

EFFECT OF A PARABOLIC TROUGH COLLECTOR WINDING COIL-OVER THE ASYMMETRIC HEAT PIPE

Submitted in partial fulfillment of the requirements of the award
of Bachelor of Engineering degree in Mechanical Engineering

By

S.HARIVIGNESH

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**DEPARTMENT OF MECHANICAL ENGINEERING
SCHOOL OF MECHANICAL ENGINEERING**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with an "A" grade by NAAC

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DEPARTMENT OF MECHANICAL ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of S.HARIVIGNESH (REG.NO. 38150035) who carried out the project entitled **"EFFECT OF WINDING COIL-OVER THE ASYMMETRIC HEAT PIPE BY PARABOLIC TROUGH COLLECTOR** under my supervision from November 2021 to May 2022.

Internal Guide

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Submitted for Viva voice Examination held on

Internal Examiner

External Examiner

DECLARATION

I'm **S.HARIVIGNESH** hereby declare that the Project Report entitled **“EFFECT OF WINDING COIL-OVER THE ASYMMETRIC HEAT PIPE BY PARABOLIC TROUGH COLLECTOR ”** done by us under the guidance of **Mr. V. SRIRAM., M.E., (Ph.D.)**, is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Mechanical Engineering.



PLACE: CHENNAI

SIGNATURE OF THE CANDIDATE

KCKNOWLEDGEMENT

I am pleased to acknowledge my sincere thanks to the Board of Management of **SATHYABAMA UNIVERSITY** for their kind encouragement in doing this project and for completing it successfully. I am grateful to them.

I convey my sincere thanks to **Dr. S. PRAKASH, M.E., Ph.D.**, Dean, School of Mechanical Engineering, and **Dr. G. ARUN KUMAR M.E., Ph.D.**, Head of the Department, Dept. of Mechanical Engineering for providing me necessary support and details at the right time during the progressive reviews.

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I also express my thanks to all Teaching and Non-teaching staff members of the Department of Mechanical Engineering who were helpful in many ways for the completion of the project

ABSTRACT

Because of its low thermal resistance and excellent heat transmission, the heat pipe is one of the most well-known passive cooling and heating systems. Heated pipes are latent heat-based two-phase transfer devices. A heat pipe's thermal conductivity can be hundreds of times higher than a solid copper rod of the same diameter. A copper pipe wounds the heat pipe in this article. Inside the pipe tube, heat fluid flow. It is feasible to bend and flatten a heat pipe to the necessary shape after closing the ends of a circular pipe while going through it. Because the vapour chamber is a planar container made by stamping, there is no way to flatten it.

CHAPTER 1

INTRODUCTION

The heat exchanger is a device that transfers process energy by continually exchanging heat from one medium to another. To improve heat transfer in heat exchangers, design researchers are constantly employing novel strategies to increase the surface area of the wall between the two fluids running through the exchanger. There have been active and passive techniques used to improve heat transfer rate from straight tubes, such as the use of tape or coil inserts, the use of the electric field, surface vibration are active techniques, the use of some additives in fluid, and the use of special surface geometry are passive techniques. However, this resulted in a reduction in mass flow rate and required additional material, resulting in an overall increase in the cost of the product in the exchange

Shell and tube heat exchangers are one of the most common types of exchanger due to the designer's versatility in providing for a broad range of pressures and temperatures. In a shell and tube exchanger, many tubes are inserted inside a cylindrical shell. It illustrates an example of a petrochemical plant unit. By running one fluid around the exterior of the tubes and the other through the tubes, two fluids can exchange heat. Single-phase or two-phase fluids can flow in parallel or cross/counter. The shell and tube exchanger is made up of four main components:

- Fluid enters the tube side of the exchanger through the front header. The Stationary Header is another name for this element.
- The rear header— In exchangers with several tube side passes, this is where the tube side fluid departs the exchanger or is returned to the front header.
- Tube bundle—comprises tubes, tube sheets, baffles, tie rods, and other components that keep the bundle together

.Fixed Tubesheet Exchanger (L, M, and N-Type Rear Headers)

The tube sheet is welded to the shell in a stationary tubesheet exchanger. The tube bores may be cleaned mechanically or chemically, resulting in a simple and cost-effective design. Except for chemical cleaning, the exterior surfaces of the tubes are unreachable. If there are significant temperature variations between the shell and tube materials, an expansion bellows may be required in the shell to minimise excessive expansion stresses. Such bellows are frequently a cause of operational weakness and

failure. U-Tube or Floating Header units are typically utilised in situations when the repercussions of failure are extremely severe. At low pressures, this is the cheapest of all detachable bundle designs, but it is somewhat more expensive than a permanent tube sheet design.

U-Tube Exchangers

Any of the front header types can be used in a U-Tube exchanger, while the rear header is usually an M-Type. The U-tubes allow for limitless thermal expansion, removal of the tube bundle for cleaning, and minimal bundle to shell clearances. However, because mechanical cleaning of the tubes is difficult, this kind is typically used only when the tube side fluids are clean.

Floating Head Exchanger (P, S, T, and W Type Rear Headers)

The tube sheet at the Rear Header end of this type of exchanger is not welded to the shell and is permitted to move or float. The tube sheet at the Front Header (tube side fluid input end) is bigger than the shell and is sealed in the same way as the fixed tube sheet. The bundle can be dragged through the shell because the tube sheet at the rear header end is slightly smaller in diameter than the shell. The use of a floating head allows for thermal expansion and the removal of the tube bundle for cleaning. here are other varieties of rear headers available, but the S-Type Rear Head is the most common. A floating head exchanger is adequate for the demanding responsibilities associated with high temperatures and pressures, but it is more expensive than a comparable fixed tube sheet exchanger (usually on the order of 25% for carbon steel construction)

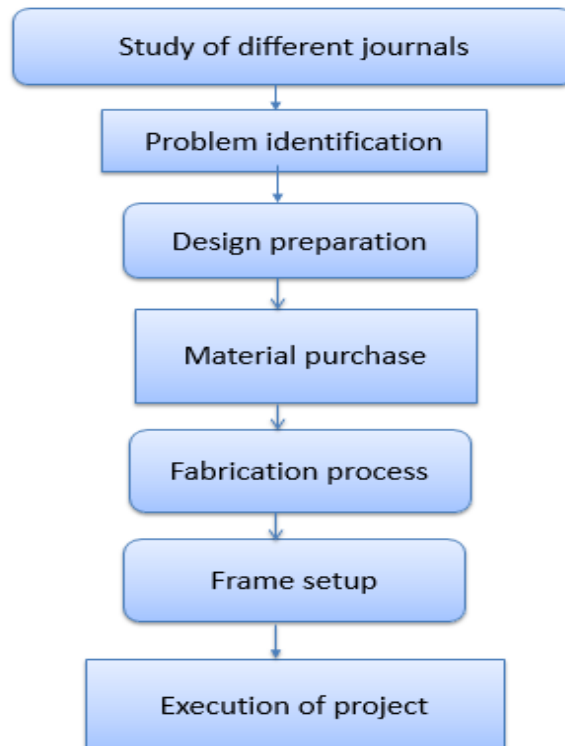
CHAPTER 2

OBJECTIVE

To reduce the temperature in a heat flow through the plain tube by using the copper winding

The cooling temperature will be measured using a k-type thermocouple.

METHODOLOGY



CHAPTER 3

3.1 HEAT EXCHANGER

Curved tubes are the most extensively used tubes in numerous heat transfer applications, such as heat recovery, air conditioning, and refrigeration systems, chemical reactors, food, and dairy operations, due to their high heat transfer coefficient and lesser area need compared to straight tubes. Spiral coils are well-known curved tubes that have been employed in many different applications. There are few theoretical and experimental investigations on heat transfer and flow characteristics for spiral tube heat exchangers. Exchanger of heat, Heat exchange is one of the most significant engineering processes. The heat exchanger's purpose is to transfer heat between two moving fluids. A heat exchanger is a device that allows heat to be transferred from one fluid to another. A heat exchanger is a device that transfers internal thermal energy between two or more fluids that are at different temperatures. A heat transfer surface separates the fluids with most heat exchangers, and they should not mix. Heat exchangers are utilized in a variety of sectors, including power generation, petroleum, transportation, air conditioning, refrigeration, cryogenics, heat recovery, alternative fuels, and others. Automobile radiators, condensers, evaporators, and oil coolers are common examples of heat exchangers in everyday usage.

Heat exchangers could be classified in many different ways.

Classification of Heat Exchangers

3.2 Tubular Heat Exchanger

Circular tubes are commonly employed in tubular heat exchangers, but elliptical, rectangular, and round/flat twisted tubes have also been utilised in various applications. Because the core shape may be readily changed by altering the tube diameter, length, and arrangement, the design has a lot of flexibility. Tubular exchangers can be built for

large pressure differences between the fluids and high pressure differences relative to the environment. Tubular exchangers are typically used for heat transfer from liquid to liquid and liquid to phase change (condensing or evaporating). They're also employed in gas-to-liquid and gas-to-gas heat transfer applications, particularly when the operating temperature and pressure are extremely high, or fouling is a serious issue on at least one fluid side, and no other methods of heat transfer are available.

3.3 Spiral Tube Heat Exchanger

Because of its small size and great heat transfer efficiency, the spiral tube heat exchanger is an efficient heat exchanger. One or more spirally wrapped coils are linked in a circular manner to a header from which fluid flows in spiral-tube heat exchangers. This spiral coil is housed in a shell in which another fluid circulates outside the tube, allowing heat to be transferred between the two fluids. A spiral tube's heat transfer rate is higher than that of a straight tube. Spiraling may also accommodate a high number of surfaces in a small space. In a spiral tube heat exchanger, thermal expansion is unusual, and self-cleaning is also possible. A spiral tube heat exchanger is a coil configuration encased in a tiny shell that maximizes heat transfer efficiency while reducing area requirements. To guarantee durability and strength, each spiral coil assembly features welded tube to manifold connections and uses the bare minimum of materials. By connecting multiple parallel tubes to a pipe or header, a spiral tube heat exchanger provides tube side flow. The shell side flow channel is formed by the spaces or gaps between the coils when the spiral tube bundle is put in the shell. Tube and shell connectors on the bottom and top of the unit allow for various flow route combinations. In a genuine counterflow system, the spiral shape of the flow for the tube and shell fluids creates centrifugal force and secondary flow, which increases heat transfer on both sides. The absence of baffles in the system reduces velocities and improves heat transfer performance. Furthermore, unlike shell and tube designs, parallel tube layouts are not limited by shell diameter constraints..

CHAPTER 4

4.1 ABOUT COPPER

Copper is the world's oldest metal. It has been used from prehistoric times. Copper has been mined for almost 10,000 years, with an 8700 BC copper pendant discovered in modern-day Iraq. Copper was smelted from simple Copper Oxides around 5000BC. Copper is found in the minerals cuprite, malachite, azurite, chalcopyrite, and bornite as well as as a native metal.

It's also a common by-product of the silver industry. The most significant ores are sulphides, oxides, and carbonates. Copper and copper alloys are among the most adaptable engineering materials. Copper is useful for a broad range of applications due to its combination of physical features including as strength, conductivity, corrosion resistance, machinability, and ductility. Variations in composition and production processes can improve these qualities even further..

Building Industry

- Copper's primary application is in the construction sector. Copper-based products are widely used in the construction sector. Copper's uses in the construction sector include:
- Roofing
- Cladding

- Rainwater systems
 - Heating systems
 - Water pipes and fittings
 - Oil and gas lines
 - Electrical wiring
- The building industry is the largest single consumer of copper alloy. The following list is a breakdown of copper consumption by industry on an annual basis:
- Building industry – 47%
 - Electronic products - 23%
 - Transportation - 10%
 - Consumer products - 11%
 - Industrial machinery - 9%

Commercial Compositions of Copper

World consumption of copper and copper alloy now exceeds 18 million tonnes per annum.

