Design and Development of Cooling Pocket for Injection Moulding Die

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***Abstract*: Injection Moulding is one in every of the foremost versatile and vital operation for production of plastic elements. In this method, cooling system style is extremely vital because it mostly determines the cycle time. A good cooling system style will cut back cycle time and come through dimensional stability of the half. This paper describes a replacement sq. divided conformal cooling channel system for injection moulding dies. Both simulation and experimental verification are finished these new cooling channels system. Comparative analysis has been done for an industrial part, a plastic bowel, with conventional cooling channels using the Mold flow simulation software. Experimental verification has been in serious trouble a check plastic give up mini injection moulding machine. Comparative results square measure given supported temperature distribution on mould surface and cooling time or state change time of the plastic half. The results provide a uniform temperature distribution with reduced freezing time and hence reduction in cycle time for the plastic part.**

***Index Terms*: Moulding, rapid heating, cooling mould, cooling pocket, cycle time.**

I. Introduction

Injection moulding is the most important industrial processes in the production of plastic parts. The basic principle of injection moulding consists of heating and injecting the polymer melt in impression created by core and cavity. The main phases in an injection moulding process are filling, cooling and ejection. The cost-efficiency of the process is dependent on the time spent in the moulding cycle. The cooling phase in injection moulding is the most significant step amongst the three, it determines the production rate. The large time of prodction gives more cost. Reducing the cooling time spent on cooling the part before it is ejected increase the production rate, hence reduce costs. Therefore, it is necessary to understand and analyses the heat transfer processes inside a mould efficiently.

II. Necessity of Work

This proposed method has to design and Heating and cooling arrangement, for that component which has been to reduce the manufacturing cycle time. To produce large quantity the compoments of small size are preferred. The selective components require for cooling operations The few operatiloons where been done in CNC and rest operations are carried out in tool dia The proposed method has to be design and fabricated the Heating and cooling arrangement for the complete operations in a single machining center. The Heating and cooling arrangement design has will serve for the economic production for the component.

III. Designing Molding die cooling pocket:

The technology of mold manufacturing for injection of plastic went over from its beginning to present time through considerable development. From basic NC machining, through CNC - possibilities and recently also through the production of shaped 3D parts. Some of these technologies have been used less and gradually subside to innovative production solutions. The volume and complexity of molds results in revolutionary innovations to achieve the necessary manufacturability of shaped cavities corresponding to intensity of plastic components. Thanks to the ever-growing possibilities of machining of the base material and then the final machining by CNC milling, EDM excavating, surface polishing or its profiling it is possible to meet the high demands on the final product. Injection molding is one of the most shape - variable and cost effective production methods. The excellence accuracy is reached by cyclical process in second intervals and in most cases they do not require additional surface treatment. High reproducibility, mechanical and physical features in the weight range of molds with gram to kilogram is unrivalled solution in every sector. The character of mold as a finished product or as a half-finished product for the needs of the assembly into larger units is another advantage.

