USE OF COLD BOX PROCESS

INTRODUCTION

Cold Box Process

Over a last decade considerable improvements in the core making process have been made possible by the ability to cure the core in the core box itself, at room temperature, within a cycle time. One such process in Cold Box Process which was invented by Dr. Jains Robins and was patented on 5th November 1968 (U.S. Patent No. 3409,519). This process was formally introduced to foundry industry at the A.F.S Congress and Exposition in 1968.

With this process, for the first time, a core or mould could be stripped from the core box and cast immediately. Cores could be produced in seconds with good strength, excellent dimensional accuracy, exceptional collapsibility and low gas content. As the cores are cured at room temperature core boxes could be made of wood plastic and composite.

The productivity of Cold Box process being 4 times that of shell process, considerable saving in manpower and of course in energy could be achieved by its introduction. Cold Box cores are suitable for all types of metals viz. Steel, Grey & Ductile iron, Aluminium, Magnesium etc.

WHAT IS COLD BOX PROCESS

The Cold Box process is a three part organic based binder system consisting of resin part - I, Hardener part – II and Catalyst part – III

Part - I resin binder is a phenol – formaldehyde, polymeric condensate, dissolved in a blend of aliphatic and aromatic solvents.

Part - II Hardener, which is a cross linking agent, contains polymeric MDI(Methylene Diphenyl DiIsocyanate) blended with aliphatic and aromatic solvents.


Part - I Resin provides the hydroxyl group which chemically combines with isocyanate group of part II in the presence of the amine catalyst to form a solid urethene resin. It is this solid urethene resin that bonds the sand grains together and gives the cold box binder the unique properties.

Part I and part II are low in viscosity to permit easy pumping and better flowability for coated sand.

This resin system is solvent based and the solvents play a vital role in the performance of the resin.
PLANT AND EQUIPMENT

a. Sand Mixers

Generally batch mixers- blade and wheel type mullers are more efficient and develop higher tensile strengths. Continuous mixers on the other hand have the advantage of mixing sand rapidly and only in required quantity.

Sand mixers should be selected to minimize heat build up in the sand. It should be sized to produce sand in quantities that can be consumed quickly by the core machines, within stipulated bench life.

High speed continuous mixer has been standardized for its advantage of obtaining maximum bench life by delivering sand only on demand, in contrast to preparing fixed and layde quantities of sand in batch mixers.

b. GAS GENERATORS

Two types Gas generators are in common use :-

i. Injector type

It forces liquid amine into a stream of fast moving carrier gas i.e. compressed air. This turbulent carrier stream evaporates the volatile amine and transports it to the input manifold and into the core box.

ii. Bubbler type

It accomplishes gasification of the amine by bubbling of carrier gas, through a deep batch of liquid amine.

The efficient gas generator must meter the proper amount of catalyst into the air stream. Use of excessive catalyst and area of high adore but makes cores weak, as a result of saturation with liquid catalyst. Too little catalyst causes slow curing of the core and a slow production rate.

c) COMPRESSED AIR DRYERS

Compressed air supply is required for gas generator, core blowers and pneumatic sand conveyor. Even a very little moisture in compressed air has an adverse effect on the final core strength, friability and also on the storage life of the cores. In view of this, the selection of a proper compressed air dryer plays an important role.

Two basic types of compressed air dryers are commercially available. Chemical dryer is preferred over refrigeration type of dryer for following reasons.
1. Chemical dryer is much more effective e.g. A dew point of -40°C at N.T.P can be achieved with chemical dryer against a dew point of merely 0 to +4°C as in the case of refrigeration type of dryer.

2. Chemical dryer is almost maintenance free and hence more reliable.

3. Chemical dryer is available indigenously and relatively at lower costs.

**COLD BOX RESIN SAFETY & HYGIENE**

Part I

Part I is a phenol formaldehyde resin in a complex mixture of organic solvents with a flash point of about 83°C. These resins are potentially severely irritating to the skin and eyes. Contact should be avoided and necessary protective clothing and equipment should be down.

Vapours form part I are also potentially irritating. Ventilation should be provided to maintain a level of air borne contamination below specified threshold limit values. The threshold limited values specified by the occupational safety and health Act (OSHA) are 5 ppm for phenol and 3 ppm for formaldehyde.

Part II

This is a blend of polymeric isocyanate in mixture of organic solvents and both have a flash point of about 100°C. Skin and eye contact should be avoided and necessary handling precautions should be followed as in line with part I.

