International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 3 Issue 11, November-2014

Experimental Determination of Optimum Reclamation Time in Dry Reclamation Process of Silicate Bonded Sands

M. Venkata Ramana[1]
Mechanical Engineering Department
Vignan Institute of Technology and Science
Hydearbad,Telangana, India

***Abstract:-*In a foundry shop floor sand is the essential moulding material. In view of the fat depletion of natural resources, the subject of molding sand reclamations is gaining importance in the recent times.. Current investigation is concentrated on moulding sands reclaimed from spent sand of silicate bonded moulds. Optimum reclamation time is determined. Optimumreclamation time is observed to be 15minutes.**

Key Words: sand, Moulding, Wet Tensile Strength, Reclamation Time, Dry Reclamation etc…

1. INTRODUCTION:

Sand is not just sand to Foundry people, but is a specialized material that should be available at the right place and at the right time with appropriate characteristics. Every day huge quantities moulding sand is handled in the foundries world over. Progressive foundries realize the physical requirements of sands for different types of moulding sands. Sand appears to be in value. Further shifting the large quantities of sand awaiting disposal is a gigantic task. In addition lot of floor space is occupied for i) storing fresh moulding sand to foundries ii) knocked out moulding sand from foundry shop floor to dump yard. With the evolution of new binders and dumping of thousands of tons of spent sand along with binders poses threat to environment and create environmental hazards. The only alternative to all these problems is exploring the ways of reclaiming the knocked out sand and reuse them .This method of treating the spent sand by physical or chemical means so that it can be brought to reusable condition is known as sand reclamation. Carbon-di-Oxide moulding is already proved to be one of the best process in producing castings of sound quality but it is suffering with its own drawback of poor collapsibility [2]. Knocked out sand of green sand mold can be used as backup sand with minor modifications but it is not the case with other kinds of sand binders. Especially in case of CO2gassed silicate bonded sands, the problem is much more severe. Knocked out sands of silicate bonded sand moulds can't be brought to reusable condition by simple means .But the usage of these molds can't be avoided, owing to its superior mould hardness that enabled the preparation of moulds for steel castings[1]

There are basically three types of sand reclamation methods. Each method of sand reclamation has its own merits and demerits: wet reclamation method can't remove insoluble silicates, thermal reclamation method is quite inexpensive [1] and third one is dry reclamation. Choice of reclamation method depends upon nature of binder coat left over on the sand grain surface after knocking out of mould. In case of knocked out sands of silicate bonded mould silica gel coat on the sand grains is hard and brittle [1].

Literature reveals that there is a third reclamation method i.e Dry Reclamation method which is widely useful if the left over binder coat on sand grains is brittle. Hence in the present study Dry reclamation with Pneumatic attrition is used in this study.

1.1Sand Reclamation Procedure

A Dry sand reclamation unit with pneumatic attrition is used for the purpose. After knock out lumps of CO2 moulding sand are broken into small pieces and then fed into the reclamation unit. Reclamation unit consists of rotating blades with hardened steel pads. Air will be blown from near to the bottom of reclamation unit along three direction inclined at 120^0 to each other. Lumps fed into the reclamation unit will be crushed and because of the air pressure the sand particles will be subjected to attrition against each other. Due to this attrition sand grains are rubbed against each other and the consequent dust will be blown up and eventually collected in a bag. Reclamation unit used for study is shown in Fig.1

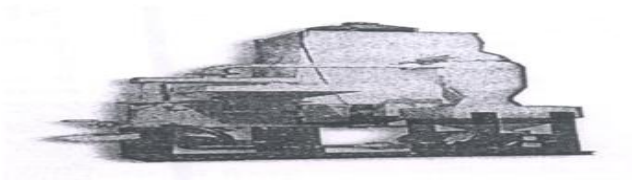

Fig - 1: Dry Reclamation Unit

2. PROBLEM DEFINITION &SCOPE:

In this process of Dry reclamation with pneumatic attrition the binder coat accumulated on sand grains during previous moulding process is removed due to attrition between sand grains and separated binder particles will be removed through pressure difference. In the process there may be alternation of sand grain size and shape. The degree of alteration of size and shape of sand grain depends on the time of attrition and in turn on the properties of mould prepared by reclaimed sand. So time of reclamation decide the extent of utility of reclaimed sand in subsequent moulding cycle. Too low reclamation times will not remove the binder coats sufficiently .At the same time too high reclamation timed may modify the sand grains and inturn may influence strongly hardness and permeability of moulds prepared subsequently .Hence in the present investigation it is attempted to optimize the reclamation time.

