UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Design for Die Casting (Spanner)

Thesis submitted in accordance with the requirements of the National Universiti Teknikal Malaysia Melaka for the Bachelor Degree of Manufacturing Engineering in Process

By

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DESIGN FOR DIE CASTING (SPANNER)

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APPROVAL

This thesis submitted to the senate of KUTKM and has been accepted as partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering
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DECLARATION

I hereby, declared this thesis entitled “Design The Die Casting” is the results of my own research except as cited in references

Signature	:	…….
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DEDICATION

"To my beloved family especially my mother and father, Mrs Salmiah Bt Awang salimin and Mr Othman Bin Mohamed. I thank my parents for performing this difficult task, and the journey does not end here.

To my supervisor, Mr Taufik for being receptive and critical, and challenging me to be a better student. To my friends, for your sacrifices, encouragement, and support towards project accomplishment"

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ABSTRACT

This report is about the design of the die casting that normally used in the industrial. Die casting is the one of the process that produces the precise product in the world. Many of the high precision industrial production used the die casting to produce the product. That why the die casting is the popular process in production. With the die casting, the manufacturer can produce the small product until the biggest one depends to the marketing. Thus for this study the main focus is to evaluate the suitable design for the metal casting process weather it can improve the several design in the manufacturing field. As we know, die casting is the one of the important section that produces the entire products that used in the company, home, school etc. Some of the product such as sport rims, spanners and others. So, the design process is important to make sure the product is suitable to use by customer. It is the direct reason why the die casting design is important in production. Before the design is approved, all of the concepts about the die casting are included in the introduction and literature review. Die casting is a process while liquid metal are injected into steel dies under high pressure and net shape parts are produced after subsequent metal solidification and cooling. The projects is focused to design the selection design and produced the design using the selected machine such as milling, lathe, wire cut and others. To design the selection part, IRONCAD software are use to produce the design.Through this design, it can produce the high quality design of the die casting. For the result, the die prototype is successfully produced and all of the process, design, and NC code are successfully included in this thesis. From that, its also can help us to know more about the die casting industry.

ABSTRAK

Tesis ini berkaitan dengan reka bentuk tuangan beracuan yang biasanya digunakan dalam industri. Tuangan beracuan adalah satu proses yang digunakan untuk mengeluarkan produk yang berketepatan tinggi dan ini merupakan salah satu faktor mengapa banyak sektor perindustrian mengggunakan proses ini untuk menghasilkan produk yang jitu. Maka, tidak hairanlah mengapa proses tuangan beracuan amat populardi dalam proses pengeluaran.Dengan kaedah ini, pengeluar dapat menghasilkan produk yang kecil atau besar bergantung kepada permintaan pasaran. Oleh itu, kajian ini berteraskan penilaian kesesuaian rekabentuk untuk memperoleh satu rekaan yang sesuai untuk dinilai, dihasilkan dan diubahsuai untuk menjalankan proses tuangan berdai khususnya didalam bidang pembuatan semasa. Sebagaimana yang diketahui, tuangan beracuan selalu digunakan didalam menghasilkan produk yang biasa digunakan dalam syarikat, rumah, sekolah dan sebagainya. contohnya seperti rim sport, spanners dan lain-lain. Maka, proses rekaan adalah penting untuk memastikan produk adalah sesuai digunakan oleh pelanggan. Ia mempunyai kaitan langsung mengapa rekaan tuangan beracuan adalah penting di dalam pengeluaran. Di dalam tesis ini, semua konsep yang berkaitan tuangan beracuan dapat diperjelaskan lagi didalam pengenalan. dan literasi. Projek ini berfokuskan untuk merekabentuk salah satu rekabentuk pilihan dan menghasilkannya dengan menggunakan mesin-mesin pilihan seperti mesin larik,miling, wire cut dan sebagainya. Untuk merekabentuk setiap bahagian, perisian IRONCAD digunakan untuk menghasilkan lukisan didalam bentuk ortografik, assembly, exploded dan 3D. menerusi rekabentuk ini, ia dapat menghasilkan reka bentuktuangan beracuan yang berkualiti tinggi. sebagai keputusannya, prototaip telah berjaya dihasilkan dan semua proses, reka bentuk, dan kod NC telah dihasilkan.Oleh itu kita dapat mengetahui dengan lebih jelas perkara yang berkaitan dengan industri tuangan berdai.

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LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURE

CAD	-	computer aided design
CAM	-	computer aided manyfacturing
CE	-	concurrent engineering
Cu	-	cuprum
in	-	inches
kg	-	kiligrams
km	-	kilometer
m	-	meter
Max	-	maximum
Min	-	minimum
s	-	Second
Si	-	silicon
SSM	-	semisolid-metal
V	-	velocity
Zn	-	zinck
^{0}C	-	degrees Celsius
^{0}F	-	degrees Fahrenheit
$	-	dollars
%	-	Percent
+/-	-	plus or minus

CHAPTER 1

INTRODUCTION

1.1. Background

Metal casting has always been one of the most important and widely used manufacturing processes. Egyptians used solidification processing to create near net-shaped components 5100 years ago. As this processing developed, it markedly expanded with the industrial revolution and advanced technology through the 20th century.