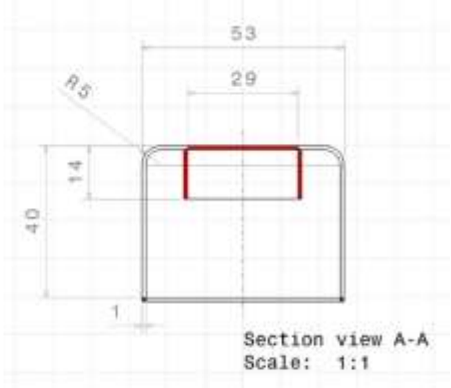

Fig-1

a. Design cooling pocket

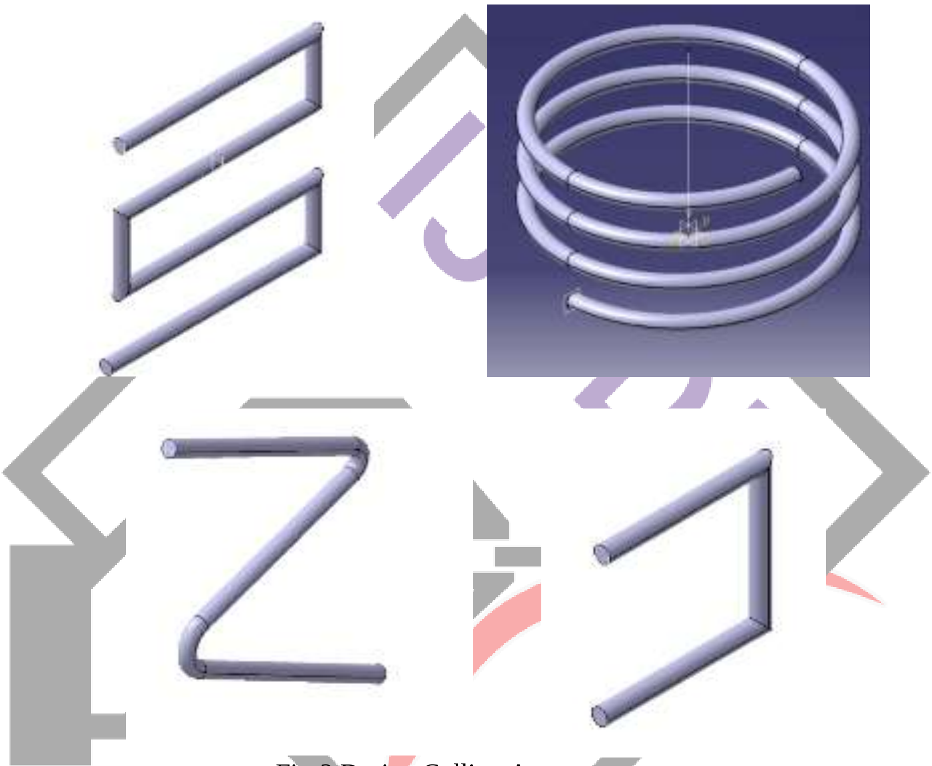

Fig-2 Design Colling Arrangement

b. Thermal-structural analysis

Comparative thermal -structural analysis have been performed with ANSYS workbench simulation software to check temperature distribution in the mould during moulding cycle. Autodesk Mold Flow Insight (AMI) software was used for complete injection moulding filling analysis (cool+flow+pack+warp). For analysis with AMI, 3D mesh has been used with 86758 elements, mould and melt temperature used were 50°C and 250°C respectively, total cycle time was 20 seconds, plastic and mould material were Polypropylene and Staved Supreme stainless tool steel correspondingly. Pure water with temperature 10°C has been used as coolant. Reynolds Number (Re) for coolant flow has been calculated to be 21404 and 16180 for cooling channels inside the core and the cavity respectively.

Temperature of the coolant [°C]	Conduction Heat Transfer H (J) [W/m2. °C	hc = convective heat transfers co-efficient [W/m2. °C]	Convection heat transfer, H [J] [W/m2. °C
210	1429.569	51970.96	1557.57
220	1506.843	51970.96	1641.763
230	1584.12	51970.96	1725.956
240	1625.12	51970.96	1802.56
250	1738.665	51970.96	1894.341

