COMBINED LOOSE PIECE PATTERN FOR A COMPLEX JOB

A thesis submitted in partial fulfillment of the requirements for the degree of

Bachelor of technology (B.Tech)

In

Mechanical engineering

By

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C E R T I F I C A T E

This is to certify that the work in this thesis entitled "Combined loose piece pattern for a complex job" by ***Subrat Mishra***, has been carried out under my supervision in partial fulfillment of the requirements for the degree of *Bachelor of Technology in Mechanical Engineering* during session 2013-2014 in the *Department of Mechanical Engineering, National Institute of Technology, Rourkela*.

To the best of my knowledge, this work has not been submitted to any other University/Institute for the award of any degree or diploma.

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ABSTRACT

Casting is one of the earliest metal-shaping methods known to human being. It generally means pouring molten metal into a refractory mould with a cavity of the shape to be made, and allowing it to solidify. When solidified , the desired metal object is taken out from the refractory mould either by breaking the mould or by taking mould apart. This process is also called founding.

A pattern is a replica of the object to be made by the casting process, with some modifications. The main modifications are addition of pattern allowances like shrinkage allowance, machining allowance, draft allowance etc. , the provision of core prints and elimination of fine details.

Loose piece pattern is used when the contour of the part is such that withdrawing the pattern from the mould is not possible. Hence during moulding, the obstructing part of the contour is held as a loos piece by a wire. After moulding is over, first the main pattern is removed and then the loose pieces are recovered through the gap generated by the main pattern.

A safety valve which is generally manufactured by complex forging method , can be easily manufactured by sand casting method which is more economical the forging method. In the sand casting method, the two wedge shaped portions of the safety valve create problem during removal of pattern, so these two portions are taken as loose pieces and held as loose pieces by a wire or pin. Once the main pattern body is removed, these loose pieces are recovered through the space vacated by main pattern body. So this project work deals with manufacturing of safety valve using sand casting with split pattern which consists of multi loose pieces (combined loose piece).

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1. INTRODUCTION

In metallurgy, casting is to pour molten metal into a mold , which contains a hollow cavity of the desired shape , and then allowing it to cool and solidify. The solidified part is also known as a casting , which is ejected or broken out of the mold to complete the process . Casting is most often used for making complex shapes that would be difficult or uneconomical to make by other methods. Casting processes have been known for thousands of years , and widely used for sculpture , especially in bronze, precious metal jewelry , and weapons and tools. Traditional techniques include lost wax casting , plaster mold casting and sand casting . The modern foundry process is divided into two main categories: expendable cast and expendable . Is divided by the mold material , such as sand or metal , and the method of deposition , such as gravity, low pressure or vacuum .

1.1 .Different type of Castings and its process

Today Castings is used to create the desired and solid shape. Foundry industries to help them grow. There are different types of castings and lost wax process and die casting, sand casting. Castings are the type of manufacturing process.

Lost wax Castings

This is the oldest metal forming or casting process. Lost Wax Casting is used for the manufacture of large parts such as the wheels of the turbocharger, golf clubs, choosing a variety of pieces ranging from turbocharger wheels golf clubs, electronic implants replacement boxes hip. Lost wax casting racks used for investment. Today investment racks are used for aircraft engine and airframe parts. Castings lost wax is similar to Lost Foam Casting patterns that are uses disposable foam casting productions. Foam pattern remains in the mold during casting of metal and is replaced by molten metal.

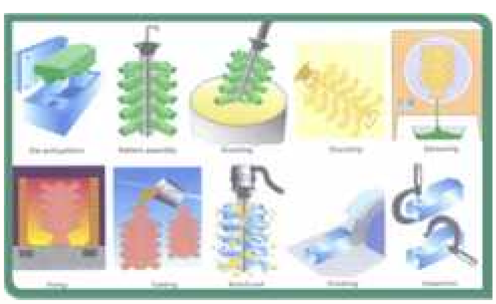

Fig 1.1.1(lost wax casting)

Die Casting

Die casting is one of the casting processes not expandable. Its a type of process in which the molten metal is forced under high pressure into the mold cavities. In the casting mold die is used again and again to produce a variety of casting size, shape and thickness. The pieces, which are manufacture by casting are the heat resistance and maintain tight tolerances. Casting produces parts with thinner walls, closer dimensional limits and smoother surfaces.

Fig 1.1.2(die casting)

SandCasting

Sand casting is used to make large parts. The sand used for sand casting mold. In the sand of the mold cavity is formed from wood or metal pattern. Using the sand casting method, you can convert large iron bell, and alos small auto parts. In sand casting, two types of green sand used as the sand, which is a mixture of silica and olivine foundry sand.Sand used for high volume production.

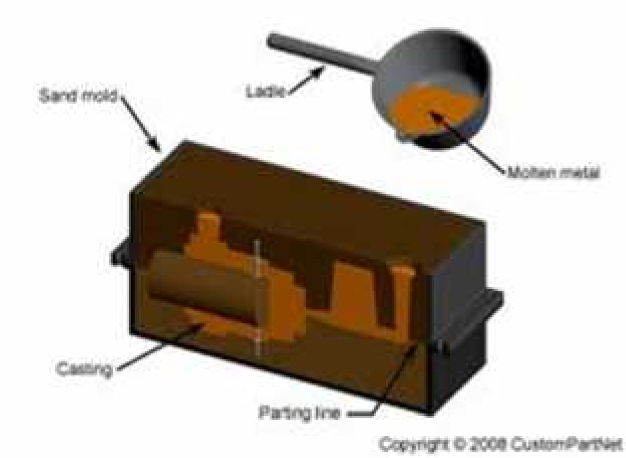

Fig 1.1.3(sand casting)

1.2. SAND CASTING IN DETAILS

Sand casting, the casting process more widely used, using expendable sand molds to form complex metal parts that can be made from almost any alloy. Because the sand mold must be destroyed in order to remove the part, called the casting, sand casting typically has a low production rate. The sand casting process involves the use of an oven, metal pattern, and the sand mold. The metal is melted in the furnace and then strained and poured into the cavity of the sand mold, which is formed by the pattern. The sand mold separates along a parting line and the solidified casting can be removed. The cycle of the sand casting process consists of six main steps, which are explained below.