Polymeric isocyanates have very low vapour pressures and under foundry conditions may not constitute a vapour hazard. However, the solvents used with part II are potentially irritating and ventilation is recommended. Ventilation should be provided to maintain a level of air borne contaminants blow threshold limit values. The threshold limit values as specified by OSHA, for methylene bisphenyl isocyanate, (a major constituent of polymeric isocyanate )is 0.02 p.p.m

Part III

Catalyst (part III) used is Triethylamine (TEA) and has flash point of 6.66°C. It is a flammable alkaline liquid with a very distinct and strong ammonia like odour. Part III Catalyst to be stored in RED LEVEL area only. Because of low flash point and the flammability and health hazards, good ventilation is recommended in areas where this material will be handled. The threshold limit value specified by OSHA is 25 ppm below which the air borne contamination should be maintained.
This catalyst is not a skin sensitizer but is corrosive. Contact with eyes and skin are to be avoided. Also inhalation of vapours should be avoided. The distinctively unpleasant odor of TEA can be detected in air at 1 ppm.

This catalyst is also liquid tertiary amine with relatively high vapour pressure that produces flammable and explosive vapours at most temperatures.

The vapour is heavier than air, tending to flow and collect in low areas.

Another catalyst DMEA (Dimethylethylamine) has flash point of 38°C. It is flammable alkaline liquid that has a strong ammonia like odor. This catalyst also should be stored in RED LABEL area only. Skin and Eye contact should be avoided due to its corrosive nature.

During purging cycle, compressed air is blown through the core to carry away all the surplus amine gas to the scrubber unit. Gas scrubber is very essential for effective removal of objectionable and potentially harmful materials form the catalyst escaping through the exhaust air.

Scrubbing action is generally performed in two stages:

In the first stage, the fumes are slowed down to a low velocity and passed through spary curtain of scrubber solution.

Second stage consists of a thick bed of plastic packing media through which scrubber solution is continuously sprayed. The fumes are impinged upon the packing media and the contaminations are absorbed and carried downwards in the scrubber solution.

After passing through both scrubbing stages, the moisture laden air passes through a mist eliminator section.

Normally dilute phosphoric acid (3 Parts water +1 part of 80 – 85 % acid by volume) is used as the scrubbing solution.

1. **Raw sand**

I. Sand must be absolutely dry before mixing

II. Coarse sand having AFS 50 to 55 GFN is most economical. The sand should be preferable with 4-sieve distribution.

III. Sand must be free from chlorides and preferable with low acid demand value.
2. **RESIN**

I. Resin additions, both part – I & part II, must be very accurate. The variation should not be more than +0.05% of sand.

II. Expect high humidity period, generally equal proportions of part I and part II i.e. 50% : 50% to be used. When the relative humidity is higher than 90% the ratio of part I to part II can be offset by increasing part II proportion.

3. **SAND MIXING**

I. During sand mixing, no heat build up should take place.

II. Optimum mixing time is required to be established, as lower mixing times result in non–uniform binder distribution whereas higher mixing time creates excessive heating and solvent losses.

III. Just sufficient sand, which can certainly be consumed within stipulated bench life period, to be prepared at a time.

IV. The prepared sand for which the bench life period is over, should not to be used for core making.

V. The prepared sand should be quickly delivered to the core making machine with minimum of variation.

4. **CORES**

I. During high humidity period, the cores must be consumed immediately.

II. If they are required to be stored, they must be sprayed with solvent base, resinous protective coating. This air drying type coating must be sprayed within 4 hours but not before 1 hour after the cores are produced.
### Table - 1
Ashland’s Specifications
For
Cold Box Sand Mix

Resin : Part I : 0.75% of sand
       Part II : 0.75% of sand
At Ambient Temperature : 70 F (21°C)
& % Relative Humidity : 40%

<table>
<thead>
<tr>
<th>Curing Time</th>
<th>C.T.S in P.S.I</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Immediate</td>
</tr>
<tr>
<td>Immediate ..........</td>
<td>110 min.</td>
</tr>
<tr>
<td>After 60 min. (Bench life)</td>
<td>90 min.</td>
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</tbody>
</table>

### Table - 2

<table>
<thead>
<tr>
<th>Sand : AFS 50 – 60 GFN</th>
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<tbody>
<tr>
<td>Resin : Part I : 0.8% of sand</td>
</tr>
<tr>
<td>: Part II : 0.8% of sand</td>
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</tbody>
</table>

#### A. FOR RELATIVE HUMIDITY > 80 %

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<tbody>
<tr>
<td></td>
<td>Immediate</td>
</tr>
<tr>
<td>Immediate ..........</td>
<td>100 - 120</td>
</tr>
<tr>
<td>After 40 min. (Bench life)</td>
<td>90 - 110</td>
</tr>
</tbody>
</table>

#### B. FOR RELATIVE HUMIDITY < 80 %

<table>
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