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Reclamation of Used Core in Foundries

S. R. Rakesh[1], D. Shri Balaji[2], S. Soundhararajan[3]
[1,2,3]*Student, Department of Mechanical Engineering, Sri Ramakrishna Engineering College, Coimbatore, India*

***Abstract*: The core which is used in Foundries to create a hollow cavity is prepared using silica sand and Sodium Bicarbonate along with carbon di oxide gas. The core is then brought to a shape and they are introduced into the green sand mould to create a hollow cavity in the castings. After the casting process is completed and when the fettling process is done the cores are thrown outside without any further processing. The core is very hard to break unlike the green sand mould.**

***Keywords*: Core, Silica sand, Castings**

1. Introduction

Industrial activity is connected to waste production. A large part of these wastes are characterized as hazardous materials. The basic question is "How can we use these wastes or how can we dispose this wastes?" is the primary problem for today's society. The main reason is protection of human health, establishment of environmental friendly technology, but also the economic aspect plays important role. The main aim of is waste reduction to the 50% during the period of 2018 to 2050. The cores, cured with chemical and thermal processes, distinguish a high primary strength at low binder content and good storability. Furthermorethese cores have a low adhesive strength to the sands grains, which allows simple regeneration. Low temperature of thermal destruction ensures excellent collapsibility. On the other side faster collapsibility is a main problem, because the cores sand become a part of the green sand, even more than 15 by weight of the mixture, influences its properties and affects the formation of casting defects such as scabs, defects of the gases, pin holes. Particulate cores are added to green sand as a replacement for new sand, during re-preparing mixtures. This way of waste core recycling can be a solution of hazardous waste utilization and then the foundry produces no waste from moulding sand and cores. However, green sand properties may be changed. From theoretical study of literature sources there is no uniform opinion on the used cores impact on the green sand system technology and re-bonding properties.

2. Literature survey

In the paper [1] "Green sand system by core sand addition the author N. Spirutova, J. Beno, V. Bednarova J. Kriz has propsed that the core sand has been influenced by green sand mixing". They have done a detailed analysis about materials and methods proposed for the preparation of core sand and their fettling methods.

In the paper [4] "Process Parameter Optimization of CO2 gas cured Sodium Silicate Moulding Process for better compression strength" the author M. Venkataramana, Department of Mechanical Engineering, C.V.R College of Engineering, Hyderabad, Telangana, India has discussed about the bond formation in CO_2 moulding process and their silicon content after the casting process. He has done experimental determination of compression strength for further processing.

3. CO_2 core preparation

The physical and chemical changes involved in the process of strength development in sand bonded with sodium silicate are vaguely understood .The individual grains of sand covered with a thin coating of sodium silicate are made to tie with each other in the process of mold or core making .The familiar strength, measured as a gross property, is the manifestation of a large number of bonds within the mould or core mass. In the simple picture of a bond between two grains, the strength is a function of the adhesion of the bond medium to the surface of the grains and the cohesion of the material forming the bond. Lack of strength can result when any one is low or both are low. Adhesion is dependent on the interfacial phenomena between bond medium and grain structure whereas cohesion is governed by structural strength of medium Chemical reaction Herein lies critical area where controversy, confusion and often misinterpretation have been very common in the foundry technology dealing with sodium silicate. The new product which is mentioned most often in the way strength development is silica gel. Na_2Co_3+[SIO_2+H_2O] In 1956 Atterton cautioned that there is considerable evidence to show that such equations are very much an oversimplification and in many ways incorrect Nevertheless, silica gel is a new product found most often in reactions caused by various hardeners. The new product that is formed when loosely rammed mass of sodium silicate mixed sand is cured with CO_2 gas is silica gel. Hardening reaction can be expressed as

$$Na_2SiO_3 + H_2O + CO_2 \dashrightarrow Na_2CO_3 + SIO_2 + H_2O.$$

Silica Gel Properties of mould depends upon process parameters normally % of sodium silicate, quantities of CO_2 gas (gassing time), mixing time etc…) mould properties greatly influence soundness of casting. Especially strength and permeability properties are important. If strength is more permeability is less and vice versa is also true. Too low strength leads to defects like sand drop and if permeability is too low lead to defects like blow holes, gas porosity etc. Hence a

