ALUMINIUM GDC TECH GREAT DIE CASTING

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MTS 1500 automated Metal Treatment Station

FOSECO

Introduction

Today's aluminium foundries operate in a competitive environment and are focused on production of higher quality castings with low scrap and waste rates and increased productivity. In order to compete, an improved metal yield in a safe working environment is essential. These needs must be fulfilled in order that the foundry can:

- Provide the customer with the best quality product
- Produce castings that are reliable, safe, and conform to specification
- Be competitive in an increasingly difficult market
- Ensure the working environment is safe, healthy and stress free
- Improve the environmental performances as set out in 'ISO 14001'
- Operate a profitable and successful business.

One process stage within the foundry that impacts on all these needs is metal treatment. Having the optimum metal quality is fundamental to the production of quality castings but it is arguably the most difficult to control and has potentially the biggest impact on the environment. The optimisation of metal treatment processes has been the subject of much development work in the recent past, which has resulted in new, more efficient and cleaner treatment processes. One such improvement, the MTS 1500 - automated Metal Treatment Station - is a recent development by FOSECO that addresses all the various technical requirements and is capable of making a significant contribution to the modern aluminium foundry.

MTS 1500 Technology

The machine

The MTS 1500, an automated metal treatment station (figure 1), comprises five components (Foundry Degassing Unit - FDU*, the hopper system, a screw dispensing unit, an automatically controlled baffle plate and a control panel) as well as consumable products (fluxes and rotor) specifically designed for the MTS 1500.

- The FDU is a rotary degassing unit, this forms the basis of the MTS 1500 by providing a firm and stable platform. Generally, most of the existing FDU types are compatible.
- The hopper system is made up of one or two containers in order to supply one or more different fluxes (for example, cleaning and/or modifying). The hoppers are closed to prevent moisture pick-up; a minimum sensor checks the product level to prevent shortage during a treatment.
- The flux dispensing unit is mounted on the hopper outlet and allows for a fully automated dosing of flux into the vortex. The dispensing unit is an electrically driven screw feeder which is capable of delivering accurate and consistent amounts of flux. Changing the length of duration that the screw operates can control the amount delivered.
- The automatically controlled baffle plate is an electrically driven two-position device that controls the speed of the metal at any time during the treatment cycle. In position 'A' (deactivated), the baffle creates the vortex needed for the efficient mixing of the treatment products. In position 'B' (activated) the baffle plate eliminates the vortex to create optimum conditions necessary for cleaning and degassing.

Figure 1 The MTS 1500 automated metal treatment station

- The control panel contains a Programmable Logic Controller (PLC) to enable the optimum treatment cycle, to establish, maintain and ensure consistent treatment. The PLC regulates the principle functions of the MTS 1500 machine: lifting and submersion of shaft and rotor into the melt, the shaft and rotor speed, the dispensing of the desired quantity of flux/fluxes, the positioning of the baffle plate to initiate and terminate the vortex as well as the flow rate of inert gas.

Consumable products

The XSR rotor and COVERAL* MTS fluxes are products, which are key to the satisfactory performance of the MTS 1500.

The novel design of the patented XSR rotor (figure 2) helps to create the optimum vortex during the addition of the treatment products. In addition, it is highly efficient in removing oxides and dissolved hydrogen from the melt.

Figure 2 XSR rotor

A range of new fluxes branded COVERAL MTS has been specifically formulated for use with the MTS 1500 which includes cleaning/drossing, sodium modifying, grain refining, and element removal fluxes (Table 1). All these fluxes have been developed to keep smoke and fumes to a minimum.

Name	Application	Classification
COVERAL MTS 1524	Cleaning/Drossing	Xi-Irritant
COVERAL MTS 1560	Cleaning/Drossing, Na free	Not classified
COVERAL MTS 1565	Cleaning/Drossing Na-Ca free	Xi-Irritant
COVERAL MTS 1572	Sodium modification	T-Toxic
COVERAL MTS 1576	Sodium modification	Xn-Harmful
COVERAL MTS 1584	Grain refining + cleaning	Xn-Harmful
COVERAL MTS 1591	Cleaning/Elements removal	Not classified

Table 1 COVERAL MTS flux range

Process steps

A standard treatment cycle with MTS 1500 is in four steps:

- Shaft and rotor introduction: the shaft and XSR rotor are lowered into the melt. Then, the baffle plate is moved into position 'A' where a vortex is created.

- Vortex formation: the rotor speed is increased to a point where a vortex is created around the shaft.

- Addition of fluxes: the required amount of flux(es) is dispensed directly into the vortex and drawn down into the melt.

- Vortex termination and degassing: after the additions are complete, the baffle plate is moved into position 'B' where the vortex is stopped, thus initiating the degassing phase.

Benefits

The MTS 1500 offers the foundry several benefits that can be divided into four main categories: metallurgical, environmental, health and safety as well as economical benefits.

Metallurgical benefits

The use of COVERAL MTS fluxes in combination with the MTS 1500 machine enables foundries to get metallurgical benefits such as consistent mechanical and physical properties, homogeneous microstructure and composition, acceptable levels of metal cleanliness and controlled gas porosity.

The technology is of interest to all foundries but particularly those in which the castings are required for safety critical applications.

Environmental benefits

With the introduction of increasingly strict environmental legislation, there is greater emphasis placed on foundries to reduce the amount of pollution they produce. ISO and other key accreditations provide necessary guidelines on how to achieve this. The MTS 1500 helps foundries to achieve better environmental performance by the use of fewer consumables (flux and inert gas), lower dross levels, reduced emissions as well as shorter treatment times and melt superheat with associated energy savings.

Health and safety benefits

The MTS 1500 contributes to a healthier and safer environment. Unacceptable emissions are reduced compared to conventional treatments because the MTS 1500 uses less flux, the action of the vortex draws the flux down into the melt where it is quickly mixed into the metal, and the flux used in the metal treatment is fully consumed and does not continue to react post treatment. As the MTS 1500 is a fully automated process the operator involvement is reduced and a safer environment results.

Economic benefits

MTS 1500 enables foundries to make substantial cost savings by reducing treatment costs and improving performance.

Treatment costs can be minimised because inert gas and flux consumption is reduced, aluminium losses in the dross are lower and less labour is required. General performance is improved by fast metal turn around, reproducible metal quality, increased reliability and decreased maintenance.

A set of case studies for different melt treatment steps such as cleaning, grain refining, sodium modification, and/or element removal gives an overview of the process and attendant benefits.

Grain refining

The grain size of cast alloys is dependent on the number of nuclei present in the melt as it begins to solidify and on the rate of undercooling. Grain refining improves hot tear resistance, reduces the harmful effects of porosity and redistributes shrinkage porosity in aluminium alloys. Titanium, particularly in association with boron, has a powerful nucleating effect and is the most commonly used grain refiner.

Case study 1

A test in a die casting foundry for brake components for automotive industry was carried out to compare AlTi5B1 rod with the newly developed COVERAL MTS 1584 grain refiner. The treatment was carried out in electrical heated crucible furnaces (Table 2).

Die casting foundry	FDU plus manual treatment	MTS 1500
Product used	AlTi5B1 rod	COVERAL MTS 1584
Alloy used	AlSi7Mg	
Furnace type and capacity	800 kg; electrical heated crucible	
Treatment temperature	730°C	
Addition rate	0.10 %	0.04 %
Titanium yield	46 ppm	55 ppm
Boron yield	4 ppm	3 ppm
Dross weight per treatment	12.0 kg	4.5 kg

Table 2 Trial parameters and results for grain refining

A comparison of yields for the two treatments can be seen in figure 3, and the respective microstructures can be seen in figure 4.

