The International Journal Of Engineering And Science (IJES)
||Volume||2 ||Issue|| 10||Pages|| 16-19||2013||
ISSN(e): 2319 – 1813 ISSN(p): 2319 – 1805

Seasonal Effect on CO_2 Cores and Its Remedial Measures

[1,] Prof.R.S.Jamgekar , [2,] Prof.M.U.Gaikwad
[12,] *Department of Mechanical Engineering,*
BharatRatna Indira Gandhi College of Engineering, Solapur

ABSTRACT

Use of CO2 cores have certain advantages over other processes but their application for mass production of cores for complicated castings is limited mostly due to poor collapsibility and seasonal effects. CO2 cores show property changes due to humidity and high temperature during rainy and summer seasons respectively.This paper describes various parameters responsible for seasonal effects and remedial measures to control them by varying molar ratio of Na2SiO3 moisture percentage, gassing time, manufacturing techniques from season to season. The above measures have shown remarkable results and minimized seasonal adverse effects in CO2 core properties to a marked extent.

KEYWORDS : *collapsibility, cores, flowability, friability,*

Date of Submission: 30 September 2013 ⟺ Date of Publication: 20 October 2013

I. INTRODUCTION

Silicate bonded cores are widely used to their simplicity and accuracy. They may be blown or rammed by any means and are hardened by passing CO2 gas. Curing is complete within a few seconds in the core box at room temperature. The mechanism of hardening effect of Sodium silicate sand with CO2 can be expressed as follows.

$$Na_2SiO_3 \times H_2O + CO_2 \rightarrow SiO_2 + Na_2CO_3 \times H_2O$$

Although the exact chemistry is not somewhat clear but the bonding may be partly due to the Sodium Carbonate Crystals, Silica Acids and Silica Gel which are formed. Even unreacted liquid silicate will react with CO2 in the atmosphere and through dehydration will provide bond strength subsequently.

In spite of having the above mentioned advantage the process is very much susceptible to the seasonal changes and extreme care and corrective steps are required to be taken to counteract the effect of heat and humidity on the process the factors mainly affecting this processes are:

- Atmospheric temperature
- Humidity
- Gassing time
- Quantum of silicates
- Molar ratio
- Specific gravity of Silicates

Generally a specified composition of sand mix and gassing time are adopted in each foundry but the variations due to factors mentioned above are so much in this process that the same parameters cannot be used for all seasons and as such the adjustment in composition and gassing time are called for.
Majority of cores weighing from 50 gms to 30 kgs are manufactured by CO2 process with the following composition as indicated in the table below.

Sand Silica	IS (18-35)
Sodium Silicate (Molar ratio 2:1)	5.5%
Dextrine	1.0%
Coal Dust	1.5%
Iron Oxide	1.0%

Table No.1 showing the composition of cores.

The required properties of the sand are given in the table below.

Moisture	2.5 to 3.0%
Permeability	250 to 350
Gassed strength	10 to 14 kg/mm2

Table No.2 showing the required properties

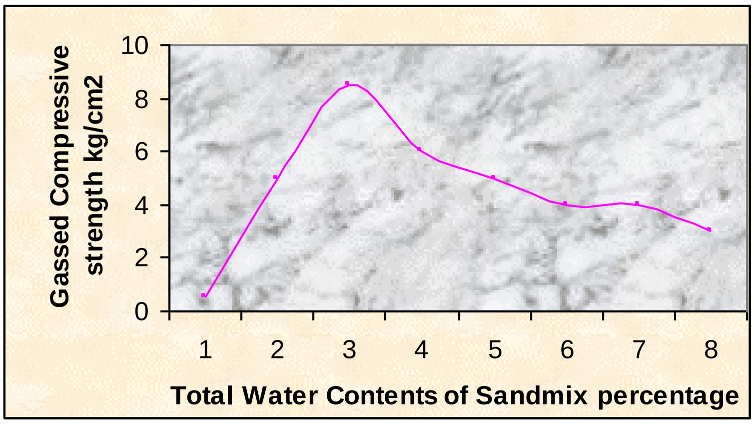
II. EFFECT OF SUMMER SEASON

During summer the temperature varies from 40̊C to 45̊C. The relative humidity remains as low as 25%. It has been observed that cores when produced with specified sand mix do not give desired quality.
The following difficulties have been observed.

- Reduction in bench life.
- Poor flowability.
- Friability in cores.