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compromise is to be struck between these two properties. On foundry shop floor it is very difficult to assess the values of process parameters for a desired value of the mould characteristics. In fact a model is required relating each of the above mould properties namely mould hardness, permeability with process parameters. These models may help foundry men to choose the values of process parameters that yields a mould with desired strength, hardness with reasonably good value of permeability. Hence in the present investigation it is attempted to model the CO2 process parameters for the desired mould hardness and permeability. [3]

4. Mould Preparation

Moulds prepared with the new inorganic binders modified with hydrated sodium silicate and hardened with ethylene glycol diacetate (2.5 parts by weight of binder and 10% of hardener respective of the binder weight) were used for casting of Al-Si alloy (AlSi9 alloy) and copper alloy (CuZn59 alloy). The waste mould material after knocking out of castings was subjected to the process of reclamation. The estimated degree of the reclaim reuse, it was established that the content of the reclaim in new moulding sand will be up to 70%, due to a marked shortening of the moulding sand bench life. From the point of view of the sand reclamability and reusability, it is very important to know its behaviour in the long-term use of reclaim, both in terms of the strength properties and, in the case of self-hardening sands, the time of binding [5]. Therefore, the stage of the research described here was based on tests conducted on multiple reclamation of sands with new inorganic binder "B" to verify the effectiveness of the reclamation after a longer lapse of time, which will occur under the real conditions of a foundry shop [5].

Studies were carried out according to the following scheme:

A. *1st cycle*

- Making sand mixture based on new sand and technological testing of the mixture.
- Making moulds and cores from the mixture based on new sand.
- Pouring of moulds and knocking out of castings (AlSi9 alloy).
- Reclamation of waste sand and physico-chemical testing of the reclaim

B. *2nd to 10th cycle*

- Making sand mixtures with the reclaim and technological testing of the mixture.
- Making moulds and cores with the reclaim.
- Pouring of moulds and knocking out of castings.
- Reclamation of waste sand and physico-chemical testing of the reclaim.

The sand reclamation process was carried out on a laboratory reclamation stand. The resulting products of the treatment and reclamation of used moulding sands were subjected to laboratory assessment [5]. The process of mechanical reclamation regains from 92 to nearly 94% of the useful material, which is the reclaimed sand. On the reclaim and new sand serving as a reference, physico-chemical tests were carried out and the results were plotted in the form of graphs (Fig. 1, 2). Tests were made after each reclamation cycle [5].

Table 1
Weight ratios

New Sand	100,0 Parts by weight
Binder "B"	2,5 parts by weight
Hardener	0,25 parts by weight
New sand	30,0 parts by weight
Reclaim	30,0 parts by weight
Binder "B"	2,5 parts by weight

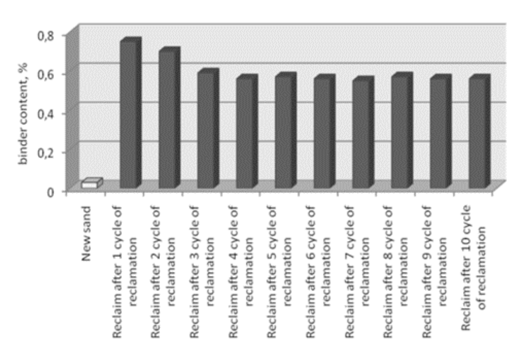

Fig. 1. Binder content in the product of multiple reclamation of self-hardening sands

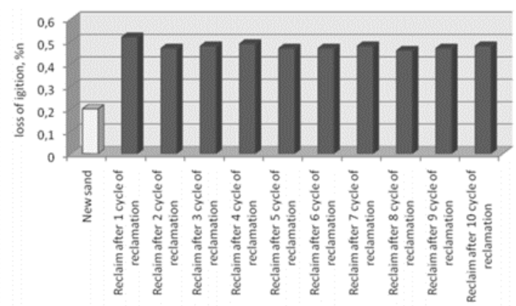

Fig. 2. Loss on ignition in materials from the multiple reclamation of self-hardening sands