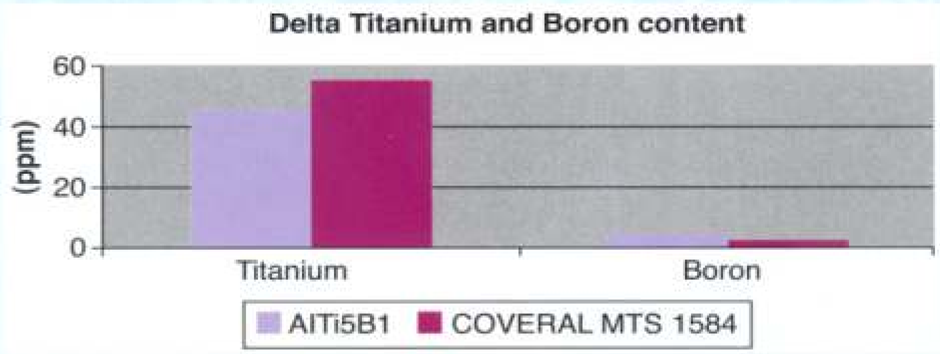

Figure 3 Yield comparison for grain refining trials

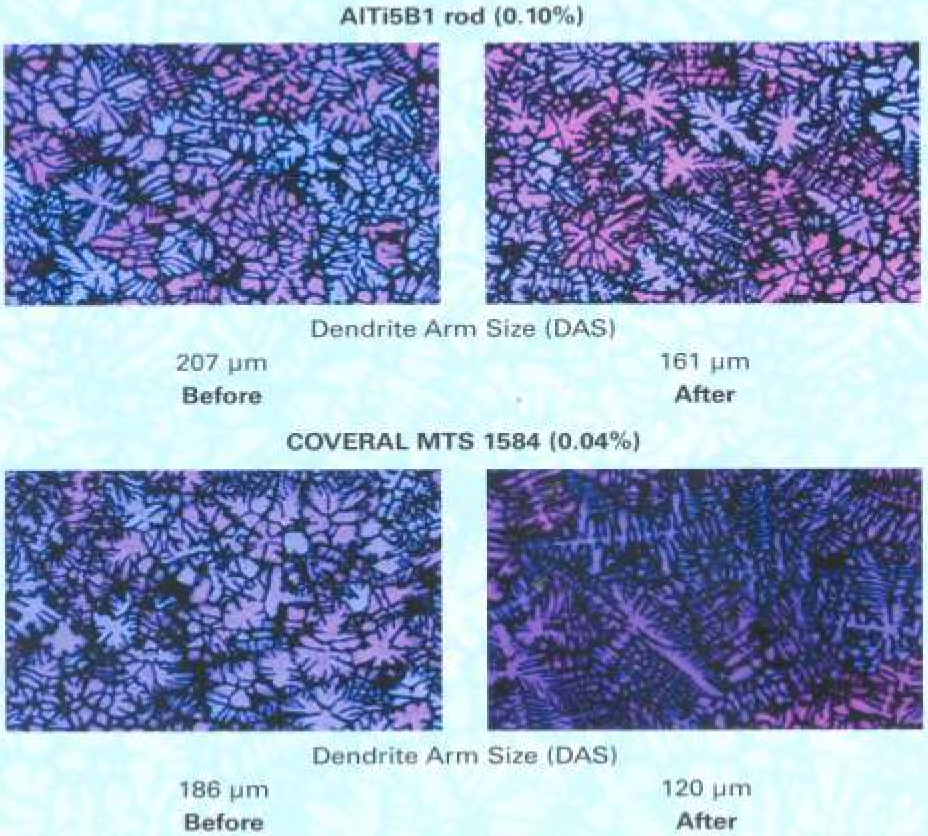

Figure 4 Microscopic structure for grain refining comparison

The material costs per treatment for AlTi5B1 master alloy (at 0.10% addition rate) and COVERAL MTS 1584 (at 0.04% addition rate) are generally similar, although this depends on specific master alloy prices.

The microstructure of the castings was improved by using COVERAL MTS 1584; the result was supported by thermal analysis curves. Additionally the grain refining granular product assists with cleaning and drossing.

Grain refining with COVERAL MTS 1584 in combination with MTS 1500 technology is a new and effective option for titanium boron nuclei addition into aluminium alloys.

Sodium modification

Modification is normally recommended for Al-Si alloys with 5 - 13% of silicon content and sodium is accepted as one of the most effective modification agents. It improves feeding properties and hot tear resistance and reduces shrinkage porosity. In the past, powder fluxes, tablets and metallic sodium were the most common products added manually. The new MTS 1500 technology gives the opportunity to automate and control the process using granular products.

Case study 2

The problem faced by a gravity die casting foundry producing safety critical componets was variability in flux additions due to operator error. This variation could be significant resulting in unacceptable scrap levels. A MTS 1500 treatment was introduced as seen in Table 3.

Gravity die casting foundry (automotive)	FDU plus manual treatment	MTS 1500
Flux used	Powder flux	COVERAL MTS 1572
Melt capacity	500 kg	
Treatment temperature	740 – 760°C	
Amount of flux used/ treatment	4.5 kg	1.8 kg
Sodium pick up	150 ppm	150 ppm
Variation in sodium content	± 13%	± 5%

Table 3 Trial parameters and results for sodium modification

Once the MTS 1500 treatment cycle had been optimised there was less than 5% variation in the sodium content of the treated metal as the cycle is constant. The foundry saved 60% of the amount of modification flux, but the biggest benefit for the foundry has been achieved through producing sounder castings with reduced scrap rates.

Case study 3

A sand foundry intended to change its melt treatment practice to MTS 1500 to achieve a better consistency. Due to its particular location near a housing estate, the use of a non-toxic material was not allowed. FOSECO developed an environmentally acceptable product which is non-toxic i.e COVERAL MTS 1576. The parameters for the process are outlined in Table 4.

Sand foundry	FDU plus manual treatment	MTS 1500
Flux used	Modifying tablets plus drossing granulate	COVERAL MTS 1576
Melt capacity	450 kg	
Treatment temperature	740 - 760°C	
Type of alloy	AlSi6Cu3	
Amount of flux used/ treatment	Modifying tablet: 0.25% Drossing granulate: 0.05%	0.23%
Sodium pick-up	80 - 100 ppm	

Table 4 Trial parameters and results for sodium modification

The intensive mixing of product with the melt given by MTS 1500 enabled the use of a non-toxic sodium modifier. The use of COVERAL MTS 1576 with MTS technology reduced significantly the operator involvement, and minimised the number of injuries caused by burns. Also it improved the working environment, which is benefical to the employees and to the local community.

Cleaning/drossing

Melt cleaning fluxes are designed to remove aluminium oxides and other impurities from the melt. The action of a cleaning flux takes place within the melt, beneath the melt surface, by trapping the oxide particles and encouraging them to float out. The flux has to be in close contact with the melt, therefore it should be plunged and stirred intensively within the melt (figure 5).

Figure 5 The action of a cleaning flux

A successful drossing agglomerates the oxides in the dross and separates them from the liquid metal leaving dry and powdery dross. Skimming is thus facilitated and metal loss due to aluminium entrapment in the dross is reduced.

Case study 4

This is a wheel foundry, part of a European foundry group, operating a considerable number of melting furnaces. The molten metal is transfered by forklift to the low-pressure machines in an 800 kg transfer ladle. Degassing and melt treatment are carried out in this ladle. Table 5 outlines procedure and result using MTS.

European wheel foundry	FDU plus manual flux addition	MTS 1500
Production capacity	20,000 tons per year	
Number of ladles treated per day	65 - 70 ladles per day (INSURAL ATL 800)	
Treatment temperature	730 – 760°C	
Type of fluxes used	COVERAL GR 2410 (0.05%)	COVERAL MTS 1524 (0.03%)
Amount of flux used per cycle	400 g ± 20g	240 ± 10 g
Flux amount used per year	6,000 kg	3,600 kg
Dross weight per treatment	7.2 kg	4.4 kg
Dross amount produced per year	108 tons	66 tons
Metal dross content	44%	36%
Amount of aluminium lost per year	47.5 tons	23.8 tons

Table 5 Trial parameters and results for melt cleaning

Figure 6 compares the amount of dross and aluminium currently lost per year.

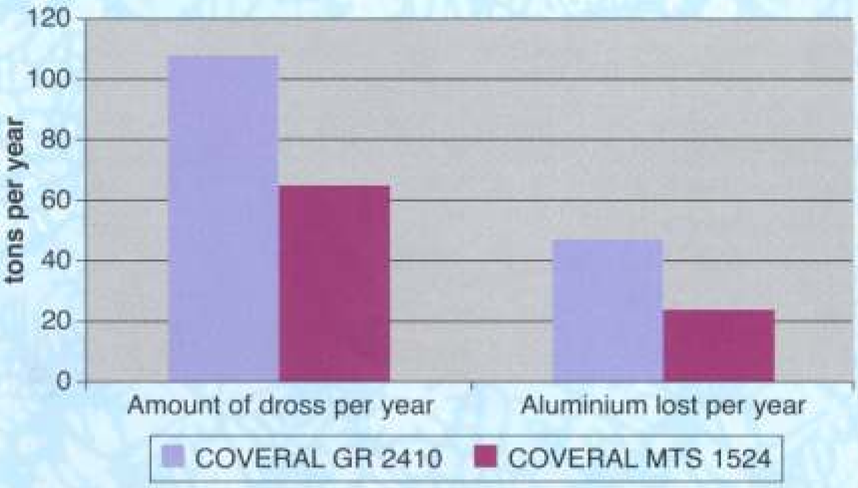

Figure 6 Comparison of dross amount and aluminium lost for melt cleaning

The installation of the MTS 1500 has resulted in immediate improvements in reliability, granular additions are precise and metal quality is consistent. The annual granular flux additions have been reduced by 20%, resulting in much lower emission rates.

The major economic benefit for the foundry has been achieved by the reduced quantity of dross and aluminum loss. The MTS 1500 provides a more intensive mixing of metal with the melt treatment product, which gives a better segregation of melt and oxides. The total amount of aluminium lost has been reduced by about 50%.

Element removal

For special types of alloys (pistons or Al-Mg alloys), the removing of sodium, strontium, and calcium is essential. COVERAL MTS 1591 is a granulated flux, which provides a strong cleaning action while removing these elements. This product is fluoride free and emits low fume.

The first results achieved with COVERAL MTS 1591 showed very low levels of calcium, strontium and sodium in the melt. Further trials on a longer period of time have to be conducted to confirm these results. The main goal is the replacement of chlorine use in foundries as chlorine is a hazardous material for people and the environment. It is likely that the chlorine use will be restricted in the future.

Conclusion

MTS 1500 system is a fully automated metal treatment station which performs all metal treatments in one single operation. It eliminates the influence of operator error and is consistent and reliable.

The use of MTS 1500 has given foundries significant metallurgical, environmental, health and safely and economic benefits.

Major cost savings are obtained by reduction of gas consumption, flux consumption, aluminium loss in the dross, energy costs by reducing treatment times and furnace temperatures, and labour costs. In addition, MTS 1500 gives a fast metal turn around, reproducible metal quality, increased reliability and decreased maintenance.

