Evolution of High Pressure Moulding Machines

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Dear Friends! Let us journey together through the Topic "Evolution of High Pressure Moulding Machines". My this presentation attempts to provide answers to the following two questions:

*(i) How the **need arose** for High Pressure Moulding Process?, and*

*(ii) How it has **journeyed** through over last more than five decades?*

1. Basic Process Needs in a Foundry

Basic process in a Foundry over the Centuries has remained the same. For example,

- **Sand** to be mixed with a binder and moisture to give the moulds strength enough to withstand molten metal pressure, and to be refractory enough, and so on.
- **Mould to be compact and hard** – not to dilate under metallostatic pressure of molten metal poured; be permeable enough, allowing gases being generated to escape; and so on. *(Basic Foundry Defects arising due to Bad Mould and Bad Sand is **not** the subject of discussion here.)*
- **Molten Metal** at right temperature, of right chemistry, and with appropriate treatment (e.g. inoculation).
- **Methoding** – Right methoding to get defect-free casting, as good as possible.

2. Change in Moulding Technology

With advent of times, the following forces drove to change in Moulding Technology.

- Modernisation
- Competition
- Increasing stringent value demands from the product
- CNC & modern Machining Centres, demanding dimensional and weight consistencies in castings
- Human fatigue demotivating work force to work on foundry shop-floor
- Need of friendly and comfortable environment, Energy efficiencies and others.

These all are well known to everybody in every walk of life, and the objective of the Author is **not** to fill volumes with these. But the prime target is to dwell upon the **evolution** of the "Moulding Process". Though Metal, Sand, Core, Fettling, QC and other areas are equally important, the Author here will focus **only** on the "**Moulding Process**".

3. Earlier Practices, and Step by Step Changes in These

3.1 Compacting the Mould : Labour intensive manual work of Tramping by Feet on the sand in the mould box, changed to use of Mechanical Tools (Rammers, and later Pneumatic Rammers). These methods were laborious, productivity & production speeds were low, mould hardness was not enough, and was also non-uniform; needing more machining allowances, and resulting in weight variations in castings produced.

3.2 Pneumatic Moulding Machines : Simple Jolt & Squeeze Moulding Machines further improved to Simultaneous Jolt & Squeeze machines, to some extent improved over the preceding methods; but suffered from high noise level, high wear & tear, with many moving parts, need of strong Foundations to take shock load. The machines were energy guzzlers, separation of the mould was not perfect, so needed more draft angle, still producing castings with poor consistency in dimensions and weights.

Self cavity draw was feasible only to a limited extent. Mould hardness achieved on flat face was OK, but was not enough on vertical mould walls. Squeeze Head, being plain, had deep draw limitations for complex and deep cavity castings.

Again, apart from mould quality parameters, production speeds were low. Obviously Cost factor and Quality factor drive to find better solutions. Also lack of flexibility, Pattern change time, and many such factors. The Author presumes that these are well known to most of the learned Foundry people.

3.3 Squeezing the Mould : Above are primarily the pre-compaction of mould except in Pneumatic Machines, where a Flat Squeeze Board is used. To get good hard mould, specific squeeze pressure needed to get Mould Hardness of 88-90 is 6-10 kg/cm^2 of the mould cross sectional area (i.e. L x B of the mould); whereas pneumatic Moulding Machines largely can give at the most upto 2.5 kg/cm^2. Here many Foundrymen err to use maximum of Mould Table Area, rather than co-relating it with the Squeeze force capability of the given machine, and in most cases Specific Squeeze Pressure is 1.6 to 1.8 kg/cm^2 only. Most of the Industrial Compressors are working at 6-7 kg/cm^2 pressure, and the squeeze Piston and Cylinder size is chosen on this basis.

3.4 Limitations of Compressed Air, and Advantages of Hydraulics : If one wants to get higher squeeze force available; he needs to either increase the Air Pressure or go for bigger size of Squeeze Piston & Cylinder. Imagine in your satandard Moulding Machine to go from 2.5 kg/cm^2 to 7.5 kg/cm^2, the size of your machine piston and cylinder becomes unworkable.

3.5 Two Fundamental Needs : *Noise Level* to be below 79 dB, and *Specific Squeeze Pressure* to be above 6-7 kg/cm^2 were the *driving force* to look for High Squeeze Force, possible with **Hydraulic Power Packs**.

4. Evolution of High Pressure *in Many Ways*

First stage alternative to JOLTING (to cut menace of Noise Level) – shoot squeeze/squeeze with sand under vacuum/ explosion moulding, vibro & squeeze moulding, all these were very capital intensive, and therefore needed high volume production, each process has its own advantages and limitations. These all required very High Energy, and producing good hard mould alone was not enough.