1.Mold-making - The first step in the process of sand casting is to create the mold for casting . In an expendable mold process , this step must be performed for each pour . A sand mold is formed by packing sand in each mold half. The sand is packed around the pattern , which is a replica of the external shape of the casting. When the pattern , the cavity to form the casting remains removed. Any internal features of the cast part that can not be formed by the pattern are formed by separate cores which are made of sand prior to the formation of mold . More details about the manufacture of molds are described in the next section. Weather moldmaking includes positioning the pattern , packing the sand, and the removal of the pattern . The mold manufacturing time is affected by the size , the number of cores, and the type of sand mold. If the type of mold requires heating or cooking time, the production time increases substantially mold . Furthermore , lubrication is often applied to the surfaces of the mold cavity in order to facilitate the extraction of the casting . The use of a lubricant which also improves the flow of the metal and can improve the surface finish of the casting . The lubricant used is selected based on the temperature of the sand and the cast metal

.2.Clamping - Once the mold is made, be prepared for the molten metal is poured. The surface of the first mold cavity is lubricated to facilitate removal of the casting. Then, the cores are positioned and the mold halves are closed and clamped together. It is essential that the mold halves remain tightly sealed to prevent any loss of material.

3. Pouring - The molten metal is maintained at a set temperature in an oven. After the mold has been clamped, the molten metal can be slipped from the holding vessel into the furnace and poured into the mold. The discharge can be manually or performed by an automatic machine. Sufficient molten metal to be poured to fill the cavity and all channels in the mold. The filling time is very short in order to avoid early solidification of any portion of the metal.

4. Cooling - The molten metal is poured into the mold start to cool and solidify after it enters the cavity. When the entire cavity is filled and molten metal is solidified, the final shape of the casting is formed. The template can not be opened until the cooling time has elapsed. The desired cooling time may be estimated based on the wall thickness of the casting and the temperature of the metal. Most defects that can occur are the result of the solidification process. If some of the molten metal is cooled too fast, the part can exhibit shrinkage, cracks or incomplete sections. Preventive measures can be taken in the design of both the part and the mold and will be discussed in later sections.

5. Removal - Once the predetermined solidification time elapsed, the sand mold can simply be broken, and the casting removed. This step, sometimes called tremor is typically performed by a vibrating machine that shakes the sand and casting out of the flask. Once removed, the casting will probably have some layers of sand and attached to the surface oxide. Blasting is sometimes used to remove the remaining sand, particularly of the internal surfaces and reduce the surface roughness.

6. Trimming - During cooling, the material solidifies in the mold channel attached to the part. This excess material must be cut or wash manually piece by cutting or sawing, or using a press clipping. The time required to trim excess material can be calculated based on the size of the casting. A larger smelter will require a slightly longer time. Waste material resulting from this cut is discarded or reused in the process of sand casting. However, it is possible that the waste material to be reconditioned at the correct chemical composition before it can be combined with non-metal recycled and reused.

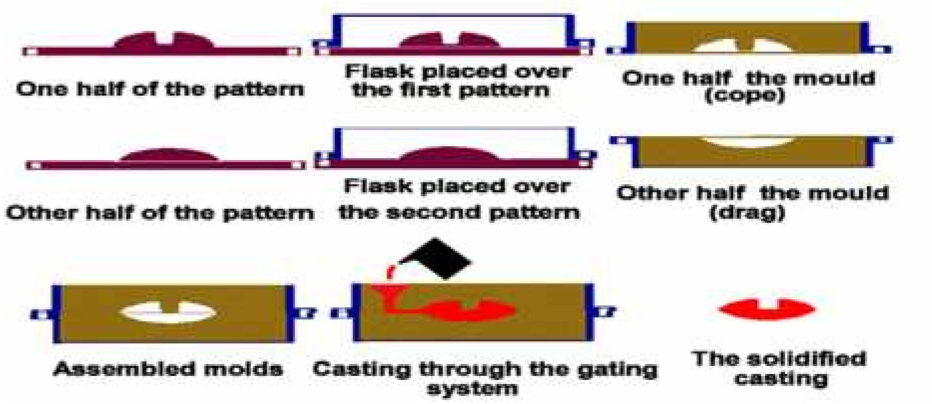

Fig 1.2.1(Sand casting process)

1.3. PATTERN USED IN SAND CASTING AND ITS TYPES

The cavity in the sand is formed by using a pattern (an approximate duplicate real part) , which are typically made of wood , sometimes metal . The cavity is contained in an aggregate housed in a box called the flask. Core is a form of sand inserted into the mold to produce the internal features of the part such as holes or internal passages . The cores are placed in the cavity to form holes of desired shapes. Core print is the region added to the pattern , core, or mold that is used to locate and support the core within the mold. An additional lift is created in a vacuum mold to contain the excessive molten material. The purpose of this is to feed the molten mold cavity as the molten metal is solidified metal and contracts, and therefore prevents the holes in the part of main casting . In a two-part mold , which is typical of molding sand , the upper half , including the upper half of the pattern , flask, and the core is called cope and the lower half is called drag . The line of separation or separation surface area is line or separating the front and drag . The drag is first filled partially with sand , and printing nucleus , nuclei , and gating system are placed near the parting line . The front is assembled on the resistance , and the sand is poured in the middle front , covering the pattern , the core and the filling system . The sand is compacted by vibration and mechanical means. Then removed the front of the avenue, and the pattern is removed carefully. The object is to remove the pattern without breaking the mold cavity. This is facilitated by the design of a project, a slight shift from vertical to vertical surfaces of the angular pattern. This is usually at least 1 or 1.5 mm (0.060 in) , whichever is greater . The rougher the surface of the pattern , plus the project to be provided.