Role of Maintenance in Die casting

C. Surianarayanan, Consultant, Tooling Soultion

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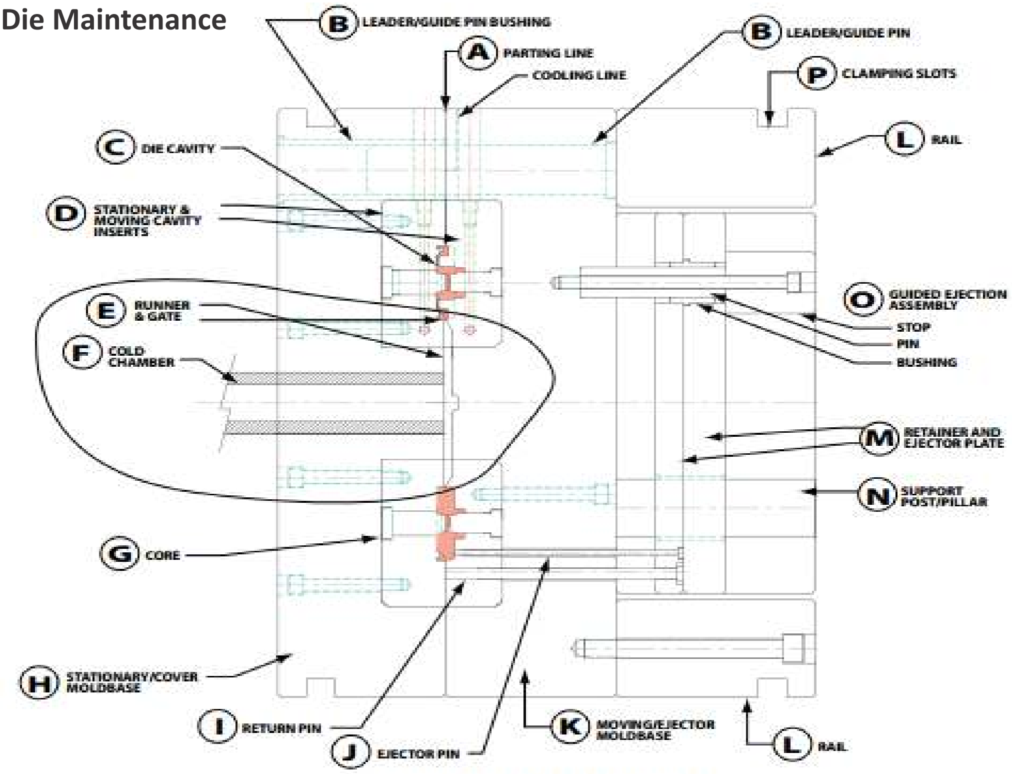
Die Maintenance



COLD CHAMBER DIE

1. Core pin Correction
2. Ejection Pins correction
3. Spreader Replacement
4. Sprue bush replacement
5. Guide rails Replacement
6. Cooling elements Cleaning.
7. Jet Cooling Cleaning.
8. Die polishing

Maintenance in Die casting:

1. Die Maintenance
2. Machine Maintenance
3. Accessories maintenance
4. Equipment maintenance.

Die Casting dies are forced to face:

- Compression load
- Thermal expansion and contraction
- Wear due to hot alloy
- Surface finish damages
- Corrosion of the parts due to water involvement
- Erosion due to hot alloy with velocity

Preventive & Periodical

Dies are to be cleaned after every run of production.

Water washing is the best to remove the die spray contamination on the die.

Total die has to be dismantled and cleaned.

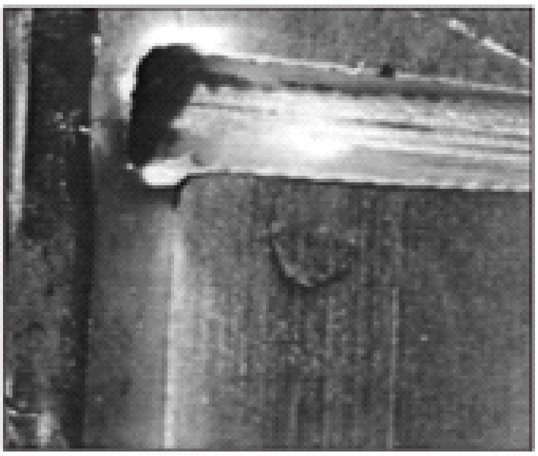
All the wear parts such as Core pins, Guide rails, Spreader, Sprue bushes are to be physically measured and checked for acceptance level to achieve good castings of dimensional quality.

Die elements that are forming dimensional aspects has to be measured and inspected for quality as per the detail drawing of the die design.

Deformation, wear can have defect of the dimensions. These are to be changed with fresh parts.

DETAILS OF THE DIE ELEMENTS TO HAVE MAINTENANCE CARE:

Ejection Pin:



Wear erosion happens on the ejection pins and Causes Flash as well uneven ejection.

Core Pins:

Chances for deformation, Soldering of Alloy, Wear due to erosion. Should maintain record for the variation and periodically changed with fresh core pins.

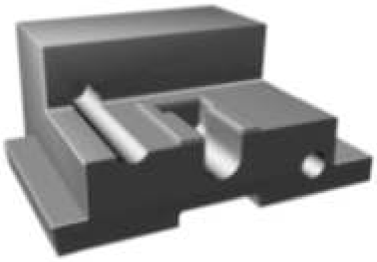
Sprue Bush:

Erosion due to hot alloy pushed in side, mechanical wear due to plunger deflection. Should have record maintained for the variation and periodically changed with fresh bush. Check the Bush after 35000 shots for ovality and surface finish.

Spreader:

Wear of the runner passage due to hot alloy pushed on the spreader with high velocity. This will create flow restrictions and can have defects in the castings. Should have record maintained for the variation and periodically changed with fresh spreader.

Holders & Guide rails:



Wear erosion due to friction can happen. This will increase the clearance and slider movement gets deflected. Check the clearance and take corrective steps.

Spot Cooling (Bubblers):

Deformation due to handling defects during assembly and disassembly. Blockage due to contamination of water or sediment formation due water calibre. This has to be cleaned and corrected for the better performance. Good cooling elements can only get you a thermal regulated die for better performance.

Jet Cooling:
Descaling & Cooling Unit:

Compact unit to remove scale and clean the internal cooling line of Inserts, Jet coolers, Jet cooling pins, Manifolds and spot coolers. Effective cleaning of cooling line leads to desired cooling in Die thus increasing die life. Leakage in cooling lines can also be checked. Very effective during maintenance activities of the Die. Helps reduce maintenance time and cost Increases life of consumables Uses shop floor air and water.

Features:

User friendly simple and manual operations.

Water/splash proof design to withstand shop floor conditions.

Works with air operated pump.

Anti-corrosive solvent followed by hot water and air is used for descaling and cleaning.

Inbuilt tank with easy mobility with wheels.

HPDC Dies are with toughness rather than the hardness due to the process requirements.

This has chances for the die edges to bulge due to locking tonnage applied on the die.

Casting retrieval from the die will have defects if the profile edges are bulged in the die.

Abrasive stones can be used to remove the bulges only.

It should not be used for die polishing because it may enlarge the die dimension and there by the casting dimension. It is advisable to clean the soldered aluminium by using soft brass wire brush.

Final polishing can be used high smooth emery paper only. Preferable emery sheet used by goldsmiths is ok.

Fully enclosed design ensures complete safety of the use.

Die Casting Machine Maintenance

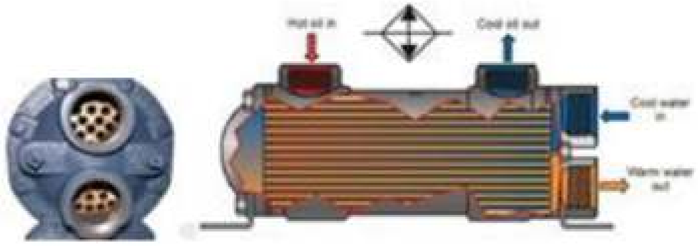
Details that can get defected and to be checked and changed are:

Hydraulic Cylinder Seals, Hydraulic oil, Toggle Pins, Platen Shoe, Tie Bar Bushes, Platen paralality, Tie bar Expansion, Accumulator Seals, All gauges ,Plunger Rod,Valves Heat Exchanger.

Preventive & periodical maintenance Charts should be prepared and Maintained.

Casting defects can occur because of the defective machine.

Defects such as Flash, Un filling, Cold shut can happen due to the machine defect also. Platen paralality, Accumulator charge defects, Toggle pin clearance can cause almost all these defects.



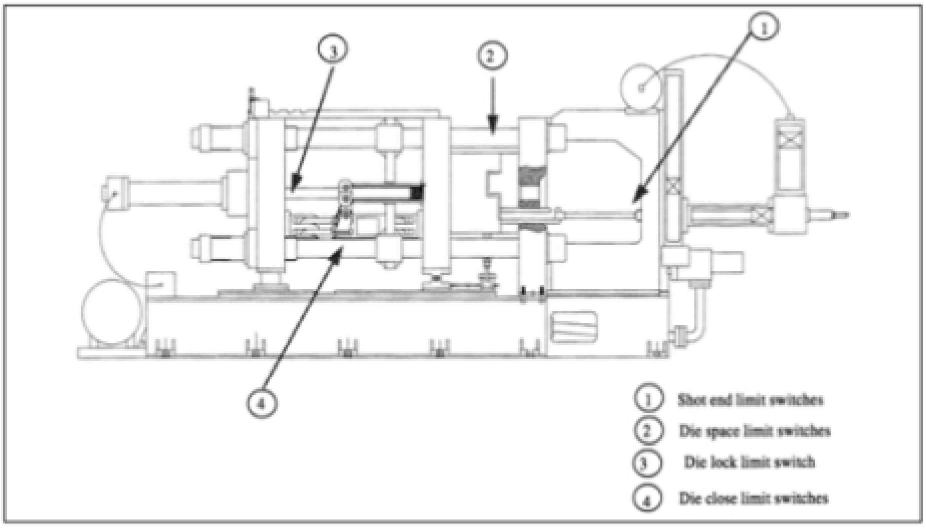
Factors affecting the efficiency of the heat exchanger are the same as those affecting die cooling. If the water lines fill up with lime (calcium), heat flow is reduced. If fluid flow is to slow, heat flow is reduced. Leakage in the heat exchanger can be troublesome in two ways. First the hydraulic oil can be contaminated by too much water. Second the recirculating water will be contaminated by the hydraulic fluid. As an operator, you should be aware of the hydraulic fluid temperature. If it gets too hot, then check for flow through the heat exchanger, both hydraulic oil and coolant Periodical cleaning of the heat exchanger should be planned based on the situation of the plant .