Applications of Copper

- Copper and copper alloy can be used in an extraordinary range of applications. Some of these applications include:
- Power transmission lines
 - Architectural applications
 - Cooking utensils
 - Spark plugs
 - Electrical wiring, cables, and busbars
 - High conductivity wires
 - Electrodes
 - Heat exchangers
 - Refrigeration tubing
 - Plumbing

- Water-cooled copper crucibles

Structure of Copper

The cubic crystal structure of copper is face-centered. It has a reddish red physical appearance and a dazzling metallic shine when polished.

Key Properties of Copper Alloys

- and deep drawing. The other key properties exhibited by copper and its alloys include:
Copper is a tough, ductile, and malleable material. These properties make copper extremely suitable for tube forming, wire drawing, spinning, a

- Excellent heat conductivity
- Excellent electrical conductivity
- Good corrosion resistance
- Good biofouling resistance
- Good machinability
- Retention of mechanical and electrical properties at cryogenic temperatures
- Non-magnetic

Other Properties of Copper

- Copper and copper alloys have a peculiar smell and disagreeable taste. These may be transferred by contact and therefore Copper should be kept clear of foodstuffs.
- Most commercially used metals have a metallic white color. Copper is a yellowish red.

Melting Point of Copper

The melting point for pure Copper is 1083°C.

Although the inclusion of other elements can increase qualities like as strength, electrical conductivity will suffer. A 1% increase in cadmium content, for example, can boost strength by 50%. However, there will be a 15% reduction in electrical conductivity as a result of this.

Corrosion Resistance of Copper

Fresh water and steam do not corrode any copper alloy. Copper alloys are corrosion resistant in most rural, marine, and industrial environments. Saline solutions, soils, non-oxidizing minerals, organic acids, and caustic solutions are all resistant to copper. Copper is attacked by moist ammonia, halogens, sulphides, solutions containing ammonia ions, and oxidising acids like nitric acid. Copper alloys are also susceptible to inorganic acids.

The development of adherent coatings on the material surface gives copper alloys their corrosion resistance. Because these layers are reasonably corrosion resistant, they shield the basic metal from further assault.

Saltwater corrosion resistance is best demonstrated by copper-nickel alloys, brass, and aluminium.

Surface Oxidation of Copper

When exposed to the environment outside, most copper alloys develop a blue-green patina. The hue of the copper Statue of Liberty in New York is an example of this. After extended exposure to the environment, certain copper alloys darken and become brown to black tint..

Lacquer coatings can be utilized to preserve the surface while also preserving the color of the alloy. Under most outdoor, abrasion-free situations, an acrylic coating with benzotriazole as an addition will last several years..

Yield Strength of Copper

Copper alloy yield points are not clearly defined. As a result, it's usually described as a 0.5 percent under load extension or a 0.2 percent offset.

In most cases, annealed material's 0.5 percent extension yield strength equals around one-third of its tensile strength. Cold working hardens the material, making it less ductile and bringing the yield strength closer to the tensile strength.

Joining of Copper

Most copper alloys may be joined using common procedures including brazing, welding, and soldering. Electrical connections are frequently soldered. Welding is not possible with high-lead alloys.

Copper and copper alloys can also be joined using mechanical means such as rivets and screws.

Hot and Cold Working

Copper and copper alloys can be hot and cold worked, despite their ability to be work-hardened. Annealing can help restore ductility. This can be accomplished by a particular annealing process or through accidental annealing operations like as welding or brazing.

Temper

Copper alloys can be specified according to temper levels. The temper is imparted by cold working and subsequent degrees of annealing.

Typical tempers for copper alloys are

- Soft
- Half-hard
- Hard, spring
- Extra-spring
- The yield strength of hard-temper copper alloys is approximately two-thirds of the materials' tensile strength.

Copper Designations

Designation systems for Copper are not specifications, but methods for identifying chemical compositions. Property requirements are covered in ASTM, government, and military standards for each composition.

The method for designating copper alloys is an expansion of the system developed by the U.S. copper and brass industry. Their old system used 3 digits, the new Unified Numbering System for Metals and Alloys (UNS) system uses five digits preceded by the letter C.

As an example, the forging brass known as alloy 377 is known as C37700 under the UNS system. Wrought compositions are included in the designations from C10000 through to C79900. Casting alloys are assigned numbers from C80000 through to C99900

Cast Copper Alloys

The nature of the casting process means that most cast alloys have a greater range of alloying elements than wrought alloys.

Wrought Copper Alloys

Wrought copper alloys are produced using a variety of different production methods. These methods include processes such as annealing, cold working, hardening by heat treatments, or stress-relieving.

Copper Alloy Families

- cast categories for copper alloys, the compositions can be divided into the following main Within the wrought and families:
 - Pure Coppers
 - High Copper Alloys
 - Brasses
 - Bronzes

Coppers

Pure Coppers have a Copper content of 99.3% or higher.

High Copper Alloys

Wrought high copper alloys have Copper contents of less than 99.3% but more than 96% but don't fall into other copper alloys group. Cast high copper alloys have Copper contents over 94%. Silver may be added to impart special properties.

4.2 STAINLESS PIPE

A tube, or tubing, is a long hollow cylinder used for moving fluids (liquids or gases) or to protect electrical or optical cables and wires.

- Although slight differences exist, the terms "pipe" and "tube" are practically identical; in general, a tube has stricter engineering standards than a pipe. Pipe and tube connote rigidity and permanency, but a hose is often movable and flexible. Standard pipe size designations, such as nominal pipe size, or nominal outer or interior diameter and/or wall thickness, can be used to specify a tube or pipe. A pipe's real dimensions are rarely the same as its nominal size: Many types of tubing are indicated by actual internal diameter, exterior diameter, or wall thickness, although a 1-inch pipe will not measure 1 inch in either outside or inside diameter.
- There are many industry and government standards for pipe and tubing. Many standards exist for tube manufacture; some of the most common are as follows:
 - ASTM A213 Standard Specification for Seamless Ferritic and Austenitic Alloy-Steel Boiler, Superheater, Heat-Exchanger Tubes.
 - ASTM A269 Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
 - ASTM A270 Standard Specification for Seamless and Welded Austenitic Stainless Steel Sanitary Tubing
 - ASTM A511 Standard Specification for Seamless Stainless Steel Mechanical Tubing
 - ASTM A513 Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing
 - ASTM A554 Standard Specification for Welded Stainless Steel Mechanical Tubing
 - British standard 1387:1985 Specification for screwed and socketed steel tubes and tubular and plain end steel tubes suitable for welding or for screwing to BS 21 pipe threads

ASTM material specifications generally cover a variety of grades or types that indicate a specific material composition. Some of the most commonly used are:

- TP 304
 - TP 316
 - MT 304
 - MT 403
 - MT 506
- Copper and stainless steel tubing must be factory pre-cleaned (ASTM B 280) and/or certified as instrument grade in hydrogen installations. This is owing to hydrogen's unique properties, which include the ability to burst in the presence of oxygen, oxygenation sources, or impurities, to leak due to its atomic scale, and to produce metal embrittlement, especially under pressure.



4.3 BALL-BEARING



A ball bearing's job is to decrease rotational friction while also supporting radial and axial stresses. It accomplishes this by containing the balls and transmitting the loads through the balls via at least two races. One race is usually stationary, while the other is coupled to the rotating assembly in most applications (e.g., a hub or shaft). When one of the bearing races rotates, the balls rotate with it. The balls have a far lower coefficient of friction than two flat surfaces moving against one other because they are rolling.

Due to the smaller contact surface between the balls and races, ball bearings have a lower load capacity for their size than other types of rolling-element bearings. They can, however, put up with slight misalignment of the inner and outer races.

There are multiple popular ball bearing designs, each with different performance trade-offs. Stainless steel, chrome steel, and ceramic are just a few of the materials that can be used.

Angular contact

Axially asymmetric races are used in angular contact ball bearings. A radial load travels along an oblique route that separates the races axially, whereas an axial weight travels in a straight line across the bearing. As a result, the contact angle on the inner and outer races is the same. Combination loads (loading in both the radial and axial directions) are best supported by angular contact bearings, and the contact angle of

the bearing should be suited to the respective proportions of each. The higher the axial load supported, but the smaller the radial load, the greater the contact angle (usually 10 to 45 degrees). The centrifugal forces created in high-speed applications such as turbines, jet engines, and dental equipment The contact angle at the inner and outer races is changed by the balls. Because of their low density, ceramics like silicon nitride are now commonly employed in such applications (40 percent of steel). These materials minimise centrifugal force substantially and work well in high-temperature situations. They also wear in the same manner as bearing steel does, rather than breaking or shattering like glass or porcelain. Because the strains on these bearings are in both the radial and axial directions, most bicycles employ angular-contact bearings in the headsets.

Axial

Side-by-side races are used in an axial or thrust ball bearing. A radial load is inadequately sustained and tends to separate the races, resulting in a higher radial load that is likely to harm the bearing.

Deep-groove

The race dimensions of a deep-groove radial bearing are similar to the dimensions of the balls that run in it. Bearings with a deeper groove may withstand higher loads than those with a shallower groove. Deep-groove bearings, like angular contact bearings, can carry both radial and axial loads, but they don't have the contact or angle options that angular contact bearings provide.

Preloaded pairs

The following basic types of bearings are often used in preloaded pairs, which involves tightly fastening two separate bearings along a spinning shaft to face each other. By taking up (preloading) the necessary little space between the bearing balls and races, the axial runout is improved. When compared to a single bearing, pairing gives the benefit of equally spreading the loads, roughly doubling the overall load capacity. Angular contact bearings are almost often employed in opposing pairs: because each bearing's asymmetric design only supports axial loads in one direction, an opposed pair is necessary if the application requires support in both directions. Because it reduces the axial force capacity of the bearings and might damage bearings if applied excessively, the preloading force must be properly calculated and built. The bearings

may be directly faced together or separated by a shim, bushing, or shaft feature in the pairing mechanism.

4.3 THERMOCOUPLE

A thermocouple is a type of temperature sensor. Two wire legs composed of different metals make up thermocouples. The legs of the wire are soldered together at one end to form a junction. The temperature is monitored at this intersection. A voltage is formed when the temperature of the junction changes. The temperature may then be calculated using the voltage and a thermocouple.

Thermocouples come in a variety of shapes and sizes, each with its own set of features such as temperature range, durability, vibration resistance, chemical resistance, and application compatibility. The most common types of thermocouples are Type J, K, T, and E "Base Metal" thermocouples. Noble Metal thermocouples, such as Type R, S, and B, are utilised in high-temperature applications (see thermocouple temperature ranges for details).

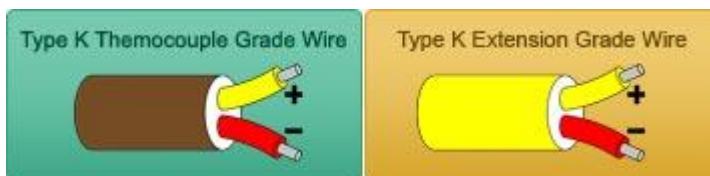
Many industrial, research, and OEM applications employ thermocouples. They are found in almost every industrial industry, including power generation, oil and gas, pharmaceuticals, biotechnology, cement, paper and pulp, and so on. Everyday equipment such as stoves, furnaces, and toasters employ thermocouples.

Thermocouples are commonly chosen for their inexpensive cost, high temperature limits, wide temperature ranges, and long life.