It called for many changes:

4.1 Squeeze Head Design Evolution :

(i) Need of Contour Squeeze

(ii) Methods of Contour Squeeze

Different shapes of castings demand called for constant squeeze force delivered as per the contour of the castings, so instead of plain squeeze plate, Water Membrane Squeeze Head, Multi-Piston Squeeze Head, with Pistons differential adjustable Pressure in group of cylinders; and ultimate was large number of Squeeze Pistons with individually controlled Pressure to get entire mould area with uniform hardness.

4.2 Pattern Separation : Pin Lift – Box to draw out – Pattern to pull down – I think the advantage of withdrawing Pattern, instead of Lifting the Box, is obvious – with minimum mould damage.

4.3 Quick Pattern Change : Short Runs, without losing plant time in Pattern changing. Solutions of Pattern Shuttle many ways to enable change of pattern within the cycle time of Moulding solutions got evolved.

4.4 Pre-Compaction : Many designers adopted fall of sand from good height to utilise the gravitational force.

4.5 Flexibility / Speed / Modular : Need of short runs, instead of mass production flexibility, possibility to go for Process change giving dimensionally and weight wise good consistent castings, good mould separation, noise-free working, and with limited mechanisation to start with, and modular in Concept capable of speeding up step by step.

4.6 Incidental Advantages :

- Machines to develop with minimum moving parts to eliminate much wear & tear,
- PLC & Digitisation based solutions to substantially eliminate human dependence, and to have ready data base operations – to recall for repetitive consistent results,
- Environmental-friendly and with Safety provisions, not to demotivate work force from choosing Foundry Floor career.

5. Gains in Productivity & Quality

Gains in Productivity, Quality, and Customer Assurance are obvious. These need to be quantified by proper Data acquisition and analysis.

6. Affordability

How to make this Technology affordable is a challenge to the Plant & Machine Suppliers, and the need to drive solutions through alternate applications of various elements of construction, including *"Make in India"* approach.

7. Sustainability of Plant Operation

How to make Plant Operation Sustainable? First of all, the concept of managing such plants should largely change. With PLCs, Digitisation, Hydraulics etc., the

My Learning in High Pressure Moulding

My Learning Curve in **High Pressure Moulding** Applications and Formulations commenced in 1974 (whilst I was successfully marketing Compressed Air Moulding Machines to **Kuenkel Wagner** Designs at **Pioneer Equipment Co.**, Vadodara).

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With my first Visit to **GIFA** and working very closely with the Team of Kuenkel Wagner of Germany, I managed and co-ordinated Technical discussions, with follow-up actions, at leading foundries of TELCO, Ghatge Patil, DCM, Menon & Menon, Ennore Foundries and others; and later with **Mr. Cappelletto** of **Fondarc, France**, at Kores and many other leading foundries.

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Mr. Cappelletto commenced his journey in Foundry Production in France, and his journey in India from 1996 with **Rhino Machines**. *(Both of us, coming from Shop-Floor, gelled well – being professional foundrymen to first generation enterpreneurs.)*

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With basic background already created from 1974, I could pick a lot from Mr. Cappelletto's invaluable field experience.

Plant needs more of *Plant Engineering,* rather than *Foundry Technology.*

Foundry Technology must focus on Methods, Quality set-ups, Maximising Box Yield, Maximising Pattern Yield, and Cost Control.

Production needs consistent plant operation, and up-keepment of the plant. Shop-floor work force must be oriented and directed towards this. The operators must be trained on routine maintenance, should have ready availability of Tools & Maintenance Kits – like Seals/ O-Rings *(Plant Supplier to Guide).*

8. Don't Rest Here – Where do you go next?

One has not to rest his Oars here, but constantly apply mind to find better and more economical materials of construction, create great working conditions like your Executive Office Room, train People to be Safety-savy, train them in multi disciplines.

Foundrymen should throw challenges to the Equipment Designers & Manufacturers. My small observation of yester decades is that in **Europe** Innovations have been driven by the Challenges posed by *Foundrymen,* and they have led to solutions – the equipment Manufacturers took advantage of Experienced retired Foundrymen's guidance for the Process to match the challenges thrown by the users.

Whereas (though in last 2 decades or so change has come), in **India** Newer Technologies were always considered to be the Domain of *Equipment Suppliers.* So much so that many Equipment Suppliers were obliged to have highly experienced Foundrymen as their consultant(s) to contribute to the Equipment concept development.

Acknowledgement

I thank my good friend & Editor of "FOUNDRY" magazine, for motivating me to present "My Journey into High Pressure Moulding Line"; as also thank you All Foundrymen, for giving the challenges to motivate, and then co-operate to find Solutions. *(Meeting Challenges has been, and is, the way of my life.)*