Machining Level-III

Based on October 2023, Curriculum Version II





Module Title: Manufacture Advance Press Tools, die and Moulds

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Acronym

2D	Two Dimensions
3D	Three Dimensions
CAD	Computer Aided Drawing
CAE	Computer Aided Engineering
CAM	Computer Aided Manufacturing
CMM	Coordinate measuring machines
CNC	Computer Numerical Control
CS	Cutting Speed
EBM	Extrusion Blow Molding
EDM	Electrical Discharge Machining
FR	Feed Rate
ISB	Injection Stretch Blow
LAP	Learning Activity Performance
NC	Numerical Control
NDT	Non-Destructive Testing
OHS	Occupational Health and Safety
OHS A	Occupational Healthy and Safety Administration
PPE	Personal Protective Equipment
SPC	Statistical Process Control
WEDM	Wire Electrical Discharge Machining

Table of Contents

Acknowledgment 1

Acronym 2

Table of Contents 3

Introduction to Module 5

Unit one:- Concept of Press Tools, Dies and Mould Design 6

1.1. Introduction to press tools, die and Mould manufacturing 7

1.2. Types of Tools, die and mould 8

1.3. Tooling Components 18

1.4. Common Press tools, die and Mould Materials 20

1.5. Design Procedure and Considerations 22

1.6. Manufacturing process of press tools, die and mould 24

Self-cheek 1 24

Unit Two:- Manufacture Tooling Components 26

2.1. Workshop Safety Procedures 27

2.2. Press Tools, Die and Mould Production machine 28

2.3. Hand tools and hand held power tools 32

2.4. Press Die and Mould design By CAD/CAM software platform 33

2.5. Machining parameters and Machinability of the material 37

2.6. Machining of die Tooling component 39

2.7. Tools, Die and Mould heat Treatment 43

Self-check 2 47

Operation Sheet 2.1 49

Operation Sheet 2:2. 50

Operation Sheet 2:3 51

LAP Test 52

Unit Three:- Assemble Tooling components 53

3.1. Assembling and fitting tooling components 54

3.2. Mold Assembly and Fitting 55

Self check 3 58

Operation Sheet 3.1 59

Operation Sheet 3.2 61
Unit Four:- Quality Assurance 63
4.1. First-off production components inspection 65
4.2. Causes of non-conformance in die and mold manufacturing 68
4.3. Deviation Modification Technique 69
4.4. Recording and reporting modifications 70
Self Check 4 71
Reference 72

Introduction to Module

Manufacturing advanced press tools, dies, and molds involves the production of specialized equipment used in various industrial processes, particularly in metalworking and plastics manufacturing, such as in metal stamping, injection molding, and casting. These tools are essential for shaping, cutting and forming raw materials into desired shapes and designs. The general processes of manufacturing press tools, dies, mould includes design and engineering to create a detailed design of the press tool, die, or mold, Material Selection for the tool or mould depend on factors, tool manufacturing (machining, Heat Treatment, Assembly), Testing and Quality Control and Maintenance and testing the tools.

This module is designed to meet the industry requirement under the Machining occupational standard, particularly for the unit of competency of Manufacture advanced press tools, dies, and molds.

The module covers the units:

- Tools, Dies and Mould Design
- Manufacture Tooling Components
- Assemble Tooling components
- Quality Assurance

Learning Objective of the Module:

- Identify and prepare work requirements
- Manufacture tooling components
- Assemble components
- Assure quality

Module Instruction

For effective use this modules trainees are expected to follow the following module instruction:

1. Read the information written in each unit
2. Accomplish the Self-checks at the end of each unit
3. Perform Operation Sheets which were provided at the end of units
4. Do the “LAP test” giver at the end of each unit and
5. Read the identified reference book for Examples and exercise

Unit one:- Concept of Press Tools, Dies and Mould Design

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Introduction to press tools, die and Mould manufacturing
- Types of Tools, Die and Mould
- Tooling Components
- Common tools, die and mould materials
- Design Procedure and Consideration
- Manufacturing Process of press tools, die and mould

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- explain Concepts of Die and Mould design
- identify types of press tools, die and moulds
- Identify and use type of Tooling Components
- Design Tools, die and mould the requirement
- Select Tools, Die and Mould Materials
- Prepare manufacturing process for press tools, die and mould machining

1.1. Introduction to press tools, die and Mould manufacturing

The production of machining centers makes it seem like die making is possible for anyone with the right equipment. However, die manufacturing is still considered a high-skill task due to the need to have techniques and skills that cover the entire process, including CAD designing, the selection of materials and machining methods, and performing minute machining that cannot be done through automated procedures.

Furthermore, even shorter turnarounds for die delivery are requested nowadays as product lifecycles are shorter and production includes smaller lots of numerous items. On another note, the emergence of 3D printers is expected to drastically change the way dies and molds are manufactured. Today, further innovations in mold and die technology are imperative.

Molds and dies are tools that are essential to mass production in present-day manufacturing. Both are key elements in manufacturing—for example, molds are used in injection molding to shape resin as well as in casting, and dies are used in stamping. Today's techniques are able to create micron-order precision molds and dies, contributing to the mass production of products with the same shape and quality in a wide range of areas.

Dies and molds are both tools for shaping. Dies are used to shape sheet metal and other metal forms. A typical application is the making of automobile body parts. On the other hand, molds are used in injection molding such as with melted resin or casting molten metal.

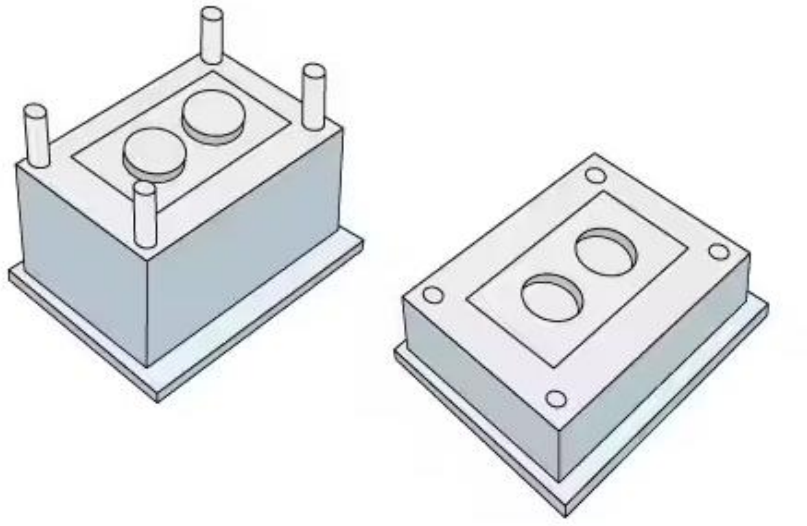


Figure 1.1: Image of a mold for injection molding

Tools, Die and mold design are critical aspects of manufacturing processes, particularly in industries such as metal stamping, injection moulding, and casting. The key concepts related to die and mould design are Die and Mould Functions, Parting Line, Core and Cavity, Draft Angle (clearances angle), Cooling Systems, punch and die clearances, the incorporation of ejector systems, the integration of guide and alignment features, and the provision of means for tool maintenance and repair also The choice of material for the mould or die depends on factors such as the manufacturing process, the material being processed, and the desired tool life. Common materials used for dies and mould include tool steels, pre-hardened steels, and various alloys. The material selection must consider factors such as strength, wear resistance, thermal conductivity, and machinability.

Tool and die design is a specialized field of engineering that focuses on designing the tools, dies, jigs, and fixtures used in manufacturing processes. These tools are critical for shaping and forming raw materials into finished products with high precision and efficiency. Tool and die design encompasses a range of tools, including progressive dies, transfer dies, blanking dies, forming dies, injection molds, and more. Each type of tool is designed for specific manufacturing processes and requirements.

1.2. Types of Tools, die and mould

There are various terms used to categorize dies, ranging from general to specific. At the highest level, dies can be classified as either cutting or forming. A cutting die is any die that removes, cuts, or shears material, regardless of its mechanism, whereas forming die does not remove any material.

However, this classification is not entirely comprehensive since some dies perform both cutting and forming functions. Moreover, certain dies like coining dies have their own specific categorization based on the process.

1.2.1. Types Dies

Another useful way to categorize dies is by analyzing what transpires with each stroke of the press during the tooling process:

i. Simple Dies

As its name implies, simple dies only have the capability to execute one type of cut or shape with each movement. Although this type of tools may have an advantage in terms of affordability, it is not as effective for more complex designs requiring several forming actions.

Simple dies also commonly produce basic forms as well as perform notching and lancing operations. Simple dies require a press operator to load and unload parts and part material before and after each press cycle.

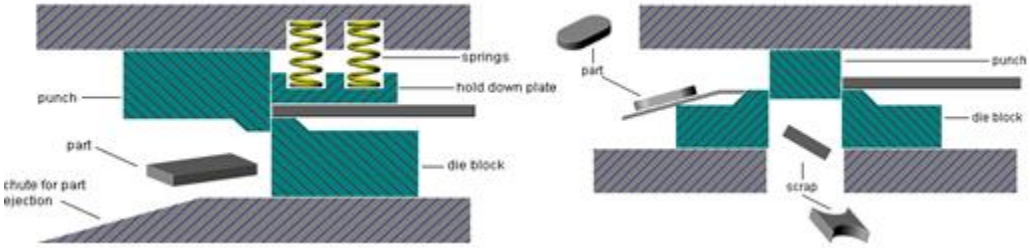


Figure 1.1: Simple Dies

i. Compound Dies

Compound dies have been created to perform several cutting and shaping processes in a single hit. Though this can reduce the speed of the stroke, they are more effective in the course of the tool manufacturing process and decrease the possibility of mistakes when transferring the work piece between various stations. Moreover, compound dies are ordinarily cost saving than progressive dies.

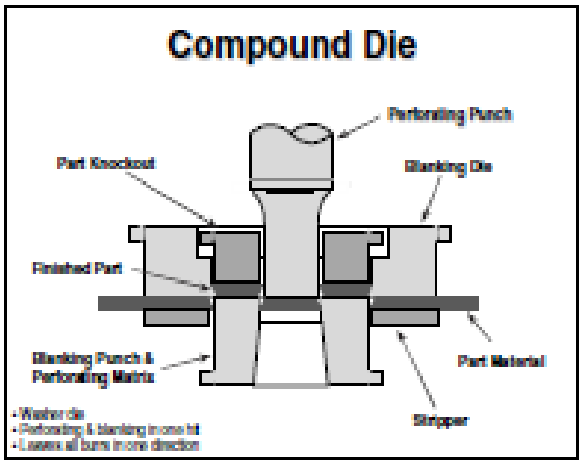


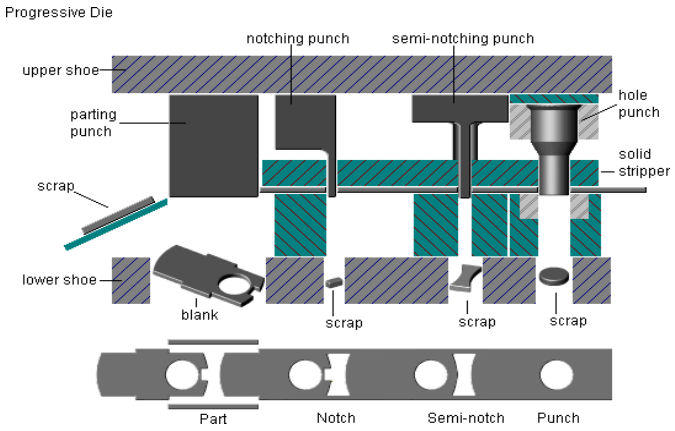
Figure1.3:-simple die (Cut off and Part off die)

ii. Progressive Dies

A progressive die is a tool which fabricates metal again and again into a consistent manner. A progressive die has multiple stations, or places where work is performed and the finished part is created in steps as it progresses through the die. We start with a strip of steel, or aluminum, copper, most any metal.

Progressive Die is a metalworking method that can encompass punching, coining, bending and several other ways of modifying metal raw material, combined with an automatic feeding system.

Progressive die stamping is a metal forming process widely used to produce parts for various industries, such as automotive, electronics and appliances. Progressive die stamping consists of several individual work stations, each of which performs one or more different operations on the part.



A progressive die

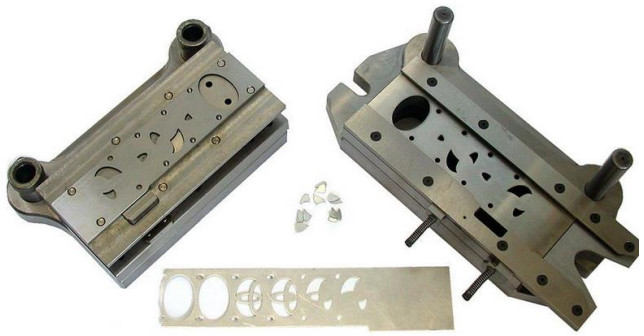


Figure 1.4: Progressive (punch and blanking) die with strip and punching

iii. Transfer Dies

Transfer dies are similar to progressive dies in structure, but they differ in that they use pre-cut blanks that need to be mechanically transferred between stations instead of utilizing a single strip of metal. Transfer fingers or conveyor belts often play a role in facilitating the transfer process. The use of transfer dies significantly enhances efficiency, particularly when cutting larger or more intricate parts that are not compatible with progressive die cutting.

A transfer die can be a single die by itself or a numbers of dies or machines arrange in row to form a production line. Transfer Press Stamping is an excellent option for the production of stampings and often offers the benefit of lower tooling costs.

iv. Multiple Dies

The multiple die press or gang press is notable for producing multiple components in a single stroke. To achieve this, multiple identical dies are connected to a single control mechanism, allowing them to operate in unison.

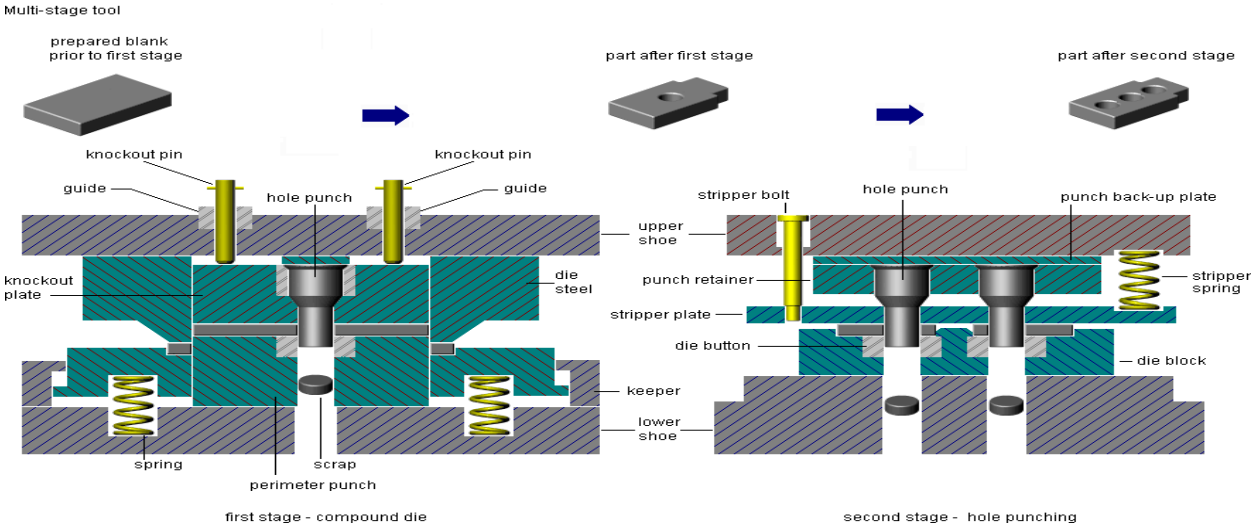


Figure 1.5: Multiple Dies

1.2.2. Injection Moulding

Injection moulding is the most common manufacturing process used to produce plastic parts. The process utilizes a machine, raw material, and a mould of the product part being produced to consistently manufacture high volumes of identical objects at a fast rate.