Factors affecting the efficiency of the heat exchanger are the same as those affecting die cooling. If the water lines fill up with lime (calcium), heat flow is reduced. If fluid flow is to slow, heat flow is reduced. Leakage in the heat exchanger can be troublesome in two ways. First the hydraulic oil can be contaminated by too much water. Second the recirculating water will be contaminated by the hydraulic fluid. As an operator, you should be aware of the hydraulic fluid temperature. If it gets too hot, then check for flow through the heat exchanger, both hydraulic oil and coolant.

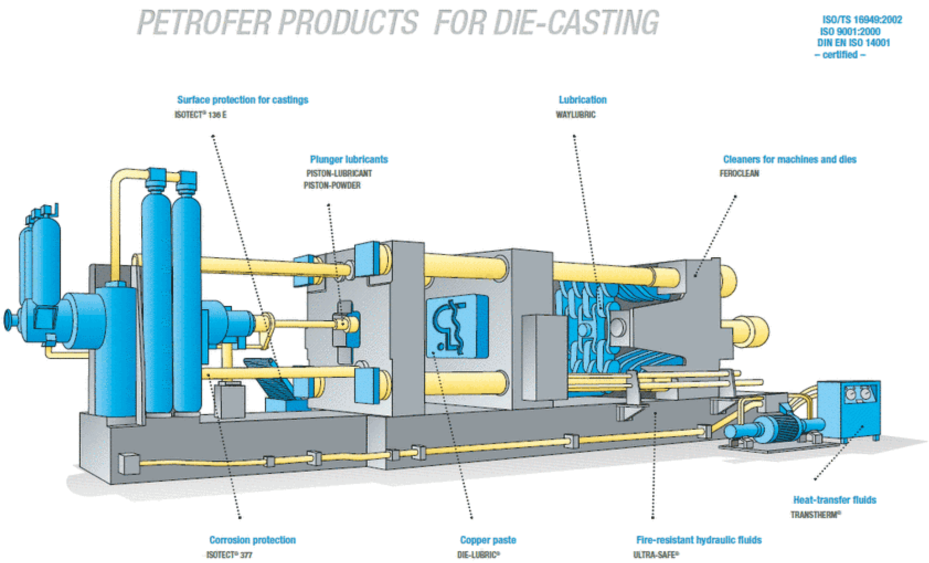
One of the things that can go wrong during normal production is overheating of the hydraulic fluid. Most manufacturers of hydraulic fluid will specify a recommended operating range for those fluids. For die casting machines, the maximum temperature is about 125°F. If the fluid overheats it will lose its viscosity and the following problems could occur:

- Leakage can increase at valves and actuators.
- Leakage at gaskets, seals, and connections.
- Increased pump slippage.
- Increased wear.
- Shortened service life of the fluid.

Operator should monitor the temperature the fluid. Most reservoirs have a thermometer on them. A good time to check the temperature is at breaks, after periods of extended operation. High fluid temperature could be an indication of a heat exchanger that is plugged or not open.



Limit Switch locations of a HPDC Machine. These are to be periodically checked and kept in good condition.



AUXILERY EQUIPMENTS OF DIE CASTING

- Air Compressor, Die Coat Pressure tank, Melting Furnaces, Holding Furnaces, Cooling Tower, Metal handling Equipment's Like EOT, Fork Lifts, Trollies, Air Dryer.
- Auto Sprayer, Ladler, Extractor electrical components are to be kept in stock for emergency.
- Fix with a service firm or the manufacturer for the periodical service and maintenance.
- Consumable spares for these are to be taken from the manufacturer and kept in stock for emergency maintenance.

- Maintenance is for the Die casting is equally important as of the Die making, Die design, QA.
- It has to be given due respect and importance with well knowledgeable team.
- Die maintenance+ Process team+ Die maintenance team only can get good results. Any one is defective or operating elusively will reflect in great loses.
- Cricket is a game where it is said "A RUN SAVED IS EQUAL TO A RUN MADE".
- Like that "A WELL PLANNED JOB IS A WELL DONE JOB".
- LIKE WISE WELL MAITAINED FOUNDRY CAN ONLY GET YOU PERFECTION THAT MEANS COST EFFECTIVE FOUNDRY.

Details mentioned are from my collection of information. These are referred by me for better die casting practices. I thank you owners of these information's.

Reduction of Oxide Inclusions in Aluminum Cylinder Heads through Autonomous Designs of Experiments

Lubos Pavlak and Jörg C. Sturm, MAGMA GmbH, Aachen, Germany

Continued from October 2020 issue...............

Simulation and Optimization of the Pouring Ladle Filling Process

The video analysis of the filling process of a pouring ladle detected high surface turbulences. Thereby, the pouring ladle is dipped horizontally 2 cm below the melt surface and filled via a thin rectangular opening. The goal of the autonomous DOE is to establish process conditions that lead to a smooth filling of the ladle. At the beginning of the dipping process, the ladle is tilted backward at a specific angle, prohibiting the melt from falling freely out of the opening and allows it to flow smoothly over the contour of the ladle. Later in the process, the pouring ladle is tilted back to the original horizontal position.

The autonomous DOE is supposed to find the best initial tilting angle and the optimal point in time and speed of rotating it back to the horizontal position. The start angle and the total filling time were defined as process variables (start angle can vary between 0° and 50° in 10° steps, the total filling time can vary between 5.1 s and 6.9 s. in steps of 0.9 s (figure 7).

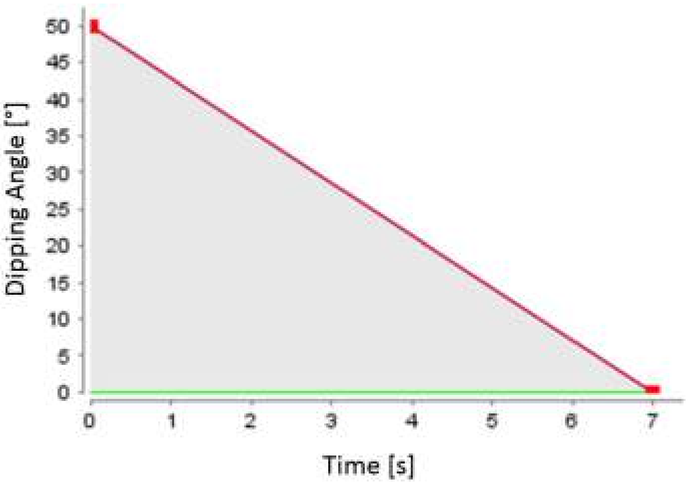


Figure 7. Definition of process variables "start angle" and "total fill time"

This leads to six (6) different start angles and three (3) available filling times resulting in 18 process versions. The automatic evaluation of all 18 calculated versions is based on the previously defined goals. The optimization program used the free melt surface as quality criteria to evaluate the smoothness of the filling process. The goal, therefore, is to minimize the accumulated free surface during the filling process of the pouring ladle.

The correlation between process versions and desired goals can be evaluated in different ways by the software. One meaningful approach is the utilization of scatter charts for all results. These display correlations between changes in process parameters and their impact on different quality criteria for all calculated versions. In addition, it is possible to display the significance of each process variable on each quality criteria.

In Figures 8 and 9, each point in the diagraph represents one calculated version. The results show that the start angle of the pouring ladle has a large impact on the quality criteria "free surface". The larger the tilt angle at the beginning of the filling process, the lower is the value of this criterion, meaning the less turbulent is the filling.