3. METHODOLOGY &SCOPE OF INVESTIGATION:

- Reclaiming the spent CO2 silicate bonded sand for varied length of time
- Preparing the mould with reclaimed sand with varied % of sodium silicate
- Determining mould hardness, permeability, Green Shear Strength, Loss on ignition Value (LOI, Acid Demand Value (ADV) etc..
- Deciding optimum reclamation time based on values of permeability, mould hardness, ADV test and LOI value

4. EXPERIMENTAL WORK

4 Grain fineness number

Grain fineness number of the reclaimed sands for varied length of times is determined and variation of grain fineness number as a function of reclamation time is given in Fig-3.

4.2 Loss on Ignition Value

Accurately weighed (1 gm) reclaimed sand, reclaimed for 10 minutes is heated in a muffle furnace at a temperature of 980 degree centigrade for 2 ½ hours and loss in weight is determined. Loss in weight as a percentage with respect to original weight of sand is expressed as loss on ignition value. Similar process is repeated for sands reclaimed for 15 minutes and 20 minutes.

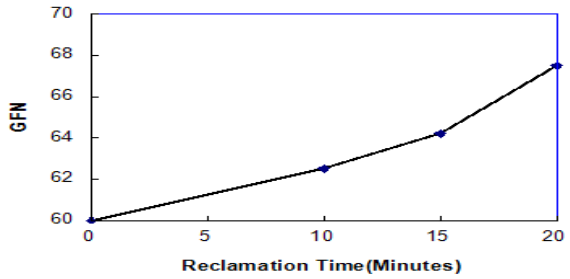

Fig-3 Variation of Sand Grain fineness number as function of Reclamation Time

Variation of Loss on ignition value as function of reclamation time is presented in Fig-2

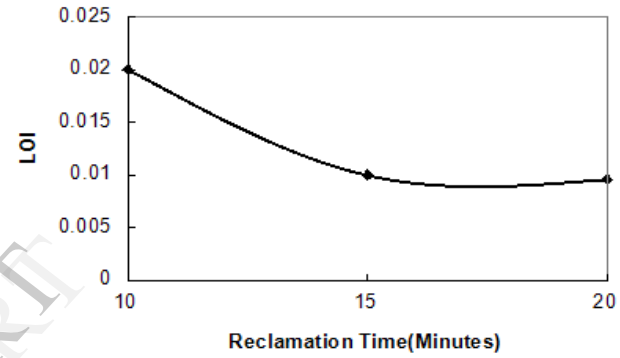

Fig-2 Variation of LOI as a function of Reclamation Time

4.3. Acid Demand Value (ADV):

In the reclamation of carbon dioxide moulding sands the residual sodium oxide content (Na2O) on the sand grains affects significantly the bonding process of the reclaimed sand with sodium silicate in the subsequent moulding process [3]. Scanning electron micro graph of reclaimed sand is made at 200X but it only gives information about sand grain size and shape but doesn't indicate the potential of residual binder coat on sand grains. The residual binder coat can be estimated by Energy dispersive X-ray spectroscopy [3] .However there is another simple test known as acid demand value test that determines alkaline matter of reclaimed sand. "Acid Demand Value (ADV) test is an attempt to determine the residual sodium oxide content on the sand grains.

ADV test is a measure of alkaline matter on the sand. When using the binder systems, which are acidic in nature, or where the catalysts are weak or strong acids, the setting properties are considerably influenced by the presence of alkaline impurities [3]. It can be used as a routine test on incoming sand supplies, to confirm the source and maintain sand quality.

ADV test is performed on sands reclaimed for 10min, 15min and 20 min.