The mixtures based on new sand as well as those having in their composition an addition of reclaim were subjected to technological tests, including compressive strength, bending strength (Fig. 4), permeability and bench life (Fig. 3). Sand mixtures for technological tests were prepared according to the formulas given below:

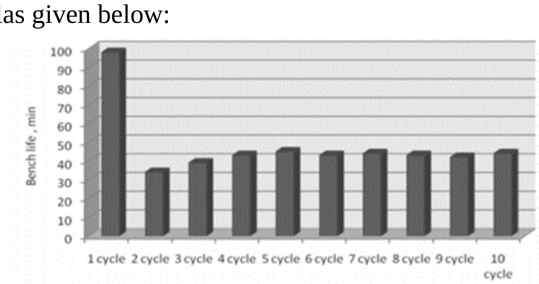

Fig. 3. Bench life of sands with reclaim from multiple reclamation

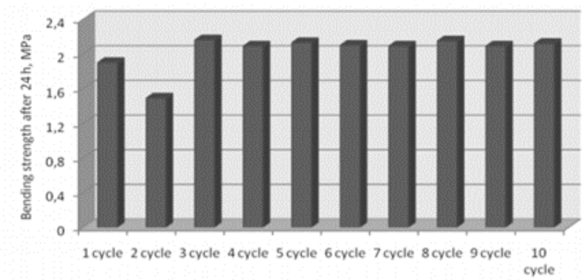

Fig. 4. Bending strength of sands with reclaim from multiple reclamation

Moulding mixtures prepared with modified inorganic binders and with the reclaim from the first cycle of multiple reclamation were characterised by slightly lower bending strength than the mixtures based on new sand (fig.4), but after subsequent cycles, the quality of the sands improved and stabilised. An important observation, useful in application work carried out for the industry, is that the bench life of the moulding sand is maintained at a constant level (the only exception is cycle 2), which allows making moulds without the loss of binding properties [5].

5. Tests and experiments

A. Innovative mechanical cryogenic reclamation

The laboratory test stand is a reduced model of the mechanical reclamation unit with blades acting as a rotating abrasive element. The test reclamation unit enables the reclamation process to be carried out with and without the use of a cooling agent. It has been provided with a feeding system for liquid nitrogen to carry out the reclamation process at extra-low temperatures. The possibility of conducting in the same equipment either the mechanical reclamation alone, or a combination of the mechanical and cryogenic reclamation provides an excellent tool for comparison of the real efficiency of the reclamation process obtained in both examined cases [6].

6. The testing procedure

Within the research described in this paper some tests have been made to improve the effectiveness of a mechanical reclamation process as applied to the most used type of the waste moulding sands typically produced during castings manufacture, namely: used sand with bentonite, The process of the proper reclamation of the sand grains was conducted under the following operating parameters of the reclamation unit: rotational speed of the impeller blades - 300 rpm, time of reclamation - 1, 3, 5, 10 and 15 min, successively. [6] A sample of the determined wastes and was subjected to reclamation. (mechanical reclamation - MR); the second analogical sample was reclaimed in temperature reduced to about-70°C (mechanical-cryogenic reclamation - MCR). The effectiveness of releasing the sand grains from the envelope of the used binding material was evaluated by means of the tests below which, were considered to be the tools reliable enough in evaluating the degree of the examined waste sand reclamation: clay binder content in bentonite reclaim, – value of pH of the reclaim, – compressive strength and permeability of the sand prepared with bentonite reclaim, – reclaims morphology [6].