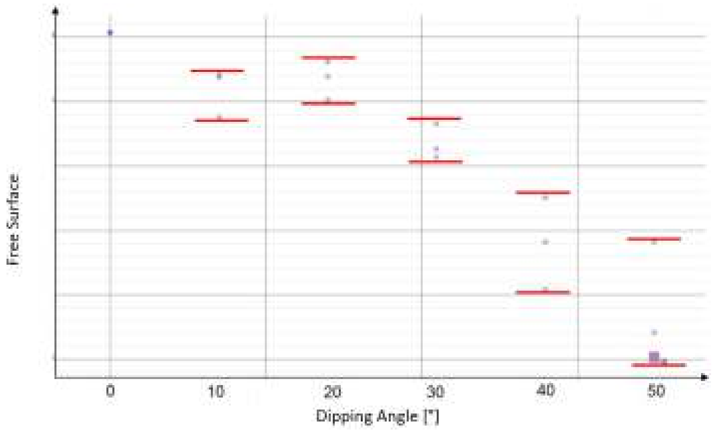


Figure 8. Quality criteria "free surface" as function of the start angle of the pouring ladle

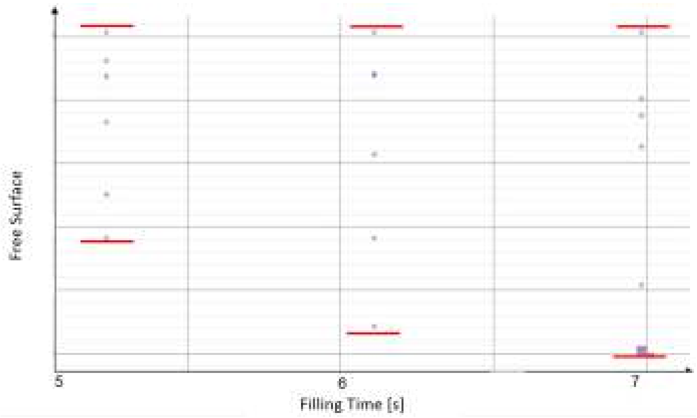


Figure 9. Quality criteria ”free surface“ as function of the filling time of the pouring ladle

However, the results also reflect that the total filling time has a negligible impact on the accumulated free melt surface (Figure 9). The best combination is a start tilt angle of 50 degrees and a filling time of 6.9 s (purple squares in Figure 8 and 9 lower right).

Figure 10 shows the development of the “free surface” over the entire filling process for the initial and the optimized versions. The best version reaches the maximum value for the free melt surface after about 1 s. At that point in time, the melt has filled the entire diameter of the pouring ladle. After that, the free surface remains approximately the same, which is an indicator for a smooth filling. In the initial version, the maximum value for the free surface was reached after 1.5 s, but was three times bigger than the one established in the optimized version.

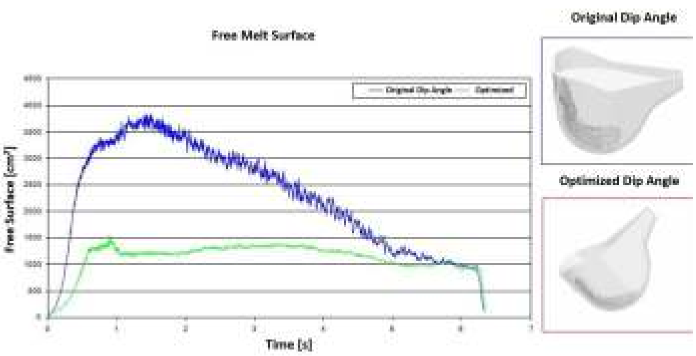
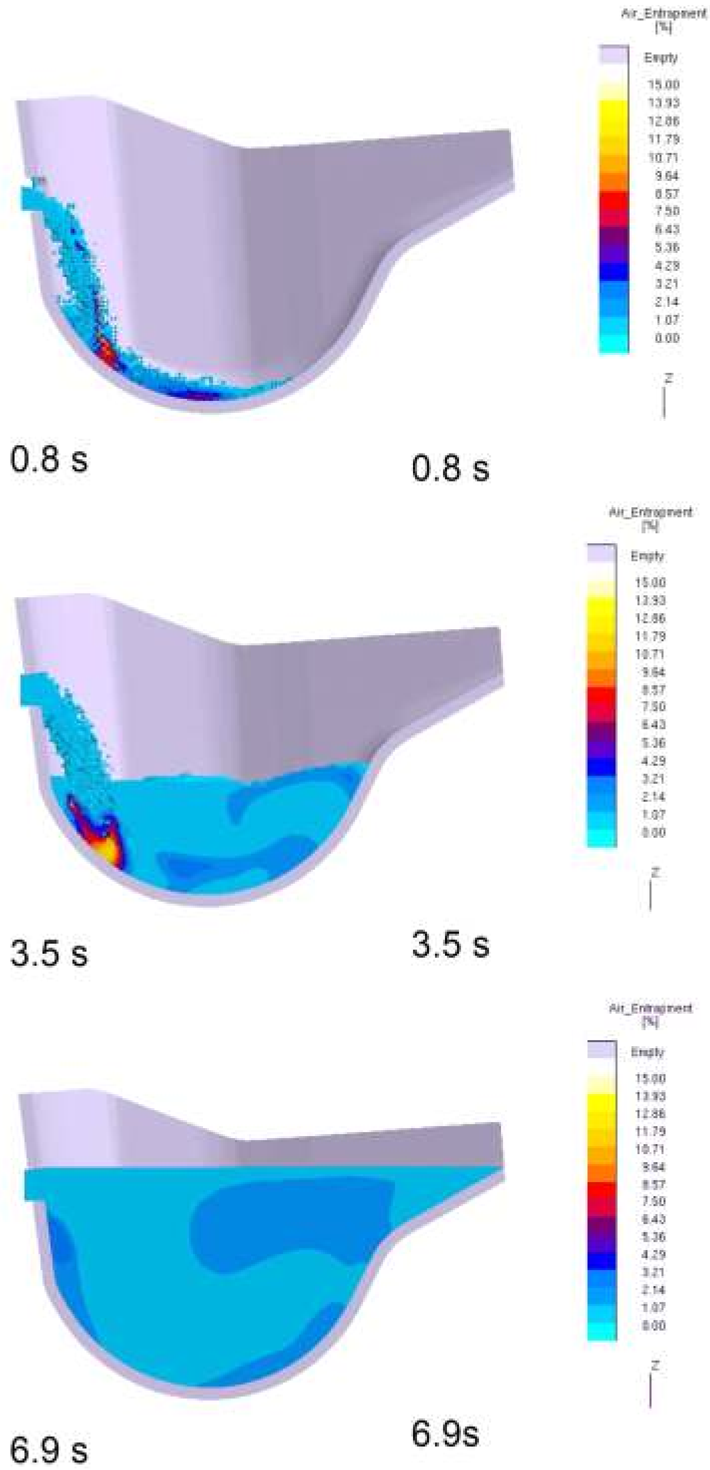


Figure 10. Calculated development of “free melt surface” over the entire filling process.



The significantly higher values for the free surface are caused by turbulence inside the melt. The melt reaches velocities above 70 cm/s (2,297 ft/s) at the bottom of the pouring ladle after exiting the opening. The melt stream continuously entrains air and oxides (Figure 11). The optimized version shows no such air entrainment.

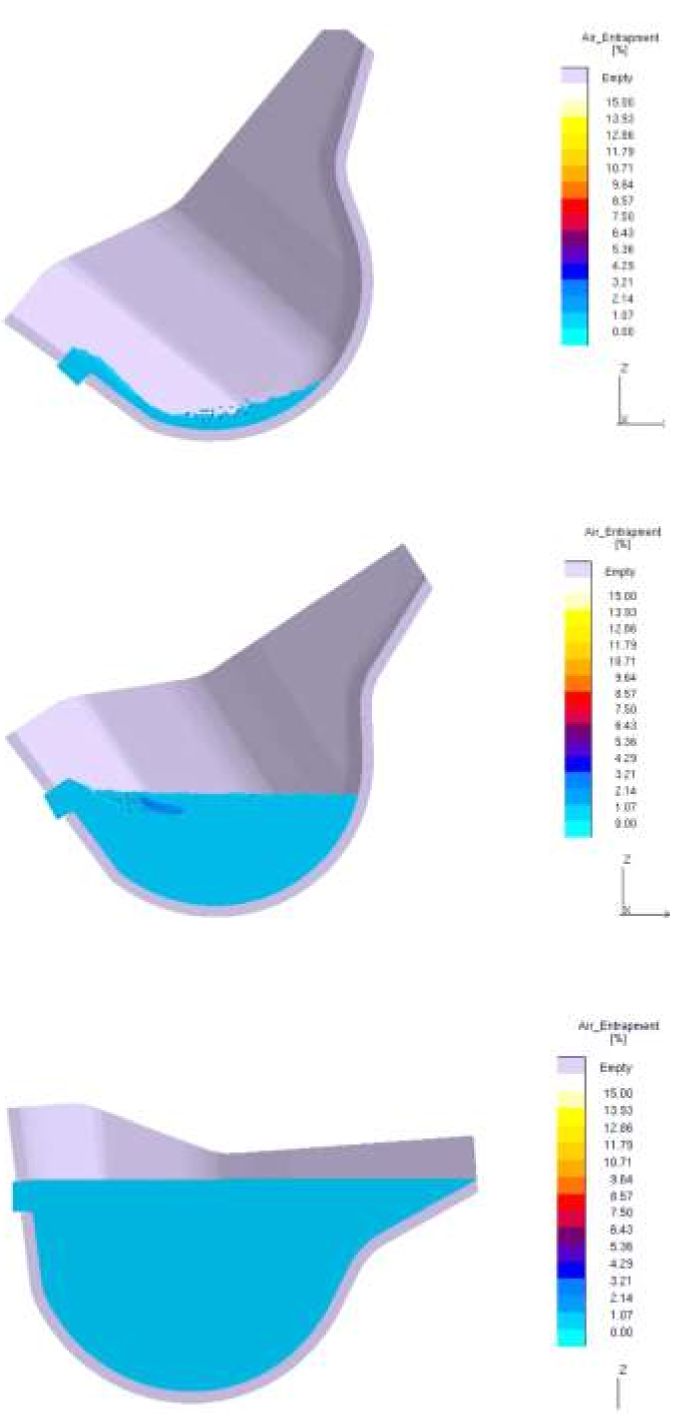


Figure 11. Air entrapment during filling process of pouring ladle comparing the initial process (left) and optimized version (right) (cut through center of pouring ladle)

The criteria "air contact" refers to the time, each melt particle is in contact with air, and is an important indicator of the amount of oxides created. In the initial version, almost the entire melt volume is exposed to air for a longer period of time (Figure 12) compared to the optimized version, where a stable melt surface is established much faster.