Type K Thermocouple (Nickel-Chromium / Nickel-Alumel)

The most prevalent type of thermocouple is Type K. It's low-cost, accurate, and dependable, with a wide temperature range. Because of its relative radiation durability, Type K is extensively used in nuclear applications. Around 1,100C is the maximum continuous temperature.

Type K Temperature Range:



Thermocouple grade wire, -454 to 2,300F (-270 to 1260C)

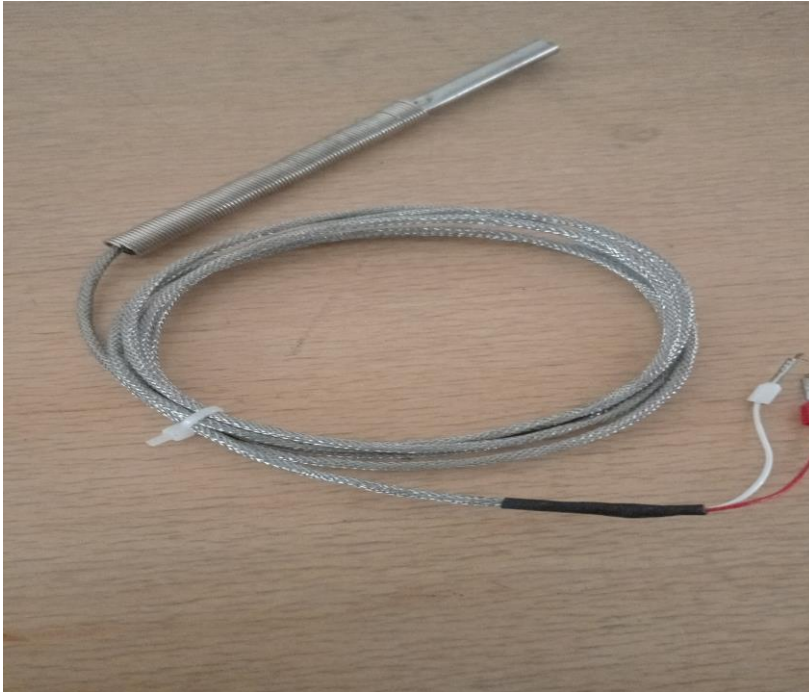
Extension wire, 32 to 392F (0 to 200C)

Type K Accuracy (whichever is greater):

- Standard: $\pm 2.2^{\circ}\text{C}$ or $\pm 0.75\%$
- Special Limits of Error: $\pm 1.1^{\circ}\text{C}$ or 0.4%

Type of K Thermocouple

- Consideration for bare wire type K thermocouple applications:



CHAPTER 5

INTRODUCTION TO CAD/CAM/CAE

The Modern world of design, development, manufacturing so on, in which we have stepped can't be imagined without the interference of computer Suter. The usage of

computers is such that, they have become an integral part of these fields. In the world market now the competition is not only cost factors but also quality, consistency, availability, packing, stocking, delivery, etc. So are the requirements forcing industries to adopt modern techniques rather than local forcing the industries to adopt better techniques like CAD / CAM / CAE, etc.

- a) The Possible basic way for industries to have high-quality products at low costs is by using the Computer-Aided Engineering (CAE), Computer-Aided Design (CAD), And Computer-Aided Manufacturing (CAM) setup. Further many tools is been introduced to simplify & serve the requirements CATIA, PRO-, and UG are some among many.
- b) This penetration of technique concern has helped the manufacturers to
- c) The Possible basic way for industries to have high-quality products at low costs is by using the Computer-Aided Engineering (CAE), Computer-Aided Design (CAD), And Computer-Aided Manufacturing (CAM) setup. Further many tools is been introduced to simplify & serve the requirements CATIA, PRO-, and UG are some among many.
- d) This penetration of technique concern has helped the manufacturers to
 - e) Increase productivity
 - f) Shortening the lead-time
 - g) Minimizing the prototyping expenses
 - h) Improving Quality
 - i) Designing better products

CAD: Computer-Aided Designing (Technology to Create, Modify, Analyze or Optimize the design using the computer.

CAE: Computer-Aided Engineering (Technology to analyze, Simulate or Study the behavior of the cad model generated using the computer.

CAM: Computer-Aided Manufacturing (Technology to Plan, manage or control the operation in manufacturing using the computer.

NEED FOR CAD, CAE & CAM

The usage of CAD CAE & CAM has changed the overlook of the industries and developed healthy & standard competition, as could achieve the target in lean time and ultimately the product reaches the market in estimated time with better quality and consistency In general view, it has to lead to a fast approach and creative thinking.

ADVANTAGES

- Cut off the designing time o Cut off the editing time
- Cut off the manufacturing time o High & controlled quality
- Reduction of process cost. o Consistency
- Maintenance of Universal accessing data

DRAWBACKS

- Requires skilled operators
- Initial setting & assumption consumes time o Setting cost is more
- Overheads are high and
- Applicable if production is high

5.1 ABOUT SOLIDWORKS

SOLIDWORKS SOFTWARE

The SOLIDWORKS CAD software is a mechanical design automation application that lets designers quickly sketch out ideas, experiment with features and dimensions, and produce models and detailed drawings. This document discusses concepts and terminology used throughout the SOLIDWORKS application. It familiarizes you with the commonly used functions of SOLIDWORKS.

SolidWorks is a solid modeling computer-aided design (CAD) and computer-aided engineering (CAE) computer program published by Dassault Systemes, that runs primarily on Microsoft Windows. While it is possible to run SolidWorks on an Intel-based Mac with Windows installed, the application's developer recommends against this. SolidWorks does not support macOS.

According to the publisher, over two million engineers and designers at more than 165,000 companies were using SolidWorks as of 2013. Also, according to the company, the fiscal year 2011–12 revenue for SolidWorks totaled \$483 million.

HISTORY

SolidWorks Corporation was founded in December 1993 by Massachusetts Institute of Technology graduate Jon Hirschtick. Hirschtick used \$1 the million he had

made while a member of the MIT Blackjack Team to set up the company. Initially based in Waltham, Massachusetts, United States, Hirschtick recruited a team of engineers to build 3D CAD software that was easy-to-use, easy to use, and available on the Windows desktop. Operating later from Concord, Massachusetts, SolidWorks released its first product SolidWorks 95, in November 1995. In 1997 Dassault, best known for its CATIA CAD software, acquired SolidWorks for \$310 million in stock. Jon Hirschtick stayed on board for the next 14 years in various roles. Under his leadership, SolidWorks grew to a \$100 million revenue company.

SolidWorks currently markets several versions of the SolidWorks CAD software in addition to eDrawings, a collaboration tool, and DraftSight, a 2D CAD product.

SolidWorks was headed by John McEleney from 2001 to July 2007 and Jeff Ray from 2007 to January 2011. The current CEO is Gian Paolo Bassi from Jan 2015. Gian Paolo Bassi replaces Bertrand Sicot, who is promoted to Vice President Sales of Dassault Systèmes' Value Solutions sales channel.

5.2 MODELING TECHNOLOGY

SolidWorks is a solid modeler and utilizes a parametric feature-based approach which was initially developed by PTC (Creo/Pro-Engineer) to create models and assemblies. The software is written on Parasolid-kernel.

Parameters refer to constraints whose values determine the shape or geometry of the model or assembly. Parameters can be either numeric parameters, such as line lengths or circle diameters, or geometric parameters, such as tangent, parallel, concentric, horizontal or vertical, etc. Numeric parameters can be associated with each other through the use of relations, which allows them to capture design intent.

The design intent is how the creator of the part wants it to respond to changes and updates. For example, you would want the hole at the top of a beverage can to stay at the top surface, regardless of the height or size of the can. SolidWorks allows the user to specify that the hole is a feature on the top surface, and will then honor their design intent no matter what height they later assign to the can.

Features refer to the building blocks of the part. They are the shapes and operations that construct the part. Shape-based features typically begin with a 2D or 3D sketch of

shapes such as bosses, holes, slots, etc. This shape is then extruded to add or cut to remove material from the part. Operation-based features are not sketch-based and include features such as fillets, chamfers, shells, applying draft to the faces of a part, etc.

Building a model in SolidWorks usually starts with a 2D sketch (although 3D sketches are available for power users). The sketch consists of geometry such as points, lines, arcs, conics (except the hyperbola), and splines. Dimensions are added to the sketch to define the size and location of the geometry. Relations are used to define attributes such as tangency, parallelism, perpendicularity, and concentricity. The parametric nature of SolidWorks means that the dimensions and relations drive the geometry, not the other way around. The dimensions in the sketch can be controlled independently, or by other parameters inside or outside the sketch.

In an assembly, the analog to sketch relations is mates. Just as sketch relations define conditions such as tangency, parallelism, and concentricity concerning sketch geometry, assembly mates define equivalent relations concerning the individual parts or components, allowing the easy construction of assemblies. SolidWorks also includes additional advanced mating features such as gear and cam follower mates, which allow modeled gear assemblies to accurately reproduce the rotational movement of an actual gear train.

Finally, drawings can be created either from parts or assemblies. Views are automatically generated from the solid model, and notes, dimensions, and tolerances can then be easily added to the drawing as needed. The drawing module includes most paper sizes and standards (ANSI, ISO, DIN, GOST, JIS, BSI, ad).

This chapter includes the following topics:

- Concepts.
- Terminology.
- User Interface.
- Design Process.
- Design Intent.

- Design Method.
- Sketches.
- Features.
- Assemblies.
- Drawings.
- Model Editing.

5.3 CONCEPTS

Parts are the basic building blocks in the SOLIDWORKS software. Assemblies contain parts or other assemblies, called subassemblies.

A SOLIDWORKS model consists of 3D geometry that defines its edges, faces, and surfaces. The SOLIDWORKS software lets you, design models, quickly and precisely. SOLIDWORKS models are:

- Defined by 3D design
- Based on components

3D DESIGN

SOLIDWORKS uses a 3D design approach. As you design apart, from the initial sketch to the final result, you create a 3D model. From this model, you can create 2D drawings or mate components consisting of parts or subassemblies to create 3D assemblies. You can also create 2D drawings of 3D assemblies. When designing a model using SOLIDWORKS, you can visualize it in three dimensions, the way the model exists once it is manufactured.

Terminology

These terms appear throughout the SOLIDWORKS software and documentation.

Origin

Appears as two blue arrows and represents the (0,0,0) coordinate of the model. When a sketch is active, a sketch origin appears in red and represents the (0,0,0) coordinate of the sketch. You can add dimensions and relations to a model origin, but not to a sketch origin.

Plane

Flat construction geometry. You can use planes for adding a 2D sketch, section view of a model, or a neutral plane in a draft feature, for example.

Axis

Model geometry, features, and patterns are all created using straight lines. An axis can be made in a variety of ways, including by intersecting two planes. Every conical or cylindrical face in a model is given a temporary axis by the SOLIDWORKS programme.

Face

Boundaries that help define the shape of a model or a surface. A face is a selectable area (planar or nonplanar) of a model or surface. For example, a rectangular solid has six faces.

Edge

The location where two or more faces intersect and are joined together. You can select edges for sketching and dimensioning, for example.

Vertex

The point at which two or more lines or edges intersect. You can select vertices for sketching and dimensioning, for example.

USER INTERFACE

The SOLIDWORKS application includes user interface tools and capabilities to help you create and edit models efficiently, including:

Windows Functions

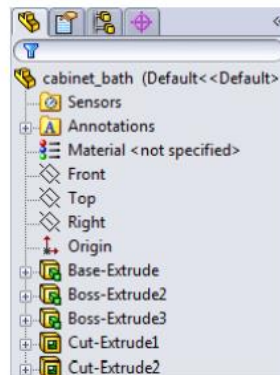
The SOLIDWORKS application includes familiar Windows functions, such as dragging and resizing windows. Many of the same icons, such as print, open, save, cut, and paste are also part of the SOLIDWORKS application.