The following factors affect the choice of a pattern.

(i) Number of Castings to be produced.

(ii) Size and complexity of the shape and size of casting

(iii) Type of molding and castings method to be used.

(iv) Machining operation

(v) Characteristics of castings

Different types of patterns:

The common types of patterns are:

1) Single piece pattern
2) Split piece pattern
3) Loose piece pattern
4) Gated pattern
5) Match pattern
6) Sweep pattern
7) Cope and drag pattern
8) Skeleton pattern
9) Shell pattern
10) Follow board pattern

1.4. DESCRIPTION ABOUT VARIOUS TYPES OF PATTERNS

(i) Solid or single piece pattern: These patterns are made in one piece and are suitable only for very simple castings. There is no provision for runners and risers etc Moulding do either on the floor of the foundry (molding called pit) or a flask. There is no difficulty in removing the pattern from the mold as the widest portion of the pattern is at the top. As an example, if a cylindrical pin with a ball head has to be melted, a pattern of a single piece below will be adequate.

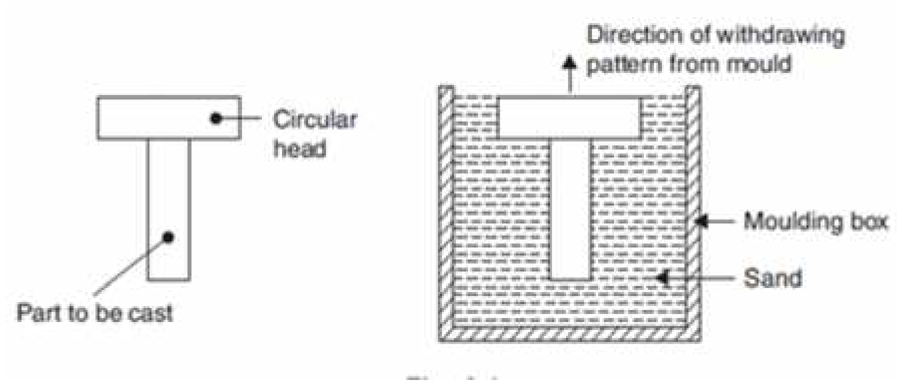

Fig 1.4.1(Singel piece pattern)

(ii) Split pattern: It is not practical to have a pattern piece pieces of complicated forms, it would not be possible to remove the pattern from the mold. For example, if a circular bottom of the pin shown in Figure head was added. 6.1, would be necessary to have a cleavage pattern as shown in Fig. below.

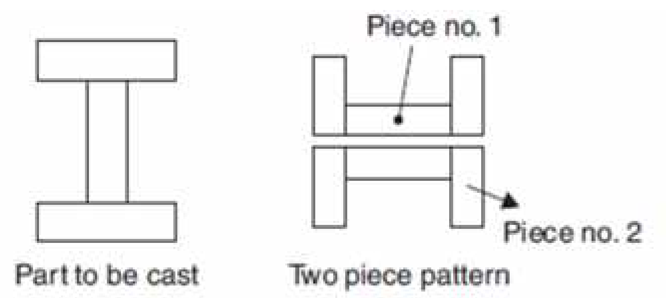

Fig 1.4.2(Split pattern)

Half the impression in the mold will be made by the use of any parts. 1 in a flask and the other half of the printing will be done by the use of parts not. 2 in a second molding box. After removing the halves of the pattern of the respective molding box, the two boxes are assembled and clamped together, so that the whole printing is available for pouring metal.

The two halves of the pattern are provided with locating pins, so that half can sit in the other half in the exact required position without gap. Also two tapped holes are provided in the flat engaging surface of each part. These bolt holes are used to provide a grip for lifting the pattern halves without damaging the mold sand-printing.

The line along which the pattern is divided into two halves called "separation line" and usually follows the broader casting cross section. Decide where the dividing line should be a matter of considerable skill and experience.

Some parts may require more complicated casting pattern is divided into three or more parts.

(iii) Loose piece pattern : In some cases, the casting may have small projections or cantilevered portions. These projections make it difficult to remove the pattern from the mold. Therefore, these projections are made as single pieces. They are loosely attached to the main part of the pattern and the mold is made in the usual way.

When the main pattern is removed from the mold, loose parts slide out and remain behind in the mold. After removing the main body of the pattern, the individual parts are taken out for the first laterally and then lifting them move through the space vacated by the main pattern. The method is illustrated in Fig. below.

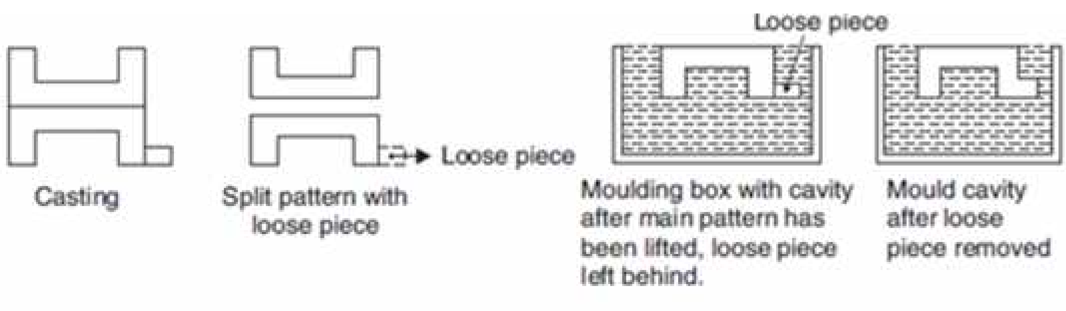

Fig 1.4.3(Loose piece pattern)

(iv) Match plate pattern: Match Plate is a plate of metal, usually aluminum. The two halves of the fracture pattern in this game are mounted on each side plate. While they are fixed to the board game, care is taken so that there is no mismatch. These patterns are used in combination with molding machine mechanical drive. Underside of the plate pattern matching is used to make the lower half of the mold impression in a molding box (known as the drag). The upper side of the pattern adjustment plate is used to make the mold impression in another flask. Finally, the two flasks are kept on top of each other, the lower housing is referred to as the trawl, while the upper part is called the front.