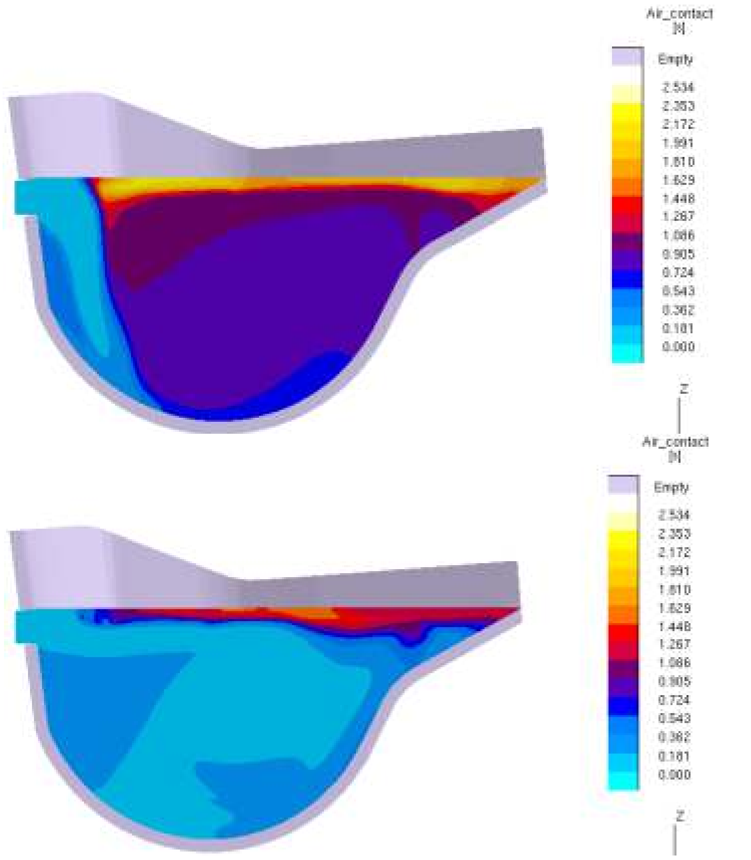


Figure 12. Comparison of air exposure between stationary filling (left) and optimized, tilted filling (right) (cut through center of pouring ladle)

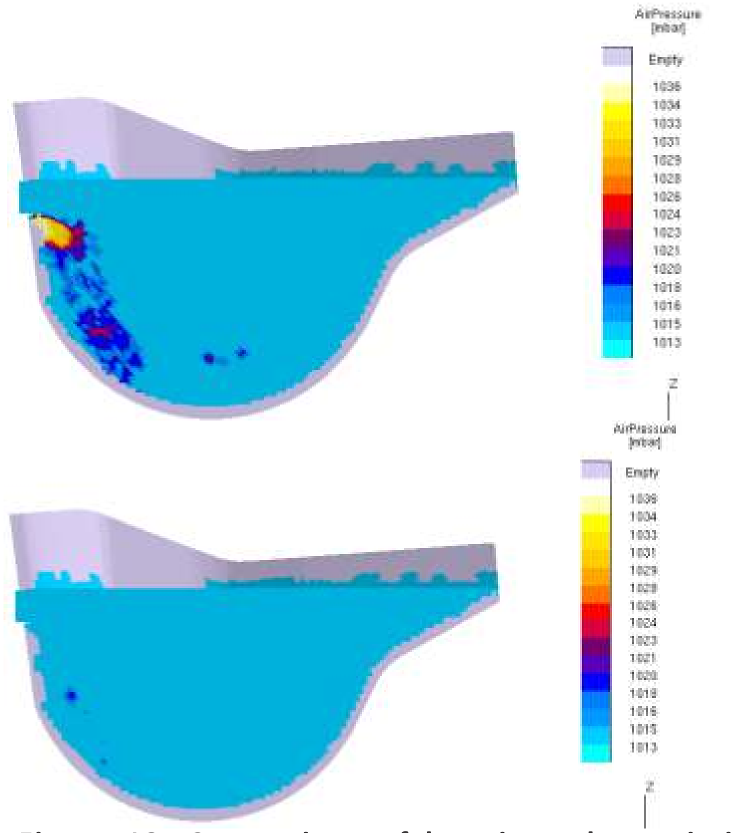


Figure 13. Comparison of location where air is entrapped during stationary filling (left) and optimized tilted filling (right) (cut through center of pouring ladle): The initial version entrained air mostly during the initial free fall of the melt out of its opening into the pouring ladle.

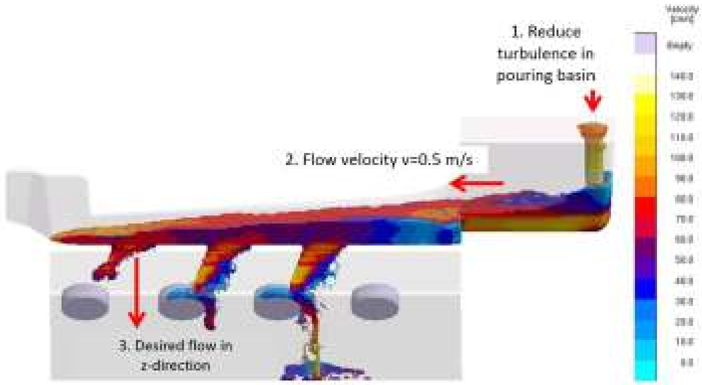
The simulation results show that the entrapped air bubbles are moving towards the surface of the melt due to their buoyancy and melt turbulence. They are leaving a trail of oxides along the way. As the melt enters the gating system and the mold cavity straight from the pouring ladle, all oxides existing at that time will enter the casting with detrimental impact on its quality.

Gating system optimization for cylinder heads

Leaks caused by oxide inclusions were the main source of defects for the evaluated cylinder head. The analysis of the mold filling process through high- speed videos and the simulation of the mold filling process of the original geometry demonstrated the potential for its optimization. Melt quality and how the mold is filled, both, have a direct impact on the amount and distribution of oxide inclusions in the casting. The original gating system created the following main contributors to the creation of oxides : Leaks caused by oxide inclusions were the main source of defects for the evaluated cylinder head. The analysis of the mold filling process through high- speed videos and the simulation of the mold filling process of the original geometry demonstrated the potential for its optimization. Melt quality and how the mold is filled, both, have a direct impact on the amount and distribution of oxide inclusions in the casting. The original gating system created the following main contributors to the creation of oxides:

- Immense melt turbulence in the pouring basin
- High melt velocity in the main runner
- Less than optimal flow direction of the melt when entering the mold cavity through the gates

An autonomous DOE was used to evaluate and quantify the impact of several geometric modifications of the gating system and process parameters on the creation of oxides, as well as the entrainment of already existing oxides into the casting and their distribution.



The first goal for the autonomous DOE was it to find an optimized layout of the gating system that will minimize the turbulence (and oxide creation) in the pouring basin. The pouring height and orientation of the melt stream was varied (hitting the rear pouring basin wall versus the pouring basin's bottom) to reduce the originally observed back wave of the melt collapsing on itself when hitting the pouring basin walls (Figure 14 (1.).

The second goal was to reduce the velocity of the melt when leaving the pouring basin and entering the runner. Besides using runners which were directly connected to the pouring basin, a deviation basin was evaluated. Several alternatives for the transition between the pouring basin into the runner (rising or stepped versus flat) were expected to support the desired velocity reduction (Figure 14 (2.).

The third goal was to realize a constant vertical flow from the gates towards the water jacket cavity inside the cylinder head. This was supposed to reduce or even eliminate premature solidification of the melt on the channel cores. Elongated gates and additional flow aids below them were the variables of this optimization aspect (Figure 14 (3.).

The optimization runs in MAGMASOFT® used a parameterized geometry of the original gating system. The complex cylinder head geometry was substituted for efficiency reasons by a simplified geometry. The wall thicknesses and angle of the wall below the gates, as well as the position of the channel cores, exactly matched the configuration of the real cylinder head.

Adding up geometric variations as central or back-wall filling of the pouring basin, flat or rising transition from pouring basin to runner, short or long gates, and present or non-present filling aids lead to 16 to be calculated versions (Figure 15).

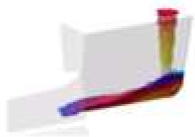
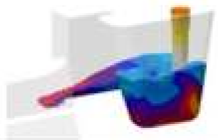
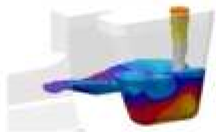
Pouring basin with flat/stepped transition		Version	Gate Height	Flow Aid
1		A	6 mm	none
2		B	16 mm	none
3		C	6 mm	6 mm thick
4		D	16 mm	6 mm thick

Figure 15. Trial plan and nomenclature for the 16 evaluated variations

The following functions for the evaluation of all simulation results were defined:

1. Minimize the maximum melt velocity in control point C1 in the transition between the pouring basin and the runner
2. Minimize the melt volume through gates A1, A2, and A3 with undesired flow direction (deviation from z-direction) (figure 16)
3. Reduce the accumulated "free surface" of the melt during the mold filling process

The autonomous DOE was performed in MAGMASOFT®, including the generation of the geometry variations, their enmeshment, the calculation and evaluation of quality criteria and functions assessing all simulations.