IV. Finite Element Analyses

a. Finite Element Analysis of cavity die mould 01

Cavity of die mould Temp 210 Figure 4.1.1 shows Max. HEAT Flux of

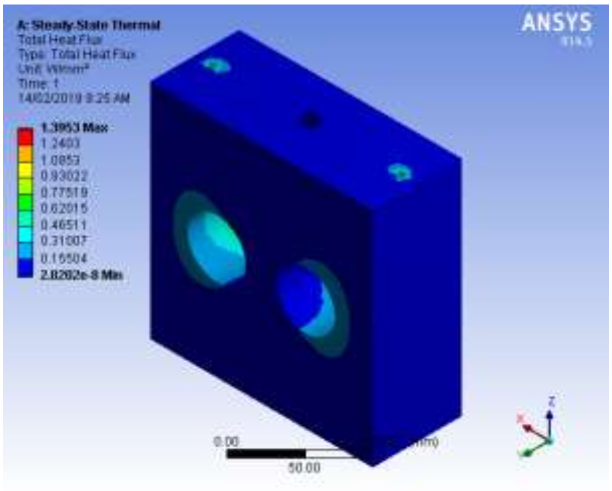

Figure -3: - Max Heat Flux of cavity of die mould

Cavity of die mould Temp 210 Figure 4.1.2 shows Max. Temperature of

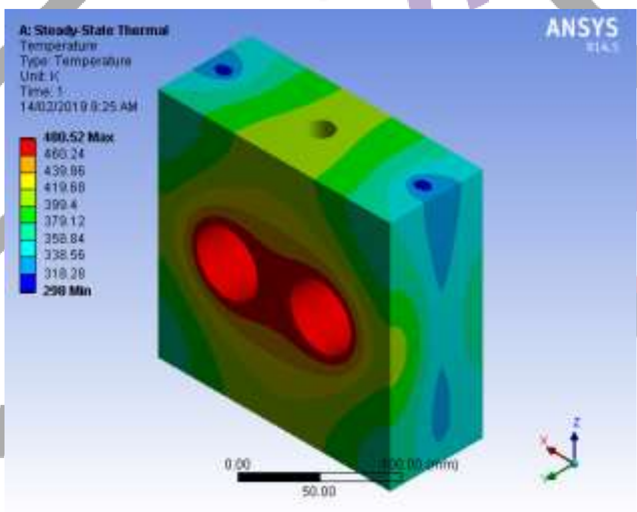

Figure -4: - Max Temperature of Cavity of die mould 01

Temperature	Max.Temperature	Max. Hit Flux
210	480.52	1.3953
220	489.97	1.4676
230	498.98	1.5365
240	509.52	1.617
250	519.68	1.6947