Variation of Acid Demand Value as function of reclamation time is shown in Fig-4

4.4 Mould properties like Mould hardness, Permeability, Green Shear Strength

For Fresh molding sand after mixing with 4% sodium silicate and hardened with carbon dioxide gas, the mold properties are determined. Properties considered are permeability, mold hardness, Green compression strength and Green shear strength... Some castings are prepared using this sand and knocked out sand is broken into lumps. These lumps of sands are reclaimed for different length of times i.e, 10 minutes, 15 minutes and 20 minutes.

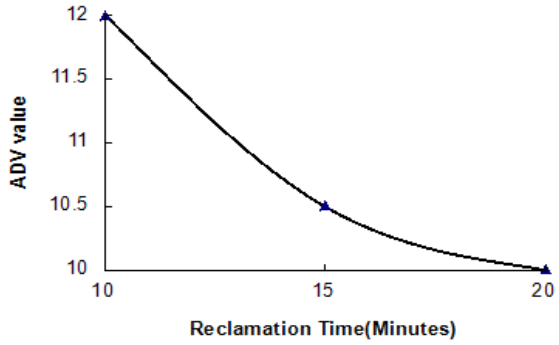

Fig-4: Variation of Acid Demand Value as a function of Reclamation time

All the above sands, one after the other, are mixed with 4% sodium silicate and molds are hardened by passing CO2 gas and the mold properties (permeability, mould hardness, Green compression strength, Green shear strength etc) are determined. Similar experiment is repeated with 5% and 6% sodium silicate.

Variations of Permeability, Mould hardness, Green Shear Strength as a function of reclamation time are given in Fig-5, Fig-6 and Fig-7 respectively.

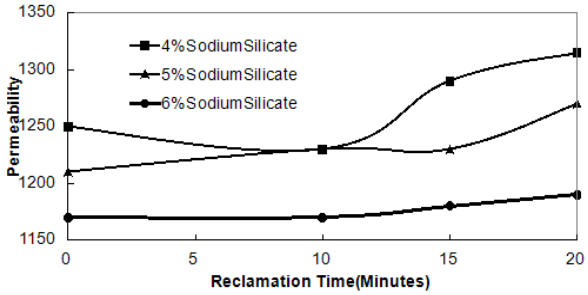

Fig -5: Variation of Permeability as a function of Reclamation time.

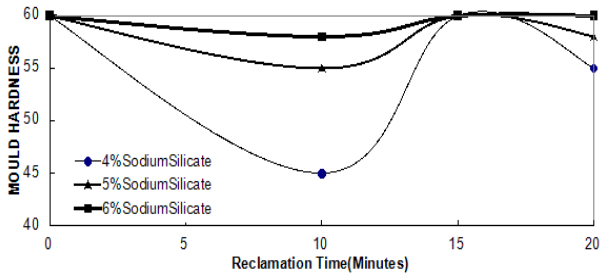

Fig-6 Variation of Mould hardness as a function of Reclamation Time

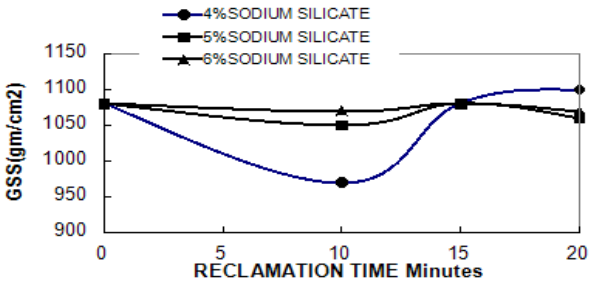

Fig-7 Variation of Green Shear Strength as a function of Reclamation Time

5. RESULTS & DISCUSSION

For all the sands considered, with increase in % of sodium silicate mold hardness increases and permeability decreases. Fresh moulding sand recorded highest mould hardness.

As a general trend, for a given percentage of sodium silicate, permeability increases as function of reclamation time .Permeability is slightly improved in case of sand reclaimed for 10 min compared to fresh sand, where as a marginal improvement in permeability is recorded in case of sand reclaimed for 20 min (Ref. Fig 5) .The rate of increase of permeability gradually diminishes with increase in percentage of sodium silicate. At 6% sodium silicate addition permeability almost remains constant. With increase in reclamation time sand becomes progressively rounder. Consequently surface area of the sand grains increases which demand more binder content. So at 6% sodium silicate addition the binder quantity is sufficient enough to form a firm adhesion and hence permeability is the least.