SOLIDWORKS Document Windows

SOLIDWORKS document windows have two panels. The left panel, or Manager Pane, contains:

Feature manager design tree

Displays the structure of the part, assembly, or drawing. Select an item from the FeatureManager design tree to edit the underlying sketch, edit the feature, and suppress and unsuppressed the feature or component, for example.



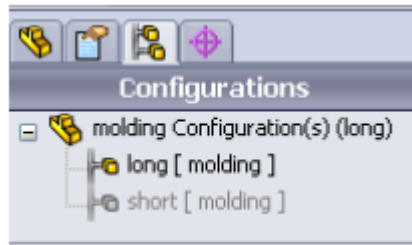
Property manager

Provides settings for many functions such as sketches, fillet features, and assembly mates.

ConfigurationManager

Let's you create, select, and view multiple configurations of parts and assemblies in a document. Configurations are variations of a part or assembly within a single document.

For example, you can use configurations of a bolt to specify different lengths and diameters.



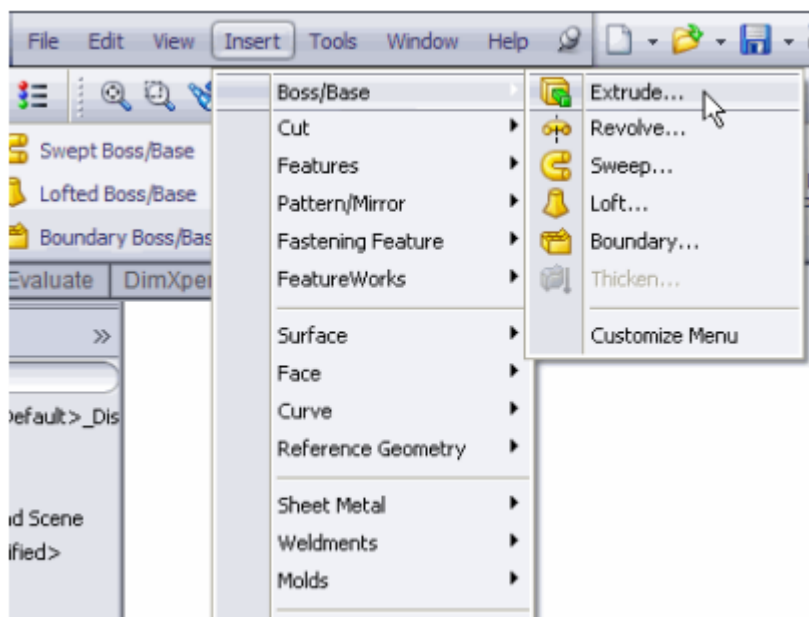
The right panel is the graphics area, where you create and manipulate a part, assembly, or drawing.

Function Selection and Feedback

The SOLIDWORKS application lets you perform tasks in different ways. It also provides feedback as you perform a task such as sketching an entity or applying a feature. Examples of feedback include pointers, inference lines, and previews.

Menus

You can access all SOLIDWORKS commands using menus. SOLIDWORKS menus use Windows conventions, including submenus and checkmarks to indicate that an item is active. You can also use context-sensitive shortcut menus by clicking the right mouse button.

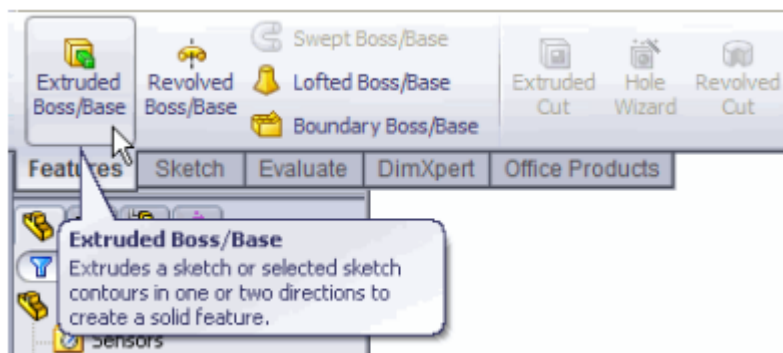


Toolbars

You can access SOLIDWORKS functions using toolbars. Toolbars are organized by function, for example, the Sketch or Assembly toolbar. Each toolbar comprises individual icons for specific tools, such as Rotate View, Circular Pattern, and Circle. You can display or hide toolbars, dock them around the four borders of the SOLIDWORKS window, or float them anywhere on your screen. The SOLIDWORKS software remembers the state of the toolbars from session to session. You can also add or delete tools to customize the toolbars. Tooltips display when you hover over each icon.

CommandManager

The CommandManager is a context-sensitive toolbar that dynamically updates based on the active document type. When you click a tab below the CommandManager, it updates to show the related tools. Each document type, such as part, assembly, or drawing, has different tabs defined for its tasks. The content of the tabs is customizable, similar to toolbars. For example, if you click the Features tab, tools related to features appear. You can also add or delete tools to customize the CommandManager. Tooltips display when you hover over each icon.



Shortcut Bars

Customizable shortcut bars let you create your own sets of commands for a part, assembly, drawing, and sketch mode. To access the bars, you press a user-defined keyboard shortcut, by default, the S key.



Context Toolbars

Context toolbars appear when you select items in the graphics area or FeatureManager design tree. They provide access to frequently performed actions for that context. Context toolbars are available for parts, assemblies, and sketches.

Mouse Buttons

Mouse buttons operate in the following ways:

Left

Selects menu items, entities in the graphics area, and objects in the FeatureManager design tree.

Right

Displays the context-sensitive shortcut menus.

Middle

Rotates, pans, and zooms a part or an assembly, and pans in a drawing.

Mouse gestures

You can use a mouse gesture as a shortcut to execute a command, similar to a keyboard shortcut. Once you learn command mappings, you can use mouse gestures to invoke mapped commands quickly.

5.4 DESIGN PROCESS

The design process usually involves the following steps:

- Identify the model requirements.
- Conceptualize the model based on the identified needs.
- Develop the model based on the concepts.
- Analyze the model.
- Prototype the model.
- Construct the model.
- Edit the model, if needed.

Current needs

Understand the purpose of the model to design it efficiently.

Future considerations

Anticipate potential requirements to minimize redesign efforts.

Design Method

Before you design the model, it is helpful to plan out a method of how to create the model.

After you identify needs and isolate the appropriate concepts, you can develop the model:

Sketches

Create the sketches and decide how to dimension and where to apply relations.

Features

Select the appropriate features, such as extrudes and fillets, determine the best features to apply, and decide in what order to apply those features.

Assemblies

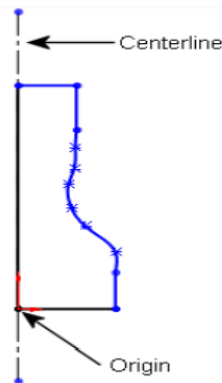
Select the components to mate and the types of mates to apply.

SKETCHES

The sketch is the basis for most 3D models. Creating a model usually begins with a sketch. From the sketch, you can create features. You can combine one or more features to make a part. Then, you can combine and mate the appropriate parts to create an assembly. From the parts or assemblies, you can then create drawings. A sketch is a 2D profile or cross-section a 2D sketch, you use a plane or a planar face. In addition to 2D sketches, you can also create 3D sketches that include a Z-axis, as well as the X and Y axes. There are various ways of creating a sketch. All sketches include the following elements:

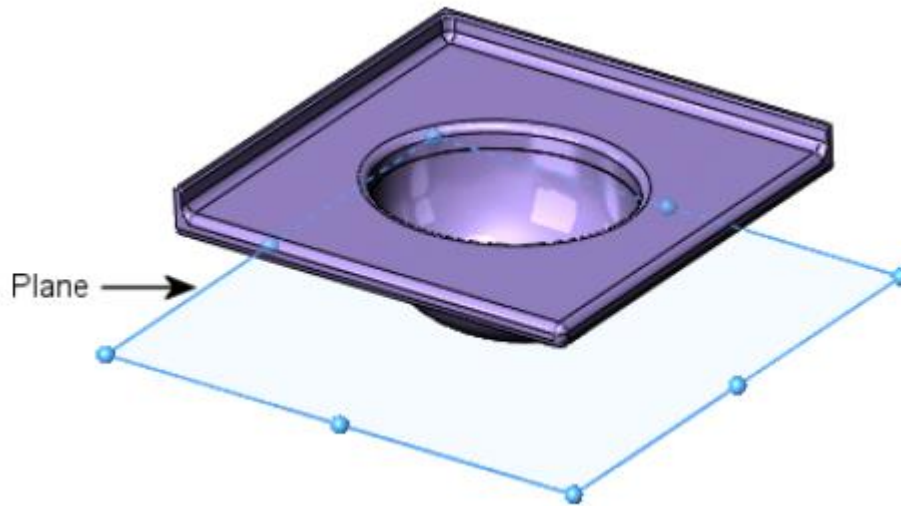
Origin

In many instances, you start the sketch at the origin, which provides an anchor for the sketch. The sketch on the right also includes a centerline. The centerline is sketched through the origin and is used to create the revolve.



Planes

You can create planes in part or assembly documents. You can sketch on planes with sketch tools such as the Line or Rectangle tool and create a section view of a model. On some models, the plane you sketch on affects only the way the model appears in a standard isometric view (3D). It does not affect the design intent. With other models, selecting the correct initial plane on which to sketch helps you create a more efficient model. Choose a plane on which to sketch. The standard planes are front, top, and right orientations. You can also add and position planes as needed. This example uses the top plane.

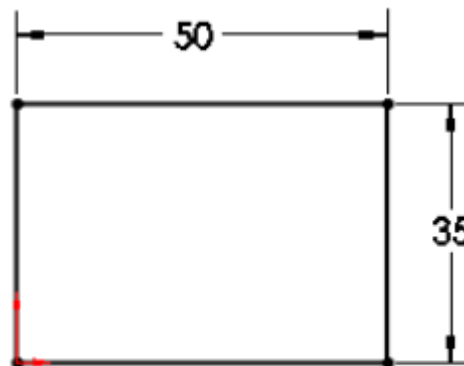


Dimensions

You can specify dimensions between entities such as lengths and radii. When you change dimensions, the size and shape of the part change. Depending on how you dimension the part, you can preserve the design intent. The software uses two types of dimensions: driving dimensions and driven dimensions.

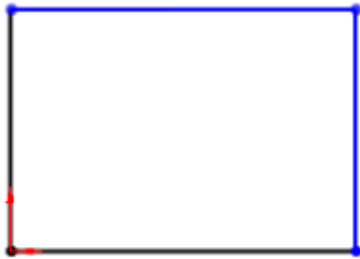
Sketch Definitions

Sketches can be fully defined, under-defined, or over-defined. In fully defined sketches, all the lines and curves in the sketch, and their positions, are described by dimensions or relations, or both. You do not have to fully define sketches before you use them to create features. However, you should fully define sketches to maintain your design intent. Fully defined sketches appear in black.



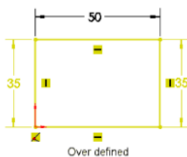
Fully defined

By displaying the entities of the sketch that are under-defined, you can determine what dimensions or relations you need to add to fully define the sketch. You can use the color cues to determine if a sketch is under-defined. Under-defined sketches appear in blue. In addition to color cues, entities in under-defined sketches are not fixed within the sketch, so you can drag them.



