088 183 (R.L. McILVAINE et al.) * claim * --	1	
A	DE - A1 - 2 622 987 (RAYTHEON CO.) * claims 1, 4 * & GB - A - 1 493 774 --	1	
A	DE - B2 - 2 622 968 (RAYTHEON CO.) * claim 1 * & GB - A - 1 497 368 ----	1	

CATEGORY OF CITED DOCUMENTS

X: particularly relevant if taken alone
Y: particularly relevant if combined with another document of the same category
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: earlier patent document, but published on, or after the filing date
D: document cited in the application
L: document cited for other reasons

&: member of the same patent family, corresponding document

X The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Berlin	05-11-1982	GOLDSCHMIDT