Most polymers can be used in the process, including all thermoplastics (nylon, polystyrene, polyethylene) and some thermosetting plastics (epoxy, phenolic). Though being mainly used for the production of plastics, other materials may also be used with injection moulding.
The main components of the process are described below:

Injection Moulding Process

- **Moulding** – A mould in the shape of the product part is designed using CAD, manufactured, and split into two halves.
- **Clamping** – The two halves of the mould are pushed and held securely closed by the clamping unit of the machine. Larger machines will require a longer time than smaller machines to carry out this step.
- **Injecting** – The raw materials, usually in the form of pellets, are melted by heat and pressure, then injected into the mould very quickly, filling the entire space within it. The build-up of pressure packs and holds the material together. The exact amount of material injected in the mould is referred to as *the shot*.
- **Cooling** – The molten material within the mould begins to cool as it makes contact with the mould surfaces, solidifying into the shape of the desired part.
- **Ejecting** – The clamping unit separates the two halves and the cooled, finished part is ejected from the mould via the ejection unit.

The production cycle is very short, usually lasting between 2 seconds and 2 minutes. Upon the completion of step 5, the cycle restarts at step 2, manufacturing a replica of the part.

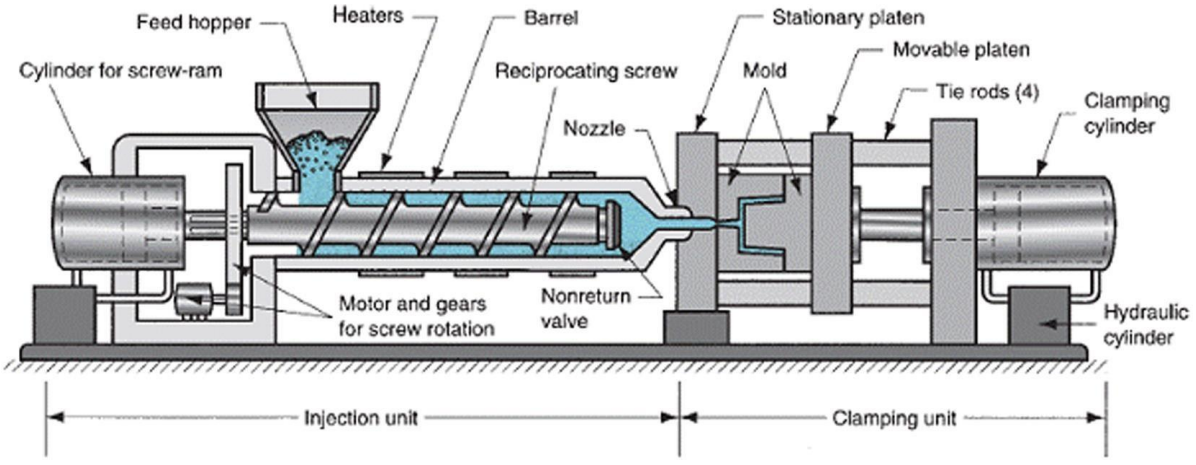


Figure 1.6: injection moulding process

Types of Injection Moulding

There are various types of the injection moulding process, ranging from:

- Gas-assisted injection moulding
- Liquid silicone rubber injection moulding
- Cube moulding
- Die casting
- Micro injection moulding
- Reaction injection moulding
- Metal injection moulding
- Thin-wall injection moulding

Uses of Injection Moulding

Injection moulding is the preferred production method for most mass-produced plastic products, due to its high output rate and consistency of quality. These products include but are not limited to:

- Automotive parts:- dashboards, bumpers, grilles.
- Electronic components:- electrical connectors, enclosures, protective sleeving.
- Medical devices:- syringes, valves, dishes.
- Consumer plastics:- mobile phone cases, bottle caps, toys.
- Furniture parts:- seat cushions, chairs, seat covers.

Advantages of injection moulding

- Ability to use **multiple materials** simultaneously, including multiple types of plastic as well as multiple colours
- Ability to design and manufacture intricate and complex geometrical shapes, as a result of the exceptionally high pressures that the moulds are applied with in the process
- Fast production, leading to a high output rate and efficiency
- Environmentally friendly process with little waste – scrap plastic is reground and re-used in the process.
- Repeatable process, leading to a consistent quality of products

- Produced parts need little work after the ejection since they have a more-or-less finished appearance.
- Low labour costs due to the process being highly machine orientated.

Disadvantages

- High initial cost to set up the machinery properly
- Not as cost effective if used to produce only a low volume of parts.
- Moulds need to be designed to a high standard, which takes skilled workers.

Injection moulding design Considerations

There are various considerations to take into account before undertaking injection moulding, ranging from:

Financial: The process can be costly to set up and operate, therefore it's most suitable to those with an appropriate budget.

Production Quantity: It's important to take into account how many parts you wish to manufacture in order to decide whether injection moulding is the most economical production method for your product.

Design Factors: Designing the mould itself is a key part of the process which can determine the quality and presence of defects during production. Simplifying the geometry and number of parts will lead to an easier process.

Production Considerations: Simplifying assembly requirements, cycle times, tooling, design and the use of hot runner moulds cam all lead to cost and labour savings.

Injection moulding is just one of the processes carried out in plastic manufacturing plants. Once the plastic parts are manufactured, they are bonded together to make a product. As a result, bonding plastics is a process just as important as producing them.

1.2.3. Blow molding

Blow molding is a manufacturing process by which hollow plastic parts are formed. In general, there are three main types of blow molding*: extrusion blow molding, injection blow molding, and injection stretch blow molding*. The blow molding process begins with melting down the plastic and forming it into a parison or in the case of injection and injection stretch blow moulding (ISB) a preform. The parison is a tube-like piece of plastic with a hole in one end through which compressed air can pass.

The parison is then clamped into a mold and air is blown into it. The air pressure then pushes the plastic out to match the mold. Once the plastic has cooled and hardened the mold opens up and the part is ejected.

In extrusion blow molding (EBM), plastic is melted and extruded into a hollow tube (a parison). This parison is then captured by closing it into a cooled metal mold. Air is then blown into the parison, inflating it into the shape of the hollow bottle, container, or part. After the plastic has cooled sufficiently, the mold is opened and the part is ejected.

Examples of parts made by the EBM process include most polyethylene hollow products, Milk bottles, shampoo bottles, Automotive ducting, watering cans and hollow industrial parts such as drums.

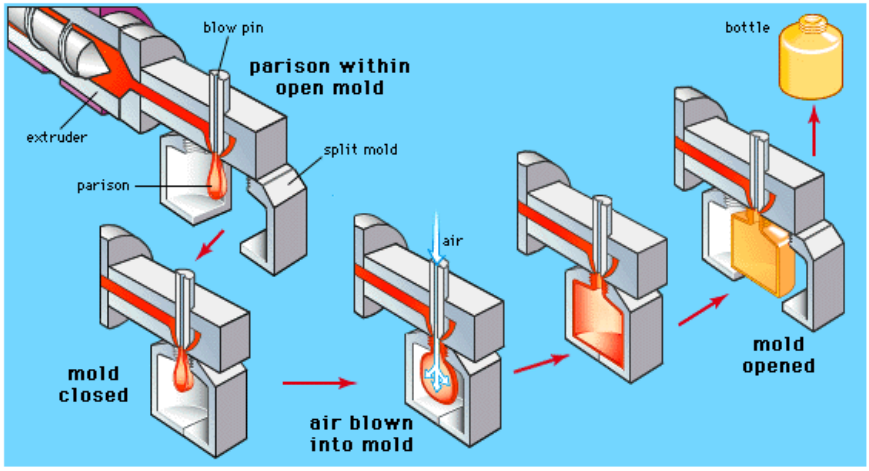


Figure 1.7: Extrusion blow molding

In Continuous **Extrusion Blow Molding** the parison is extruded continuously and the individual parts are cut off by a suitable knife. In Intermittent blow molding there are two processes: straight intermittent is similar to injection molding whereby the screw turns, then stops and pushes the melt out.

Advantages of blow molding include: low tool and die cost; fast production rates; ability to mold complex part; Handles can be incorporated in the design.

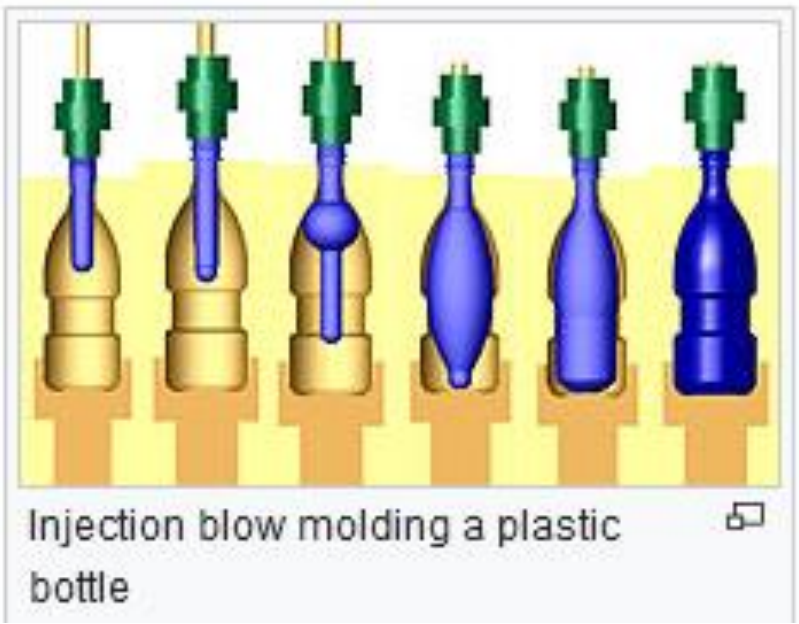
Disadvantages of blow molding include: limited to hollow parts, low strength, to increase barrier properties multilayer parisons of different materials are used thus not recyclable. To make wide neck jars spin trimming is necessary

1.2.4. Injection blow molding

The process of injection blow molding (IBM) is used for the production of hollow glass and plastic objects in large quantities. In the IBM process, the polymer is injection molded onto a core pin; then the core pin is rotated to a blow molding station to be inflated and cooled. This is the least-used of the three blow molding processes, and is typically used to make small medical and single serve bottles. The process is divided into three steps: injection, blowing and ejection.

The injection blow molding machine is based on an extruder barrel and screw assembly which melts the polymer. The molten polymer is fed into a hot runner manifold where it is injected through nozzles into a heated cavity and core pin. The cavity mold forms the external shape and is clamped around a core rod which forms the internal shape of the preform. The preform consists of a fully formed bottle/jar neck with a thick tube of polymer attached, which will form the body.

After a cooling period the blow mold opens and the core rod is rotated to the ejection position. The finished article is stripped off the core rod and as an option can be leak-tested prior to packing. The preform and blow mold can have many cavities, typically three to sixteen depending on the article size and the required output. There are three sets of core rods, which allow concurrent preform injection, blow molding and ejection.



Injection blow molding a plastic bottle

Advantages: It produces an injection molded neck for accuracy.

Disadvantages: only suits small capacity bottles as it is difficult to control the base centre during blowing.

Plastic forming process where a plastic tube is created in a first mold to be moved and then blow molded in another.

The process

Plastic pellets [1] are supplied via a hopper into a rotating screw [2] whose spiral shape moves the pellet forward through a heated chamber [3].The pellets are heated gradually and turns into a homogeneous plastic melt as it approaches the end of the helical screw.

The molten mass is pressed into a mold [4] as the entire screw is pushed forward by an applied pressing force. After the mass has solidified the mold parts are separated and the part, in the form of a tube with a closed end, is removed.

A: The parts are assembled and heated up later in a different mold.

B: By pressurizing the workpiece from the inside with a gas as it expands and conforms to the walls of the mold giving us the final product.

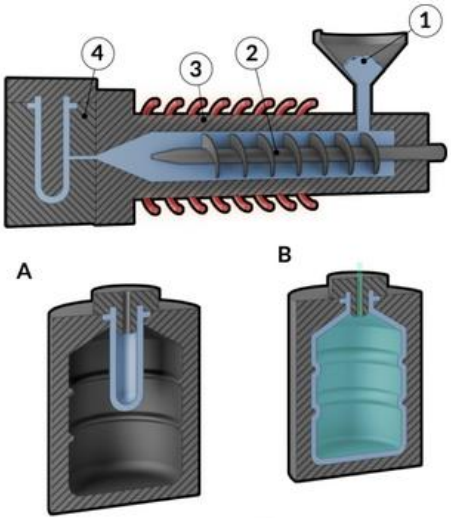


Figure 1:8: The process of Bellow Moulding

1.2.5. Close Die

Closed Die Forging is a forging process in which dies move towards each other and covers the work piece in whole or in part. The heated raw material, which is approximately the shape or size of the final forged part, is placed in the bottom die. The shape of the forging is incorporated

in the top or bottom die as a negative image. Coming from above, the impact of the top die on the raw material forms it into the required forged form.

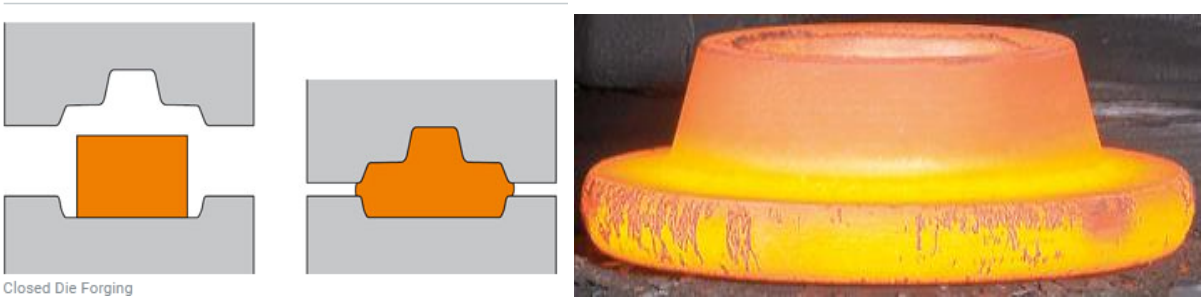


Figure 1.9: Closed Die and its product

1.3. Tooling Components

Tooling in manufacturing, also known as machine tooling, is the process of designing, cutting, shaping, and forming materials that will be used to produce parts and components.