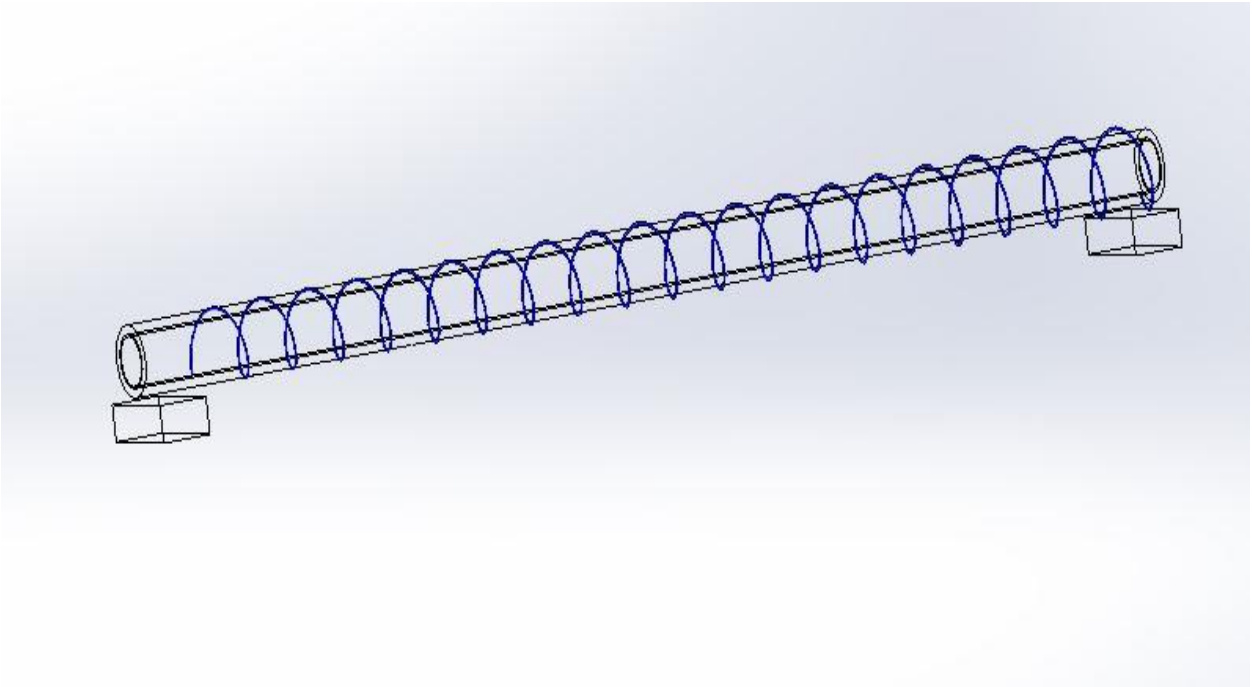
Under defined

Over-defined sketches include redundant dimensions or relations that are in conflict. You can delete over-defined dimensions or relations, but you cannot edit them. Over-defined sketches appear in yellow. This sketch is over-defined because both vertical lines of the rectangle are dimensioned. By definition, a rectangle has two sets of equal sides. Therefore, only one 35mm dimension is necessary.

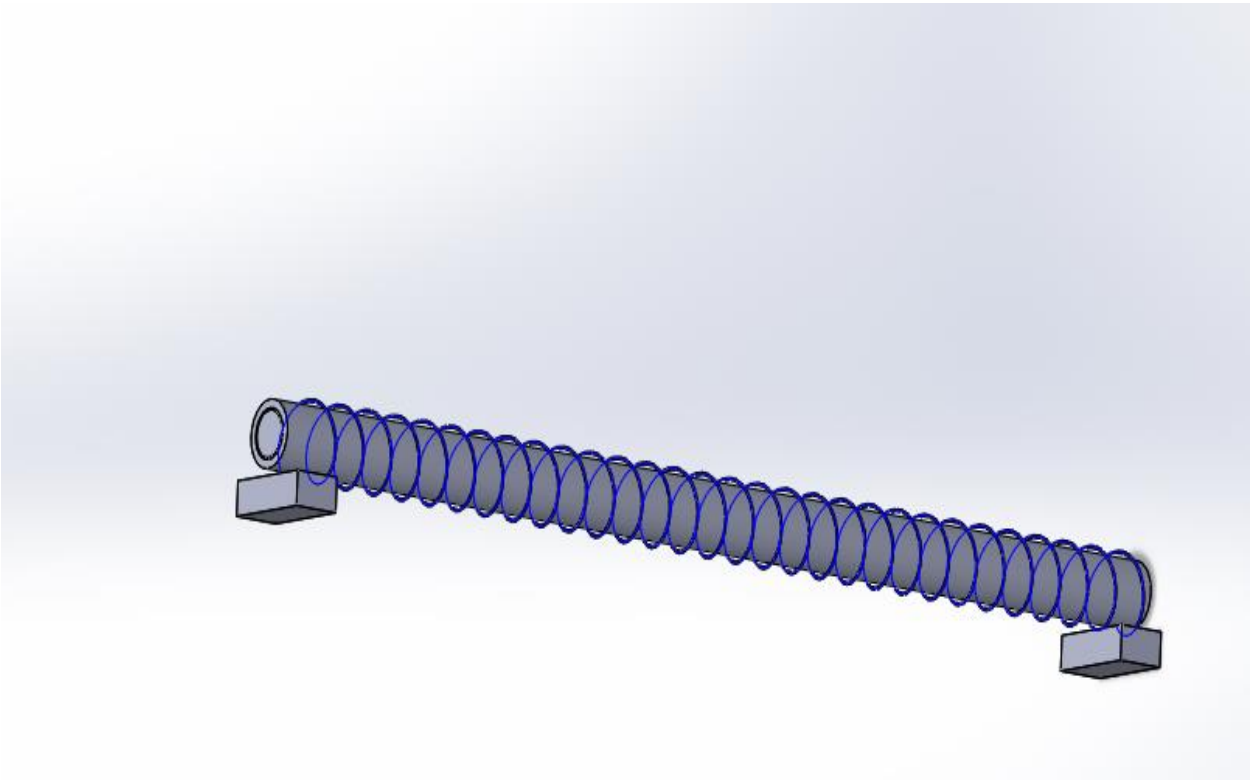


Over defined

5.5 2D DESIGN



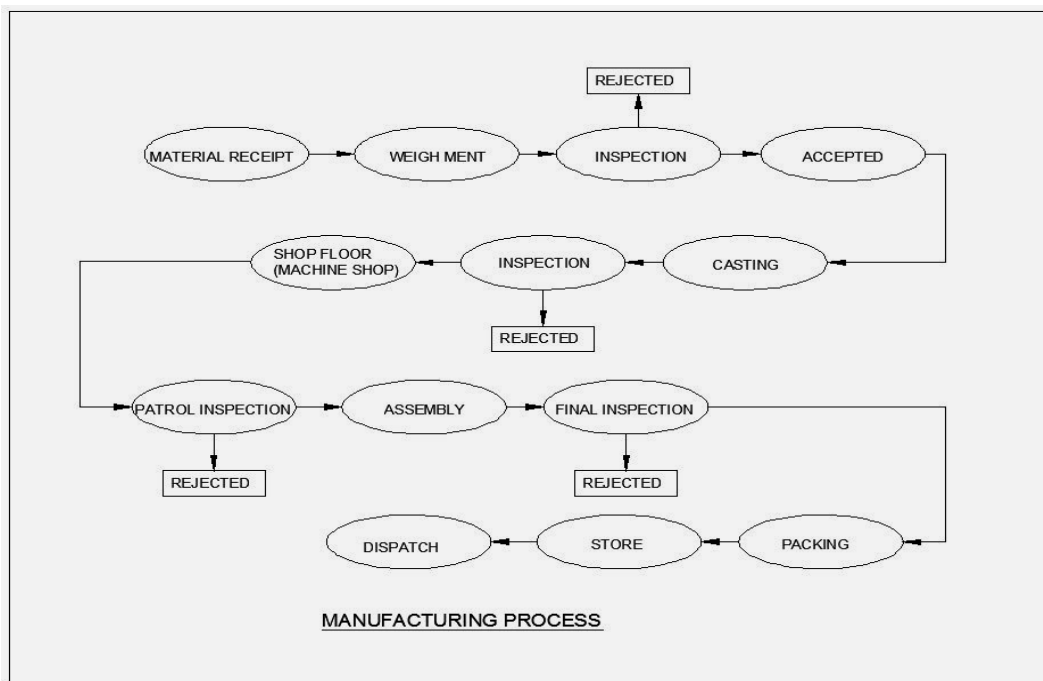
5.6 3D DESIGN



CHAPTER 6

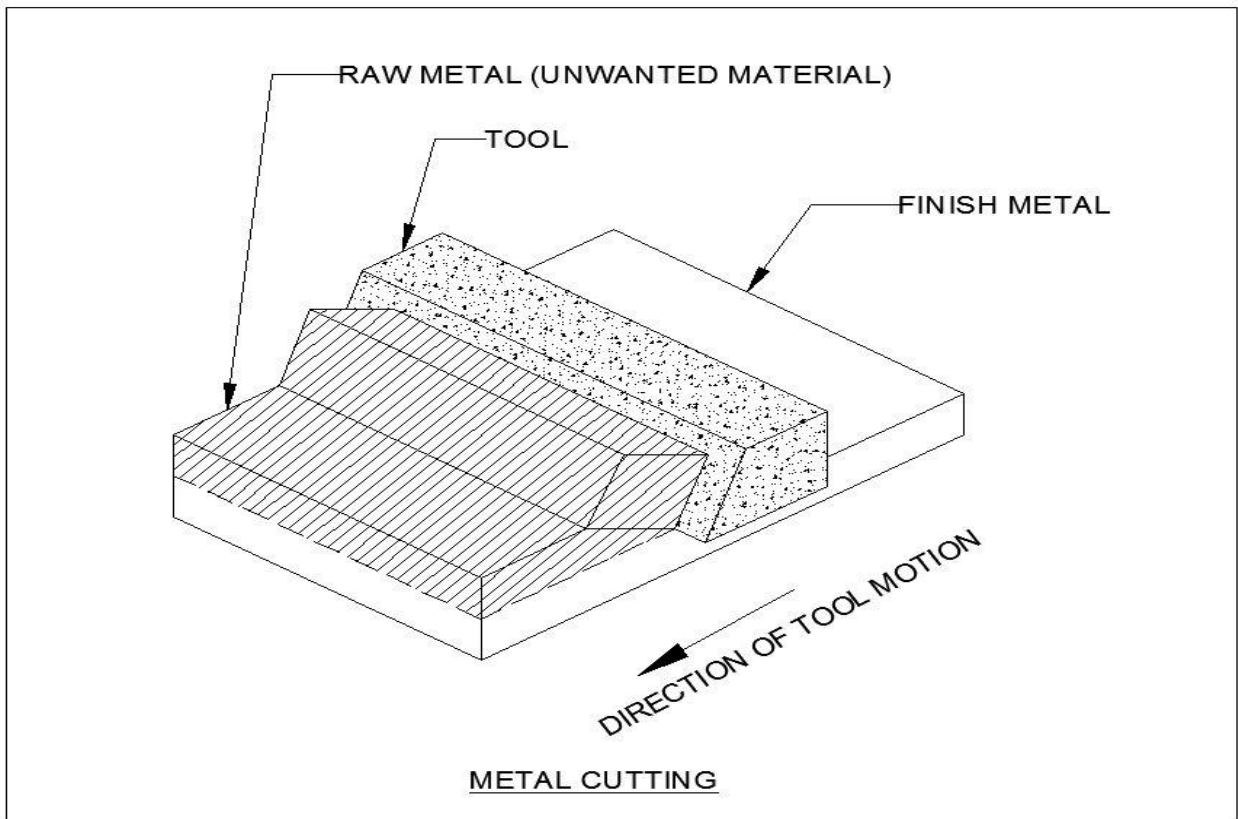
MANUFACTURING PROCESS

Manufacturing procedures are the phases that raw materials go through to get a finished product. The development of the materials from which the design is formed is the first step in the production process. These materials are subsequently transformed into the needed part through manufacturing methods. Treatment (such as heat treatment or coating), machining, or reshaping the material are all examples of manufacturing operations. The manufacturing process also involves quality assurance tests and inspections before and after production, as well as production process planning prior to production.

