MODERN CORE PROCESSES FOR THE NON-FERROUS FOUNDRY(*)

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The authors intend to project cogent thoughts concerning the rapid development of modern core practices, as also to indicate how India can benefit from the background of available practical experience. The growth of modern core practice has been concurrent with the growth of the use of synthetic binders. Thin walled light non-ferrous alloys would be very difficult to economically cast otherwise. Magnesium and aluminium based castings and copper alloys have benefitted from the use of modern synthetic binders; and to a lesser extent brass and bronze industries.

Iron products heated to above 2000°F. become castable, whereas aluminium and magnesium liquefy at about 500°F. less. At lower temperatures more energy is required to remove cores from castings since less binder is burned during founding, the physical property measured to remove cores from castings being known, as you are aware, as "collapsibility". The resin industry provided binders which would easily collapse in a heavy core surrounded by light metals as thin as $\frac{1}{2}$".

<u>Baking binders:</u> Synthetic urea-formaldehyde binders were substituted in place of vegetable and core oils near the end of World War II. Drawbacks such as stickiness, **odour,** bench life, were overcome through proper sand mixture formulation by the use of additives.

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Proper collapsibility was quickly imparted to core
sand mixtures for light alloy practice and resulted in
such beneficial side effects as the satisfactory use
of lower baking temperature and faster baking times.
Di-electric baking became an accepted foundry fact with
the advent of synthetic resins, though the growth of
this process has been stunted by the still newer pro-
cesses such as no-bake, hot-box, cold-box and shell
core practices.

The use of ferrous metals required higher hot
strength materials than urea-formaldehyde resins.

Resins such as a one-step phenol-formaldehyde
type were quickly adopted for areas where iron was cast.
Although more expensive than vegetable oils etc., speed
of bake, higher hot strength qualities, smoother cast-
ing finishes and the requirement for less coating and
washing promoted their widespread use. High viscosity,
low solids salts of polyacrylic acids (acrylate core
binders) also appear to be satisfactory binders from a
foundry standpoint.

Sodium silicate process: The CO_2 process developed
ahead of todays' 'cold-box' was one of the most improved
advances since World War II. The latest development is
this organic "cold-box" process wherein the core is
gassed to produce "instant green strength". Silicate
cores which have this feature (in widespread use since
the early 50s) have a major advantage; i.e., a non-toxic
gassing media. The collapsibility of CO_2 cores has been
improved by additives. The bench life and hydroscopicity
of silicate still leaves them behind the cold-box in some
applications.

Shell process: Mr. Johannes Croning was responsible for
the greatest contribution to modern core practice. He
worked with phenol formaldehyde in both shell moulding
and shell core making. Lack of food stuffs in Germany
probably made cereal binders, soybean oil and even
linseed oil, products for human (rather than industrial)
consumption; extreme difficulty in rebuilding anti-
quated foundries which had been destroyed must also have
been a consideration leading to this development. Shell
systems were much more portable and therefore did away
with the necessity for equiping foundries with large
cranes and ovens. Moreover, accurate castings needing
much less machining could be produced. Small and
medium cores are cured in the United States using a
heated metal core box; high quality castings are also
produced in moulds prepared by the use of heated mould
patterns. Both shell cores and hot box cores are made
with this system.

Mr. Johannes Croning used a powdered phenolic to which 'hexa' was blended. This was thoroughly mixed with dry sand and applied by gravity to a heated pattern to form a shell mould-half. It could not satisfactorily be compacted into a core box by means of compressed air because of the resultant segregation of resin and sand. As resin manufacturing and sand mixing techniques improved coated sands with greater cure strength and lesser resin content became possible. The early coating process used volatile thinners such as alcohol and acetone. The resin was easily coated on the sand grain by mulling the liquid resin and sand without application of heat, i.e. "cold coating". However, hazards involving volatile flammable solvents were present. An improvement over cold coating involved addition of water to the alcoholic solution to bring about desired safety and economic considerations. But heat had to be applied and resins had to be reformulated. An added "bonus" obtained was the greater strength which resulted due to more efficient liquid coating techniques and improvements in resin technology.

The process of warm coating involves thorough mixing of liquid resin, wax, and hexa with sand followed by evaporation of the solvent by flushing with hot air. There is left behind a small residue of alcohol which tends to produce caking of coated sand during storage and 'peel back' during core and mould production, and sand-wall movement during metal pouring. Warm coating was only a transitional period between **cold** and hot coating. In the hot coating process, the resin can be either in the liquid, or in the solid (flaked) form. The choice of resin type is determined by the economics of the higher capital outlay required for proper handling of the liquid system.

The process of hot coating is a procedure of decreasing temperature from start to finish. First the resin is thoroughly mixed with sand which has been heated above the melting point of the resin, then quenching to a temperature well below the melting point of the resin. Required wax and hexa additions are made at the proper times.

Hot-box process: The requirements of heated core box in this process are not as severe as for shells. The resins for this system are more pH dependent and heating acts to speed the reaction. Although liquid phenol formaldehyde is used, hot box resins are not restricted

only to this type. Some of the hot box resins depend
on pH sensitive furfuryl alcohol and fast setting urea-
formaldehyde polymers. Combinations of furane, urea,
and phenol formaldehyde resins have been developed to
fit certain specific foundry conditions.

Generalities with respect to hot box process:

1. Resins have less drum storage stability.

2. Operations are more critically affected by
   impurity of sand and pH of sand.

3. Sand preparation and use is more critical with
   respect to sand temperature.

4. The prepared sand has much shorter usable life.

5. Prepared sand is not as blowable (flowable).

6. Cores more often require core wash.

7. Cores have less resistance to high humidity during
   storage.

8. Sand is easier to mix and requires less expensive
   mixing equipment.

9. Prepared sand is less costly per ton of sand.

10. Cores cure in about one-third the time of shell.

11. Cores evolve less total gas during pouring (in
    the case of solid cores).

12. Cores have better collapsibility.

Hot box will be an improvement wherever "shell"
cores are now being used as solid cores. Also where
the extra core box cost is justified by high production
requirements, hot box can more than double production
capacity, per man or machine. Hot box sands are more
critical than shell sand because of the pH factor.

In summary, core production in non-ferrous found-
ries centres around processes already developed for
ferrous foundries. In usages of light metals, the
accent on collapsibility has made consideration of the
most modern information on synthetic resins mandatory.

The non-ferrous metallurgists are constantly on the
look-out to make better castings cheaper. It has
been shown that hot box cores require about a $1\frac{1}{2}$
tonnes sand to make a tonne of iron castings; shell
cores require only $\frac{3}{4}$ of a tonne to accomplish the
same job. This type of progress in foundry practice
keeps the industry competitive with many other types
of metal forming from welding to forging through
explosive fabrication methods.

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