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CONCEPTUAL DESIGN OF PATTERN TO REPLACE INVESTMENT CASTING

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Abstract**: Our this project is based on the alternative solution of the precision investment casting process , which is very slow in production process and vary costly process due to large manual labour and loss of wax during the casting process. The demerits of precision investment casting develop the need of development of new method of casting which can replace precision casting and remove its demerits. In our project we have proposed a new conceptual design of pattern of casting which the loose-piece and piece- wise pattern manufacturing process to replace precision investment casting process. There is an object that has prepared using the loose-piece pattern process with all the allowances which is provided during producing a pattern and compared with the precision investment casting process. The investment casting process have the limitation of the size and mass of the casting. On the other hand our proposed method of pattern loose-piece pattern require a low cost and also a less time consuming process as compared to the precision investment casting process. The new conceptual pattern loose piece pattern process does not produce a high grade surface finish product as compared to the precision investment casting process which produces a higher grade surface finish. But because of technological development, high quality grinding and finishing operation machines are available which can provide better surface finish. So the new conceptual method of producing casting can produce high quality surface finish of final product, large and heavy product with less cost and high speed.

KEYWORDS: Investment Casting, Shrinkage Allowance, Draft Allowance, Machining Allowance

I. INTRODUCTION

Pouring molten metal into hollow cavities of desired shape and then allowing it to solidify, so it is a manufacturing process that can be traced back thousands of years. The product from traditional method is usually rough product with simpler design with increased complexity of the designs,

the lost wax process was introduced to handle casting of complex shapes. The lost wax process, also called **investment casting process** that employ a wax mould around which the ceramic shell is built. The wax is removed by burning the ceramic mould to get a net shape cavity inside ceramic mould. The molten metal in then poured into cavity to get complex shapes and designs [1]. The investment casting process has been an important method to produce components for aero-industry since 50's. It offers excellent tolerances and surface finish with freedom of design for complex geometries. A portion of the vital properties are recorded beneath. Fluidity play main roll in foundry and casting process. So here is some property of fluid that affect fluidity. Like (a) Temperature (b) Solidification Mode (c) Viscosity of Material (d) Composition (e) Thermal Conductivity (f) Heat Of Fusion (g) Surface Tension

Investment Casting: It is one of oldest technique of metal forming. Wander throwing is a collecting technique in which a wax configuration is secured with a resolute stoneware material. Once the let go material is cemented its inward geometry takes the condition of the throwing. The wax is condensed out and fluid metal is filled the gap where the wax configuration was. The metal sets inside the terminated shape and after that the metal tossing is broken out. This amassing method is generally called the lost wax process. Wander throwing was delivered more than 5500 years prior and can follow its foundations back to both antiquated Egypt and China [4]. Parts manufactured in industry by this process include dental fixtures, gears, cams, ratchets, turbine blades, machinery components and other parts of complex geometry.

II. MATERIAL AND METHODS

Procedure for pattern development:

The objective is to think about the diverse kind of the throwing technique and give an answer or option of the speculation throwing process. As there is parcel of cost include in the venture throwing process so exchange is free piece

design. In this theory our goal is to examine the free piece design as arrangement or exchange of the venture throwing process.

The first step in this procedure will be gather the measurement of the item as item here is a wellbeing valve. Valves pouring experience a similar procedure of throwing , There is two alternatives of discovering measurement of the item either by estimating the measurement by utilizing distinctive instrument like scale , Vernier calipers and so on either by detail given by an organization.