Mold components are what make the mold work and the mechanisms used to deliver a quality end product. Key components include *mold bases, pins, ejectors, lifters, bushings, guides and alignment devices*.

Molding System:- This includes the cavity, core, inserts, sliders, and insert pins. The die casting cavity determines the casting shape as the moving core closes.

Mold Base System:- The primary components of the die cast mould base system are steel plates and frames. This system combines different parts of the mold and allows mold installation on the die casting machine.

Ejection System:- This system works to eject parts from the mold. These parts include ejection, returned, and guiding parts.

Runner System:-The runner system connects with the die casting part and pressure chamber. Thus, it guides the metal material into the die cavity in a specific direction. This system directly impacts the pressure and speed of molten metal. The runner system components are a runner, a sprue, an inner gate, etc.

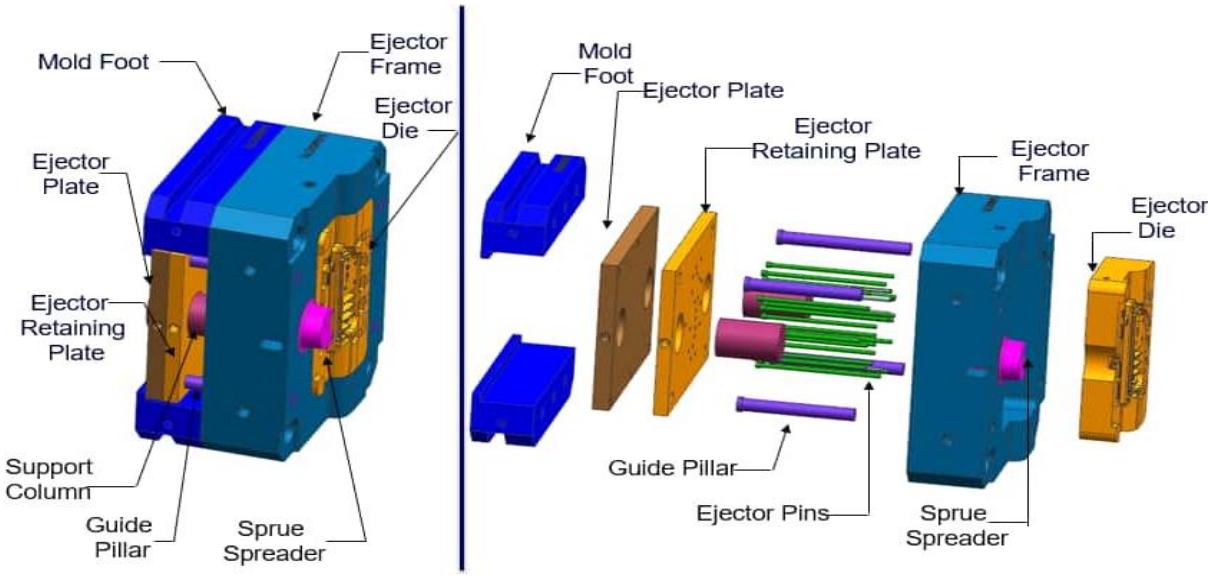


Figure 1.10: Mold Components

Overflow System:- This channel removes air from the pressure chamber. Generally, the primary components are overflow slots and venting slots. However, manufacturers install vent plugs in the deep cavities to improve venting conditions.

- Punch – The punch is the male part of the die that applies force to the work piece, resulting in a change in shape.
- Punch plate – The punch plate connects the punching feature to the ram, allowing it to move.
- Stripper plate – The stripper plate is used to separate the work piece from the punch after each hit.
- Pressure plates or backup plates – To evenly distribute the high pressure applied by the punch, different pressure plates are placed inside the die.
- Die block – The die block is similar to a mold and is designed with holes and indentations to create the desired shape of the component. It is pressed into by a punch or press to achieve the shape, and is usually female.
- Die holder – A die holder is used to support the die block and is attached to the upper or lower die shoe. It is supported by a bolster plate.
- Guide pins – Guide pins are critical for aligning the upper and lower parts of a die accurately

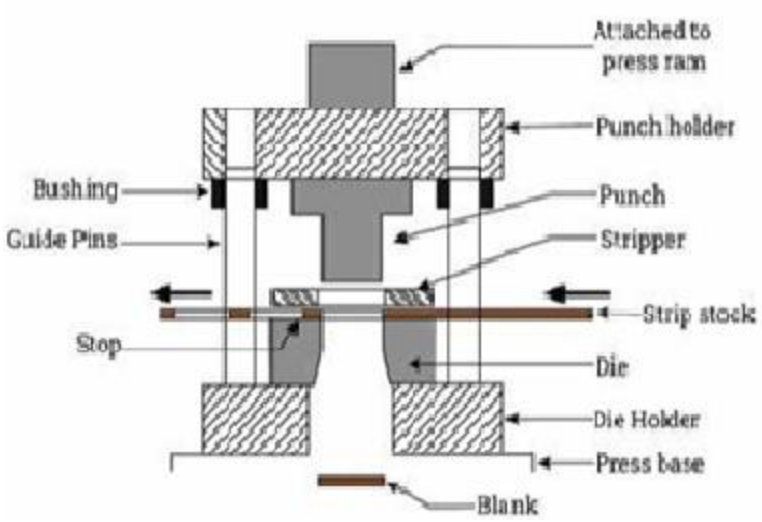


Figure 1.11: Die components

1.4. Common Press tools, die and Mould Materials

Materials for dies and molds include tool steels with carbon or chromium content, as well as die steel, high-speed steel and cemented carbide. Recently, ceramics have also been adopted as a material.

Commonly used materials for tools, dies, and molds include:

Tool Steels: Tool steels are widely used for their high hardness, strength, and wear resistance. Some common tool steels for die and mold applications include: H13: A hot work tool steel with excellent toughness, heat resistance, and wear resistance. It is often used for hot forging and die casting dies; D2: A high-carbon, high-chromium tool steel with good abrasion resistance and dimensional stability. It is commonly used for cold work applications like forming and punching dies; P20: A pre-hardened tool steel with good machinability and polishability. It is often used for injection molding and extrusion dies.

Stainless Steels: Stainless steels are known for their corrosion resistance and are suitable for applications where cleanliness and hygiene are crucial. Some stainless steels used for tooling include: 420 Stainless Steel: A martensitic stainless steel with good corrosion resistance and high hardness. It is often used for plastic injection molds; 440C Stainless Steel: A high-carbon martensitic stainless steel with excellent wear resistance and good corrosion resistance. It is commonly used for cutting tools and precision molds.

Aluminum Alloys: Aluminum alloys are lightweight and have good thermal conductivity, making them suitable for certain applications. Some aluminum alloys used for tooling include: 6061 Aluminum: A versatile alloy with good strength and machinability. It is commonly used for prototype molds and low-volume production; 7075 Aluminum: An aerospace-grade alloy with high strength and hardness. It is used for molds subjected to high stresses and pressures.

Copper Alloys: Copper alloys are known for their high thermal conductivity and excellent electrical conductivity. They are commonly used for electrical and electronic components. Some copper alloys used for tooling include: Beryllium Copper: A copper alloy with high strength, hardness, and conductivity. It is commonly used for electrical connectors and plastic injection molds MoldMAX®: A copper alloy with high thermal conductivity and excellent heat resistance. It is used for mold cores and inserts in plastic injection molding.

Materials used for dies and molds are mostly *hard and difficult* to cut. For this reason, dies and molds are cut using machining centers or other NC machining tools, but the products generally go through subsequent processes such as grinding for added precision. Furthermore, electrical discharge machining is used to produce dies and molds with even greater detail. Electrical discharge machining uses sparks from an electrical discharge to melt the surface of the work piece during machining. Not only is this method capable of producing precision metalworking, it also supports the creation of complex three-dimensional shapes.

Mold steel can be divided into three categories according to its purpose. The general principle of selection is to meet the requirements of service performance, good process performance, and proper consideration of economy.

The performance of materials has a substantial impact on the durability of injection or **casting molds**. One of the most important responsibilities of mold engineers is the selection of mold materials based on the structure and function of molds. Heat treatment and surface reinforcement are the most important processes for ensuring the quality and durability of molds. Real-world application has demonstrated that improper heat treatment is a major cause of mold failure. Let’s examine the most prevalent mold materials and heat treatment processes.

- **Cold work tool steel**: mold for making metal deformation in a cold state, including cold stamping die, cold extrusion die, cold upsetting die, and powder pressing die. It requires high hardness, high wear resistance, and sufficient strength and toughness.
- **Hot work tool steel:** it is used to manufacture the mold formed by heated solid or liquid metal under pressure, including hot forging die and die casting die. It requires sufficient strength, toughness, and wear resistance at high temperatures, as well as high thermal fatigue resistance and thermal conductivity
- **Plastic mold steel:** manufacturing all kinds of plastic molds. There are many kinds of plastics with different requirements, and the range of mold materials is wide.

1.5. Design Procedure and Considerations

Designing tools, dies, and molds involves a systematic approach that incorporates various considerations to ensure efficient and effective manufacturing processes. Here are some key steps involved in the design process:

Define Requirements: Begin by clearly defining the requirements for the tool, die, or mold design. Understand the intended application, production volume, material specifications, dimensional tolerances, and any specific functional or aesthetic requirements.

Conceptual Design: Generate initial concepts for the tool, die, or mold design based on the defined requirements. Consider factors such as part geometry, manufacturing processes, ease of use, maintenance, and cost-effectiveness. Sketch out different design ideas and evaluate their feasibility.

Detailed Design: Once a concept is selected, proceed to the detailed design phase. Utilize computer-aided design (CAD) software to create 2D and 3D models of the tooling components. Incorporate precise dimensions, tolerances, and features. Pay attention to factors such as parting lines, gating or feeding systems, cooling channels, and ejector mechanisms.

Material Selection: Select appropriate materials for the tool, die, or mold based on factors such as operating conditions, expected tool life, and compatibility with the manufacturing process. Consider using tool steels, carbide materials, or other specialized alloys that offer the necessary hardness, toughness, and wear resistance.

Simulation and Analysis: Utilize computer-aided engineering (CAE) software to simulate and analyze the tooling design. Perform analyses such as mold flow analysis, finite element

analysis (FEA), or thermal analysis to identify potential issues, optimize the design, and validate its performance. This step helps identify problems like air trapping, warpage, or excessive stresses.

Tooling Components:- Select and integrate the appropriate tooling components such as punches, dies, inserts, guide components, cooling components, ejector components, and fasteners. Ensure that the components are compatible, properly aligned, and securely fastened.

Design for Manufacturability: Design the tool, die, or mold with manufacturability in mind. Consider factors such as machining processes, assembly procedures, and accessibility for maintenance or repair. Optimize the design to minimize complexity, reduce manufacturing costs, and maximize efficiency.

Documentation and Drawings: Prepare detailed documentation and drawings of the tool, die, or mold design. Include assembly drawings, part drawings, and specifications that provide clear instructions for manufacturing, assembly, and maintenance.

Prototype and Testing: Build a prototype of the tool, die, or mold design to evaluate its functionality and performance. Conduct testing to verify its ability to produce parts that meet the specified requirements. Iteratively refine the design as necessary based on the test results.

Tooling Manufacturing:- Once the design is finalized, proceed with the manufacturing of the tooling components. Utilize machining, EDM, or other appropriate processes to fabricate the components to the required specifications. Ensure proper heat treatment and surface treatment, if necessary.

Tooling Assembly: Assemble the tooling components according to the design specifications. Pay careful attention to alignment, clearance, and proper functioning of moving parts. Verify that all components are securely fastened and adjusted for optimal performance.

Tooling Validation: Validate the tool, die, or mold by conducting production trials. Monitor the process parameters, inspect the produced parts, and evaluate their dimensional accuracy, surface finish, and overall quality. Make any necessary adjustments or refinements to achieve the desired results.

By following these steps, designers can create well-designed tools, dies, and molds that meet the required specifications, optimize manufacturing processes, and ensure high-quality parts production.

Four factors influence the design of a die block for any particular die. They are:

- Part size
- Part thickness
- Complexity of part contour
- Type of die

1.6. Manufacturing process of press tools, die and mould

Using dies and press, the tool and die manufacturing process manipulates the form of a material to produce components with different shapes and sizes. In this method, the press forces the material into the die cavity to transform the object into the same shape and size as the cavity.

Manufacturing process planning includes operation sequencing, machining process planning, assembly process planning, and assembly line planning, as well as the communication of plans throughout the organization and extended enterprise.

Manufacturing process planning software helps design and manufacturing engineers to concurrently develop product and manufacturing process definitions. This ensures that manufacturing constraints are reconciled during product design and vice versa. Importantly, this PLM software tool connects all members of the design/build process – from design, engineering, and manufacturing to plants and suppliers – into one virtual enterprise.

Self-cheek 1

Instruction: Answer all the following questions

Part I: Choose the correct answer from the given alternatives

1. Which of the following is the primary purpose of a tool, die, or mold in manufacturing?
   a. To provide decorative finishes
   b. To facilitate material handling
   c. To shape or form materials
   d. To provide electrical conductivity
2. Which of the following statements best describes the function of a die in manufacturing?
   a. It is used to create hollow cavities or spaces in the material.
   b. It is used to apply surface finishes or coatings.
   c. It is used to join two or more components together.
   d. It is used to cut or shape the material into a desired form.
3. Which of the following is true about mold design?
   a. Molds are only used in metalworking processes.
   b. Molds are used to shape materials through extrusion.
   c. Molds are designed to create castings or reproduce parts.
   d. Molds are primarily used for surface finishing operations.
4. Which of the following factors is important to consider in tool, die, and mold design?
   a. Material strength
   b. Surface color
   c. Electrical conductivity
   d. Sound insulation
5. Which of the following is a common method of tool and die manufacturing?
   a. Injection molding
   b. Powder coating
   c. EDM
   d. Electroplating
6. Which of the following is a consideration in designing a tool, die, or mold for high-volume production?
   a. Complex geometries
   b. Low-cost materials
   c. Limited tool life
   d. Single-use applications
7. Which of the following is an advantage of computer-aided design (CAD) in tool, die, and mold design?
   a. Reduced precision and accuracy
   b. Limited design flexibility
   c. Quicker design iterations
   d. Higher cost of design implementation
8. Which of the following is a typical material used in die or mold construction?

a. Glass
b. Rubber
c. Wood
d. Steel

Part II: Write True if the statement is correct and Write False if incorrect

1. The primary purpose of a tool, die, or mold is to shape or form materials.
2. A die is used to join two or more components together.
3. Material strength is an important factor to consider in tool, die, and mold design.
4. Injection molding is a common method used in tool and die manufacturing.
5. Complex geometries are a consideration in designing a tool, die, or mold for high
6. Computer-aided design (CAD) can provide quicker design iterations in tool, die, and mold design.