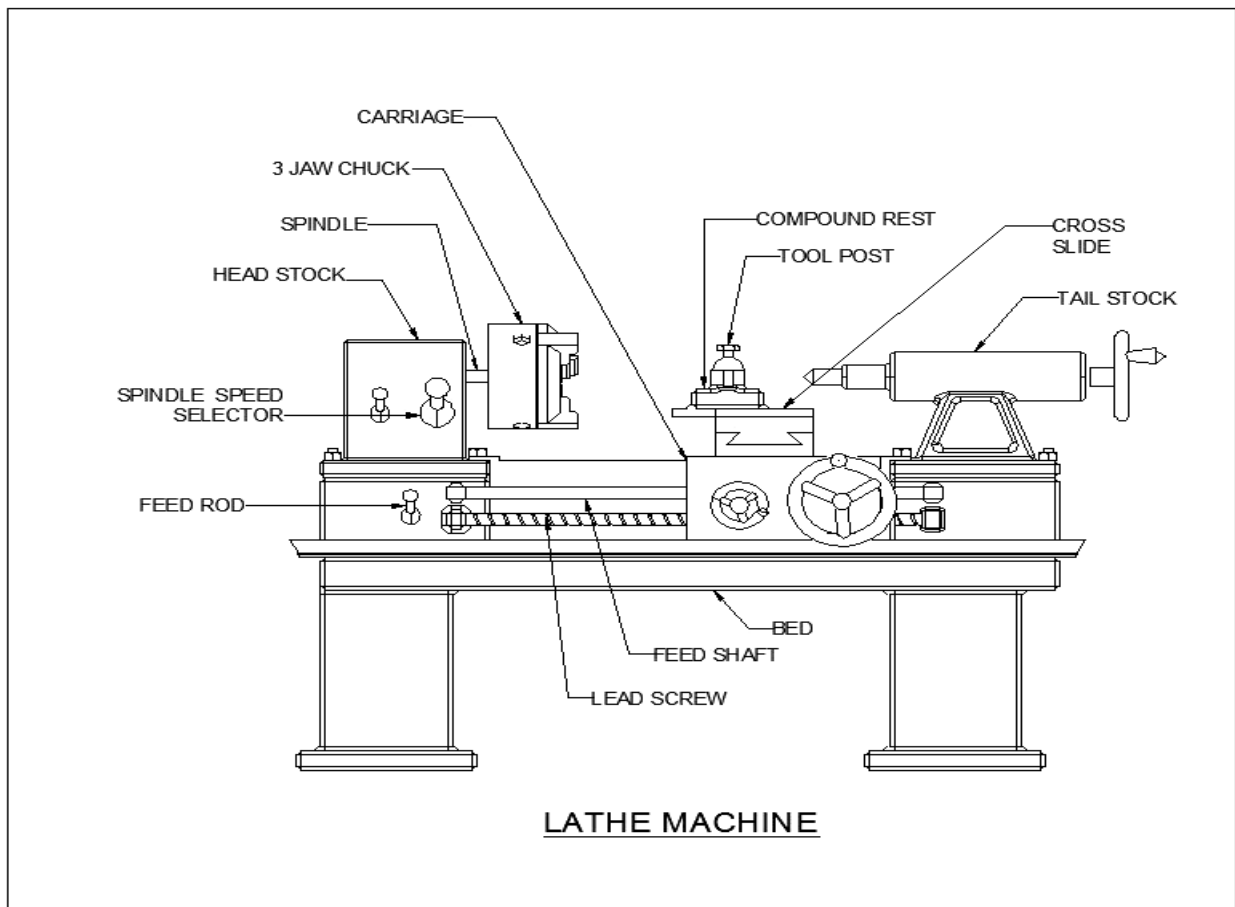


6.1 METAL CUTTING

Metal cutting or machining is the process of removing unwanted material from a block of metal in the form of chips.



Cutting techniques function by fracturing the material being worked on. The cracked section is usually broken up into little fragments called chips. Sawing, shaping (or planning), broaching, drilling, grinding, turning, and milling are all common cutting procedures. Although the cutting machines, equipment, and methods may appear to be highly diverse, a simple model termed orthogonal cutting may explain the core mechanism that causes the fracture.



The workpiece is a form that may completely cover the final component shape in all machining operations. The goal is to remove any surplus material and produce the final product. This cutting is normally done in numerous phases, with the component being held in a fixture at each step and the exposed piece being accessed by the tool to the machine in that section. Vises, clamps, 3-jaw or 4-jaw chucks, and other fixtures are common. A setup is the name given to each position in which the part is held. In each setup, one or more cutting operations may be done using one or more cutting instruments. We must release the component from the prior fixture to transition from one arrangement to the next. Change the machine's fixture, clamp the component in the new position on the new fixture, configure the machine tool's coordinates for the new part location, and finally begin the machining processes for this configuration.

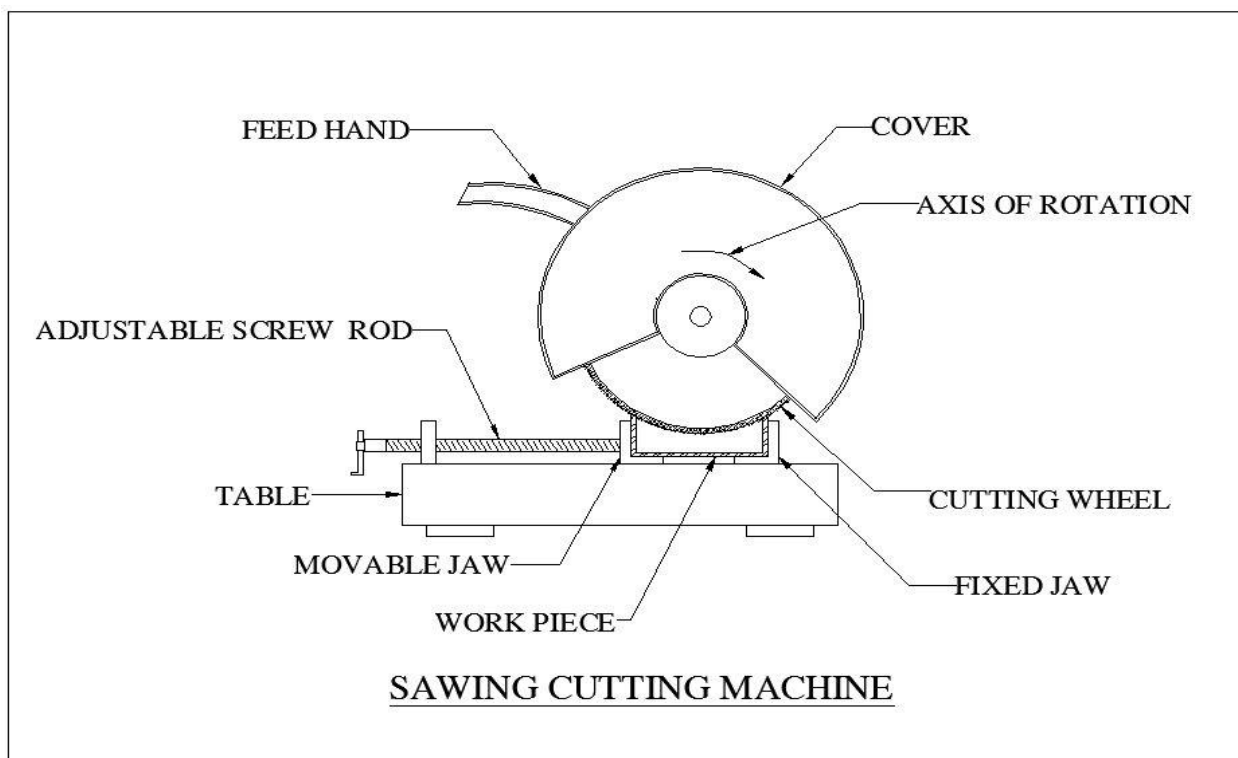
As a result, setup changes are time-consuming and costly, so we should try to complete the cutting process in as few setups as possible. Process planning is the task of determining the sequence of individual operations, grouping them into (a minimum

number of) setups, and determining the fixture used for each setup. These notes will be organized in three sections:

- (i) Introduction to the processes,
- (ii) The orthogonal cutting model and tool life optimization and
- (iii) Process planning and machining planning for milling.

6.2 SAWING

Cold saws are saws that cut through many forms of metal, including sheet metal, with a circular saw blade. The saw's name refers to the motion that occurs throughout the cutting process, which prevents both the metal and the blade from becoming too hot. A cold saw is a saw machine that is driven by electricity and is generally stationary rather than portable.



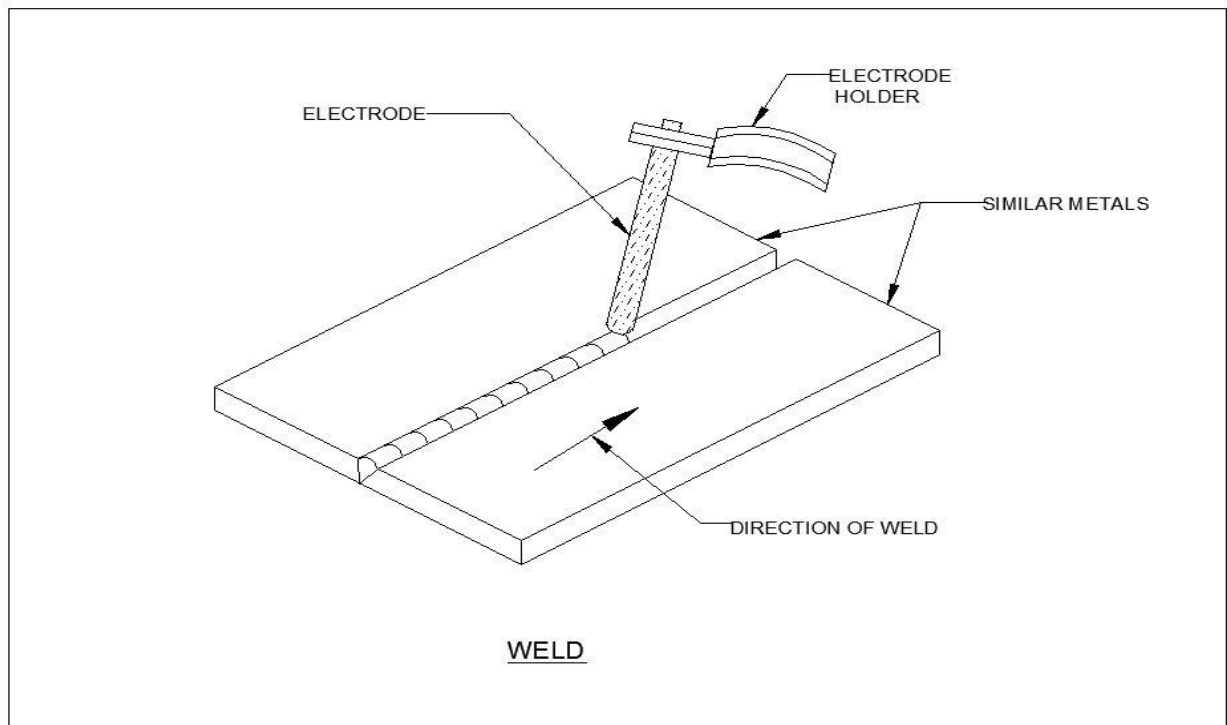
Circular saw blades for cold saws are frequently made at high speeds. This type of steel blade is resistant to wear even when used on a daily basis. As a consequence, it is able to accomplish multiple cutting tasks before the blade has to be replaced. When

cutting through larger portions of metal, high-speed steel blades are extremely beneficial.