In mold hardness fresh sand is superior to the reclaimed sands (Ref.fig. 6). Better bonding characteristic of fresh sand with sodium silicate and CO2 may be attributed to higher mold hardness of fresh sand.

Among the sands reclaimed for varied length of times sand reclaimed for 15 min has higher mold hardness. Sand reclaimed for 10 min records the least mold hardness (Ref.Fig6). Perhaps a reclamation time of 10 minutes may not be sufficient to remove the left over binder coat from

sand grains effectively. This left over binder might have acted as an obstruction during re-bonding of this reclaimed sand and hence it is reflected as lower mold hardness for molds prepared of sand reclaimed for 10 minutes.

A slight decrease in mold hardness is observed in case of sand reclaimed for 20 min compared to that of sand reclaimed of 15 minutes. It appears that amount of removal of binder is considerably less beyond 15 minutes reclamation time. During this period (beyond 15 min), instead of removal of binder coat from sand grains, sand grains are worn out more rapidly. This can be clearly observed from AFS grain fineness number of sand reclaimed for 20 minutes. More the reclamation time more the sand is subjected to attrition and hence the higher surface area is to be taken care of in subsequent bonding (moulding) process. For the same gassing time and binder content the extent of bonding will be lesser leading to lesser mould hardness. This may be the reason for lower mold hardness of molds made of sand reclaimed for 20 min. However, the difference in mould hardness value gradually diminishes as the % of sodium silicate increases. Perhaps the need of higher amount of silicate addition for higher surface area of sand grains could be the reason for gradual diminishing of difference in mould hardness values between sands reclaimed for 15 minutes and 20 minutes.As the reclamation time is increased the sand grains became progressively rounded and finer (Ref.Fig.3):

While conducting experiments for determination of GCS for fresh sand and sand reclaimed for 15 min samples are not failed within the range available in equipment (0 to 1380 gm/cm2) for any percentages sodium silicate considered in the study. However samples made of sand reclaimed for 10 min are failed. Reason may be inadequate bonding capability of sand grains with sodium silicate during re-bonding. This may be attributed to higher amount of left over binder content on sand grains. For sands reclaimed for 20 min only the specimen bonded with 4% sodium silicate failed in shear only within the range. This may be due to lesser sodium silicate content and worn out sand grains. The attempt of determining GCS is not fruitful as most of the value is beyond the range of machine used for the test, hence a comparison could not be made between GCS values of fresh sand and reclaimed sand. However foundry sand reclaimed for 10 min is the least of all the sands considered (Fig-7) Only for the purpose of comparison of fresh sand and sand reclaimed for 10 minutes Fig-7 are shown but these figures will not show the actual values of GCS and GSS for fresh sand

ADV Test indicates that residual Na2O content is maximum for sand reclaimed for 10 min.The amount of binder content removal during 10 minutes reclamation time is less and hence there will be a higher amount of residual binder content on sand and hence a higher ADV is registered compared to that of sands reclaimed for 15 min and 20 min.

Decrease in value of ADV for sand reclaimed for 20 min when compared to ADV of sand reclaimed for 15 min is not so significant (Fig 4) which indicates that most of the binder content on sand grains is removed during 15 minutes reclamation time. So between 15 minutes reclamation time and 20 minutes reclamation time not much binder content is removed, instead sand grains are subjected to attrition and hence Acid demand value continuously decreases with reclamation time, however the rate of decrease is steep between 10 min and 15 min reclamation time and beyond that it is almost negligible. Hence it is concluded that optimum reclamation time is 15 minutes.

6. CONCLUSIONS:

Time of reclamation has significant bearing on properties of moulds made I reclaimed sand. Optimum reclamation time is observed to be ’15 ‘minutes.

REFERENCES

1) IIF Hand book
2) AD.Sarkar “Collapsibility of Silicate bonded sands Foundry Management & Technology vol 90 p-52(Aug 1962)
3) M.D Malone,J.Roth & Trikha “Thermal reclamation of ester-cured phenolic bonded sands;A cas history”Castmetal Research journal ind.
4) R.Iyer,C.K Johnson “Reclamation of phenolic ester cured no bake sands “ AFS Transactions Vol 96 p 611 (1988).