b. Finite Element Analysis of cavity die mould 02

4.2 Cavity of die mould 02 Temp 210 Figure 4.2.1 shows Max. HEAT Flux

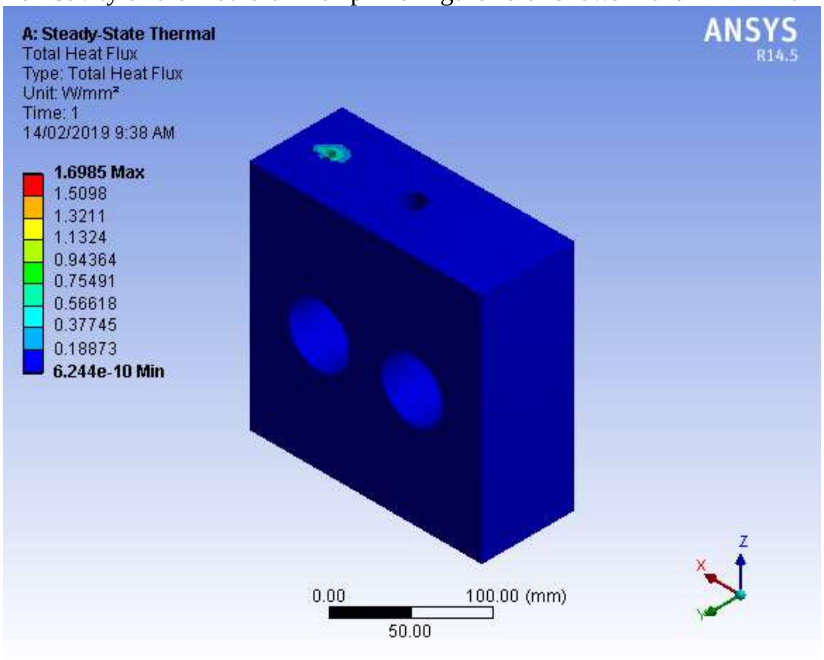

Figure -5: - Max Heat Flux of cavity of die mould

Cavity of die mould 02 Temp 210 Figure 4.2.2 shows Max. Temperature of

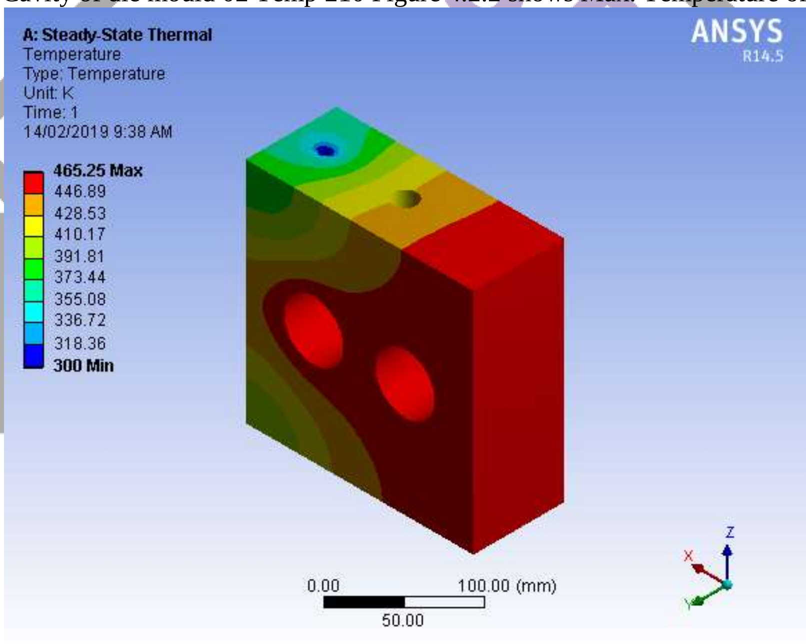

Figure -6: - Max Temp. Of Cavity of die mould 02

Temperature	Max.Temperature	Max. Hit Flux
210	465.25	1.6985
220	478.85	1.8383
230	489.56	1.9484
240	502.63	2.0828
250	512.36	2.1828

c. Finite Element Analysis of core die mould 01

Core of die mould Temp 210 Figure 4.3.1 shows Max. HEAT Flux of the 30mm diameter circular made up with