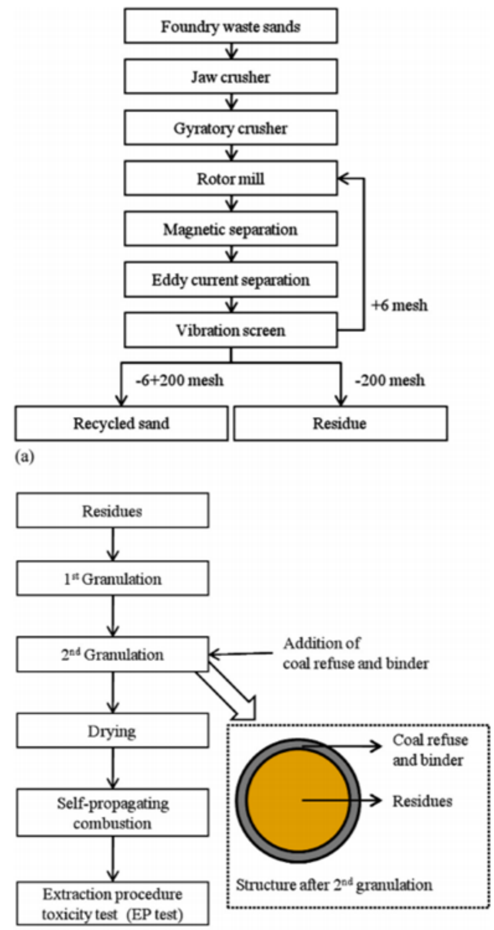

Fig. 5. Reclamation process

7. The results of the tests

The results of tests for the waste sand with bentonite are presented in combined diagrams (Fig. 1 and 2) and in Table 1. Theanalysisoftheobtaineddataisgiven below. In evaluating the effectiveness of a reclamation process of the waste sand with bentonite, as a main indication of the effectiveness of this reclamation has been adopted the content of the clay binder present in reclaim. After reclamation treatment, the content of the clay binder in the sand drops to a value of 4, 20 % and 3,5 % for, respectively, the mechanical and mechanical-cryogenic reclamation conducted. The chemical analysis of reclaim also indicates a high degree of removal of the used binder from the sand grains in the case of mechanical-cryogenic reclamation this effect is even more pronounced.The sand composition included 7% of Zebiec bentonite and 3,5% of water content [6].

8. Mechanical regeneration and mechanical reclaimed sand characteristics

Mechanical regeneration uses mechanical force to remove the binder film on the surface of waste sand. Mechanical regeneration was performed with the roller-type sand mixer. This regeneration is suitable for the waste sand with a brittle binder film. During the moulding of animal glue sand, a large number of water molecules evaporate from the sand by heating, which makes the binder film change from toughness to brittleness. The residual brittle film on the waste sand surface can easily fall off through the collision and friction between sand grains, and sand and equipment, so as to realize the regeneration. The binder film of the waste sand surface was removed by the roller compaction machine; however, with increase of the rolling time, the reclaimed sand size became thinner and AFS fineness increased. The mechanical regeneration time was 25minutes. It can be seen that the mechanical regeneration reclaimed sand surface has become smoother and cleaner than the waste sand, and there is a little of the residual binder around the reclaimed sand. [4]

9. Regeneration of waste foundry sand

The particle size distribution of the samples of WFS after being crushed by the jaw crusher and the gyratory crusher is depicted in Fig. 3. The weight percent of particles ranging from 0.075 mm to 3.35 mm in size was over 90%. This range is the typical particle size distribution of foundry sand that is used in the casting industry. Ries and Conant also reported that foundry sand is usually observed in sizes that are coarser than 0.25 mm.

10. Conclusion

In this paper the preparation of CO_2 core methods are discussed step by step and the use of hydrochloric acid for reclamation of CO_2 core. In the use of hydrochloric acid it was found that 0.2 ml of hydrochloric acid is required for dissolving 100 gms of sand with the sodium content in it.

Another methodology was the basic reclamation of CO_2 core and the loss of ignition during the casting process. This was obtained as a result as to protect the environment from the pollution from foundries and also reduce the procurement cost of new silica sand rather than the use of reclaimed core sand.

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