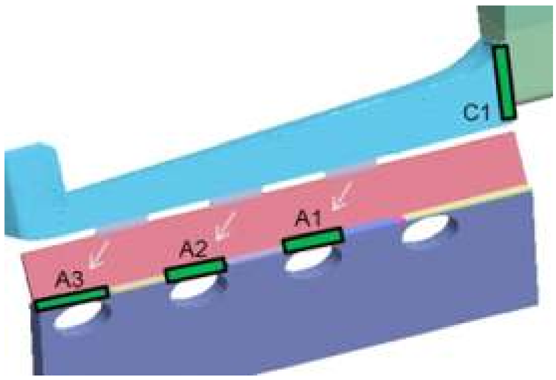


Figure 16. Definition of evaluation areas A1, A2, A3 for the evaluation of the deviation of the melt flow from the desired z-direction and the location of control point C1 for the melt velocity evaluation

.....To be concluded in next issue......

Demystifying Wealth Creation - Eli Goldratt WAY

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E-mail : deepak.nagar@yagnaworld.com

India has been a developing country for a very long time. Per capita GDP is currently at $2,199 (nominal; 2019 est.) $8,484 (PPP; 2019 est.) ranked 142nd (nominal; 2018) 119th (PPP; 2018), from Economy of India - Wikipedia. We are poor and the average age of the population is quite low. India has more than 50% of its population below the age of 25 and more than 65% below the age of 35. It is expected that, in 2020, the average age of an Indian will be 29 years. Although young, the aspirations are very high.

Unless the per capita GDP is increased rapidly we would have young, restless and frustrated population to cope with.

If we wish to see this scenario change rapidly, then we need to find a WAY to demystify wealth creation. We need to find a WAY to increase productivity of Indian enterprises by orders of magnitude.

We can have an agreement on one principle. Legitimate and legal wealth creation is an outcome of production. More production (which is consumed in market) for same investment and same operating expense would mean more wealth. In other words, higher profit and profitability for enterprises across board would mean more money available to be spread around in terms of paying wages, buying services as well as investment in more productive capacities. This can be converted into a virtuous cycle. More intensely this cycle operates, more wealth can be generated!

Wealth needs to be generated fast and in copious amounts before it can be distributed.

India has 1000s of enterprises in SME category. They occupy a vital space in Indian economy in wealth generation, employment and producing goods and services used domestically and exported. However, the Entrepreneur, who lays the foundation stone of these entities, is ill equipped to grow their businesses productively. This results in great loss to the economy.

Statistics about SME start-ups

- 80% do not survive 5 years
- 80% of remaining do not survive 10 years
- Surviving 4% struggle to exist.

There is lot of focus, verging on the level of obsession, on “start-up” but hardly any fundamental thinking on why the above statistics prevails and how this could be averted.

SMEs are involved in production and supply of both physical goods and services. For a moment if we consider their involvement only for physical goods productions, we observe that the operations that they run are quite inefficient and costly. Lot of money is locked in.

inventory and receivables. The reasons could be many, including inability to attract and retain talent who can create systems to manage and improve productivity. SME Entrepreneur is stuck in a vicious cycle where in the entrepreneur's time is spent mostly on fire-fighting. S/He has little time to spend on forward planning and improving systems. SME keeps on bleeding and the profitability is low. This leaves very little money in hand to pay competitive compensation to attract and retain talent.

There is a 'personal' cost that entrepreneurs pay in the form of disturbed work-life balance, indebtedness to the banks and creditors. This creates an environment of thinking on "local optima". What is in it for me? Zero sum thinking kicks in - in order to win, someone must lose.

The worst effect of current "Local Optima" driven business thought process is borne by SMEs themselves. Every input that an SME Entrepreneur gets from business books, journals, academia, consultants is tinged with "Local Optima" thinking. This is like administering poison instead of medicine to a struggling, unwell entity. This has an impact on Indian Economy and hence it touches all of us now as well as in future (Including our kids).

Any good solution that we examine must meet following criteria

- A quick implementation of solutions that remove the cause of current fire-fighting.
- There is no further risk by infusing new capital
- The existing team is able to learn and able to assimilate new way of doing things with some external help
- The solution is stable
- A decisive competitive edge is created to sustain growth

Imagine the scale of wealth generation when 1000s of enterprises get to know this WAY.

Dr. Eliyahu Goldratt, renowned author of "The Goal", used to espouse a concept of Viable Vision, wherein, he claimed that it is possible to convert top-line into bottom-line in 4 years for most of the for-profit organizations without significant increase in investment and operating expenses.

This was a bold assertion, but it was not just theory, many organizations have experienced it. The concepts that Dr. Goldratt recommended can be used in Indian context to facilitate rapid growth of SMEs which have survived for more than a decade, without seeking additional investment or significant increase in operating expense or in other words facilitating a journey of "Chaos to Success".

Each SME entity has unique challenges and there is no one-size-fits-all solution. Any entity which has survived for more than 10 years has most of the pieces of jig-saw puzzle in place. But the Entrepreneur is not trained to envision and implement a growth strategy on their own. They are very good at technology of the solution that their company provides to the market but not at building and sustaining an organisation equipped with systems and process that can support their vision.

Each SME entrepreneur involved in manufacturing has to visualize the big picture. The big picture that every one can relate is that of FLOW. Flow of material from mines / refineries / farms to market. Each enterprise is small segment of this continuous flow that takes place because of pull created by end-user consumption. Each entrepreneur has to create conditions so that more flow happens through not only their enterprise but also through the supply chain that they are part of. The principles of flow as practiced by manufacturing greats like Henry Ford and Taiichi Ohna are as follows:

- Improving flow (or equivalently lead time) is a primary objective of operations.
- This primary objective should be translated into a practical mechanism that guides the operation when not to produce (prevents overproduction).
- Local efficiencies must be abolished.
- A focusing process to balance flow must be in place.

Its all about flow!

Dr. Goldratt has created a huge body of knowledge (Theory of Constraints) that guides leaders to follow a disciplined process of ongoing improvement. There are logical step by step methods to create conditions to achieve higher and smoother flow through the enterprise on an ongoing basis.

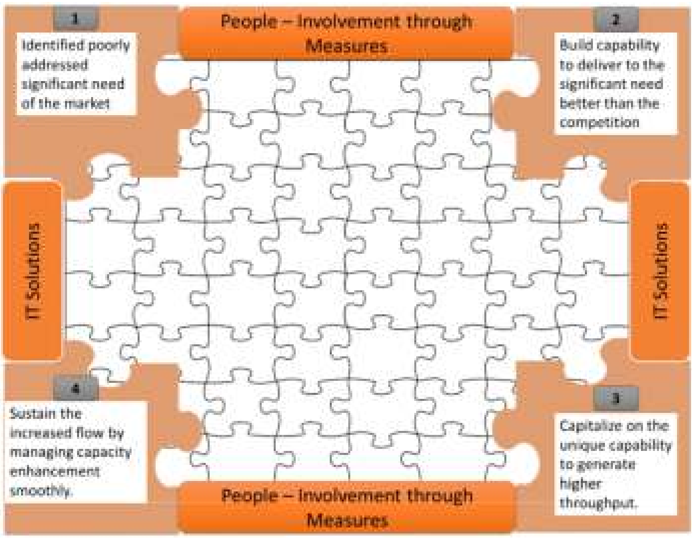
Following method will uncover the entrepreneurial opportunity in reinvigorating existing SMEs who have survived for more than a decade due to sheer grit and staying power of an entrepreneur but are struggling none-the-less.

Using analogy of solving a jigsaw puzzle, Goldratt's concepts can be applied for real-life scenarios for Designing the new organization reality of the SME.

A repeatable method of solving a rectangular jigsaw puzzle involves following smart steps:

1. Identify the corner pieces, four in number, which can be spotted from the whole mass of puzzle pieces.
2. Identify the edge pieces, number depending on the size of the puzzle (for a 10 X 10, there will be 4X8=32 edge pieces).
3. Using the above 36 pieces create a frame for solving the puzzle.
4. Once the outer frame is ready, inner pieces can be added by trial and error to complete the picture.

The proposed outcome of the above intervention is realization of explosive growth and stability simultaneously for the SME. The methodology also creates a road-map for next 4 quarters for investment in capacity and capability so that the growth becomes sustainable.



The four corners:

1. What and how of a **Decisive Competitive Edge** that an SME can aim for, by exploiting the unmet needs of the market. These are nothing but chronic complaints that the customers have from suppliers like your SME.
2. Align the Order Execution Process to **BULD** capability to support unrefusable (Mafia) offer decided in the above exercise.
3. Align the marketing and sales effort to **CAPITALIZE** on the above capability.
4. Align the investment decisions to support and **SUSTAIN** increased business that would flow into the company as a logical outcome of the above 3 steps

The Edges

1. Align the measurements, rewards and recognition system for employees and other stake-holders to participate in the Chaos to Success journey in a positive manner.
2. Gear up the enterprise IT system to facilitate day to day planning and execution as well as provide timely information to support tactical and strategic decisions.

TOC (Theory of Constraints) has been classified as a Continuous Improvement Methodology.

The concepts can be used for Design Thinking for Organization Design very effectively.

It would aim at using logical thinking processes and will equip Entrepreneur to

- Do more with less in less time.
- Release capital stuck in non-moving inventory and receivables.
- Make smart investment decisions...Exploit before Elevate.
- Generate capital to plough back in achieving scale
- Improve quality and cost competitiveness.
- Foster harmony among disparate stakeholders on firm and stable Win-win platform.