A cold saw may also be fitted with tungsten carbide-tipped blades in addition to high-speed steel blades. This style of blade structure also aids in wear and tear resistance. One significant distinction is that tungsten-tipped blades may be re-sharpened, increasing the blade's life. This blade is ideal for cutting sheet metal and other metallic components with a thin design.

6.3 WELDING

Welding is a method of connecting metals that are similar in composition. Welding is a method of joining metals by melting and fusing the base metals and the filler metal. Welding uses targeted heat input that is identified. The majority of welding is done using ferrous metals like steel and stainless steel. Weld joints are often as strong as or stronger than the basic metals they connect.

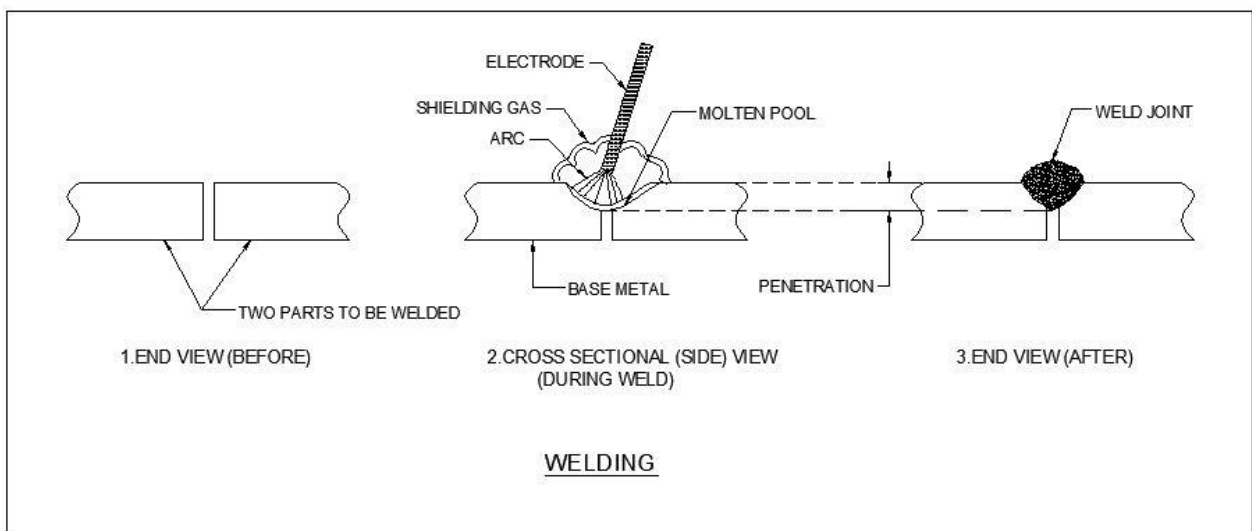


Welding is used to create permanent connections. Automobile bodywork, aeroplane frames, railway carriages, machine frames, structural works, tanks, furniture, boilers, general repair work, and shipbuilding are all made using it.

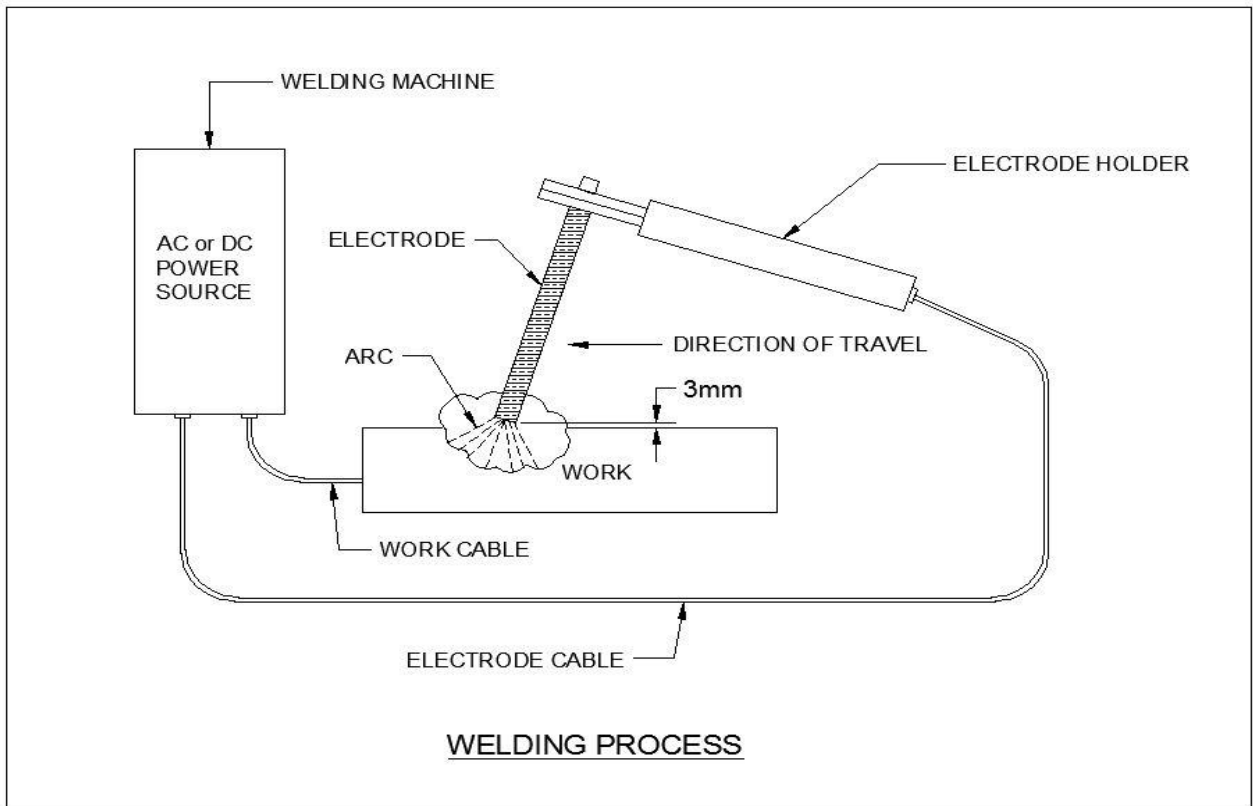
OPERATION

Several welding procedures use an electric arc to heat materials; however, only a handful are discussed here, beginning with the simplest, simple arc welding, also known as shielded metal arc welding (SMAW) or stick welding.

An electrical machine (which can be DC or AC, but is most commonly AC nowadays) delivers current to an electrode holder, which holds an electrode that is generally coated with a chemical or flux combination. To provide a return channel for the electricity, an earth wire links the workpiece to the welding machine. The weld is started by tapping ('hitting') the electrode tip on the workpiece, causing an electric arc to form. The high temperature (about 6000oC) creates a molten pool practically instantaneously, and the end of the electrode continuously melts into this pool and forms the joint.



The operator needs to control the gap between the electrode tip and the workpiece while moving the electrode along the joint.



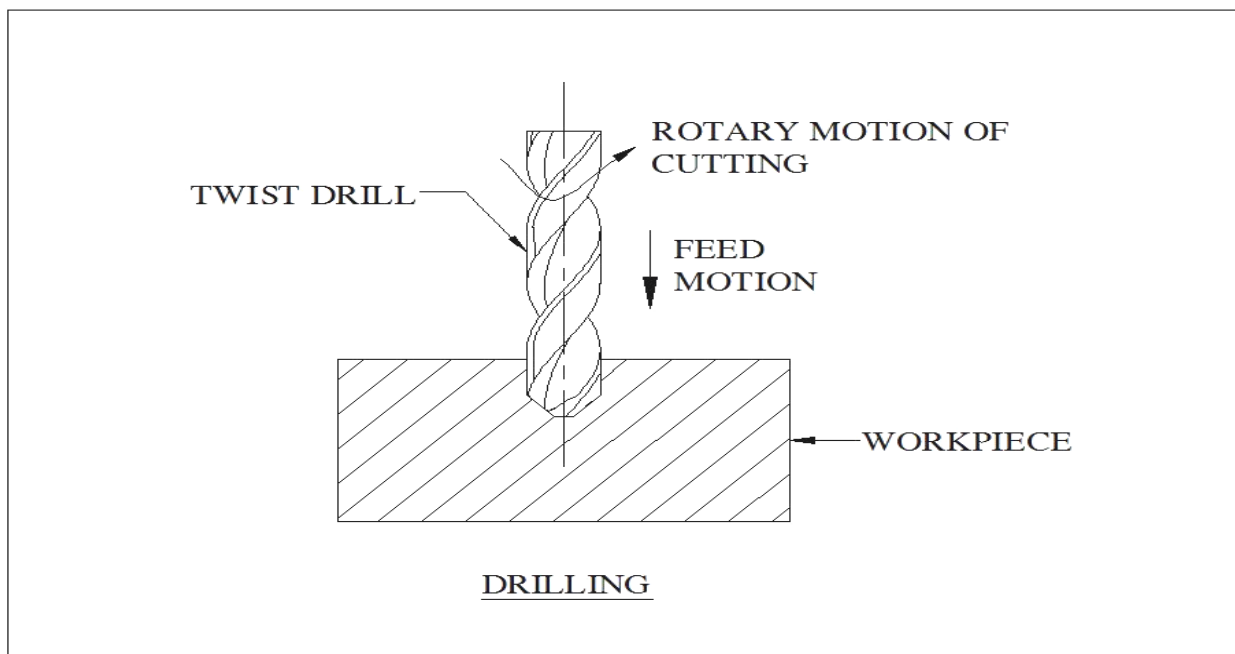
The 'stick' electrode is coated with an extruded flux coating in the shielded metal arc welding process (SMAW). The arc's heat melts the flux, creating a gaseous barrier that keeps air out of the molten pool. Flux components also react with undesired contaminants like surface oxides, resulting in slag that floats to the weld pool's surface. This generates a crust around the weld that protects it as it cools. The slag is chipped off when the weld is cool.

Because the SMAW process is discontinuous and only appropriate for manual operation, it cannot be utilised on steel thinner than roughly 3mm. It's commonly utilised in jobbing shops and for onsite steel construction. The method can be used on most steels, heat-resistant alloys, and many types of cast iron thanks to a wide selection of electrode materials and coatings.