(**v) Gated patterns:** Sometimes alongwith the pattern for casting another portion is added so that when printing is performed on the molding, the cavity has a shallow channel along with the main cavity for the object to be melted. This channel is used for feeding molten metal into the main cavity and is known as the "door". Such patterns where provision has been made for gating patterns are called closed. It eliminates the need for a separate door.

(vi) Other pattern: types include skeletal pattern, pattern scanning and segmental pattern etc. In these models, the entire pattern fails and the mold is complete with an improvised pattern. This is done to reduce the manufacturing cost of the models. This procedure is resorted to, if only one or two molds to be made

.

1.5. PATTERN ALLOWANCE

The pattern is a mirror image of the casting ,when used with suitable molding material forming a cavity called as template. When the cavity is filled with molten metal after solidification and obtain the desired casting .

Some subsidies are provided in the pattern. They are like :

a.. Forecast for the shrinkage of the metal.

b . Forecast for machining.

c . Project grant to facilitate the extraction of sand.

d . Prints base as additional projections for production of seats for the cores.

The tools used to perform the pattern includes the tools already discussed in carpentry workshop ie airplanes as a bet tickets rib, block plane , airplane router, plow plane, spoke shave , draw knife etc. saw as the jigsaw , bow saw , saw meter etc. measurement and markup tools such as scaling folding carpenter's rule , dividers, trammel nets , tweezers and diverse, such as gauges , file tools , etc

Shrinkage allowance:

Most of the metal have a tendency to shrink during metal solidification. The amount of shrinkage also differs from metal to metal, the factors affecting the shrinkage include temperature, while the metal material specifications of the casting mold, the molding method, casting material is poured.

Fig 1.5.1(Shrinkage allowance)

Machining allowance:

Machining may be required by the casting, can be partially or completely. In preparing the part to be machined, and identifies those parts of machining allowance, plus shrinkage allowance is also provided. Allowance also depends metal casting, machining methods, the specification of the required casting and finishing.

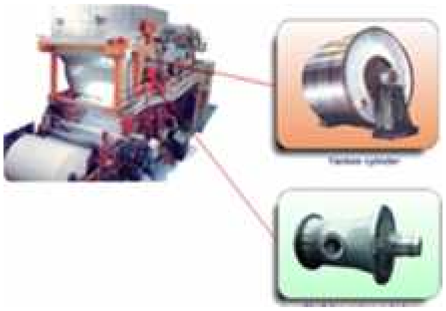

Fig 1.5.2(machining allowance)

Draft allowance:

Slight narrowing pattern occur in all vertical surfaces, this cone is the proposed allocation. That is, either in degree or linear measurements and is provided in the inner and outer surfaces. Easy removal of the pattern is provided. Project subsidy depends on your method of molding and vertical height. The figure is in the next page.

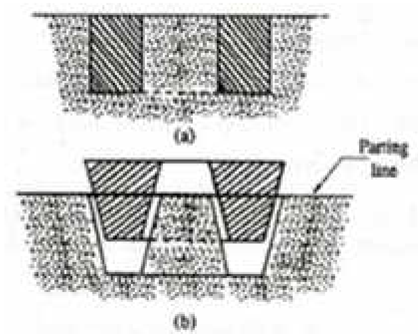

Fig 1.5.3(Draft allowance)

Shake allowance:

Prior to removal of the pattern is first of all stirred so that it is free of adjacent walls, due to the size increase of the mold cavity whereby a negative pattern is given allocation.

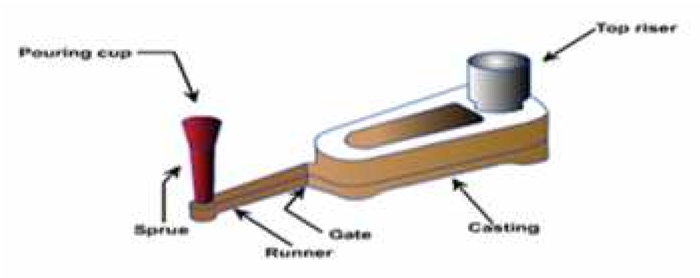

Fig 1.5.4(Shake allowance)

Distortion allowance:

There is some melt in the cooling of the metal is not uniform throughout the casting due to the very complicated way. Because of this there is no distortion in the castings. To minimize the effect of distortion in the opposite direction is given in the pattern.

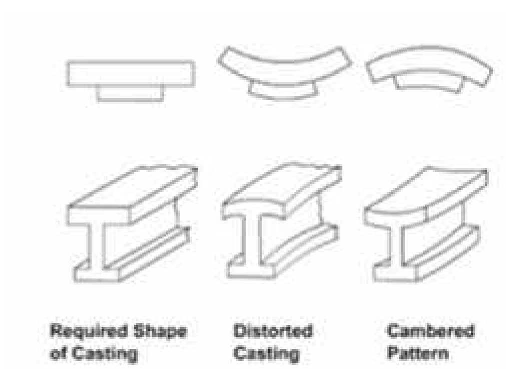

Fig 1.5.5(Distortion allowance)

2.OBJECTIVES AND THE PRESENT WORK

A "**safety valve"** , used to protect pressure vessels, piping systems, and other equipment from pressures exceeding their design pressure by more that a fixed predetermined amount., which is manufactured by **complex CNC forging** and by many secondary manufacturing processes like , drilling, heat treatment and polishing can be easily manufactured by **sand casting** using combined Loose piece pattern.