Part III: Write short Answer for the following questions

1. What are the different types of dies?
2. What are the key components of an injection mold?
3. What are the components of a blow mold?
4. What is the function of the blow pin in a blow mold?
5. What is the main advantage of blow molding compared to other molding processes?
6. What are the common applications of blow molded products

Unit Two:- Manufacture Tooling Components

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Workshop Safety Procedure
- Tools, Die and Mould Production Machines
- Hand tools and hand held power tools
- Die and Mould Design by CAD?CAM software Platform
- Machining Parameters and Machinability of materials
- Machining of Die Tooling Components
- Press Tools, Die and Mould heat Treatment

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Apply workshop Safety procedures
- Operate press tools, dies and mould production machineries
- Use hand tools and hand held power tools for die and mould manufacturing
- Apply CAD/CAM software platforms for manufacturing of press tools, die and mould
- Perform Machining of tooling components by using different Machines
- Discuss machining parameters and Machinability of the material
- Apply heat treatment of tools, Die and mould

2.1. Workshop Safety Procedures

Safety laws vary greatly from one state to another. However, the Occupational Safety & Health Administration (OSHA) has regulations/ laws governing operator safety. All states have some laws requiring protective guards and devices to safeguard workers. Safety should be designed into the tooling.

Occupational Health and Safety (OHS) is an important consideration in various manufacturing processes, including EDM (Electrical Discharge Machining), grinding, CNC milling, and CNC lathe operations.

Here are some OHS considerations specific to each process:

a) **EDM (Electrical Discharge Machining):**

Electrical safety: Proper grounding and insulation of EDM machines are essential to prevent electrical hazards.

Fire safety: EDM involves the use of flammable dielectric fluids. Adequate ventilation and fire prevention measures should be in place.

Eye and respiratory protection: Operators should wear appropriate personal protective equipment (PPE) like safety glasses and respirators to protect against sparks, debris, and fumes generated during the process.

Ergonomics: Operators should be trained in proper posture and lifting techniques to minimize the risk of musculoskeletal injuries.

b) **Grinding:**

Machine guarding: Grinding machines should be equipped with proper guards to prevent contact with moving parts and flying debris.

Eye and face protection: Operators must wear safety glasses or face shields to protect against sparks, particles, and abrasive dust generated during grinding.

Dust control: Adequate ventilation or local exhaust systems should be in place to control and capture grinding dust.

Noise control: Grinding can produce significant noise levels. Hearing protection should be provided to workers to prevent hearing loss.

c) **CNC Milling and CNC Lathe**

Machine guarding: CNC milling machines should have appropriate guarding to protect operators from moving parts and cutting tools.

Chip management: Proper chip management systems should be in place to prevent accumulation of chips, which can cause slipping hazards or interfere with machine operation.

Eye protection: Safety glasses or face shields should be worn to protect against flying chips, coolant, or other debris.

Tool handling: Safe handling and storage procedures for sharp cutting tools should be implemented to prevent injuries.

Ergonomics: Adequate training in ergonomics should be provided to prevent injuries related to repetitive motions or manual material handling.

In all these processes, comprehensive training, hazard assessments, regular equipment maintenance, and adherence to safety protocols are crucial to ensure a safe working environment and minimize the risk of accidents or injuries. It is important for employers and workers to comply with applicable OHS regulations and guidelines.

2.2. Press Tools, Die and Mould Production machine

Tool and die manufacturing is a machining method used to create a variety of implements that are important in various manufacturing processes. Die cutting is a fabrication process which employs specialized machines and machine tools to convert stock material by cutting, forming, and shearing it into custom shapes and designs.

The fundamental elements of tool and die manufacturing consist of:

- Precise cutting and shaping tools for metals and other materials.
- Dies that are used to shape metals through forging or stamping, such as for plastic, ceramic, or composite materials.
- Jigs that securely hold the metal during boring, drilling, or stamping processes

Tool and die machining machines are specialized machines used in the manufacturing of tooling components, dies, and molds. These machines are designed to perform precise and complex machining operations to create the required shapes, features, and surface finishes. Here are some commonly used machines in tool and die machining:

CNC Milling Machines

CNC (Computer Numerical Control) milling machines are widely used for machining molds, dies, and tools due to their versatility, precision, and ability to handle a wide range of materials. Here are some key points regarding the use of CNC milling machines in mold, die, and tool machining:

CNC milling machines are extensively used for producing mold components, such as cavity and core inserts, slides, and ejector pins and also for machining die components, such as punches, dies, inserts, and form tools. Mold design is created using CAD (Computer-Aided Design) software, and the design data is translated into machine-readable instructions, typically using G-code, which is then programmed into the CNC milling machine.

CNC milling machines remove material from a work piece using rotating cutting tools, such as end mills or ball mills, to create the desired shape of the mold components.

The machines offer high accuracy and repeatability, allowing for the precise machining of complex mold geometries, including fine details, intricate contours, and smooth surface finishes

Various materials, including tool steels, aluminum alloys, and even plastics, can be machined using CNC milling machines to create molds for different applications.



Figure 2.1: CNC Milling

EDM Machines

Electrical Discharge Machining (EDM) machines utilize electrical discharges to remove material from the work piece. EDM is particularly useful for machining hard materials and creating complex shapes with tight tolerances.

EDM (Electrical Discharge Machining) machines are widely used in the manufacturing of dies, tools, and molds due to their ability to accurately shape and form complex features in hard materials. Here is an overview of how EDM machines are used in die and tool/mold production. It is used to create cavities, details, and contours in die components. The process begins by designing the die using CAD (Computer-Aided Design) software. Wire EDM machines are commonly used to cut the cavity shapes in the die blocks. A thin, electrically charged wire is guided along a programmed path, eroding the material through electric sparks. EDM machines are utilized in the production of molds for various industries, such as plastics, automotive, and aerospace. EDM allows for the production of molds with high precision, complex contours, and tight tolerances, which are critical in industries where accuracy and surface finish are vital.

In all these applications, EDM machines offer excellent precision, the ability to work with hardened materials, and the capacity to achieve intricate shapes and fine details. The specific EDM process used (wire EDM or sinker EDM) depends on the requirements of the project and the complexity of the features being machined.



Figure 2.2. Wire EDM or sinker EDM

Wire Cut Machines: Wire cut machines, also known as wire electrical discharge machines (WEDM), and use a thin wire electrode to cut complicated shapes in a work piece. They are

precise machines suitable for cutting complex profiles and contours. Wire cut machines are commonly used in tool and die machining for creating punch and die components, as well as for making intricate cuts in hard materials.

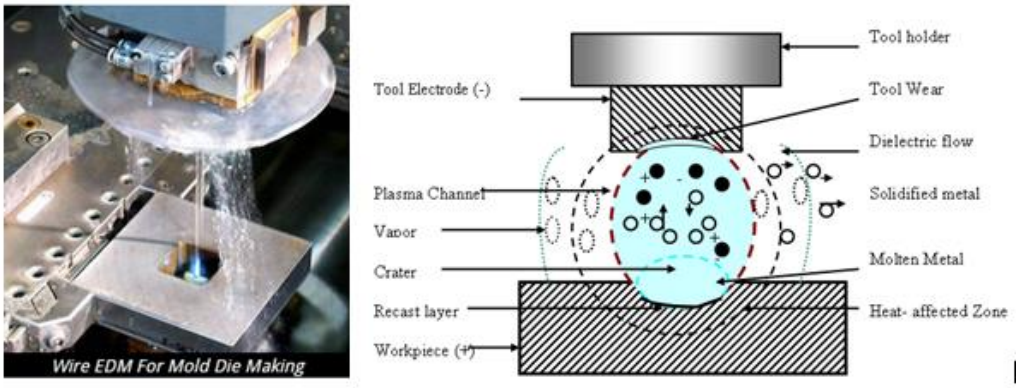


Figure 2.3. Die and Mould Making by EDM

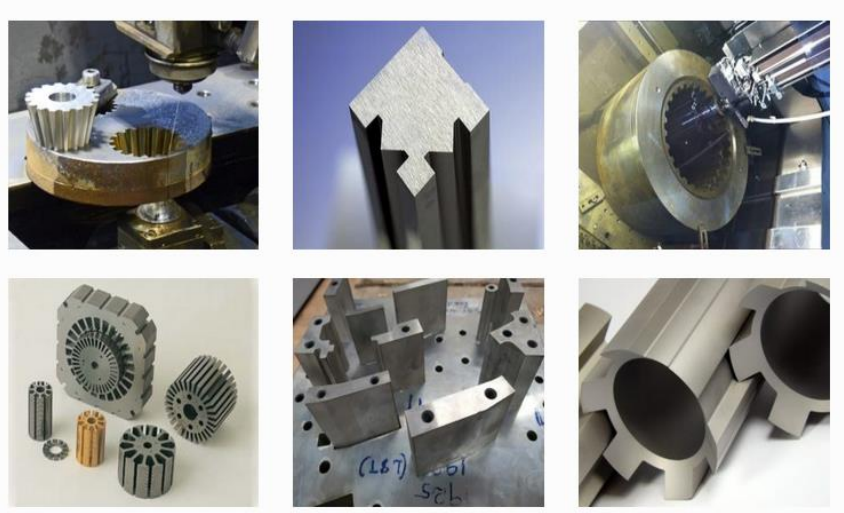


Figure 2.4: punch holder tool machine by CNC EDM wire cut punch

CNC tool grinders have a long history of swallowing an ever increasing range of grinding jobs apart from just drills and mills. Broaches, reamers, inserts, burrs and medical tools are now routinely produced on tool grinders. Medical implants, turbine blades and pinion gears are also fast succumbing to the superior versatility, accuracy and speed of grinding on modern 5 axis tool grinders. Grinding machines are used for precise and high-accuracy machining operations. Surface grinding machines, cylindrical grinding machines, and tool and cutter

grinding machines are commonly used in tool and die machining to achieve precise dimensions and surface quality.



Figure 2.5: CNC grinder and punch product

2.3. Hand tools and hand held power tools

Portable grinders are handheld power tools that are used for grinding, cutting or polishing. These versatile tools can be used for a variety of tasks when used with the proper grinder wheels according to the manufacturer's recommendations, including: Removing paint, rust or mortar.

A die grinder or rotary tool is a handheld power tool and multi-tool used for grinding, sanding, honing, polishing, or machining material (typically metal, but also plastic or wood).



(a) Die grinder (b) Portable Drill (c) handheld grinder



(d) A set of punch and stamps, hammer, files etc.

Figure 2.6 Hand tools and hand held power tools

2.4. Press Die and Mould design By CAD/CAM software platform

The use of CAD/CAM reduces lead time and improves communication between design and manufacturing activities, as well as quality and reproducibility. Computer Aided Engineering (CAE) uses various analysis techniques to simulate material flow to predict and avoid defects and improve die design.

AD/CAM refers to the integration of Computer-aided design (CAD) and Computer-aided manufacturing (CAM). CAD/CAM software is used to design and manufacture prototypes, finished products, and production runs of products using a single development tool.

CAD (Computer-Aided Design) Software: CAD software is widely used in press tool and mold design. It enables designers to create detailed 2D and 3D models of the tools, incorporating precise dimensions, tolerances, and features. CAD software provides a range of tools and functionalities for designing complex tooling components, generating parting lines, creating assemblies, and performing simulations. Popular CAD software for press tool and mold design includes SOLIDWORKS, CATIA, AutoCAD, and NX.

CAM (Computer-Aided Manufacturing) Software: CAM software is used to generate tool-paths and instructions for the manufacturing process. It takes the CAD model and translates it into machine-readable instructions for CNC (Computer Numerical Control) machines. CAM software allows for efficient programming of machining operations, such as milling, turning, drilling, and EDM (Electrical Discharge Machining), ensuring accurate and precise tool fabrication.

2.4.1. The SolidWorks CAM Process

The chart below illustrates how the functions in SOLIDWORKS CAM are utilized to generate NC code.

SolidWorks CAM is computer-aided manufacturing (CAM) software integrated within the SolidWorks CAD environment. It enables the generation of toolpaths and machining operations for molds and dies directly from SolidWorks 3D models. Here's an overview of SolidWorks CAM machining for molds and dies:

Setup and Stock Definition:

SolidWorks CAM allows you to define the machining setup by selecting the machine, work coordinate system, and other parameters specific to the machining process.

The stock material is defined based on the 3D model of the mold or die. You can specify the stock size and orientation relative to the part.

Machining Operations:

SolidWorks CAM provides various machining operations to perform specific tasks on the mold or die.

Roughing: This operation removes the bulk of material from the stock, leaving a rough shape. It typically uses larger tools and deeper cuts to optimize material removal.

Finishing: This operation removes the remaining material and achieves the final surface finish. It uses smaller tools and more precise toolpaths to achieve the desired level of detail and accuracy.

Contouring: This operation follows the contour of the part to create features, such as cavities, holes, or profiles.

Drilling: This operation creates holes in the mold or die using appropriate drill tools and parameters.

Pocketing: This operation removes material from within a defined boundary, such as pockets or recesses.

Toolpath Generation:

SolidWorks CAM generates toolpaths based on the selected machining operations.

The software analyzes the part geometry, tooling parameters, and machining strategy to generate efficient toolpaths.

Toolpath generation considers factors such as cutting direction, tool engagement, feeds, speeds, and tool changes.

SolidWorks CAM supports various toolpath strategies, such as parallel, radial, spiral, and zigzag, to accommodate different machining requirements.

Simulation and Verification:

SolidWorks CAM provides simulation capabilities to visualize and verify the machining process.

You can simulate the toolpaths to check for collisions, tool clearances, and any potential issues that may arise during machining.

Simulation helps identify and rectify any errors or clashes before actual machining, reducing the risk of damage to the mold or die.

Post-processing:

After generating the toolpaths, SolidWorks CAM can generate machine-specific G-code or other CNC machine instructions required for the specific manufacturing equipment.

The post-processor converts the toolpaths into machine-readable instructions, including tool movements, feeds, and speeds, tailored to the CNC machine being used.

SolidWorks CAM integration simplifies the mold and die machining process by allowing seamless transition from design to manufacturing within a single software environment. It enables efficient toolpath generation, simulation, and post-processing, ultimately improving productivity and accuracy in mold and die machining operations.