Then model the product in the software. We may use any 3D modeling software for model this product in digital form. Here we will use AutoCAD software to model both geometry and pattern. As shown in figure below

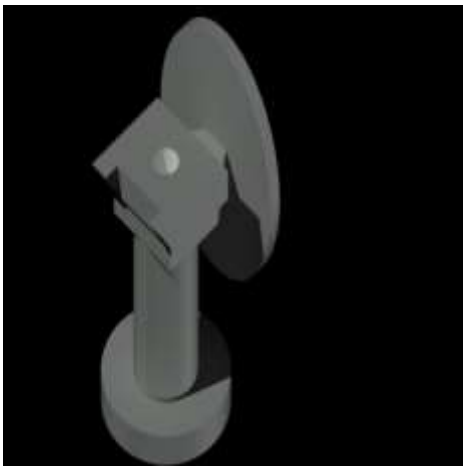

***Fig.1 Sample of safety* valve** **Fig.2 3D view of the product in AutoCAD software**

Then here we have to calculated allowance like shrinkage, draft and machine allowance .Then there is to generate the dimension of the pattern of the product. Then have to model in the software. For instance, when a copper compound valve and spigot valve is looked at, both made of a copper combination as its material, the valve key and washing forms require electroplating, Also, when a valve copper alloy / cast iron valve compared to a steel valve cast / stainless steel valve, valve cast steel / stainless steel valve requires hard material cutting oil in the process of machining and also requires a process for cleaning the cutting oil.

Modeling of Geometry: First work is to get measurement of the last item required as wellbeing valve is utilized here for our proposition reason. As given above two alternative of discovering measurement of the item either by estimating the measurement by utilizing distinctive instrument like scale, verniercalipers and so on either by particular given by organization on list. In any case, because of inaccessibility of information from organization, here we measure the measurement from the item with verniercalipers. Noticed that parameter.

Then model the item in the product. We may utilize any 3D demonstrating programming for display this item in advanced frame. Here we have utilize Auto CAD programming to display both geometry and example. The figure 6, demonstrates the measurement in mm of item in various perspectives front view, top view and side view. Figure 5 and it shows 3D perspective of the result of the item modelled in the AutoCAD.

For further calculation of the pattern, we divide the product in 5 part. For loose piece pattern, there are also requirement of divide the component in number of component which can be modelled single and can be combine with pin joint so that easily join and disassemble of different part. This selection should be done carefully otherwise may be result in error.