The manufacture of die-casting molds or injection molds is a precise yet clean production process. Casting is applied widely in the motor, aeroplane, ship, electronics, and precision machinery industries, etc., because it can produce high-strength high-quality casting. It has a profound influence on the speed and accuracy demanded by modern industries. Die casting is a precision casting method of injecting molten metal into a die cavity applying a high pressure (cold chamber method: 170–2000 km cm^{-2}, hot chamber method: 90–500 km cm^{-2}) and making use of high velocity (20–60 m s^{-1}).

Whether the forming of a casting is successful or not is always determined by the flow system of the casting. In the die-casting process there are many complex factors that determine the casting quality and the production. In carrying out the die-casting process, the plane of the casting generally determines the accuracy of the mold-surface profile; the arrangement and shape of the gate, runner, sprue, pouring basin, overflow, air vent, etc., being the most important factors in the design of the die-casting die.

In recent years, modern industries have been demanding esthetically satisfactory surface curves in product design, and so the mold-surface has become

increasingly more complex. During the die casting process, liquid metal is injected into steel dies under high pressure and net shape parts are produced after subsequent metal solidification and cooling. After the parts are ejected, the dies are sprayed with a lubricant, and the process cycle starts again. Lubricants facilitate the ejection of the finished product and cool the dies.

Further, die design is still dependent on the experience of operators, and due to the lack of analytical ability in die and melting metal flow and heat transfer, die design is unable to know and handle the deformation resulting from material and thermal expansion and shrinkage of the die. Finite elements analysis software is capable of analyzing the flow condition of the injected metal and the stress, strain and temperature distribution conditions of the product (the work-piece) under various injection conditions, but the establishment of an analytical model is very difficult. For understanding of the die, and the metal flow and solidification process, the user should be fully acquainted with the basic finite element software.

The application of die castings is expanding continuously. The construction of die castings is becoming more complex and large-sized, and at the same time a shorter development cycle of new die casting products is required. How to produce high quality die castings in a shorter period with a lower cost has become an important and urgent task of die casting enterprises. Recently concurrent engineering (CE) has been introduced into die casting production, and the CAD/CAE/CAM integrated system of die casting dies has been established. In the CE process, the first step is to create a 3D part database for use in all aspects of the production process. The next step is to design the die casting process, which includes the design of gating system, overflows and cooling channels and whole set of die casting dies. So, those are the same of the process to make the design in this project.

1.2. Scope Of Project

This project is about the die casting design aspect in the manufacturing process. The major scope of this project is specifically to design the suitable system in the die casting. The project is focused to design the die casting system includes the die. For a practical, the side of the project is to design the die and produce the die using all of the machine in the lab. For a design, The IRONCAD software are used to design the project based to the selection design. The design are selected using the screening and scoring concepts.Besides that, all of the aspect about the material and the several designs that we have in the manufacturing process must be know to produce the quality of the design. In doing this project, it required to design the die casting, which includes the design of gating system, overflows and cooling channels and whole set of die casting dies.

1.3. Problem Statement

The manufacture of die-casting molds or injection molds is a precise yet clean production process. Casting is applied widely in the motor, aeroplane, ship, electronics, and precision machinery industries. The main problems that are want to focus in this project paper is about the die casting design that are including the suitable aspect such as machine, product and the material. This project also was proposed to design the complete system of the die casting. As we know, the entire thing we do should have a planning to make sure our job is smooth. So in the industry, especially in highly risk, to design the die casting it must have the planning and preparation in anything have done to make sure the die design is smooth to produce the product. Sometimes, the die casting failure caused the production will stop automatically because the safety aspect. So, the die casting design must suitable to the product and the casting machine that used in the production. If the design is failed, the product at the final has many defects such as crack, unfilled, weld line and

others. The design aspect is important to make sure the die casting system can function quickly and also produces the product in short cycle time.

1.4. Objective

To make the project, the objective is important aspect that must be clearly before make some of the process. The entire objective is shown above;

1. To make the suitable design based to the product.
2. To understand the system that used in the die casting.
3. To make the decision of the suitable product, material and machine for the selection product
4. To produce the detailed drawing of the product.
5. To produce the prototype based to the selected design.