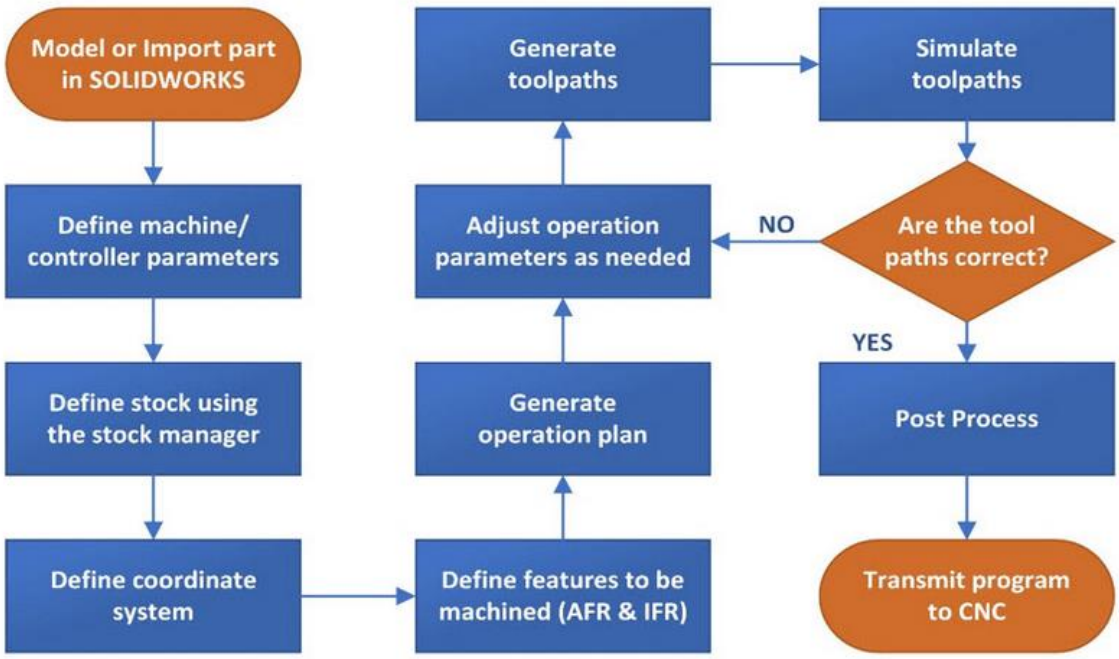


Figure 2.7: SolidWork project Simulation and Verification

The SOLIDWORKS CAM Interface

The SOLIDWORKS CAM user interface closely follows the above process. These commands will be discussed in greater detail in future articles.

A. Set-up options
B. Program generation commands

C. Options to add operations interactively

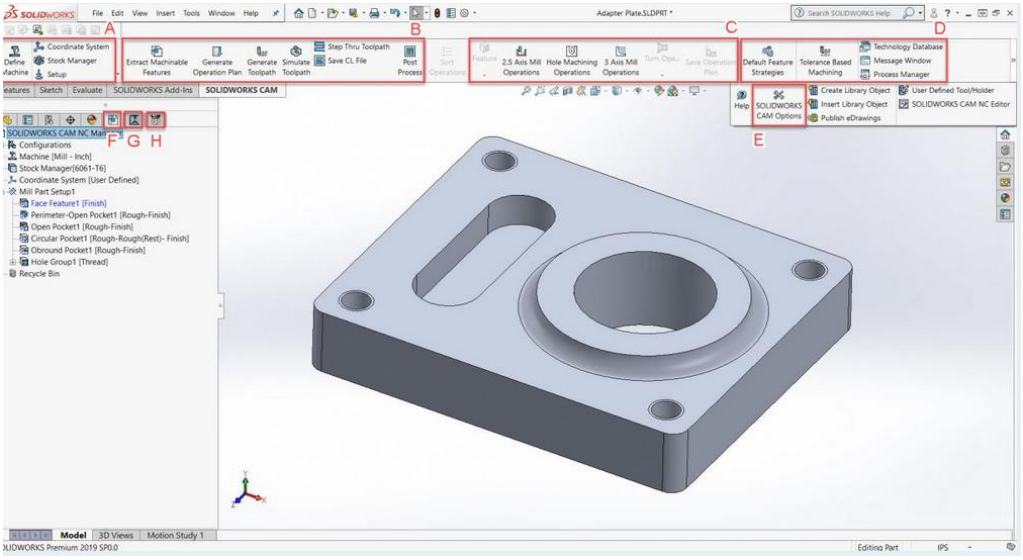
D. Technology Database Options

E. Options for defining features to be extracted when using (AFR)

F. CAM Feature Tree – Shows extracted features

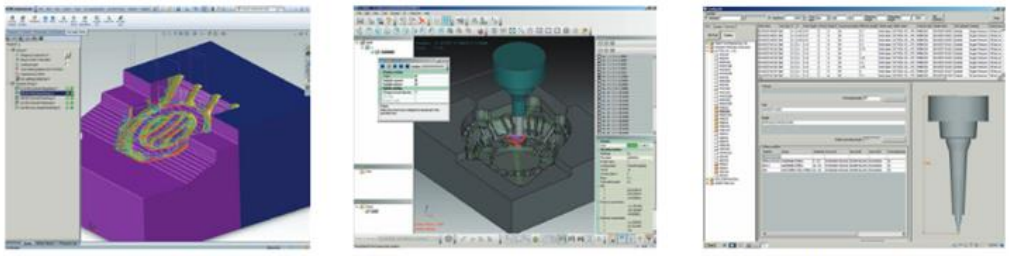
G. CAM Operations Tree – Edit or add operations interactively

H. CAM Tool Tree – Editing current Tool Crib





(a) Project Setting (b) Machining Process



(c) Optimization / Cutting Simulation (d) CL Editor (d) Tooling DB

2.5. Machining parameters and Machinability of the material

2.5.1. Machining parameters

Machining parameters for different machining processes, such as EDM (Electrical Discharge Machining), milling, and lathe, are typically determined based on empirical knowledge, experience, and recommendations from tooling manufacturers. While there are no specific universal formulas for setting machining parameters, I can provide you with some general guidelines and examples for each process.

i. EDM Machining Parameters

Pulse Duration: Pulse duration refers to the duration of the electrical discharge during the EDM process. It depends on factors such as material type, thickness, and desired surface finish. Shorter pulse durations are typically used for fine surface finishes, while longer durations are used for rough machining. The pulse duration is generally set based on experience and trial-and-error.

Pulse Frequency: The pulse frequency determines the number of electrical discharges per unit time. It affects the material removal rate and surface finish. Higher pulse frequencies result in faster material removal but may affect surface finish. Pulse frequency is typically adjusted based on the desired material removal rate and surface finish.

Peak Current: Peak current is the maximum current applied during the EDM process. It influences the spark intensity and material removal rate. Higher peak currents lead to faster material removal but may affect electrode wear. The peak current is typically determined based on the material type, thickness, and desired machining speed.

Gap Voltage: The gap voltage is the voltage applied between the workpiece and electrode. It affects the spark gap and the material removal rate. Higher gap voltages generally result in faster material removal rates. The gap voltage is typically adjusted based on the desired material removal rate and machining speed.

ii. Milling Machining Parameters:

Cutting Speed: The cutting speed in milling refers to the speed at which the cutting tool rotates and engages with the work piece. It is typically measured in surface feet per minute (SFPM) or meters per minute (m/min). The cutting speed is determined based on the material being

machined, tool material, and desired balance between tool life and productivity. It can be calculated using the formula:

Cutting Speed (CS) = (π x Diameter of the Cutter x Spindle Speed).

Feed Rate: The feed rate in milling refers to the speed at which the workpiece moves relative to the cutting tool. It is typically measured in inches per minute (IPM) or millimeters per minute (mm/min). The feed rate is determined based on factors such as material being machined, tool geometry, and desired chip thickness. It can be calculated using the formula: Feed Rate (FR) = (Number of Teeth on the Cutter x Chip Load per Tooth x Spindle Speed).

Depth of Cut: The depth of cut in milling refers to the distance that the cutting tool penetrates into the work piece during a single cutting pass. It is typically measured in inches (or millimeters). The depth of cut is determined based on factors such as tool rigidity, material hardness, and desired machining time. It is generally recommended to use a depth of cut that is less than the tool diameter to avoid excessive tool deflection.

iii. Lathe Machining Parameters:

Cutting Speed: The cutting speed in lathe machining refers to the speed at which the work piece rotates and engages with the cutting tool. It is typically measured in surface feet per minute (SFPM) or meters per minute (m/min). The cutting speed is determined based on factors such as material being machined, tool material, and desired balance between tool life and productivity. It can be calculated using the formula:

Cutting Speed (CS) = (π x Diameter of the Work piece x Spindle Speed).

Feed Rate: The feed rate in lathe machining refers to the speed at which the cutting tool moves along the work piece to remove material. It is typically measured in inches per revolution (IPR) or millimeters per revolution (mm/rev). The feed rate is determined based on factors such as material being machined, tool geometry, and desired chip thickness. It can be calculated using the formula:

Feed Rate (FR) = (Number of Tool Passes x Depth of Cut).

Depth of Cut: The depth of cut in lathe machining refers to the distance that the cutting tool penetrates into the work piece during a single cutting pass. It is typically measured in inches (or millimeters). The depth of cut is determined based on factors such as tool rigidity,

material hardness, and desired machining time. It is generally recommended to use a depth of cut that is less than the tool radius to avoid excessive tool deflection.

2.5.2. Machinability of the material

Die and Mold Machining: Materials used for dies and molds are mostly hard and difficult to cut. For this reason, dies and molds are cut using machining centers or other NC machining tools, but the products generally go through subsequent processes such as grinding for added precision.

2.6. Machining of die Tooling component

Modern production of die and mold tools is quite different in comparison with conventional machining. The basic theory of cutting process and cutting geometry is similar, but the techniques and technology is quite different. High-speed cutting (HSC) principles are not applicable with conventional machine-tools. Difference between conventional and high-speed cutting velocity is analyzed on chip formation. The comparison between EDM and HSM(high speed machining) has been made and shows great HSC benefits. Usage of modern software (CAM) optimizes tool production and helps us to save unnecessary additional machining time and costs.

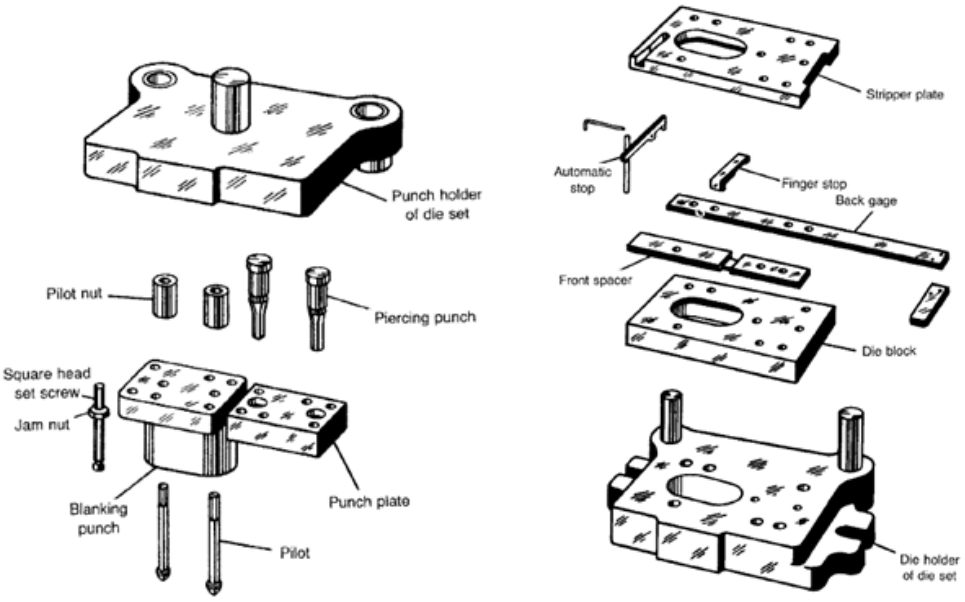


Figure 2.8: Die components

Die Design Figure 2.9 shows the die block of the die. The die block is made of hardened tool steel into which holes have been machined, before hardening, at the piercing station and also at the blanking station. These are the same size and shape as the blank holes and contour. Other

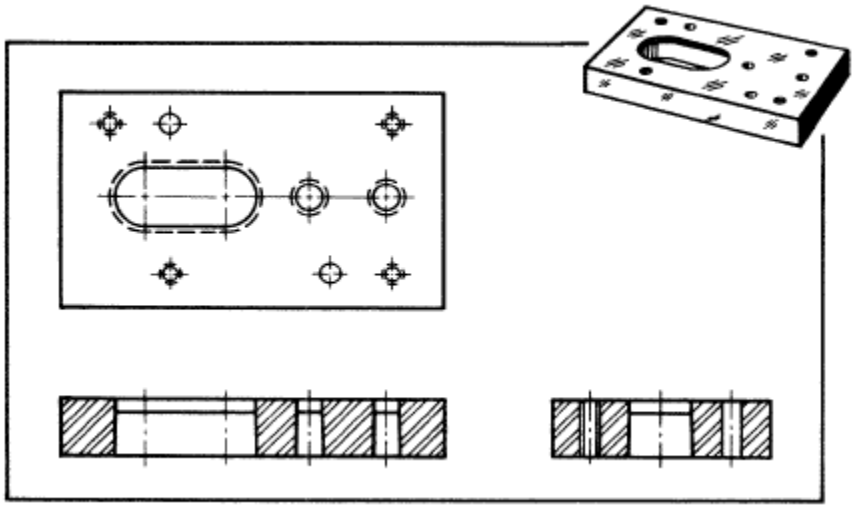


Figure 2.9: The die block.

The **blanking punch** (Figure 2.10) removes the blank from the strip. The bottom, or cutting edge, is the shape and size of the part. A flange at the top provides metal for fastening the blanking punch to the punch holder of the die set with screws and dowels. Two holes are reamed all the way through the blanking punch for retaining the pilots, which locate the strip prior to the blanking operation. Locate the views of the blanking punch in the die drawing, Figure 1.2, to improve your ability to read a die drawing.

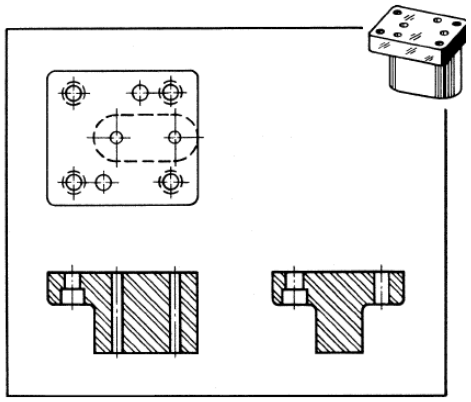


Figure2.10: Blanking Punch

A **piercing punch** (Figure 2.11) pierces holes through the material strip or blank. It is usually round and provided with a shoulder to keep it in the punch plate. When a piercing punch penetrates the strip, the material clings very tightly around it. A way must be provided to strip or remove this material from around the punches.

The means employed to remove such material is called a “stripper.”

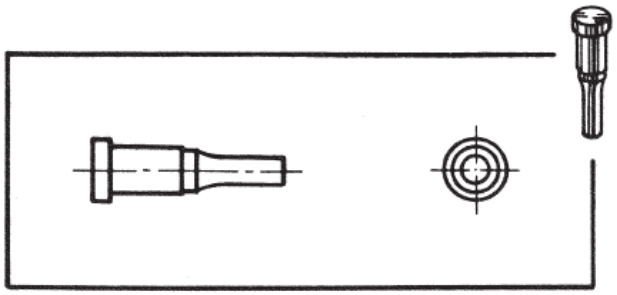


Figure2.11: Piercing Punch

The pu**nch plate** (Figure 2.12) is a block of machine steel that retains punches by keeping the punch heads against the punch holder of the die set. The punches are held in counter bored holes into which they are pressed. Four screws and two dowels retain the punch plate to the punch holder of the die set. The screws prevent it from being pulled away from the punch holder. Dowels, which are accurately ground round pins, are pressed through both the punch plate and punch holder to prevent shifting. Locate the front view and plan view of the punch plate in the die drawing.