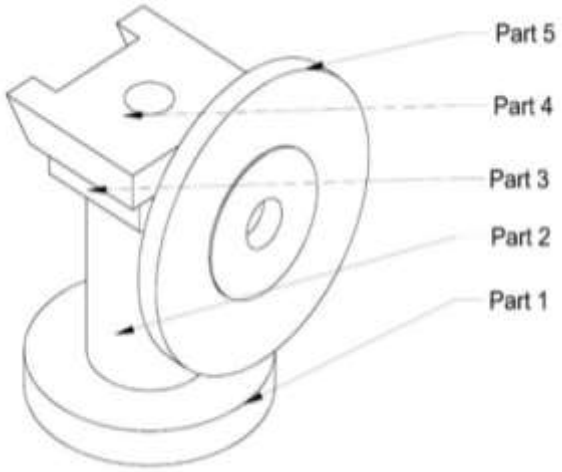

Fig.3 Part of Product with their number

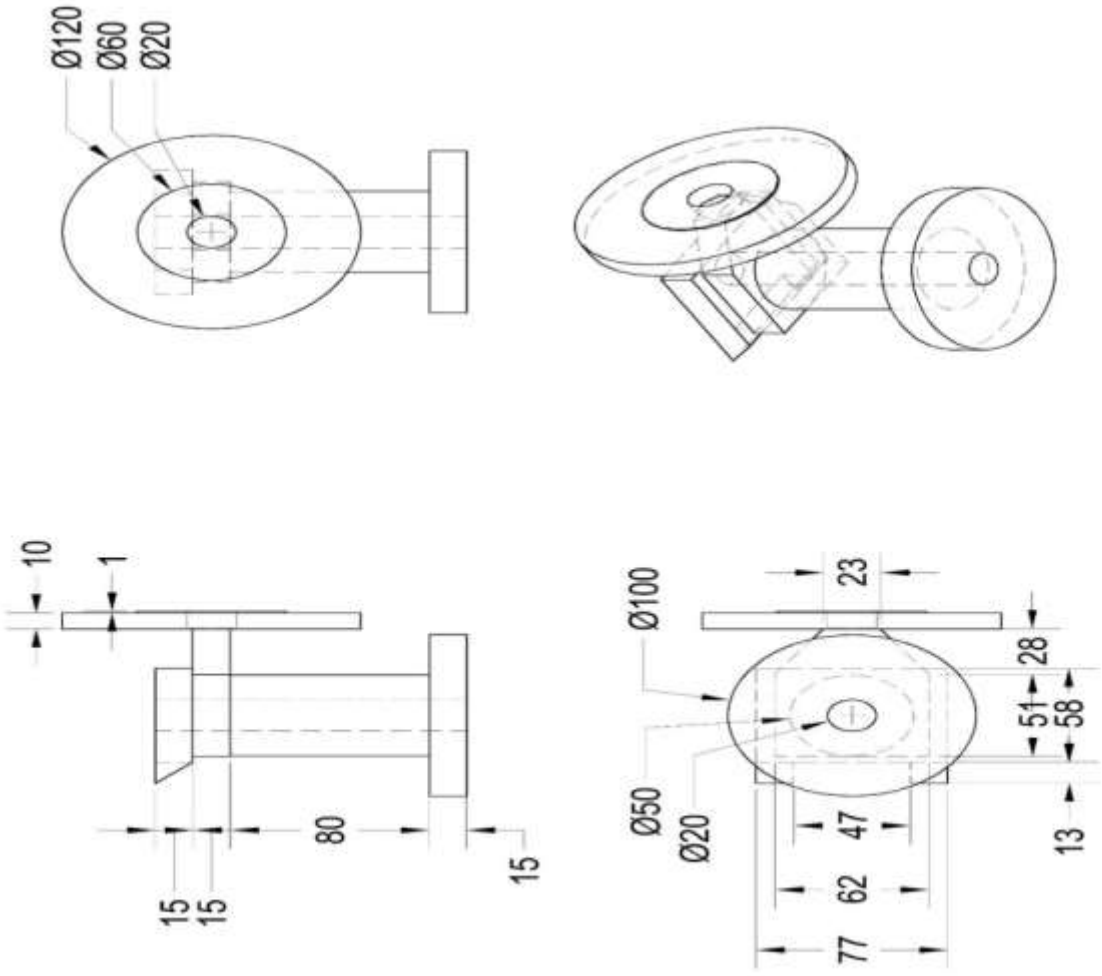

Fig. 4: Drafting drawing of safety valve with dimension on different views (all are in mm)

Pattern Allowances:

A pattern is always made larger than the required size of the casting considering the various allowances. These are the allowances which are usually provided in a pattern. So the actual dimension of the pattern is going to be changed accordingly.

Size of the pattern = size of actual product+ allowances (mainly shrinkage, machining and draft allowances)

(a) Standard Table for Shrinkage or Contraction Allowance for different metal:

Material	Al	Brass	Bronze	Cast iron	Cast steel	copper	gunmetal	Lead	Magnesium
Shrinkage Allowance (mm/mm)	0.13	0.0155	0.0155-0.022	0.0104	0.208	0.016	0.01-0.016	0.26	0.013

Table No.1: Standard Table of Shrinkage allowance for different material

Pattern Material	Draft, angle(degree)	
	Outer	Inner
Wood	0.25-3.00	0.50-3.00
Metal	0.35-1.50	0.50-3.00
Plastic	0.25-1.00	0.35-2.25

Table No.2 Standard Table of Draft allowance for different material

Largest dimension mm		Required machining allowance mm RMA required on all cope casting surfaces Note: A minimum of 6 mm					
		Required machining allowance grade					
Over	Up to and including	E	F	G	H	J	K
		0.4	0.5	0.5	0.7	1	1.4
40	63	0.4	0.5	0.7	1	1.4	2
63	100	0.7	1	1.4	2	2.8	4
100	160	1.1	1.5	2.2	3	4	6
160	250	1.4	2	2.8	4	5.5	8
250	400	1.8	2.5	3.5	5	7	10

400	630	2.2	3	4	6	9	12
630	1000	2.5	3.5	5	7	10	14
1000	1600	2.8	4	5.5	8	11	16
1600	2500	3.2	4.5	6	9	13	18
2500	4000	3.5	5	7	10	14	20

Table No.3 Standard table for machining allowance

DESIGN AND DIMENSIONING OF THE PATTERN

Though the material of the valve is mild steel, and the pattern material is wood so we have to change the dimension of the pattern according to the values given in the above table.