6.4 DRILLING

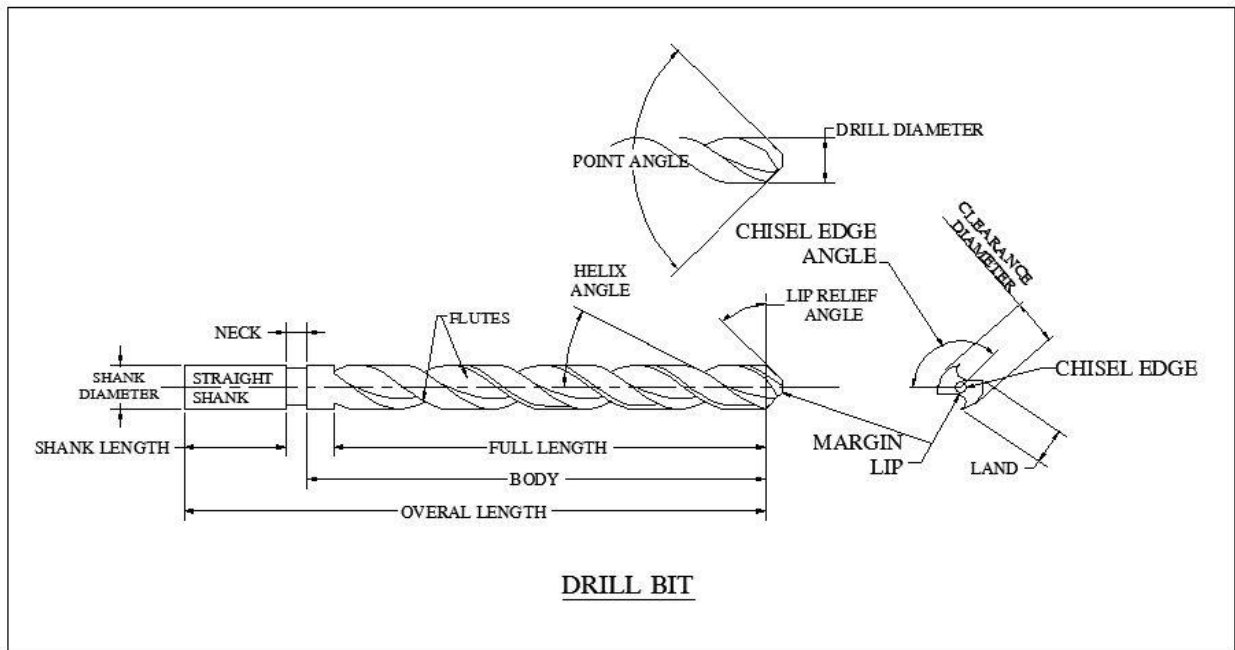
Drilling is a cutting technique that involves using a drill bit to create or widen a circular hole in solid materials. The drill bit is a multipoint rotary cutting tool. The bit is pushed against the workpiece and spun at speeds ranging from hundreds to thousands

per minute. As the hole is drilled, the cutting edge is forced against the workpiece, cutting off chips (swarf)..



OPERATION

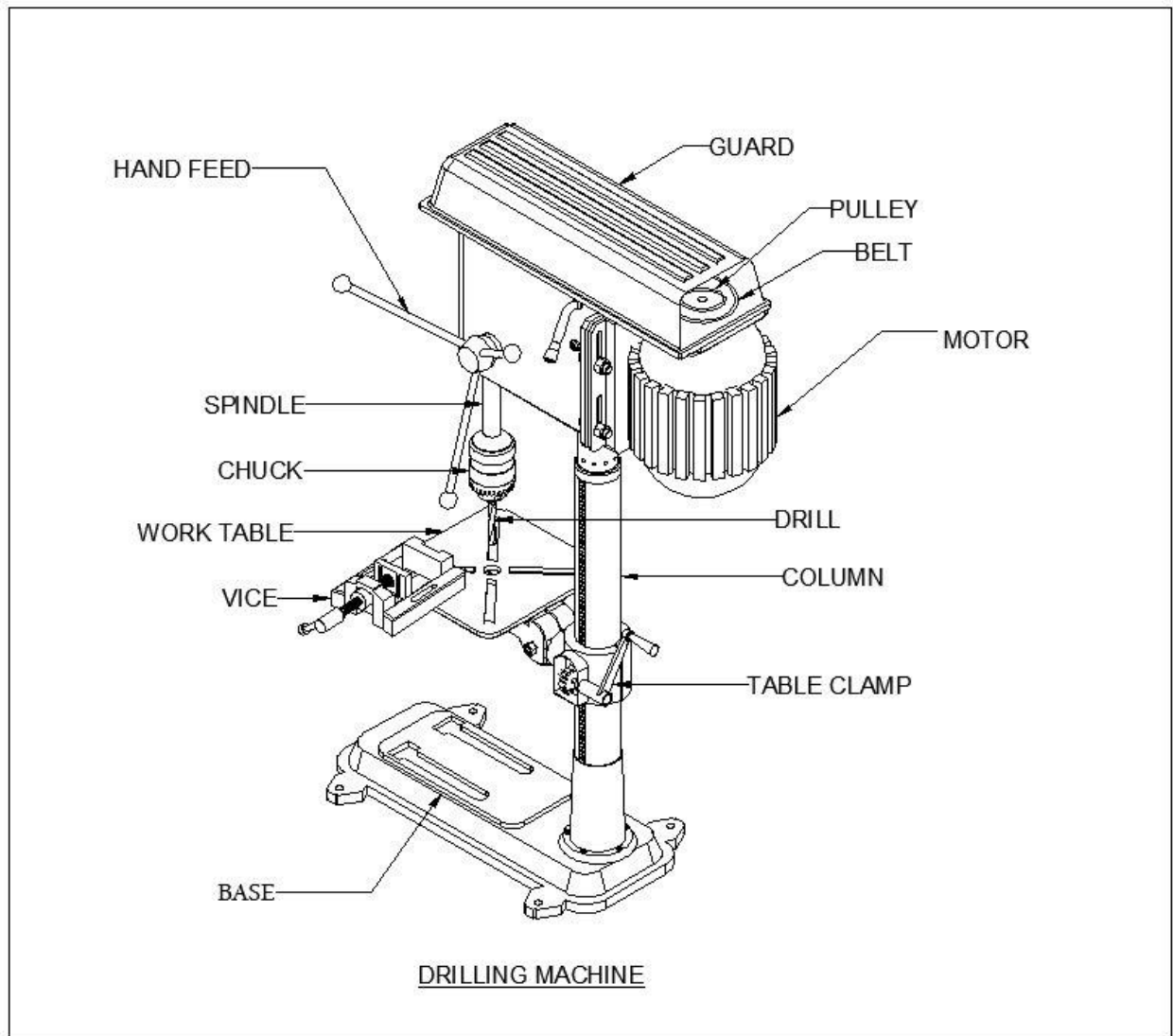
The standard twist drill tool (also known as a drill bit) has a complicated geometry, with straight cutting teeth at the bottom that do the majority of the metal cutting and curved cutting teeth along the cylindrical surface. Flutes are the grooves made by the helical teeth, and they help force chips out of the hole as it is being machined. Because the drill tip's velocity is zero, this part of the tool can't accomplish any cutting. As a result, before using the drill, it's typical to create a small hole in the material called a centre hole. Special drills called centre drills create centre holes and give a nice route for the drill to move about alignment with the hole's centre. There are hundreds of different drill shapes and sizes; we will just cover a few basic facts regarding drills in this article.



Hardened steel (High-Speed Steel, Titanium Nitride Coated Steel) is a common drill bit material; drills with hard inserts, such as carbide or CBN inserts, are used to cut tougher materials.

Drills for cutting softer materials often have smaller tip angles, whereas drills for cutting hard and brittle materials have wider point angles.

When the length/diameter ratio of the hole to be machined is high, specific guiding support for the drill, which must be very long, is required; this is known as gun-drilling. For holes having a diameter of a few millimetres or more and an L/D ratio of up to 300, this method is utilised. These are used to make gun barrels.;

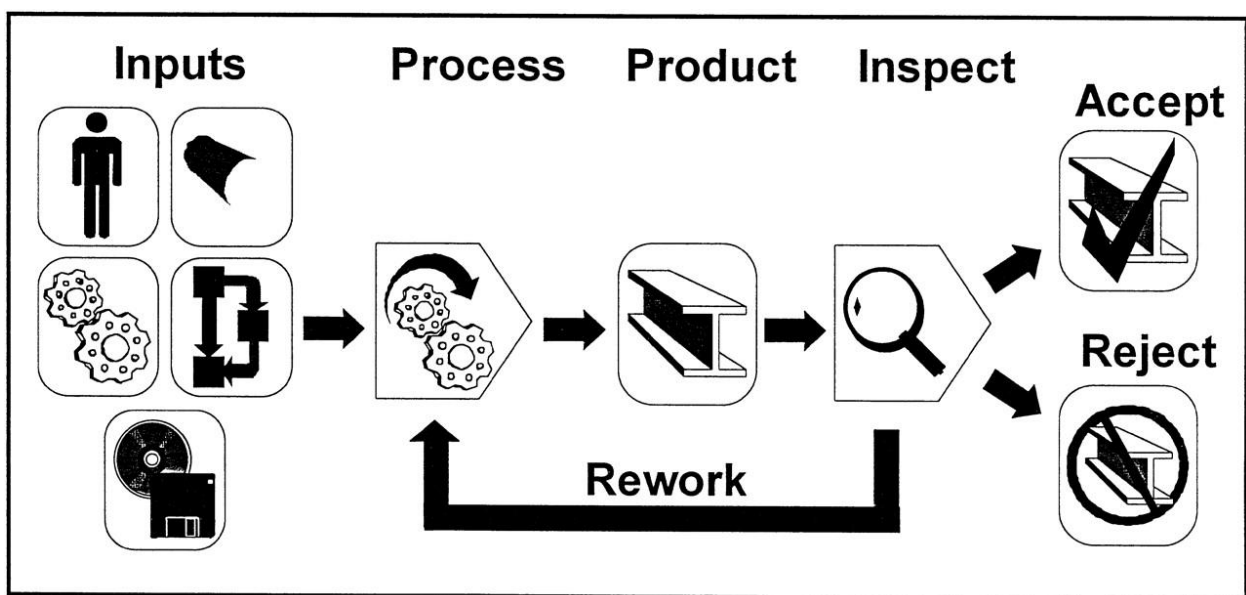


Drilling is not recommended for holes with very tiny diameters (less than 0.5 mm), since the tool may shatter and become caught in the workpiece; The size of the hole drilled by a drill is usually somewhat bigger than the drill's specified diameter - this is due to vibration of the tool spindle as it rotates, probable drill misalignment with the spindle axis, and other variables.;

We utilise a specific type of drill called a reamer to drill a hole that is slightly smaller than the required size (e.g. 0.25 mm smaller) for strict dimension control on hole diameter. Reaming has a modest rate of material removal and a shallow cut depth, yet it provides high dimension accuracy.

6.5 INSPECTION

Examining, measuring, testing, gauging, and comparing materials or products are all part of critical assessment. An inspection evaluates if the material or object is in the correct quantity and quality, as well as whether it meets the relevant or defined standards. Receiving inspection, in-process inspection, and final inspection are the three types of inspection that are often used. Inspection's job in quality control (which is guided by the idea that "Quality cannot be inspected into a product") is to check and validate variance data, not to separate good from bad.



ASSEMBLY

An assembly line is a manufacturing process (sometimes referred to as progressive assembly) in which pieces (typically interchangeable parts) are added in sequence as the semi-finished assembly goes from work station to work station until the final assembly is completed. A final product may be constructed significantly faster and with much less labour by mechanically moving parts to the assembly task and moving the semi-finished assembly from work station to work station than by having people transport parts to a fixed piece for assembly.

6.6 FINAL OUTPUT IMAGE



CHAPTER 7

CONCLUSION

We have fabricated the plain stainless tube with a copper winding in the future, we will implement the cooling method in the heat exchanger, and we will use the k type thermocouple to measure the cooling temperature of the inlet and outlet of the tube, then analyse the temperature and apply it to the air cooling system, shell, and tube heat exchanger.

7.1 ADVANTAGES

- The heat transfer rate is increased
- Performance is improved
- Better efficiency

7.2 APPLICATION

- Boilers
- Power plants
- Condensers
- Turbines

7.3 FUTURE WORK

Customers are expecting more value and longevity from their HVAC equipment than ever before. The use of copper heat transfer coils allows you to select a higher-quality, lighter-weight, and longer-lasting evaporative cooling unit. In the future, we will assess the cooling surface using a k type thermocouple and apply it in big industry heat exchangers.

7.4 REFERENCES

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