The geometry of the safety valve is such that , if we make a pattern for its manufacturing using casting process, there will be a number of projection or parts which would create problem during removal of the pattern from the mould intact. The removal of these parts will affect the mould boundary thereby affecting the dimension of the cavity produced.

In order to overcome this problem, these portions can be treated as loose pieces and these loose pieces are attached to main pattern body loosely. when the main pattern is withdrawn from the mould, the loose pieces slip off and remain behind in the mould. After the main body of the pattern, the loose pieces are taken out by first moving them laterally and then lifting them through the space vacated by main pattern.

3. LITERATURE REVIEW

Xiaoyun Li & Shanshan Lu

Analysis of the Manufacturing Process and Development of Vavles [1]

The first objective of this thesis is to analyze the whole process of making the way to make semi-finished products into finished products in Anhui Tongdu Valve Co., Ltd. The second objective was to analyze the common problems of operation and maintenance of valves and offer solutions. Depending on the situation , there were many different types of problems that arose in different parts of the valves, such asstem , body and door. The third objective was to analyze the problems in the production process, and learn to solve them. The production line environment and the current work were not as efficient as expected. They cause unnecessary loss of time, energy and capital. First all, according to the analysis of the manufacturing process , every step of gate valves manufacuring must be understood. Secondly , based on the analysis of common problems , useful solutions have been on two aspects that were how to avoid accidents before it happene and how to handle problems after they have occurred. Third, the authors' research , problems in the production process were mainly in two fields: the problems of occupational safety and health in the manufacturing process and quality management in processing. Beneficial suggestions offered to reduce the harm caused to workers by machines and materials. A new design of the workshops was designed to reduce the loss .

The stem fracturing occurs mostly in the roots of the upper and lower parts of thread because cross-sectional areas are smaller in these places, and cause the centralization and excessive stress . Especially working conditions comparatively deviate from the design parameters . For example , in Then the nuts of the stem got stuck and the stem broke down. The most probable reason of this accident is that the debugging operation was not done correctly during installation causing the pair of protector is too big. Other stem fracture often happens exactly at the time of valve opening . It appears that the gate valve seat does not leave the door yet and the stem is already broken at the root of the thread portions . Usually, it is considered that the reason for this type of fracture is that the valve gate is stuck . But in reality , this is only part of the reason . In other words, this is the second reason . The most important reason is the impulse unusual stress after the body cavity of the valve is closed , which means that after the valve is closed , the stress caused by the fluid in the body cavity is much greater than water stress above .

This problem means that the gate valve is stuck in its track in the valve cavity , and this problem is caused by defects in the design and manufacturing process, for example , the contact width of the track is too short or too long or the runway surface is too rough and so on. When the door is stuck in the valve seat and the stem is forced to rise , usually the valve gate is fractured or deformed. In addition to the magnification of unusual stress , there is another possible factor : the temperature differences .

As shown in Figure 34 , a typical condition caused by temperature differences is that the valve gate is closed in the cold state and warm state opened . The stem extends longer because of the heat , which means that the valve gate is further compressed . This leads to the adhesion of the valve gate . There are two reasons that cause damage to the surface of the board : the damage artificial and natural damage. Artificial damage are caused by poor design , manufacturing unrestricted , the wrong choice of material and some other reasons . Natural Damage is damage caused by the normal working of the valves, such as the inevitable corrosion and erosion of the medium.

Yi-qi Wang, Jae-gyu Kim, Jung-il Song

Optimization of plastic injection molding process parameters for manufacturing a brake booster valve body[2]

The plastic injection molding (PIM) process parameters have been investigated for producing a servo valve body . The optimal process parameters of PIM is determined by the application of computer-aided engineering integrating with the Taguchi method to improve the compression property of the valve body . The parameters considered for optimization are the following: number of gates , the gate size , the mold temperature , a resin temperature , the filling volume switching , switching by the injection pressure and the current training time . L18 orthogonal array is created in the statistical design method based on experiments Tagu - Chi . Then , the Mold -flow analysis is performed using the process parameters are designed based on the orthogonal array L18 . The (S / N) and signal to noise analysis of variance (ANOVA) ratio used to find the optimal process parameters PIM and to ascertain the impact of the viscosity of the resin , curing rate , and compression resistance in a body of servo valve. When compared with the average compressive strength of 18 design experiments , the compressive strength of the valve body produced using the optimum process parameters PIM showed an improvement of almost 12%. Safety is the primary objective of the automotive manufactures . Undoubtedly, the braking system is the most important part of any vehicle , it should work every time without fail during the lifetime of the vehicle. A servo valve body is a key component of the braking system , which is usually manufactured by plastic injection molding technique (PIM) . PIM is an important technique for manufacturing plastic products because the benefits of product quality , competitive cost , high productivity, and good mechanical properties. The cycle consists of four stages PIM : plasticizing, injection , packing and cooling. PIM quality parts is profoundly influenced by many factors, such as the process parameters applied to materials , mold design , manufacture them. Due to the high cost and time consuming process of trial and error is not suitable for the complex manufacturing process to determine the optimal parameters of PIM process. Therefore, the Taguchi method , artificial neural networks (ANNs) and genetic algorithm (GA) are applied to optimize the parameters of the PIM process to achieve the high quality product . Subsequently, com - puting has been used to smooth the process parameters optimization . To optimize the process parameters , Shie conducted research that integrates numerical software , back-propagation neural network (BPNN) and GA . When parameter values are discrete , the Taguchi method can efficiently find the combination of process parameters best experiments the minimum specified level . Therefore , investigations are carried out routinely in the optimal process parameters from different points of view to determining . Oktem et al. proposes an approach using the Taguchi method to reduce shrinkage of thin shell plastic components or - in part through the signal to noise ratio (S / N) and analysis of variance (ANOVA). Ozcelik performs Tagu L9 - Chi (March 3) design orthogonal matrix to optimize the effect of the injection parameters and the welding line on the mechanical properties of molded polypropylene . . Erzurumlu and Ozcelik have - min imized deformation and rate of sink in pieces made of polycarbonate / acrylonitrile butadiene styrene , polyoxymethylene , and Polyamide66 based on Taguchi optimization method . In this study, the effects of process parameters PIM in the compression force of a servo valve body were investigated using the method of optimization Taguchi ..