Shrinkage allowance is 0.0208 mm/mm of length.

Draft allowance is taken as 1.5 degree for outer.

III. Calculation of allowances

Part 1

Product Diameter= 100 mm, Shrinkage Allowance = 0.0208 x 100 = **2.08** mm **,**
Machining Allowance = 2.7mm
Total Allowance = Shrinkage Allowance + Machining Allowance = 2.08 + 2.7= **4.78** mm
Dimension of pattern = Product Diameter + Total allowance = 100 + 4.78= 104.78 ≈ **105 mm**
Product height = 15 mm , Shrinkage Allowance= 0.0208 x15= **0.312** mm **,**
Machining Allowance = 0.95 mm
Total allowance = Shrinkage Allowance + Machining Allowance
= 0.312 + 0.95**= 1.262 mm**
Dimension of pattern = Product Height + Total allowance
= 15 + 1.262 = **16.263** ≈ **17 mm**

Above "As I have calculate the dimension of first part with the help of standard value of allowances for different material that are given in standard table, Similarly , I have calculate all the dimension of remaining four parts of the final product . After calculation of the all product dimension, I have made a table in which all proposed dimension are given ."

Proposed Pattern Dimension: The summary of the proposed pattern dimension are as follows:

PART 1				
Actual Dimension	**Shrinkage allowance**	**Machining Allowance**	**Calculated Pattern Dimension**	**Proposed Pattern Dimension**
100 mm	2.08 mm	2.7 mm	104.78 mm	105 mm
15 mm	0.312 mm	0.95 mm	16.262 mm	17 mm

Table No.4 Proposed dimension for part one

Part 2				
Actual Dimension	**Shrinkage allowance**	**Machining Allowance**	**Calculated Pattern Dimension**	**Proposed Pattern Dimension**
50 mm	1.04 mm	1.35 mm	52.39 mm	53 mm
80 mm	1.664 mm	2.7 mm	84.364 mm	85 mm

Table No.5 proposed dimension for part 2

Part 3				
Actual Dimension	**Shrinkage allowance**	**Machining Allowance**	**Calculated Pattern Dimension**	**Proposed Pattern Dimension**
51 mm	1.0608 mm	1.35 mm	53.4108 mm	54 mm
62 mm	1.2896 mm	1.35 mm	64.6396 mm	65 mm
28 mm	0.5824 mm	0.95 mm	29.5324 mm	30 mm
23 mm	0.4784 mm	0.95 mm	24.4284 mm	25 mm
15 mm	0.312 mm	0.35 mm	16.262 mm	17 mm

Table No. 5 Proposed dimension for part 3

Part4				
Actual Dimension	**Shrinkage allowance**	**Machining Allowance**	**Calculated Pattern Dimension**	**Proposed Pattern Dimension**
77 mm	1.6016 mm	2.7 mm	81.3016 mm	82 mm
58 mm	1.2064 mm	1.35 mm	60.5564 mm	61 mm
13 mm	0.2704 mm	0.95 mm	14.2204 mm	15 mm
15 mm	0.312 mm	1.262 mm	16.262 mm	17 mm

Table No.6 Proposed Dimension for part 4

Part 5				
Actual Dimension	**Shrinkage allowance**	**Machining Allowance**	**Calculated Pattern Dimension**	**Proposed Pattern Dimension**
120 mm	2.496 mm	4.1 mm	126.596 mm	127 mm
11 mm	0.2288 mm	0.95 mm	12.1788 mm	13 mm

Table No.7 Proposed Dimension for part 5

Modeling of Proposed Pattern: Modeling of proposed pattern are done in AutoCAD. The fig 4.6 shows the dimension of the model of proposed Pattern in different views like front view, top view and side view.