2.1. Reduction in Bench Life

The cores are required to be stored upto 48 hours. As such the less bench life of CO2 cores which is a chronic problem during summer season, is given due attention to overcome the same. This trouble in CO2 sand arises due to dehydrational water from the sand mixture and formation of a hard layer on the surface. The above shortcomings can be overcome by storing the sand mixture in a sealed container or by covering the sand with damp sacks and these are followed strictly in almost all foundries. The bench life in case of high basicity ratio silicates appears to be very short due to its faster rate of evaporation. These cores should therefore be used immediately after manufacturing otherwise the cores will get friable.Relation of water percentage of sand mixture and gassed strength is shown in Graph No.1.From the graph it may be seen clearly that the optimum strength is achieved when percentage between 2 to 3 percent.



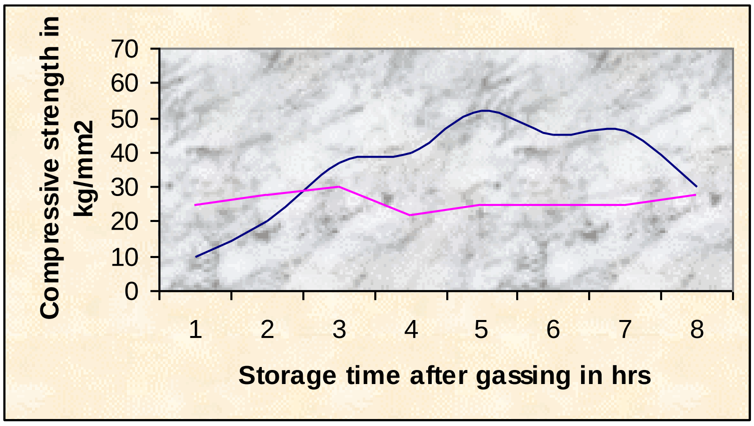
Graph No.1 Relation of water percentage of sand mixture and gassed strength.

2.2 Poor Flowability

Poor flowability of core sand is generally encountered during summer season particularly in core shooting machines. The flowability or the ease with which sand rams in a restricted portion of a core box is frequently reduced by the core binder. The reduction of sand flowability may cause porous surface on the gassed core resulting in scrap core or metal penetration if the cores are used. In our foundry this problem has been solved through addition of a little kerosene oil to the sand mixture.

2.3 Friability

The problem of friability of CO2 cores is a common begin faced in the foundries. Over gassing and less moisture content are mainly responsible for this defect. However gassing of CO2 core should be co-related with the expected period of storage time of the course. Under gassing gives weak friable cores, which of course, grow stronger with time. This is due to air during effect, which eventually produces good strength, but with poor collapsibility. Medium gassing time gives reasonable as gassed strength in the cores with less friability. Gassing for long period, although, gives high strength immediately but causes weakening of the cores later on and the cores becomes friable. (As per graph No.2)



Graph No.2 Showing the relation between storage time after gassing and compressive strength.

As shown in the Graph No.2 with less gassing time the initial strength is less but it increases its strength rapidly and after 48 hours the cores start to loses strength and become friable. In case of high gassing though initial strength is more but the cores loses strength immediately.Moreover moisture content in the sand mixture is to be kept on the higher side in case of silicate of high ratio and to the lower side of the specification in case of low silicate range in order to get a non-friable core. Due to complex hardening mechanism of sodium silicate binders, the strength of CO_2 cores is liable to change if the cores are stored and not used immediately. It is also established that bond strength is in fact due to chemical reaction with CO_2 gas while physical reaction also occurs due to removal of water from the silicate solution during extended gassing of air drying. It is a continuation of the physical drying process that determines change in the strength of the silicate bonded cores on storage. The extent of any strength change during storage is largely determined by the SiO_2 ratio of the binder solutions and the gassing time. It has been observed that silicates 2.0,2.5 and 3.2 ratio after short gassing on being kept in storage for 3 days at temperature of 15˚C and relative humidity 55% resulted in strength of increasing trend but as the $SiO_2 : Na_2O$ ration was raised the duration of gassing becomes more critical and there was a tendency of decreasing the storage strength resulting in friable cores. The reason of which is attributed to the evaporation of water from the silicate bond and a possible solution to the problem of deterioration and friability, when cores made with high ratio silicate are stored, is to apply a surface coating due to which the outer surface of the core develop imperviousness and good abrasion resistance.