4. METHODOLOGY ADOPTED DURING THE PROJECT WORK

1) Though my prime job is to make a wood pattern for the safety valve, first I collected the proper dimensions of a general safety valve. The safety valve consists of parts or projections those may create problem during removal of pattern from mould.

2) Size of the pattern is not same as the size of the desired product because some allowances like shrinkage allowance, draft allowance, machining allowance, shake allowance and distortion allowance. size of the pattern was modified in accordance with various allowances. By adding all the allowances ,the proper dimension for the wood pattern was calculated .

3) Then the main body of the pattern was manufactured in the workshop (carpentry shop).After that the loose pieces will be manufactured .The loose pieces are attached loosely to the main pattern body so that these parts slips off when main pattern body is removed from the mould intact.The pattern material will be wood .

4)Then a mould box was made in the foundry shop and the pattern used consists of two loose pieces .

5)Molten metal was poured through the cavity made by the pattrn after removing the main pattern body initially followed by loose pieces using a pin .

6) sufficient time was given for the molten metal to solidify.

7) Final product was taken out of the mould by destroying the mould box.

5. DESIGN AND FABRICATION

5.1. VALVE MANUFACTURING..A BRIEF IDEA..

The manufacture of the valves is divided roughly into a method of casting and forging method , and their manufacturing processes are different. The forging method has a smaller number of manufacturing steps and is limited to small-size valves , as it is not suitable for large scale manufacturing. Accordingly valve , the casting method is mainly made using the method used. Valves pouring undergo the same process of casting, but can follow different manufacturing processes after the casting process. For example , when a copper alloy valve and faucet valve is compared , both made of a copper alloy as its material , the valve key and washing processes 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.

The characteristics of the industry are many manufacturers of valves currently have themelting process / foundry hired responsible for external expertise, and conduct themselves only from the machining processes .

5.2 DIAGRAM OF THE VALVE..

Fig 5.2.1(safety valve)

5.3 DESIGN AND DIMENSIONING OF THE PATTERN

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)

1: shrinkage or contraction allowance:

The various metals used for casting contract after solidification in the mould. Since the contraction is different for different materials, therefore it will also differ with the form or type of metal.

Table 5.3.1(shrinkage allowance)

Material	Shrinkage allowance (mm/mm)
Aluminum	0.013
Brass	0.0155
Bronze	0.0155 to 0.022
Cast iron	0.0104
Cast steel	0.0208
Copper	0.016
Gunmetal	0.01 to 0.016
Lead	0.026
Magnesium	0.013

2: **Draft allowance**

It is a candle that is given to all vertical walls pattern for easy and clean removal of sand pattern without damaging the mold cavity. It can be expressed in millimeters on one side or degrees. The amount of taper varies with the type of patterns. Wooden patterns which require more tapered metal patterns due to increased frictional resistance of the wood surfaces. Table 5.3.2 shows the values of the proposed subsidy.

Table 5.3.2(Draft allowance)

Pattern material	Draft, angle(degree)	
	Outer	Inner
Wood	0.25 to 3.00	0.50 to 0.300
Metal	0.35 to 1.50	0.50 to 3.00
Plastic	0.25 to 1.00	0.35 to 2.25

3: Finish or machining allowance

The subsidy is provided in the model if the casting to be machined. This grant is in addition gives shrinkage allowance. The amount of this benefit varies from 1.6 to 12.5 mm, depending on the type of metal casting, the size and shape of the casting. Ferrous metals require more excess of non-ferrous metals.

Required Machining Allowance

- Required machining allowances (RMA) in millimeters for steel castings based on ISO 8062.

Table5.3.3(machining allowance)

Largest dimension mm		Required machining allowance mm Note: A minimum of 6 mm RMA required on all cope casting surfaces					
over	up to and including	Required machining allowance grade					
		E	F	G	H	J	K
-	40	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

Sand casting, hand molded use garde G--K

Sand casting ,machine molded (and shell) use grade F—H

5.4 : DIMENSION OF WOOD 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.