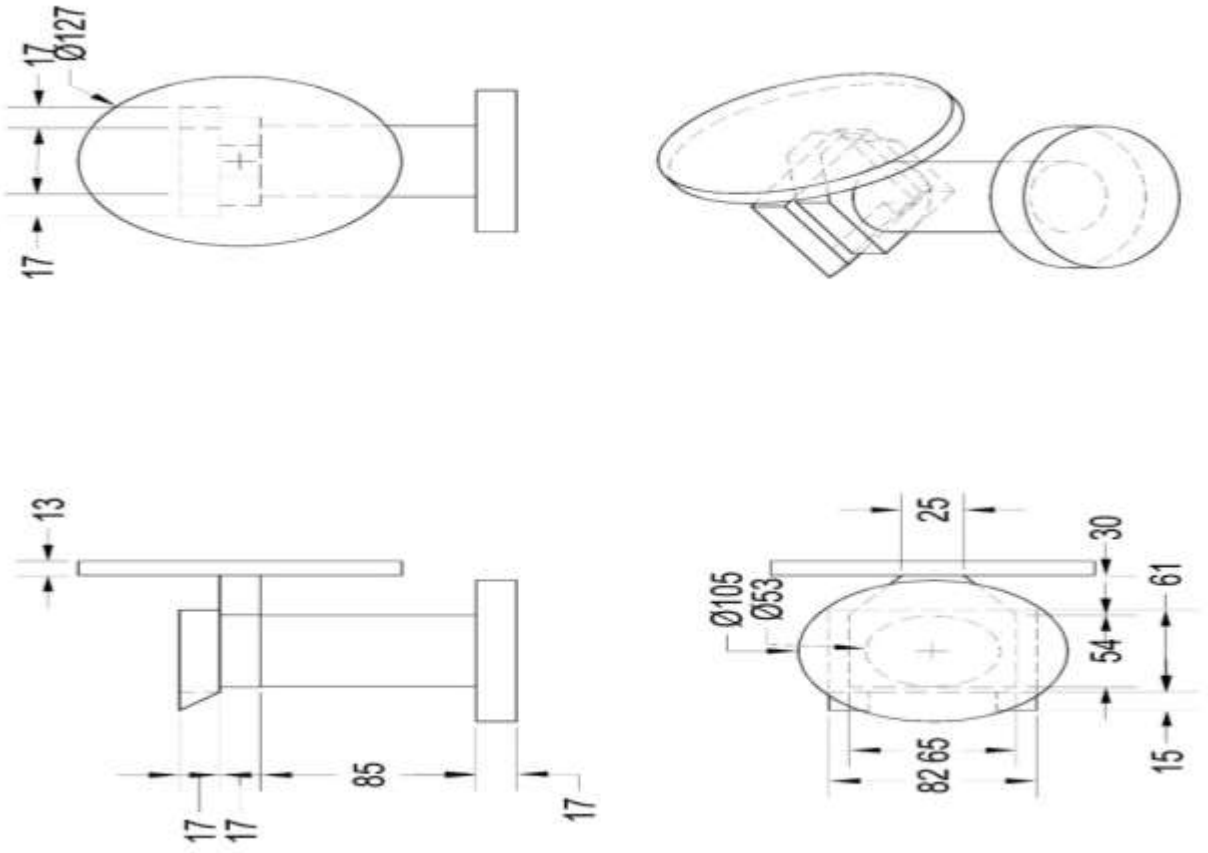

Fig.5 Drafting Drawing of proposed pattern of safety valve with dimension on different views (all dimensions are in mm)