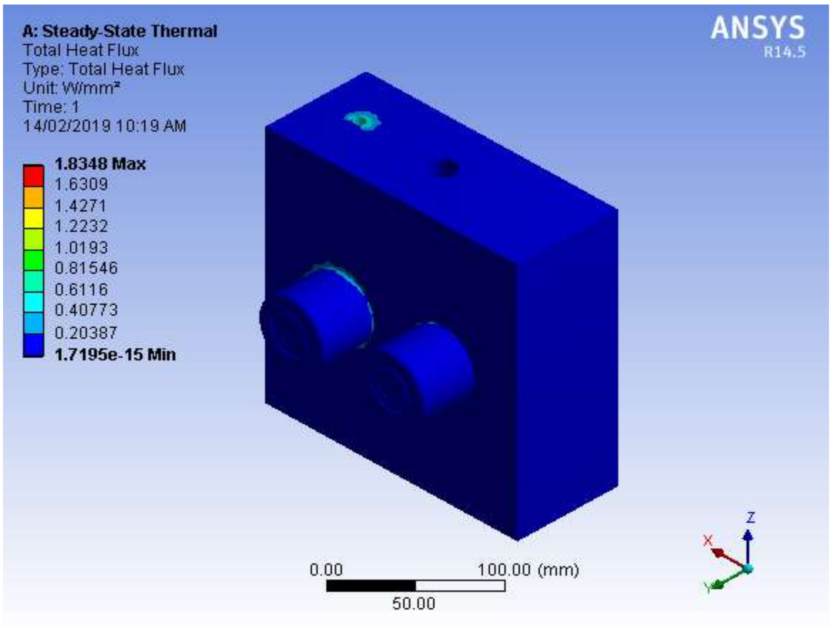

Figure -7: - Max Heat Flux of core of die mould

Core of die mould Temp 210 Figure 4.2.2 shows Max. Temperature of

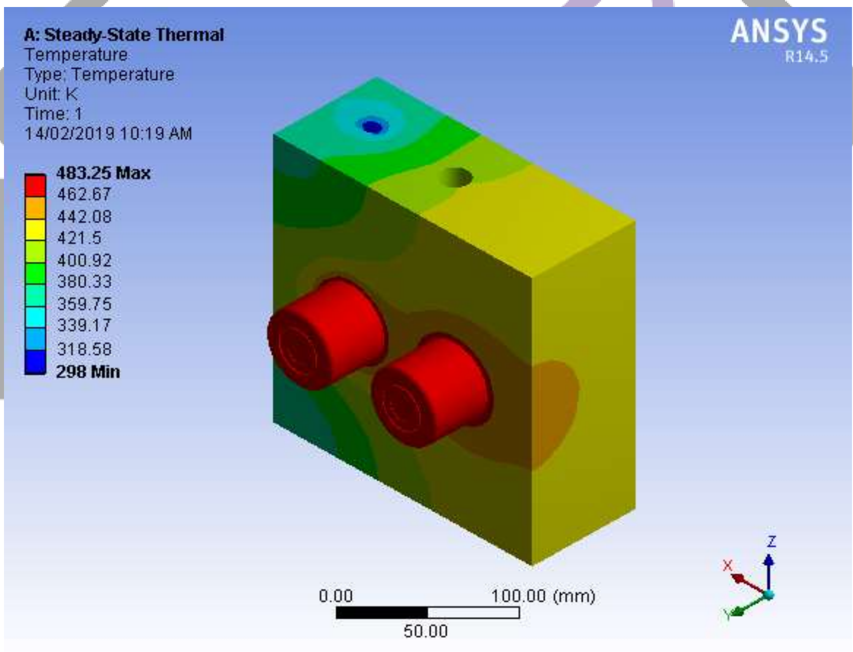

Figure -8: - Max Temperature of Core of die mould 01

Temperature	Max.Temperature	Max. Hit Flux
210	483.25	1.8348
220	491.52	1.9167
230	498.95	1.9484
240	502.63	2.091
250	519.2	2.1909

d. ***Finite Element Analysis of core die mould 02***

Core of die mould Temp 210 Figure 4.4.1 shows Max. Hit Flux of the 30mm diameter circular made up with