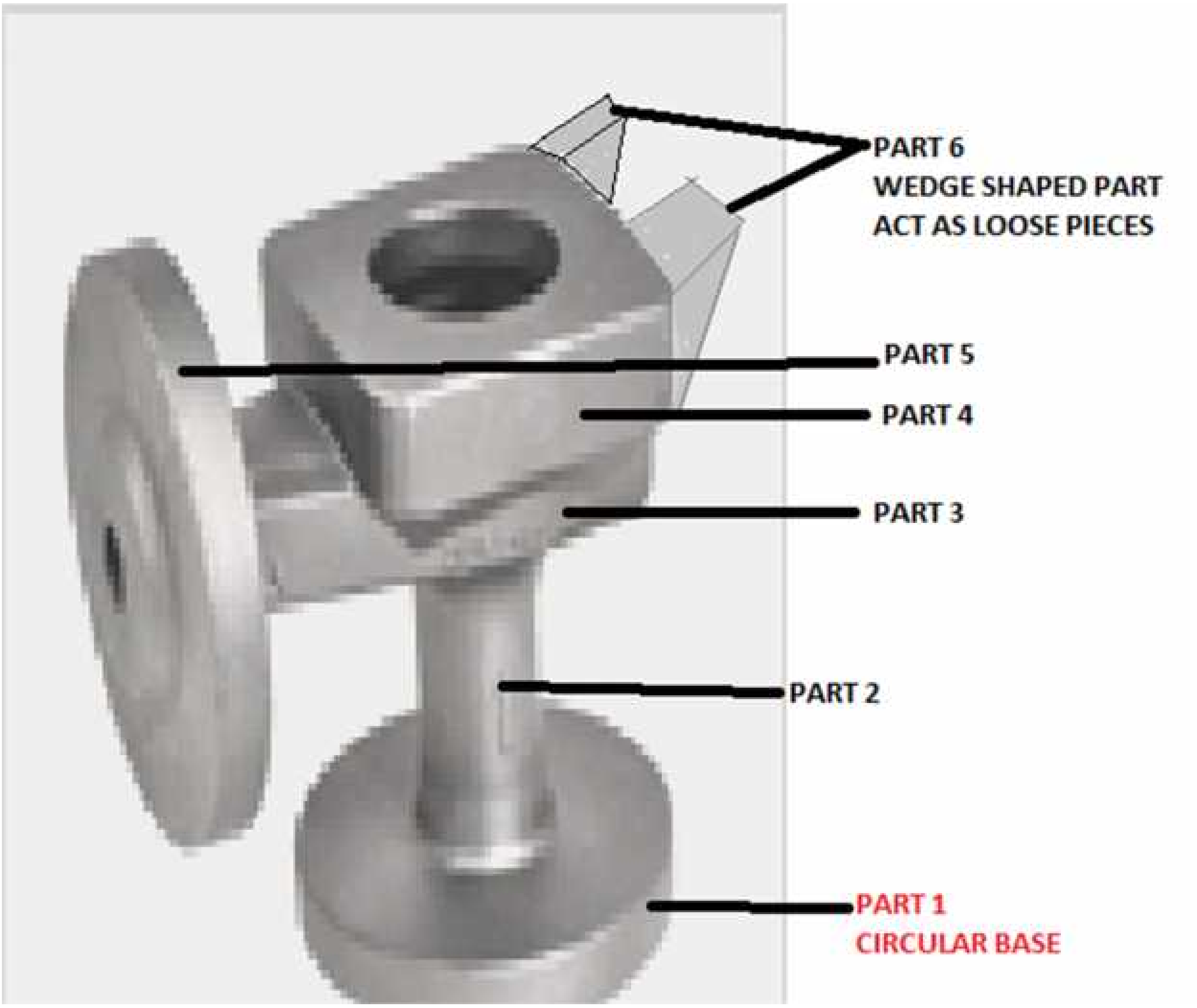

Fig 5.4.1(valve with parts)

Shrinkage allowance is 0.0208 mm/mm of length.

Draft allowance is taken as 1.5 degree for outer ..

For part 1: **(TABLE 5.4.1)(dimension of part 1 of the pattern)**

ACTUAL DIMENSION	SHRINKAGE ALLOWANCE	MACHINING ALLOWANCE	FINAL DIMENSION OF THE PATTERN
10 cm (100 mm)	2.08 mm	2.7 mm	104.78 mm=10.4cm
1.5 cm (15 mm)	0.312 mm	0.95mm	16.262mm=1.62cm

For part 2 **(TABLE 5.4.2)(dimension of part 2 of the pattern)**

ACTUAL DIMENSION	SHRINKAGE ALLOWANCE	MACHINING ALLOWANCE	FINAL DIMENSION OF THE PATTERN
8 cm (80 mm)	1.664 mm	2.7 mm	84.34 mm=8.43cm
2.5 cm (15 mm)	0.52 mm	0.95mm	26.47mm=2.64cm

For part 3 **(TABLE 5.4.3) (dimension of part 3 of the pattern)**

ACTUAL DIMENSION	SHRINKAGE ALLOWANCE	MACHINING ALLOWANCE	FINAL DIMENSION OF THE PATTERN
5.1cm (51 mm)	1.0608 mm	1.35 mm	53.41 mm=5.34cm
6.2 cm (62 mm)	01.28 mm	1.35mm	64.63mm=2.64cm
2.8cm (28 mm)	0.58mm	0.95 mm	29.53mm=2.953cm
2.3cm(23 mm)	0.47mm	0.95mm	24.42mm=2.44cm
1.5cm(15 mm)	0.312mm	0.95 mm	16.2mm=1.62cm

For part 4 **(TABLE 5.4.4)(dimension of part 4 of the pattern)**

ACTUAL DIMENSION	SHRINKAGE ALLOWANCE	MACHINING ALLOWANCE	FINAL DIMENSION OF THE PATTERN
7.7cm (77 mm)	1.60 mm	2.7 mm	81.3 mm=8.13cm
5.8 cm (58mm)	01.20 mm	1.35mm	60.55mm=6.05cm
3cm (30 mm)	0.62mm	0.95 mm	31.57mm=3.15cm
1.5cm(15 mm)	0.312mm	0.95 mm	16.2mm=1.62cm

For part 5 **(TABLE 5.5.5)(dimension of part 5 of the pattern)**

ACTUAL DIMENSION	SHRINKAGE ALLOWANCE	MACHINING ALLOWANCE	FINAL DIMENSION OF THE PATTERN
12cm (120 mm)	2.496 mm	4.1mm	126.59 mm=12.65cm
1cm (10 mm)	0.2mm	0.95 mm	11.157mm=1.11cm
1.5cm(15 mm)	0.312mm	0.95 mm	16.2mm=1.62cm

5.5. FABRICATION OF WOOD PATTERN (carpentry shop intensive job)

After having the dimension of the pattern in hand, fabrication process started at the carpentry shop where by the use of various machines like hand saw, cutter saw, circular saw, jig saw, chisel and iron planar , the pattern is fabricated.