IV. Conclusion

First the main body part of the pattern was fabricated followed by two wedge shaped loose pieces. These loose pieces were attached loosely to main body part of the pattern. A mould box was prepared and the pattern was used to make a cavity of the shape of the final product valve. It has been observed that removal of the pattern from the mould did not create any problem. The main part of the pattern was taken out of the mould first followed by two loose pieces using a pin. It has also been observed that the pattern removal did not affect the sand boundary and the mould intact. So we can now implement the idea of manufacturing of the safety valve using casting with a split pattern consisting of two loose pieces rather than using the process of forging which is more costly than casting and requires more manpower and skilled labours as well. In addition to this, forging method for the manufacturing of safety valve is limited to small sized valves only wherea by the use of casting

method , we can produce safety valves of large size which is impossible in case of forging. Again casting method was found more economical than forging. So finally, we can conclude here that instead of using forging method for the manufacturing of valves, we can now switch on to casting method with split pattern with number of loose pieces. During my project work, I have successfully completed the design and modeling of the pattern with loose pieces for safety valve and analyzed the total process of casting and found no error or problem.

REFERENCES :

"Production technology", HMT publication.

1. "Elements of workshop technology", S K Hajra Choudhury, S K Bose, A K Hajrachoudhury, Niranjan Roy.
2. Production technology by P.C. Sharma' S. Chand publication
3. Dai et al., 2011, H.J. Dai, H.B. Dong, N. D'Souza, J.C. Gebelin, R.C. Reed, Grain selection in spiral selectors during investment casting of single-crystal components: Part II. Numerical modeling,
4. Panwisawas et al., 2013a, C. Panwisawas, J.C. Gebelin, R.C. Reed, Analysis of the mechanical deformation arising from investment casting .
5. Panwisawas et al., 2013b, C. Panwisawas, H. Mathur, J. Gebelin, D. Putman, C.M.F. Rae, R.C. Reed, Prediction of recrystallization in investment cast single-crystal superalloys, Acta Mater., 61 (1) (2013), pp. 51-66
6. Wereszczak AA, Breder K, Ferber MK, Kirkland TP, Payzant EA, Rawn CJ, Krug E, Larocco CL, Pietras RA, Karakus M (2002) Dimensional changes and creep of silica core ceramics used in investment casting of superalloys. J Mater Sci 37(19):4235–4245
7. Degarmo, E. Paul; Black, J. T.; Kohser, Ronald A. (2003), Materials and Processes in Manufacturing (9th ed.), Wiley, ISBN 0-471-65653-4
8. Kalpakjian, Serope; Schmid, Steven (2006), Manufacturing Engineering and Technology (5th ed.), Pearson.
9. Todd, Robert H.; Allen, Dell K.; Alting, Leo, Manufacturing Processes Reference Guide, Industrial Press Inc.
10. Pryor, W.J. Injection Molding of Plastics for Dentures. J. A. D. A. 1942;29:1400–1408.
11. Grunewald, A.H., Paffenbarger, G.C., Dickson, G. The Effect of Molding Processes on Some Properties of Dentures
12. Woelfel, J.B., Paffenbarger, G.C., Sweeney, W.T. Dimensional Changes Occurring in Dentures During Processing. J. A. D. A. 1960;61:413–430.
13. Marcroft, K.R., Tencate, R.L., Hurst, Use of a Layered Silicone Rubber Mold Technique for Denture Processing.
14. B. Thomas, 2001 Modeling of the Continuous Casting of Steel- Past, Present and Future Electric Furnace Conf.
15. P. Riboud, Y. Roux, L. Lucas, H. Gaye, 1981 Improvement of Continuous Casting Powders Fabricate.
16. M. Hanao, M. Kawamoto, 2008 Flux Film in the Mould of High Speed Continuous Casting ISIJ Int. 48 180 185
17. H. Nakada, M. Susa, Y. Seko, , K. Nagata, Mechanism of Crystallization of Mould Flux for Continuous Casting .
18. E. Wei, Y. Yang, C. Feng, I. Sommerville, A. McLean, 2006 Effect of Carbon Properties on Melting Behaviour.