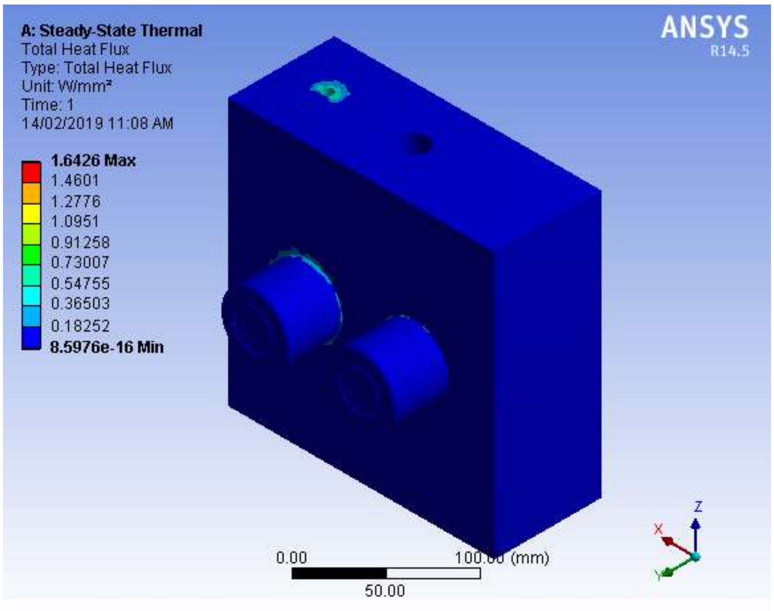

Figure -9: - Max Heat Flux of core of die mould

Core of die mould Temp 210 Figure 4.4.2 shows Max. Temperature of

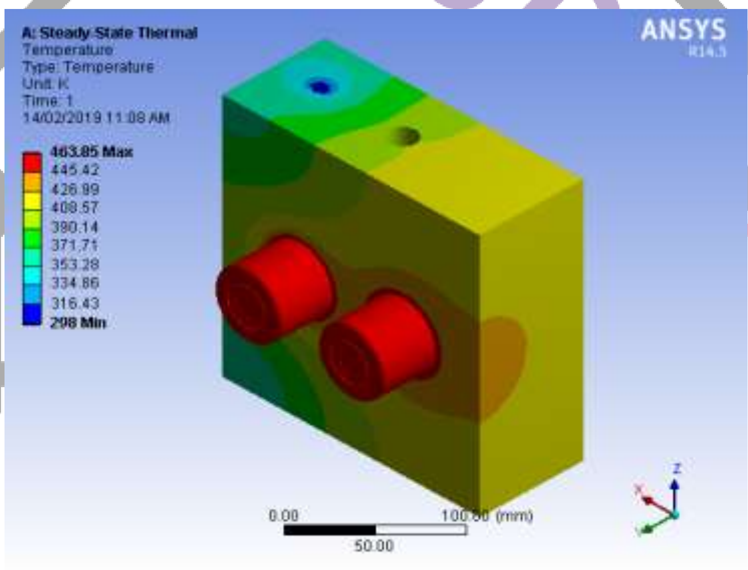

Figure -10: - Max Temp. of Core of die mould 02

Temperature	Max.Temperature	Max. Hit Flux
210	463.85	1.6426
220	478.62	1.7889
230	491.53	1.9168
240	509.5	2.0948
250	516.87	2.1678

V- Simulation Work

a. *Machine Selection*

Fig-11-CNC injection moulding machine

b. Die as per Colling pocket

Fig- 12

c. Sample heating Chart

Cavity mould 01					
Sample	Heater 01	Heater 02	Heater 03	Heater 04	Heater 05
01	110	100	90	70	60
02	115	110	95	75	65
03	120	115	100	80	70
04	125	120	115	85	75
05	130	125	120	90	80

Cavity mould 02					
Sample	Heater 01	Heater 02	Heater 03	Heater 04	Heater 05
01	110	100	90	70	60
02	115	110	95	75	65
03	120	115	100	80	70
04	125	120	115	85	75
05	130	125	120	90	80

Core mould 01					
Sample	Heater 01	Heater 02	Heater 03	Heater 04	Heater 05
01	110	100	90	70	60
02	115	110	95	75	65
03	120	115	100	80	70
04	125	120	115	85	75
05	130	125	120	90	80

Core mould 02					
Sample	Heater 01	Heater 02	Heater 03	Heater 04	Heater 05
01	110	100	90	70	60
02	115	110	95	75	65
03	120	115	100	80	70
04	125	120	115	85	75
05	130	125	120	90	80

VI. Result Analysis

The right heating of material will improve job preparation and lower the risk of dia breakage by minimizing deflection upon contact with the stack.

In order for the heating and cooling material to function properly, it must be flat and free of pits, dents, and scratches. Warped or twisted material will result in increased extents of entry burrs and job not complete fill. Surface imperfections and materials that are too hard contribute to drill deflection, resulting in decreased hole registration accuracy and breakage of small wall thickness job.

Phenolic materials or phenoplast composites (i.e., aluminum-clad phenolic) often warp and under most drilling conditions contaminate the hole wall, which results in problems with adherence of the plating because de smearing chemicals are not designed to remove phenolic resin. Solid metal materials of the right composition ANd hardness that don't seem to be of an excessive thickness, yet are not too thin, may work satisfactorily with larger-diameter drill bits.

However, drilling with solid metal materials (0.008 in and thicker) may increase the risk of breakage of smaller-diameter drills. Aluminum-clad polyose core materials give a tough surface to forestall burrs nevertheless minimize drill deflection and breakage related to solid aluminium

SAMPLE TESTING: -
Testing Name: -Job completion as per DWG
Machine Name: -Manually compeer with DWG