It is possible to usher in a productivity revolution in Indian economy along the lines of Green revolution and White revolution that India experienced with collaborative and cooperative efforts of many people to achieve a common Goal. This can generate enormous amount of wealth that can be used to reinvest to make Indian economy healthier.

Link : https://www.linkedin.com/pulse/demystifying-wealth-creation-eli-goldratt-way-nagar-ddpp-ddpp-i/

.....Deepak Nagar....

Coffee talk

7th October 2020 (Wed)

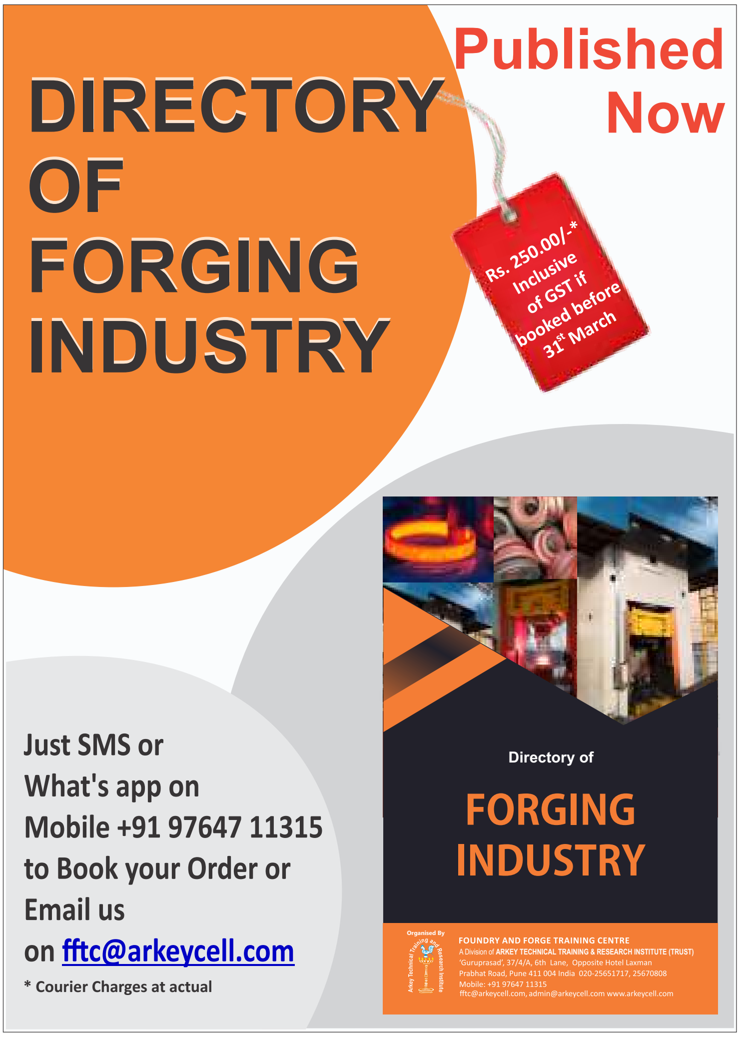
Speaker

Mr. Shrikant N Pangarkar
Management Consultant

Subject

Managing Business Crisis

How as a person responsible for running a Business, should prepare to Manage a Business Crisis, using own Strengths, Abilites and Confidence. Developing consistently, Willpower, Focus, Self Discipline and Collaboration. Simple Habits and Actions will help achieve success



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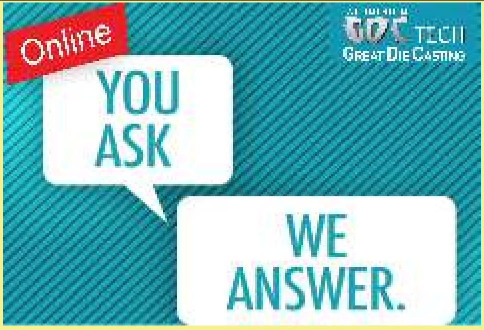

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- Faculties will be available online
- Foundries are requested to send their questions in advance

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Upcoming Webinars (Proposed)

A. MULTIPLE SESSIONS PROGRAMMES

1. Metallurgy of Cast Alloys
   - Effect of Alloying Elements & Phase Diagrams – Two sessions
   - Heat Treatment of Aluminium Alloys – One Session

2. Comprehensive Die Design PDC
   - Basics of Die Design for Aluminium HPDC
   - Selecting right material for each die parts and its recommended treatments
   - Simulation for optimisation – A Die Designers' guide
   - Exploiting 3D Modelling software for maximum benefits.
   - Design for Manufacturing and maintenance

3. HPDC Machine Maintenance

4. Problem Solving Techniques
   - 7 QC Tools
   - Methodology of use
   - Examples
   - Case Studies of use in Aluminium Foundries

5. Process Control for manufacturing of Quality Castings.
   - Raw Materials
   - Melting & Metal Treatment
   - Core shops – Core Boxes, Sand
   - Heat Treatment
   - Die Preparation and Maintenance
   - Fettling, Shot blasting, Impregnation

B. SINGLE SESSION PROGRAMMES

1. Costing
2. Cost Reduction – Operating Expenses Reduction.
3. Productivity Improvements
4. Yield Improvements
5. Low Cost Automation
6. Methoding Cylinder Head

Coffee talk

4th November 2020 (Wed)

Speaker
Mr. Deepak Nagar
Management Consultant
Yagna Entrepreneur Success Services LLP.

Subject
Productivity Improvement using Theory of Constraints

Core points presented were:

- Dr. Eliyahu Goldratt in his Novel, The Goal:

1. Every action that does not bring the company closer to its goal is not productive.
2. Productivity is meaningless unless you know what your goal is.

If you are searching for a definitive answer to your continuous improvement quest, then Dr. Goldratt's Theory of Constraints provides the same. Large companies like ...Toyota, General Motors, Mazda to numerous manufacturing, project management and services organisations have benefited immensely by understanding and implementing the silver bullets offered by this Body of Knowledge.

Online Webinars Held for Aluminium Foundries

1. Defect Analysis And Remedial Measures – 22 & 24 July 2020
   Faculty : Mr. V. G. Patil, Consultant (Ex – KOEL)

2. Importance Of Release Agents In Aluminium Die Casting Process - 11th August 2020
   Faculty : Mr. Ashok Konduskar, Technical Manager -India, Middle East & Africa region , AAC Surface Treatment/Cleaners & Lubricants

3. Casting Defects In Aluminium High Pressure Die Casting (Two Sessions). - 19th & 20th August 2020
   Faculty: Mr. Rajesh R Aggarwal, Director, TechSense Engineering Services

4. Machining & Automation Solutions For The Die Casting Industry. - 24th August 2020
   Faculty: Mr. Jagannath V, Business Head, m2nxt Solutions – A BFW subsidiary

5. Practicing Of OEE (Overall Equipment Efficiency) Matrix And Cost Reduction - Operating Expenses Reduction" - 4th September 2020
   Faculty : Aasheem Samadarr, Founder-CEO, EBIT>Management Consultant

6. Panel Discussion for Auto Comp manufacturers, theme was "GO GLOBAL INDIA Demonstrate Competitiveness & Capabilities . - 6th September 2020
   Panelist are:
   - Mr. Hrishikesh Kulkarni, Valeo Group Purchasing Director India, VALEO INDIA PVT. LTD.
   - Mr. Mohan Kadam, General Manager, DANA INDIA PVT. LTD.
   - Mr. Nagaraj P. SONALIKA ,
   - Mr. Shankhadeep Mukherjee, Team Leader, CRU ANALYSIS & CONSULTING (INDIA) PVT. LTD.
   - Mr. R. Pattabhiraman, Tech Expert - Casting & Forgings , Global Core Powertrain STA, FORD MOTOR PVT.LTD.

   Panel Co-ordinator :
   - Mr. Deepak Mahajan, Management consultant, domestic & international business development for auto component manufactures

7. Die Coating Basics, Composition and Application
   12th September 2020
   Faculty: Shrikant Bhat, Head Non-Ferrous Foundry, FOSECO INDIA

8. NEW PRODUCT DEVELOPMENT. - 18th September 2020
   Faculty : Sanket Anil Kulkarni. Director operations, Pooja Castings Pvt Ltd.

9. METHODING OF GRAVITY DIE CASTING COMPONENTS. - 6th & 7th October 2020
   Faculty : U. M Nadgar, Consultant

10. NON DESTRUCTIVE TESTING FOR ALUMINIUM CASTINGS". - 27th October 2020 –
    Faculty : Mr. Sunil Gophan, Chairman Of ISNT Pune Chapter.

11. Panel Discussion
    Theme: Uncertainty in Manpower, Demand, Capacity, Utilisation and Quality Demands " On 1st Nov. 2020
    Panellist :
    - Mr. Umesh Sholapurkar, Sourcing Manager, ATLAS COPCO (INDIA) LTD.
    - Mr. Samir Kukade, President – Human Capital, PRAJ INDUSTRIES LTD.
    - Mr. M. M. Umadi, Executive Director, SIPRA ENGINEERS PVT LTD.
    - Mr. Jitendra Lakhotia, Chief Executive Officer, AAKAR FOUNDRY PVT. LTD.
    - Mr. Kishor Dukare, Vice President (2W Alloy Wheel Division), MINDA INDUSTRIES Ltd.,
    - Mr. Shrirang Tambe, GM, Global Purchasing Office, MTU India Pvt. Ltd.

Panel Co-ordinator :
Mr. Deepak N. Mahajan, DEEPAK MAHAJAN & ASSOCIATES

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