III. EFFECT OF RAINY SEASON

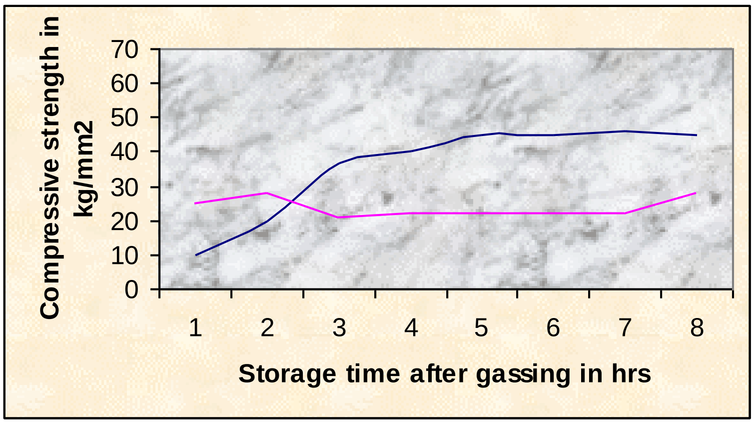
The average rainfall is about 50” and it extends from middle of June to end of September. Humidity shoots upto 98% at times. The problems mainly encountered in the foundry during rainy season are the following:

3.1 Poor Strip i.e. Sand Sticking to Core Box

One of the factors, which affect the smoothness of cores, is the characteristic of some sand mixture to stick to the surface of core boxes. It is a common problem in the foundry during rainy season and to solve this problem it is preferred to add fuel oil to the mixture or partly by using or applying dry graphite powder in the core box. Some binders coat the surface of core boxes with a sticky film, which prevent a perfect draw from the boxes. The amount of cleaning required depends on the cores sand mixture begin used. Generally the wetness of the sand affects the property of the sand to stick to core boxes and thus produce rough cores. As a rule the moisture content in the sand mix is kept at the lower side of the range. This is also achieved by changing the addition of other additives in CO_2 sand mixture.

3.2 Poor Green strength i.e. Collapsibility or Deformation of Cores just after stripping from the core box

The problem of core collapsibility or deformation at the manufacturing stage is mainly responsible due to low strength of the CO_2 sand mixture and is always required to be given due attention during rainy season. The silicate bonded core sand with 2.0:1:0 ratio gets its gassed strength after storage but its initial strength is very low. As a result cores with intricate shape have a tendency to deform or collapse with formation of minute cracks just after stripping from the core box. In such cases either gassing time is to be increased or silicate of higher ratio should be used to obtain high initial gassed strength. Different types of cores carriers can be used also to overcome the problem of deformation of cores.In the Graph No. 3 two lines are drawn with different gassing times in the rainy season when humidity is as high as 98%. With less gassing time, strength develops after sometime but initial strength is very low, as a result intricate cores bend or collapse due to its low strength. In case of higher gassing time, strength is more becomes slightly lower after storing.



Graph No.3 Showing the relation between storage time after gassing and compressive strength.

3.3 Storage problem due to Seasonal effect

Changes in climatic conditions have an important influence on the strength of the cores during storage. In weather (40-50 relative humidity) all cores lost weight due to evaporation of water. Cores bonded with 2.0 ratio silicates increased sharply in strength while cores containing high 3.0 ratio binder showed a drastic strength reduction. The intermediate 2.5 ratio silicate binder maintained or improved strength under the same condition of storage. Core stored in humid conditions also loose water and again the loss is very much pronounced with the high 3.0 ratio binder. Deterioration starts from relative humidity of 88%.The strength of cores do not show appreciable change under the same condition. The most interesting feature is the high retained strength of cores bonded with the 3.0 ratio silicate. Strength of 10.5 & 12.0 kg/cm2 is maintained even after 6 days storage condition shows strength of only 3.5kg/cm2 after 24hrs.

IV. CONCLUSION:

4.1 The molar ratio of sodium silicate used for CO2 process largely controls the rate of reaction and subsequently variations in strength of the cores during storage.

4.2 Sand mixture made from high ratio silicate need extreme care for preventing water evaporation to get bench life.

4.3 Various control measures from different angles are to be taken during CO2 sand preparation to avoid the problems arising due to seasonal effect.

4.4 The changes in atmosphere condition have a significant effect on the strength of silicate-bonded cores. In rainy season the change in strength is drastic with CO2 cores when stored in summer.

ACKNOWLEDGMENT:

We would like to take opportunity to express our depth of gratitude to M/S Kirloskar Oil Engines Limited, Solapur for giving us an opportunity to work on this project.

REFERENCES:

[1] American Foundry Men's Society, *"Safe Practice in Sand Preparation, Moulding and Core Making",* A.F.S., 1970.
[2] American Foundry Men's Society, *"Moulding Methods and Methods"*, A.F.S., 1968.
[3] H.W.Dietert, Foundry Core Practice, 1988
[4] Jain P L, " *Principles of Foundry Technology",* TataMcGrawhill, 2003.
[5] Rusinoff, S E, *Foundry Practice, American Technical Society,* 1970.
[6] Sarkar A D, *" Foundry Core and Mouldmaking"*, Pergmon, 1964