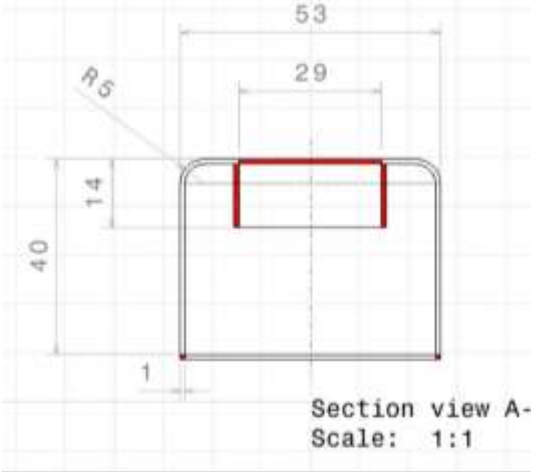

Fig-13 Job completion as per DWG

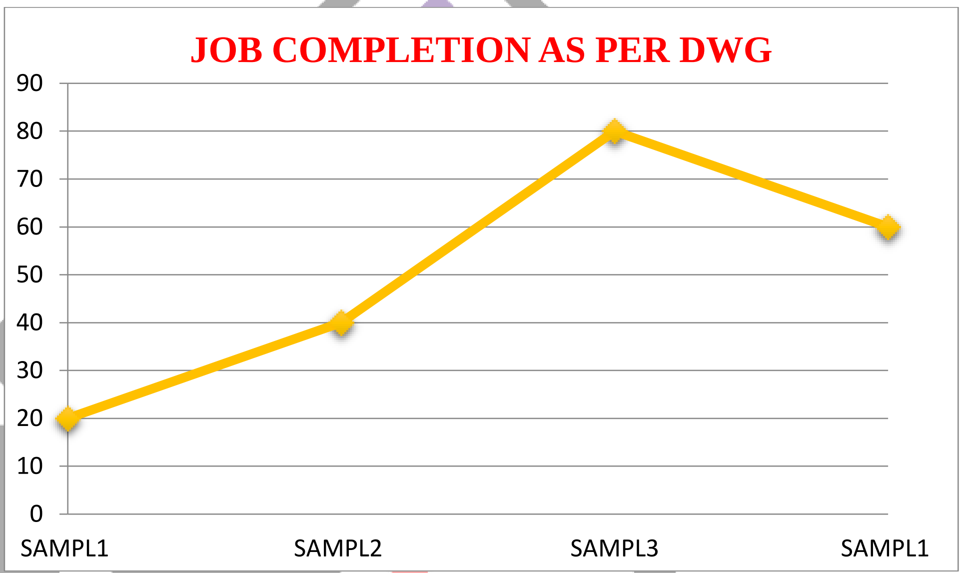

Fig-14- Comparative statement graph

Testing Name: -Shot Weight with respect original
Machine Name: -Weight measuring meter

2) Shot weight measurement by weight measuring meter

Sample no	Required	Actual	Remark
CORE Sample 1 Heating 1 Colling sample 1	9.75	4.40	poor
Core Sample 2 Heating 2 Colling sample 2	9.75	8.67	good
Cavity Sample 1 Heating 1 Colling sample 1	9.75	9.72	best