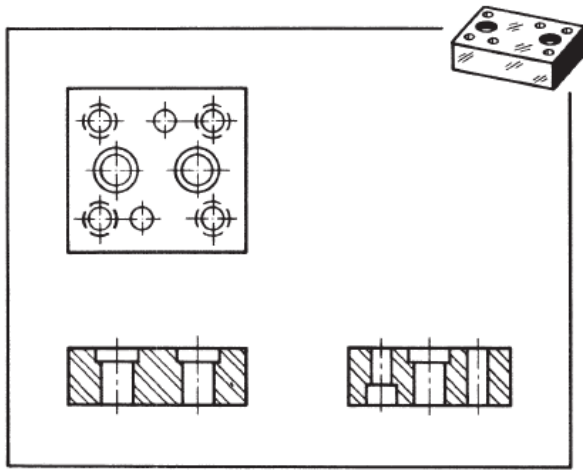


Figure 2.12: Punch Plate

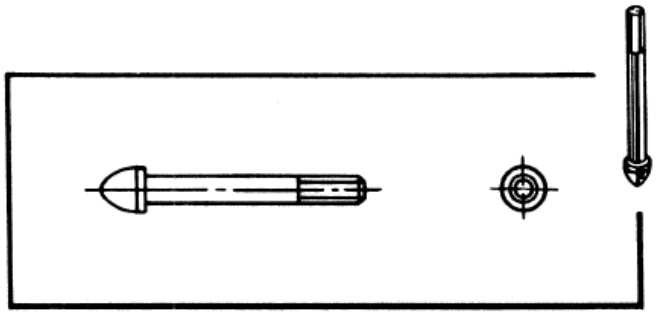


Figure 2.13: pilot

The back gage (Figure 1.16) is a relatively thin steel member against which the material

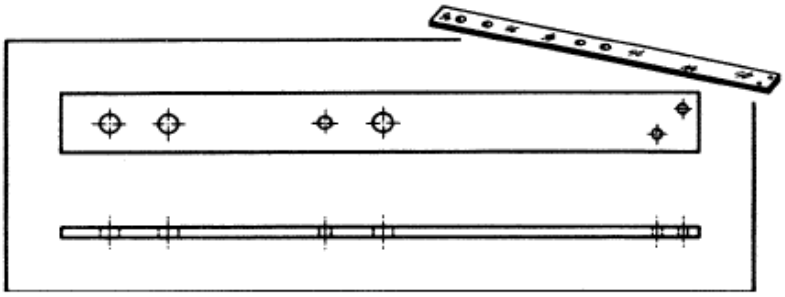


Figure 2.14: Back guide

The Stripper Plate: The stripper plate (Figure 1.19) removes the material strip from around blanking and piercing punches.

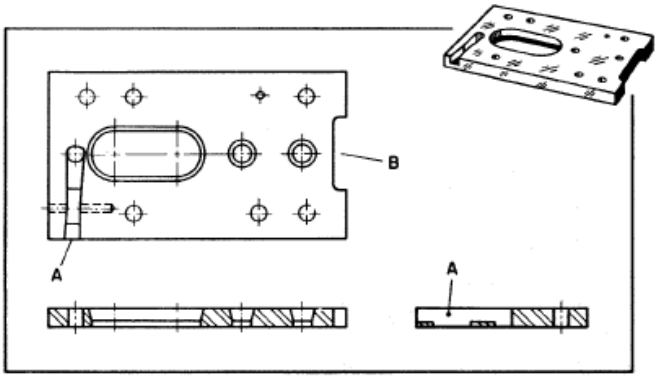


Figure 2.15: stripper plate

The one illustrated is solid. The stripper plate has a slot **A** machined into it in which the automatic stop operates. Another slot **B** at the right provides a shelf for easy insertion of a new strip when it is started through the die.

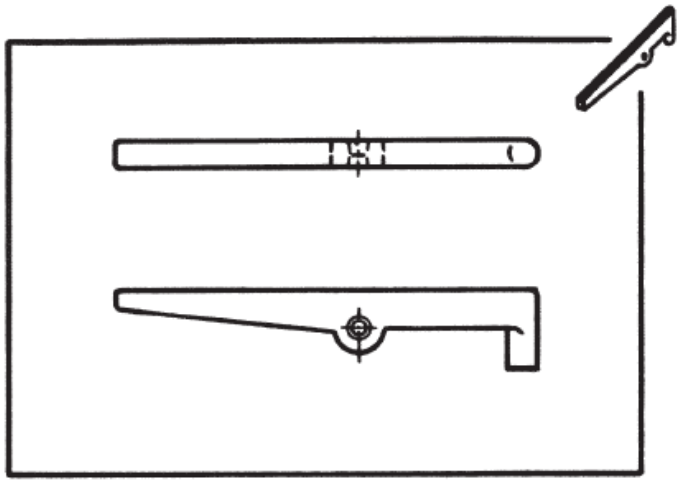


Figure 2.16: automatic stop

Fasteners: Fasteners hold the various components of the die together

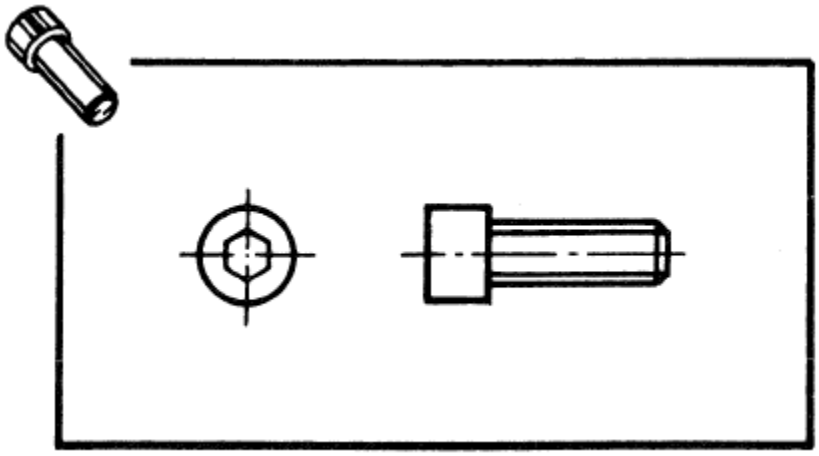


Figure 2.16: Socket head cap screw for use as a fastener.

2.7. Tools, Die and Mould heat Treatment

Heat treatment is a fundamental process in the manufacturing of dies, tools, and molds. It involves controlled heating and cooling of the material to alter its mechanical properties, such as hardness, toughness, and wear resistance. The specific heat treatment process and parameters depend on the material composition, desired properties, and the intended application of the die, tool, or mold.

The main performance requirements of die steel:

- Hardness and wear resistance (the most important form of die failure determines to die life)

- Machinability (the shape of die parts is complex, requiring small heat treatment deformation)
- Strength and toughness (sufficient strength to withstand high pressure, impact load, and other requirements)
- Hardenability, polishing, and corrosion resistance (corrosion effect of plastics and additives).

Common Heat Treatment Process of Mold

Mold heat treatment includes mold material heat treatment and mold parts heat treatment.

Heat treatment of die material: it shall be completed in the steel plant to ensure the quality of steel, such as basic mechanical properties and metallographic structure, which shall comply with national standards or industrial standards. It is characterized by mass production in large industrial furnaces.

Heat treatment of mold parts: completed in the mold manufacturer or professional heat treatment plant. It is characterized by small batch or single piece production, complex and diverse processes, and sophisticated equipment.

The heat treatment process includes preparation heat treatment and final heat treatment. Common methods include normalizing, annealing, quenching, quenching and tempering, carburizing, and nitriding.

Heat treatment process is used for different types of mold materials

A. Cold Work Tool Steel Heat Treatment

Cold working mold is mainly used for blanking, stretching, bending, and other processes of metal or non-metallic materials. The working parts bear various mechanical forces such as tension and compression, bending, impact, fatigue, friction, and so on. The main failure forms include fracture, collapse, wear, adhesion (bite), gnawing, softening, etc.

Heat treatment of carbon tool steel: it is used for small simple cold working die working parts with low requirements (T8A, T10A). T10A is the most widely used, with high strength and toughness. The hardenability of carbon tool steel is poor, and the hardened layer is 1.5 ~ 3.0mm after conventional quenching. T8-T10A hot rolled steel round bars, **T8, T10 and T12** are carbon tool steels. They are very hard. The Brinell hardness in annealed state is more than

300. Manual saw blade is T12 material, just quenching, hardness is greater 10 and 20 are low carbon, high quality



Figure 2:17: T8, T10 and T12 are carbon tool steels.

AISI T8 tool steel is a tungsten-cobalt-vanadium high-speed tool steel. The following datasheet will provide an overview of grade T8 tool steels.

Heat treatment of low alloy steel: commonly known as oil quenched steel, this kind of steel generally has low quenching temperature, cooling in oil, small deformation, and good dimensional stability.

Heat treatment of high alloy steel: it is mainly high chromium high carbon steel with high hardenability and micro deformation, also known as micro deformation steel. It is a high-grade cold working steel.

B. Plastic Mold Steel Heat Treatment

Pre-hardening steel generally refers to the steel that has been subject to final heat treatment (quenching and tempering) in the steel plant. Typical pre-hardened plastic die steel: sm3cr2mo. The heat treatment process is 840-880℃ quenching, oil cooling, 600-650℃ tempering, air cooling, and supply hardness of 32hrc.

Typical heat treatment of free cutting pre-hardened steel: annealing at 800 ± 10 ℃, holding for 2-4h, cooling to 700-720 ℃, holding for 4-6h, furnace cooling, hardness < = 229hbs, quenching at 880-920 ℃, air cooling, hardness 63hrc, tempering at 160-200 ℃, air cooling, hardness > = 58hrc.

Non-alloy medium carbon plastic die steel is a medium carbon structural steel with higher metallurgical quality (purity), with a C content of 0.4% – 0.6%. Typical materials are SM45 and SM50. Its heat treatment process is no different from the conventional process. For small plastic mold parts with low precision requirements, this steel is the first choice.

–Corrosion-resistant plastic mold steel is used to manufacture plastic products and mold parts that corrode metals. Typical steel types are Cr13, 9Cr18, and other martensitic stainless steels

that can be strengthened. Its heat treatment is the same as that of general stainless steel products.



Figure 2.18: cold work tool steels

Hot Work Tool Steel Heat Treatment

Hot working dies mainly include forging die, hot extrusion die, die casting die, etc. the main failure forms are fracture (crack or mechanical fatigue crack), plastic deformation or cavity collapse, thermal fatigue, thermal wear, and hot melt loss.

Hot working die steel with high thermal strength is mainly used to make working parts of die-casting die and machine forging die. High thermal strength, thermal fatigue, hot melt loss, tampering resistance, and thermal stability are required. Generally, it contains more Cr, W, Si, Mo, V, and other alloy elements. Representative steel grades are: 4Cr5MoSiV, 4Cr5MoSiV1, etc.



Figure 2.19: Tool Steels High Speed Steel Mold & Die Steels Special Steel

High wear resistance hot working die steel has good hardness, good thermal wear resistance, high-temperature strength, high-temperature toughness, and thermal stability. Representative steel grade: 3Cr2W8V. High quenching temperature: 1100-1150^{o}C. In order to reduce deformation, the temperature rises slowly and preheats complex and large parts.

Self-check 2

Part I: Choose the correct Answer form the given alternative

1. Which of the following manufacturing processes is commonly used for producing tooling components with complex geometries?
   a. Injection molding
   b. Sheet metal forming
   c. 3D printing/Additive manufacturing
   d. Sand casting
2. Which of the following materials is commonly used for manufacturing tooling components that require high strength and wear resistance?
   a. Aluminum
   b. Brass
   c. Stainless steel
   d. Acrylic
3. Which of the following machining processes involves rotating a cutting tool against the surface of a work piece to remove material and shape the tooling component?
   a. Turning
   b. Milling
   c. Drilling
   d. Grinding
4. Which of the following manufacturing processes is commonly used for producing tooling components with high precision and surface finish?
   a. Sand casting
   b. Powder metallurgy
   c. Electrical discharge machining (EDM)
   d. Injection molding

Part II: Write True if the Statement is correct and write False if it is Incorrect

1. Press tools are typically made from soft and ductile materials.
2. Heat treatment is a process used to enhance the mechanical properties of die and mold materials.
3. Annealing is a heat treatment process used to increase the hardness of tool steels.
4. Feed rate refers to the distance the cutting tool travels along the work piece per revolution.
5. Cutting speed refers to the rotational speed of the cutting tool during machining.
6. Depth of cut refers to the thickness of the material removed by each pass of the cutting tool.
7. SolidWorks CAM is standalone software separate from SolidWorks CAD.
8. SolidWorks CAM allows for the generation of toolpaths directly from SolidWorks 3D models.
9. SolidWorks CAM does not support simulation and verification of the machining process.

Part III : write short answer for the following questions listed bellow

1. What are some common heat treatment methods used for tools, dies, and molds?
2. Why is heat treatment important for tools, dies, and molds?
3. What are some commonly used materials for making dies and molds?
4. What is the significance of selecting the appropriate die material for a specific application?
5. What are some common machining methods used for die and mold production?
6. How does electrical discharge machining (EDM) contribute to die and mold manufacturing?

Operation Sheet 2.1

Operation Title: Create a CAD die Model by using SolidWorks,

Purpose: To examine the functionality press die and mould

Conditions for the operations:

- Safe working area
- Properly operated tools and equipment
- Appropriate working cloths fit with the body

Equipment Tools and Materials:

- Desktop computer with solidwork software

Quality Criteria: Assured performing of all the activities according to the procedures

Precautions:

- Read and interpret manual which guide you how to use tools and equipment

Steps in doing the task

1. Creating 3D Models: SolidWorks allows you to create 3D models of your designs using a variety of sketching and modeling tools. You can define dimensions, constraints, and relationships to accurately represent your design intent.
2. Assembly Design: SolidWorks enables you to create complex assemblies by bringing together multiple components and defining their relationships, constraints, and motion. You can simulate the assembly's functionality and detect any interferences or clashes.

3. Drafting and Detailing: SolidWorks provides tools to generate 2D engineering drawings with accurate dimensions, annotations, and geometric tolerances. You can customize drawing templates and automatically update them when the 3D model changes.

Operation Sheet 2:2.

Operation Title: Performing machining of die tooling components using CNC milling,

Purpose: To enhance the skills of die components by CNC Machine

Conditions for the operations:

- Safe working area
- Properly operated tools and equipment
- Appropriate working cloths fit with the body

Equipment Tools and Materials:

- Desktop computer with solidwork software
- CNC Milling with tools and accessories
- Tool Steel, Stainless Steel

Quality Criteria: Assured performing of all the activities according to the procedures

Precautions:

- Read and interpret manual which guide you how to use tools and equipment

Steps in doing the task

1. Set up the CNC milling machine by securing the workpiece and installing the necessary cutting tools.
2. Load the CAM program into the CNC machine and set the appropriate machining parameters.
3. Execute the program to perform milling operations, such as roughing, profiling, and drilling, as per the design specifications.
4. Monitor the machining process, ensuring accuracy and making any necessary adjustments.
5. Inspect the machined die tooling component to verify dimensional accuracy and surface finish.