Two wedge shaped loose pieces are also fabricated which are loosely attached to main pattern body by means of a groove.

Various machines are

(cutter saw) Fig 5.5.1 **(circular saw) Fig 5.5.2**

(chisel) Fig 5.5.3 **(hand saw) Fig 5.5.4**

(jig saw)

(iron planar)fig5.5.6

5.6 Designing and Drawing

After having the proper dimension of the wood pattern, a complete three dimensional drawing is designed using high end software like CATIA (Computer Aided Three-dimensional Interactive Application) .Using this design, we can get a three dimensional view of the wood pattern properly.

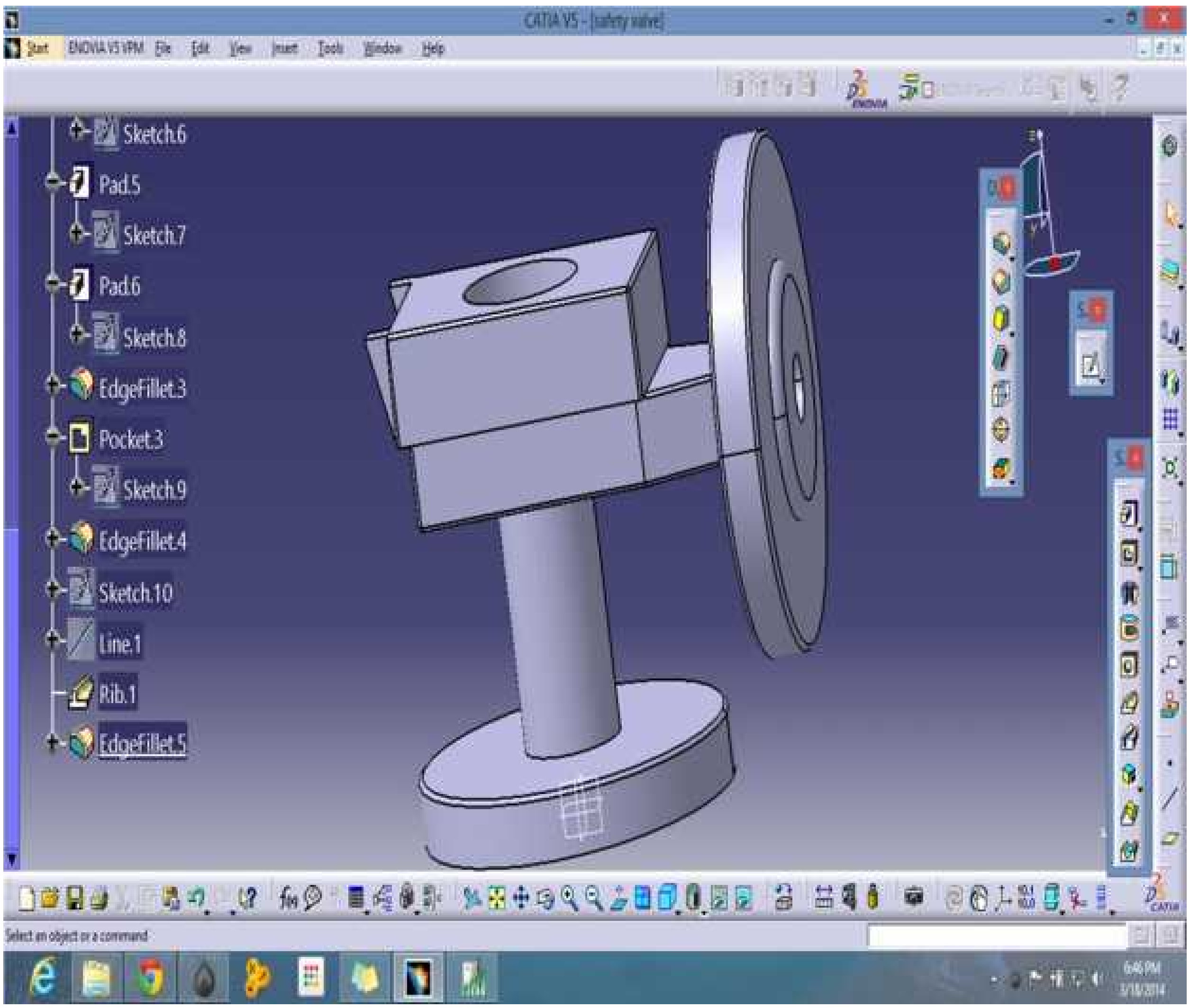

Fig 5.6.1 (CATIA DRAWING OF SAFETY VALVE)

6. EXPERIMENTATION AND OBSERVATION

First the main part of the pattern was fabricated followed by two wedge shaped loose pieces. These loose pieces are attached to main body of the pattern loosely. When a mould was prepared from the for manufacturing purpose, it was observed that there was no problem during removal of the pattern from the mould by aid of these two loose pieces which were removed from the mould after the removal of main body of the pattern using a pin. A split pattern was prepared that is the whole pattern is symmetrically divided into two parts ..one part is in cope half whereas other in drag part.

SIDE VIEW

TOP VIEW

FRONT VIEW

Fig 6.1 [showing side vies , top view and front view of the wood pattern (split pattern consisting loose pieces) respectively.]

7. CONCLUSION

1 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.

2)It has also been observed that the pattern removal did not affect the sand boundary and the mould intact.

3)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 labour as well. In addition to this, forging method for the manufacturing of safety valve is limited to small sized valves only whereas by the use of casting method , we can produce safety valves of large size which is impossible in case of forging.

4)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.

5)During my project work ,I successfully completed the manufacturing of wood pattern with loose pieces for safety valve and analyzed the total process of casting and found no error or problem .

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