Cavity Sample 2 Heating 2 Colling sample 2	9.75	8.33	better

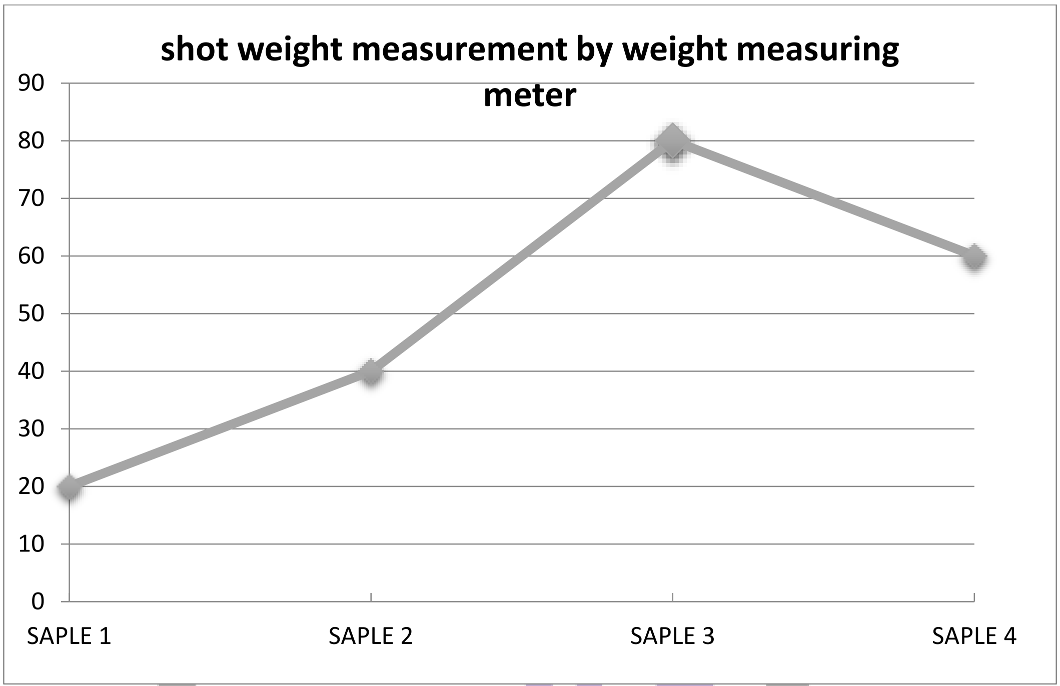

Fig- 15

Testing Name: -weight of runner
Machine Name: - Weight measuring meter

3) Delamination of weight of runner

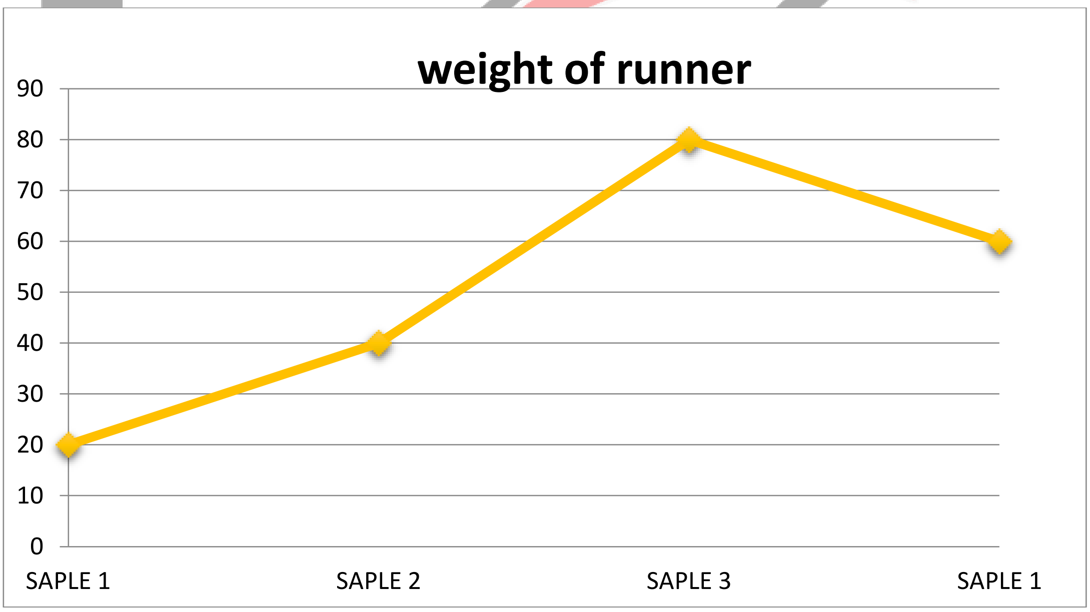

Fig-16

Testing Name: - Machine cycle time
Machine Name: -As experiment taken

Sample no	Required	Actual	Remark
CORE Sample 1 Heating 1 Colling sample 1	2.06	2.89	poor
Core Sample 2 Heating 2 Colling sample 2	2.06	2.10	good
Cavity Sample 1 Heating 1 Colling sample 1	2.06	2.09	best
Cavity Sample 2 Heating 2 Colling sample 2	2.06	1.86	better

VII. Conclusion

From the discussion so far it has been concluded that Trial no 3 men's heater parameter (Table no 3) and cooling in pocket in cavity is better result than sample no 1,2,3. Al will help in reduction in cycle time, runner weight plain surface finishing and better product quality than other heating and cooling pocket design etc. cycle time minimization techniques can be easily implemented in cavity cooling. The overall conclusions from the investigations are:

- Cycle time, product quality with increased cooling pocket
- Shrinkage with reduced cooling time.
- Significant reduction of exit product quality with properly constructed clamping system.

ACKNOWLEDGMENT

I have taken efforts in this project. However, it would not have been possible without the kind support and help of many individuals and organizations. I would like to extend my sincere thanks to all of them. I am highly indebted to Guide Prof Mandhare M for their guidance and constant supervision as well as for providing necessary information regarding the project & also for their support in completing the project. My thanks and appreciations also go to my colleague in developing the project and peope who have willingly helped me out with their abilities.

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