CHAPTER 2

LITERATURE REVIEW

2.1. Die Casting Process

The Die casting process, developed in early 1900s, is a further similar to permanent mold casting except that the metal is injected into the mold under *high pressure* of 10-210Mpa (1,450-30,500) psi. This results in a more uniform part, generally good surface finish and good dimensional accuracy, as well as 0.2 % of casting dimension. [3]

Die casting is similar to permanent molding in that a metal mould made in two halves is used. The differenced is that the metal is not gravity poured into the mould (die), but instead the metal is injected under high pressures ranging from 1000 to 100,000 PSI. This requires massive machine that are generally operated hydraulically to exert the hundred of tons the force necessary to hold the two halves of the die together when the molten metal is being injected at such high pressures. [4]

Die Casting is the process of forcing molten metal under high pressure into the cavities of steel molds. The molds are called dies. Dies range in complexity to produce any non-ferrous metal parts (that need not be as strong, hard or heat-resistant as steel) from sink faucets to engine blocks (including hardware, component parts of machinery, toy cars, etc) [3]. In fact, the process lends itself to making any metal part that:

1. must be precise (dimensions plus or minus as little as .002 inches--over short distances),
2. must have a very smooth surface that can be bright plated without prior polishing and buffing,

3. have very thin sections (like sheet metal--as little as .050 inches),
4. must be produced much more economically than parts primarily machined (multicavity die casting molds operating at high speed are much more productive than machine tools or even stamping presses),
5. must be very flexible in design; a single die casting may have all the features of a complex assembly. [3]

Typical parts made through die casting are motors, business machine, appliance component, hand tools and toys. The weight of most castings ranges from less than 90g (3oz) to about 25kg (55lb). For many parts, *post-machining can be totally eliminated*, or very light machining may be required to bring dimensions to size. [3]

The Dies are usually made of alloy or tool steel and are quite expensive to make. Some have one or two identical mould cavities for larger parts, and others may have several different cavities. Some dies are more complicated and have sections that move in several directions. Grooves or overflows around the cavity on the parting face permit gases to escape. [2]The overflows of excess metal must be trims off by a secondary operation after the casting is removed from the mould. This trimming is done with trimming dies that also removes the sprues and runners. The mould must also have provisions for water cooling so that a constant operating temperature can be maintained. Knock-out pins provides for injection the parts when the die is opened. When cores are used they are made of metal and are usually drawn out before the die is opened. Cores are retracted either in a straight line or in circular motion.

Complex components with intricate features are commonly pressure die cast using sophisticated tools. Tool tolerance is critical. Flashing at tool faces can defeat the economics of die casting if it necessitates deburring or secondary finishing. In conventional die-casting tools, molten alloy is forced into the cavity until it flashes out between adjoining surfaces. For zinc-alloy die casting of small components, tools are assembled to tolerances of +/-0.0001 in. -- a tight seal around the cavity which eliminates flash. [10]

It easy to see that these complex dies are quite expensive. Their costs can range from a few thousand dollars to $100,000 depending on the size of the die, its complexity, and the size of the casting machine used. Obviously, this process is not

suitable for small-quantity production or for making very large parts. The large investment for dies and machines will pay off only when very large quantities (20,000 to millions of parts per year) are required. [7]

Die casting is means of producing castings of lower levels temperature alloys at a relatively high rate. These casting are usually thin walled, smooth, and highly accurate. [3] The process is highly adaptable to the manufacture of small parts such as automobile door handles, wiper motors, Kitchen appliance parts, and thousands of small items we used every day.

A die-casting tool is basically a six-sided cube that opens and closes like a clamshell, with a parting line where the two halves meet. The cavity inside is the shape of the component to be formed. Any component feature parallel to that open/close motion is easily incorporated into the two halves with the use of cores. For example, a fixed core pin in the movable half of the tool forms a center hole. For features offset from the parting line, movable side cores are driven in a sideways motion to be retracted before the die-cast component is ejected from the tool. These cores can be at any angle. For a wheel that requires features on the outside diameter corresponding to each month of the year, 12 cores are used, one every 30*. [10]

The quality of die castings is high because of a rapid cooling rated that produces fine grains in the metal. The surfaces tend to be harder than the interior as a result of the chilling actions of the metal die. Porosity is sometimes a problem as a result of entrapped air, but with the proper venting this can be overcome. [9]

Cylindrical cores form holes with a 0.001 in. tolerance, which can be tapped to 60 to 75% full thread without drilling. Side cores enable the production of holes and undercut features that are parallel to the major parting line of the tool. A movable core can form a hole or slot of virtually any shape to tolerances of 0.002 in. External, internal, face, helical, spur and worm gears are cast to angles of 20° and can incorporate shafts, ratchets, and cams. [10]

Zinc-based alloys are the most commonly used in die casting. Other metals used in die casting are alloys using copper, aluminum, and magnesium. Zinc alloys have the lowest melting point, about 700^0F (371^0C), and so have a less destructive effect on dies. Aluminum and Magnesium alloys melt at about 1100^0F (593^0C), and copper alloys melt about 1700^0F (927^0C). Therefore, dies using these alloys have a