6. Perform any necessary deburring or surface treatment processes to remove sharp edges or improve the component's aesthetics.
7. Assemble the machined component into the larger die assembly if required.

Operation Sheet 2:3

Operation Title: Performing machining of die tooling components using Wire EDN Machine

Purpose: To enhance the skills of die components by CNC Machine

Conditions for the operations:

- Safe working area
- Properly operated tools and equipment
- Appropriate working cloths fit with the body

Equipment Tools and Materials:

- Desktop computer with solidwork software
- Wire EDM Milling with tools and accessories
- Tool Steel, Stainless Steel

Quality Criteria: Assured performing of all the activities according to the procedures

Precautions:

- Read and interpret manual which guide you how to use tools and equipment

Steps in doing the task

1. Set up the Wire EDM machine by securing the work piece and installing the appropriate wire electrode.
2. Load the CAM program into the Wire EDM machine and set the necessary parameters, such as wire tension and cutting speed.
3. Initiate the EDM process, where controlled electrical discharges are used to erode the workpiece material along the programmed path.
4. Monitor the EDM process, ensuring precise and accurate cutting according to the design.
5. Inspect the machined die tooling component to verify dimensional accuracy and surface finish.

6. Perform any necessary deburring or surface treatment processes to remove sharp edges or improve the component's aesthetics.
7. Assemble the machined component into the larger die assembly if required.

LAP Test

Practical Demonstration

Name: _____ **Date: _____**

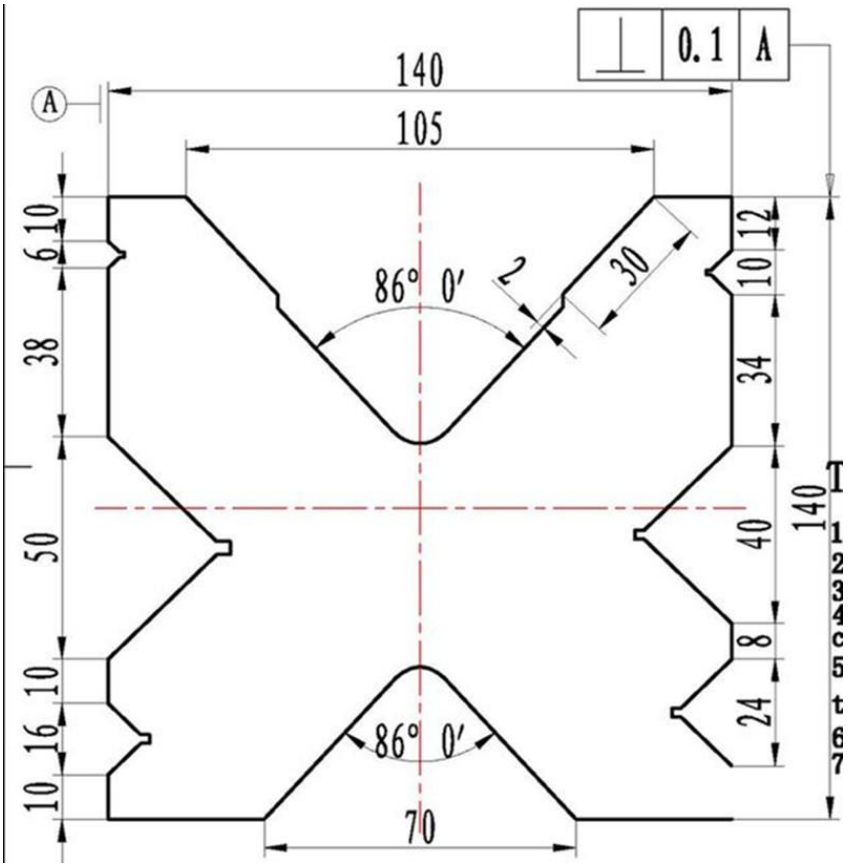
Time started: _____ **Time finished: _____**

Instruction: Perform the following tasks

Task 1: convert CAD (Computer-Aided Design) model to CAM (Computer-Aided Manufacturing) instructions and generating G-code

Task 2: Perform machining of die tooling components using CNC milling

Task 2: Perform machining of die tooling components using Wire EDN Machine



All dimensions are in mm

Materials: Tool steel or Stainless Steel

Unit Three:- Assemble Tooling components

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Assembling and fitting tooling components
- Mould assembly And Fitting

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Assemble and fit tooling components
- assemble And Fit Moulding

3.1. Assembling and fitting tooling components

3.1.1. Die Assembly

In-die assembly can combine multiple stamped parts together during the stamping process, eliminating the need for secondary processing. We can also perform the insertion of non-stamped components to yield your finished parts

It is a machine tool used in manufacturing industries to cut and/or form material to a desired shape or profile. Similar to molds, dies are generally customized depending on their purpose in manufacturing.

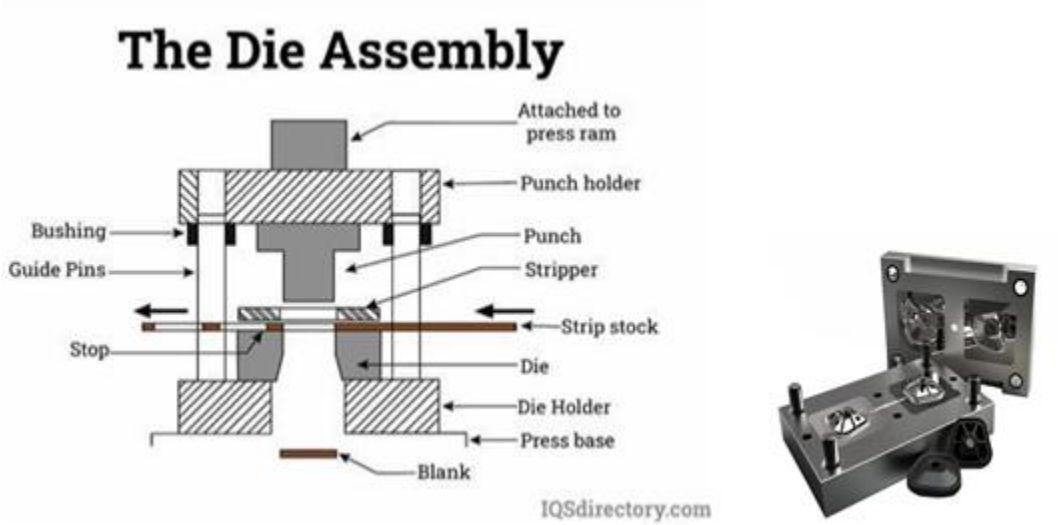


Figure 3:1 Tooling component Assembly

3.2. Mold Assembly and Fitting

Mold assembly is one of the most critical steps of mold making procedure, all the parts machined or purchased need to be put together and required to be work functionality. Mold assembly job requires comprehensive understanding of mold structure as well as injection molding. Quality of mold assembly determines the mold precision, injection productivity. The work instructions below can be treated as a guide for mold makers.

All parts are machined correct and clean, the work tools required are available and the workplace is well organized, before assembling the mold, all the components must be check and verified.

And there are more for different types of mold structure, such as 3 plate mold, they have unique design of latch lock, limited pull plate, runner plate etc. and for hot runner molds, they have special design for hot runner manifold plate, and installation of hot nozzle wiring, plugging etc.

Tooling components refer to the individual parts that make up a tool, die, or mold. These components are designed and manufactured to work together to achieve a specific function in a manufacturing process. Assembly, on the other hand, involves the process of combining these tooling components in a systematic manner to create a functional tool or mold.

Tooling components can vary depending on the specific application and manufacturing process. Some common tooling components include:

Base or Frame: The structural foundation of the tooling assembly that provides stability and support.

Inserts:- Removable components that are used to create specific features or shapes in the final product. Inserts can be easily replaced or modified to accommodate different product variations.

Punches and Dies: These components are commonly used in metalworking processes such as stamping and forming. Punches create holes or shapes in the material, while dies provide the corresponding cavity or form.

Cavity Plates: These plates define the shape and form of the final product in injection molding or casting processes. They create the negative space into which the molten material is injected or poured.

Ejector Pins: These pins help in the removal of the finished product from the mold or die. They push or eject the product out of the cavity once it has solidified or taken shape.

Slides and Lifters: These components are used in molds to create complex shapes or undercuts. Slides and lifters enable the release of the finished product from the mold by creating additional movement or action.

Cooling and Heating Systems: These components help regulate the temperature during the manufacturing process. Cooling channels or circuits remove heat from the tooling components, while heating elements provide controlled heating, if required.

Generlly, Assembling tooling components such as press tools, dies, and molds involves the careful alignment and integration of various parts to ensure proper functionality and performance. Here are the general steps involved in assembling these components:

Preparation: Gather all the necessary tooling components, including the base or frame, inserts, punches, die blocks, cavity plates, ejector pins, and other related parts.

Cleaning and Inspection: Before assembly, ensure that all components are clean and free from debris, rust, or other contaminants. Inspect each part for any damage, wear, or defects that may affect the assembly or performance.

Alignment and Fit: Proper alignment and fit are crucial for tooling component assembly. Use precision measuring tools, such as micrometers and dial indicators, to ensure that the components are within the specified tolerances. Make any necessary adjustments or modifications to achieve the desired fit.

Fastening: Secure the components together using appropriate fastening methods. This may include bolting, clamping, or welding, depending on the specific requirements and design of the tooling components. Follow the recommended torque specifications for fasteners to ensure proper tightness.

Lubrication: Apply suitable lubrication to the moving parts and sliding surfaces to reduce friction and facilitate smooth operation. Use lubricants that are compatible with the materials and operating conditions of the tooling components.

Testing and Validation: After assembly, conduct functional tests to ensure that the tooling components perform as intended. Verify proper alignment, movement, and clearances. Test the tools, dies, or molds with sample materials to ensure they produce the desired results. Make any necessary adjustments or fine-tuning.

Documentation: Maintain detailed documentation throughout the assembly process. Record any modifications, adjustments, or special considerations made during assembly. This documentation helps in traceability, future reference, and troubleshooting if issues arise.

Ongoing Maintenance: Regularly inspect and maintain the assembled tooling components to ensure continued performance and longevity. Clean, lubricate, and address any wear or damage as needed. Follow the manufacturer's recommendations for maintenance schedules and procedures.

Proper assembly of tooling components is crucial for achieving consistent and reliable manufacturing processes. Following manufacturer guidelines, industry best practices, and specific design requirements is essential to ensure the tooling components function optimally and produce high-quality products.

Self check 3

Part I: Choose the correct Answer form the given alternatives

1. Which of the following is an essential step in the assembly of tooling components?
   a. Surface coating
   b. Dimensional measurement
   c. Material selection
   d. Heat treatment
2. Which of the following fastening methods is commonly used to assemble tooling components?
   a. Welding
   b. Adhesive bonding
   c. Riveting
   d. Soldering

3. Which of the following is a common technique used to ensure proper alignment and fit during the assembly of tooling components?
   a. Tolerance analysis
   b. Jig and fixture design
   c. Statistical process control
   d. Failure mode and effects analysis

5. Which of the following is a quality control measure commonly employed during the assembly of tooling components?
   a. Visual inspection
   b. Material selection
   c. Surface treatment
   d. Heat treatment

6. Which of the following assembly methods is commonly used for tooling components with tight tolerances and high precision requirements?
   a. Press fit assembly
   b. Bolted assembly
   c. Welded assembly
   d. Soldered assembly

7. Which of the following is a consideration when selecting the appropriate lubrication method for tooling component assembly?
   a. Temperature resistance
   b. Surface finish
   c. Electrical conductivity
   d. Material strength

Part II: Matching

Column A	Column B
Cavity	A. Injection molding
Ejector Pins	B. Die assembly
Cooling Channels	C. Mold assembly
Core	
Sprue	

Part III: Write True if the stement is correct and write False if incorrect

1. In die assembly, the components are securely fastened together using bolts, screws, or clamps.
2. Mold assembly involves the integration of core and cavity inserts to create the desired shape of the molded part.
3. The assembly of a die or mold may involve the use of guide pins, bushings, or alignment features to ensure proper alignment and precision.
4. The tooling assembly process involves the installation of ejector systems to facilitate the removal of molded parts from the mold.
5. The tooling assembly for both dies and molds requires careful consideration of clearance and tolerance to ensure proper functioning and part quality

Operation Sheet 3.1

Operation Title: Assembling tooling components

Purpose: To examine the functionality press die and mould

Conditions for the operations:

- Safe working area
- Properly operated tools and equipment
- Appropriate working cloths fit with the body

Equipment Tools and Materials:

- Tooling components
- Wenches
- Measuring equipment

Quality Criteria: Assured performing of all the activities according to the procedures

Precautions:

- Wearing proper clothes, eye glass, glove
- Make working area hazard free
- Read and interpret manual which guide you how to use tools and equipment

Steps in doing the task

The assembly process for tooling components typically involves the following steps:

1. Preparation: Gather all the required tooling components and ensure they are clean, inspected, and in proper working condition.
2. Alignment and Fit: Ensure that the components are aligned correctly and fit together according to the design specifications. This may involve using precision measuring tools and making any necessary adjustments.
3. Fastening: Secure the components together using appropriate fastening methods such as bolts, screws, clamps, or welding. Follow recommended torque specifications for fasteners to ensure proper tightness.
4. Lubrication: Apply suitable lubricants to moving parts and sliding surfaces to reduce friction and enable smooth operation.
5. Testing and Validation: Conduct functional tests to ensure that the assembled tooling components function as intended. Verify proper alignment, movement, and clearances. Test the tool or mold with sample materials to ensure it produces the desired results.

6. Documentation: Maintain detailed documentation throughout the assembly process, recording any modifications, adjustments, or special considerations made. This documentation aids in traceability, future reference, and troubleshooting.

Operation Sheet 3.2

Operation Title: Removing the Die Assembly

Purpose: To examine the functionality press die and mould

Conditions for the operations:

- Safe working area
- Properly operated tools and equipment
- Appropriate working cloths fit with the body

Equipment Tools and Materials:

- Tooling components
- Wenches
- Measuring equipment

Quality Criteria: Assured performing of all the activities according to the procedures

Precautions:

- Wearing proper clothes, eye glass, glove
- Make working area hazard free
- Read and interpret manual which guide you how to use tools and equipment

Steps in doing the task

Before you remove the current die assembly, you must prepare yourself and your work area. Follow these steps to remove the previous die assembly:

i. Locate the die setup instructions, the setup instructions contain all of the information that you need to ensure that the die is ready for setup.

ii. Check that all necessary equipment is properly positioned and readily available. Some shops have a cart, like the one which conveniently holds all of the necessary equipment.

iii. Remove or disconnect any previous tooling, coil stock, gauges, samples, and any other materials from the previous setup that are not needed for the next setup.

iv. Remove auxiliary equipment, such as the part or scrap conveyor bins. Also, remove or disconnect air or automatic lubrication lines.

v. Remove and properly store the safety block, which is in place beneath the slide. Be sure to replace the safety block in its holder. Reconnect the safety plug, if there is one.

vi. Remember to save a sample of the strip along with samples of the parts from the previous press operation. These samples remain with the die in the tool room.

LAP Test

Practical Demonstration

Name: _____ Date: _____

Time started: _____ **Time finished:** _____

Instruction: Perform the following tasks

Task 1: Perform Assembling mechanisms of tooling components press die and punch

Task 2: Perform Dis assembling or removing mechanisms of tooling components of press die and punch

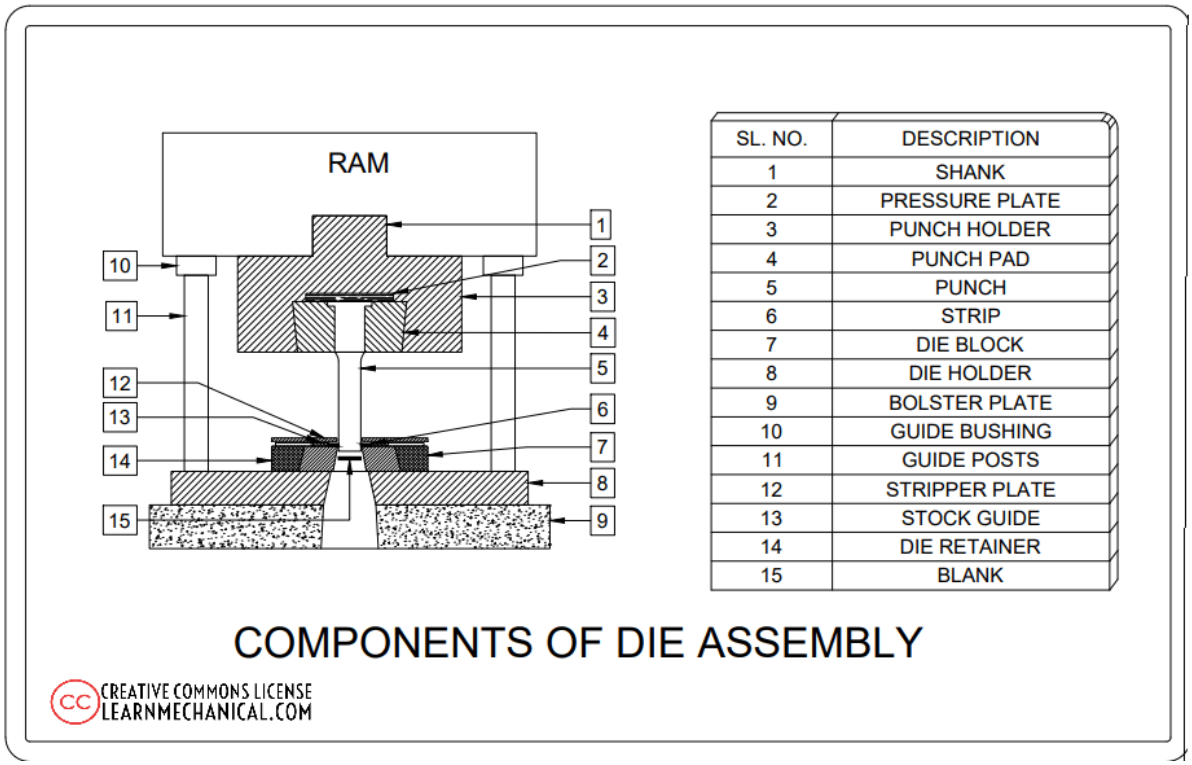


Figure 3: 2: Final Assembly of Die componets

Unit Four:- Quality Assurance

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- First-off production components inspection
- Causes of non-conformance
- Deviation Modification technique
- Recording and reporting modifications

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Test first-off production components inspection with precision instruments
- Check causes of non-conformance
- Modify Deviation to original tooling design, prints or plans
- Record and report modifications according to standard operating procedures

4.1. First-off production components inspection

Plastic molding quality control is crucial in plastic injection molding if you want perfect results. Let's look at how water is controlled during the process of casting. Using the right amount of water is very important for making high-quality plastic goods. If there isn't enough water, the plastic structure can weaken, making apparent plastic goods cloudy and ruining their finish.

On the other hand, too much water can cause cracks, a problem for businesses that care a lot about how their products look, like the medical and automotive industries. This is a big problem for some Chinese businesses that make plastic molds.

In the past, dryers were used to reduce the amount of water in plastic particles, but they could not properly measure the amount of water. Advanced moisture monitors have been made in the United States, Europe, and China to deal with this problem.

Before casting, these monitors can accurately measure how much water is in the plastic. This makes it easier to control and improve production. With this kind of cutting-edge technology, the plastic molding industry can improve production efficiency, cut costs, and make high-quality goods that meet the high standards of many industries.

Mold and Pre-Production Inspection

Plastic molding quality control ensures that a product meets all of the standards. It is an integral part of any manufacturing process. This stage can be broken down into four steps:

- Designing the mold
- Inspecting the mold before production
- Inspecting the mold during production
- Inspecting the mold after production

Mold Design

This is where you create the mold that will be used to make your product. This is the first step in getting your product made. Then, you use different materials to make the mold based on what you're making. For instance, injection molding usually uses molds made of metal or steel alloys, while other processes use ceramic or sandstone molds.

Pre-Inspection:

During this step, the parts made during the injection-molding process are checked before they are sent out. It can also be called the "first article inspection." This ensures that each part meets the requirements and that problems are found before reaching customers.

Now, inspectors look at each part visually and use measuring tools to ensure that the sizes, weights, and tolerances are right according to your requirements. They also test how well the parts work by seeing if they fit well.

Another consideration in this regard is the part's strength. This is because the parts may not always work perfectly right out of the mold. In addition to visual plastic molding inspection and plastic molding testing, inspectors may also use X-rays or other non-destructive testing (NDT) or **plastic molding testing** methods to ensure that things are safe and work as they should.

When plastic is injected, the most common kinds of mistakes that can happen are:

- Not all the colors and textures are the same
- Misaligned or missing holes
- The sizes of holes, width, and other measurements are wrong.
- Cavities that aren't filled (flash or short shot)

In-Process Quality Control:

Raw materials must be checked before they are used in the injection-molding process to ensure they meet standards. This is the first step in the Plastic molding quality control process.

The second step is to check the temperature, pressure settings, and other parts of the injection-molding machine to ensure they are working properly. This step ensures the material is melted completely before entering the molding machine. This helps eliminate problems like air bubbles or a bad finish on the surface of molded parts.

The next step is to check the molten plastic for any alien particles that could cause problems when injection molding. After the plastic has been cleaned of any small pieces, it can be inserted into a mold.

The last step in quality control is to check molded parts for gaps or other flaws. This ensures that each piece comes out of an injection-molding machine with the right shape and no flaws.

Final Inspection:

Before a part leaves the plant, this is when it is checked for flaws. Before being packed and sent out, each piece is inspected by hand to ensure that only the best ones get to customers. This process ensures that the product is of high quality and has no flaws, such as scratches, bubbles, or other flaws. If there are any problems, they are fixed before the product is packed and sent out.

People with a lot of training do the check and can find any problems with the parts and materials used to make the product. Only perfect products are sent out, so customers only get the best.

First-off production components inspection in die and mold machining refers to the initial inspection conducted on the first batch of components produced during the manufacturing process. This inspection is performed to verify the quality, dimensional accuracy, and conformance of the components to the required specifications and design.

Here are some key points regarding first-off production components inspection in die and mold machining:

Purpose: The primary purpose of this inspection is to identify any potential issues, defects, or non-conformities early in the manufacturing process. It helps ensure that the produced components meet the desired quality standards and are suitable for further processing or assembly.

Timing: The first-off production components inspection is typically conducted after the initial batch of components is manufactured, but before proceeding with full-scale production. It allows for any necessary adjustments or corrective actions to be taken before producing a larger quantity of components.

Inspection Parameters: The inspection process may include various parameters depending on the specific requirements of the components. This can involve dimensional measurements, visual inspections for surface defects or imperfections, functional checks, and adherence to design specifications.

Inspection Methods: Various inspection methods and tools can be employed during the first-off production components inspection. This may include using precision measurement instruments such as calipers, micrometers, coordinate measuring machines (CMM), visual inspection, or specialized gauges or fixtures.

Documentation: The results of the first-off production components inspection are often documented and recorded for future reference. This documentation helps track the quality history of the components and provides valuable data for process improvement or troubleshooting purposes.

Quality Control Personnel: The inspection is typically carried out by trained quality control personnel or inspectors who have expertise in dimensional measurement techniques and quality assurance practices.

By conducting a thorough first-off production components inspection, any deviations, errors, or non-conformities can be identified and addressed promptly, ensuring that subsequent production runs maintain the desired quality and adherence to specifications.

4.2. Causes of non-conformance in die and mold manufacturing

There can be several causes of non-conformance in die and mold manufacturing. Here are some common factors that can contribute to non-conformance:

Design Errors: Non-conformance can occur if there are errors or inconsistencies in the design of the die or mold. This can include incorrect dimensions, tolerances, or other design specifications.

Material Issues: Non-conformance can arise from problems with the materials used in the manufacturing process. This can include using the wrong type of material, poor material quality, or improper material handling.

Machine or Equipment Problems: If the machinery or equipment used in the manufacturing process is not calibrated correctly or is malfunctioning, it can lead to non-conformance. This can result in dimensional inaccuracies, surface defects, or other manufacturing issues.

Process Variability: Inconsistent or poorly controlled manufacturing processes can contribute to non-conformance. Variations in temperature, pressure, cooling rates, or other process parameters can affect the final product's quality and conformance to specifications.

Human Error: Mistakes made by operators, technicians, or other personnel involved in the manufacturing process can lead to non-conformance. This can include errors in measurement, incorrect assembly, or improper handling of the die or mold.

Lack of Inspection or Quality Control: Insufficient inspection and quality control procedures can contribute to non-conformance. If there is a lack of rigorous inspection and testing throughout the manufacturing process, defects or deviations from specifications may go unnoticed.

Environmental Factors: Environmental conditions, such as temperature, humidity, or contamination, can impact the manufacturing process and lead to non-conformance. For example, changes in humidity can affect the dimensional stability of the materials used in the die or mold.

Supplier Issues: Non-conformance can occur if there are problems with the materials or components supplied by external vendors. If the supplied materials do not meet the required specifications or quality standards, it can result in non-conformance in the final product.

To address non-conformance, it is important to identify the root causes and implement corrective actions. This can involve improving design processes, enhancing quality control measures, training personnel, and ensuring proper maintenance and calibration of equipment.

4.3. Deviation Modification Technique

In die and mold machining, there are various techniques and approaches that can be employed to modify or adjust deviations in the manufacturing process. These techniques may include:

CNC Machining: Computer Numerical Control (CNC) machining allows for precise control over the machining process, enabling adjustments to be made to correct any deviations or errors in the manufacturing of dies and molds.

Iterative Machining: If deviations are identified during the manufacturing process, an iterative machining approach may be used. This involves making incremental adjustments to the machining parameters or tooling to gradually reduce or eliminate the deviations.

Surface Finishing: Surface finishing techniques, such as grinding, polishing, or lapping, can be employed to modify the surface of the die or mold and correct any deviations or imperfections.

Electrode Adjustment: In the case of electrical discharge machining (EDM), adjustments can be made to the electrodes used in the process to compensate for deviations and achieve the desired accuracy.

Heat Treatment: Heat treatment processes, such as annealing or stress relieving, can be applied to modify the material properties of the die or mold and minimize any residual stresses or deformations.

It's important to note that the specific techniques used to modify deviations in die and mold machining can vary depending on the specific requirements, materials, and manufacturing processes involved.

4.4. Recording and reporting modifications

Recording and reporting modifications of die and mold machining is an important aspect of maintaining documentation and traceability in the manufacturing process. It involves documenting any changes, adjustments, or modifications made to the dies and molds during the machining process. Here are some key points to consider:

Modification Details: Each modification made to a die or mold should be recorded in detail. This includes documenting the reason for the modification, the specific changes made, the date of modification, and any relevant specifications or requirements that prompted the modification.

Documentation Format: This format should allow for clear and concise documentation of the modifications and be easily accessible for future reference.

Traceability: This can be achieved through unique identifiers or part numbers assigned to each die or mold, making it easy to trace the modification history of individual components.

Reporting Channels: This may include notifying the engineering team, quality control team, or any other relevant stakeholders involved in the manufacturing process.

Communication and Collaboration: it ensures that all modifications are properly documented and shared with the appropriate teams to maintain transparency and facilitate collaboration.

Self Check 4

Part I: Write True if the statement is correct write False if the is incorrect

1. First-off production components inspection is conducted after the final production of all components.
2. Material issues have no impact on non-conformance in die and mold manufacturing.
3. Machine or equipment problems cannot lead to non-conformance in die and mold manufacturing.
4. Components inspection is a one-time process and does not need to be repeated for subsequent batches.
5. Components inspection can help identify defects, errors, or non-conformities in the manufactured components.
6. Design errors can contribute to non-conformance in die and mold manufacturing.
7. Process variability has no effect on non-conformance in die and mold manufacturing.
8. Human error does not play a role in non-conformance in die and mold manufacturing.

Part II: Matching

Column A	Column B
1. Achieved through unique identifiers or part numbers assigned to each die or mold	A. Modification Details
2. Include notifying the engineering team, quality control team, or any other relevant stakeholders involved in the manufacturing process	B. Traceability
3. Each modification made to a die or mold should be recorded in detail	C. Reporting Channels
4. Electrical discharge machining (EDM), adjustments	D. Electrode Adjustment
5. Mistakes made by operators, technicians, or other personnel	E. Human Error:

Reference

1. Herbert, R, 2001. *Understanding Injection Mold Design*. 1st ed. Cincinnati, USA: hanser Gardner Publications.
2. All about plastic moulding. 2009. *The History of Plastic Moulding*. [ONLINE] Available at: http://www.plasticmoulding.ca/history.htm#Plastic. [Accessed 10 October 11].
3. Autronic plastics INC. 2008. Glossary of Plastic Injection Molding Terms. [ONLINE] Available at: http://www.apisolution.com/images/glossary_plastic_injection_molding_engineering_manufacturing.pdf [Accessed 18 August 11]
4. Pmold industrial limited. 2010. *The injection molding process*. [ONLINE] Available at: http://www.pmolds.com/news/4/15/The-injection-molding-process/. [Accessed 18 August 2011]RUTLAND plasti
5. B. H. Amstead, P. Ostwald, M.L.Begaman, Manufacturing Processes,(8 Edition) 7.Moltrecht, Karl Hans: Machine Shop Practice, 2nd ed. New York: Industrial Press, 1981, Volume 1, p. 403. 8. El – Hoffy : Advance Machining Process, McGraw Hill Companies, 0.007- 1466940, 2005.

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