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MECHANICAL ENGINEERING DEPARTMENT

M.E. DESIGN LESSON I

GENERAL REPORT

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How does the heart work?

The heart, whose main task is to pump blood to the body, performs tasks such as removing waste products from the body as a result of metabolic activities, regulating body temperature, maintaining acid-base balance, and transporting hormones and enzymes to the necessary parts of the body.

- ✓ The heart functions as a motor in this system. The heart pumps 5-35 liters of blood per minute, and 9000 liters of blood per day, at a rate varying between 60-80 beats per minute. It pumps approximately 8 thousand tons of blood to the body without stopping, approximately 100 thousand times a day, 40 million times a year, approximately 2.5 billion times in a whole human life.

- ✓ The average weight of an adult woman is 200-280 grams, and an adult male weighs 250-390 grams. It is claimed that each person's heart is the size of his fist.

- ✓ The heart is located in the thoracic cavity, between the 2 lungs, on the diaphragm muscle, two-thirds to the left and one-third to the right of the midline.

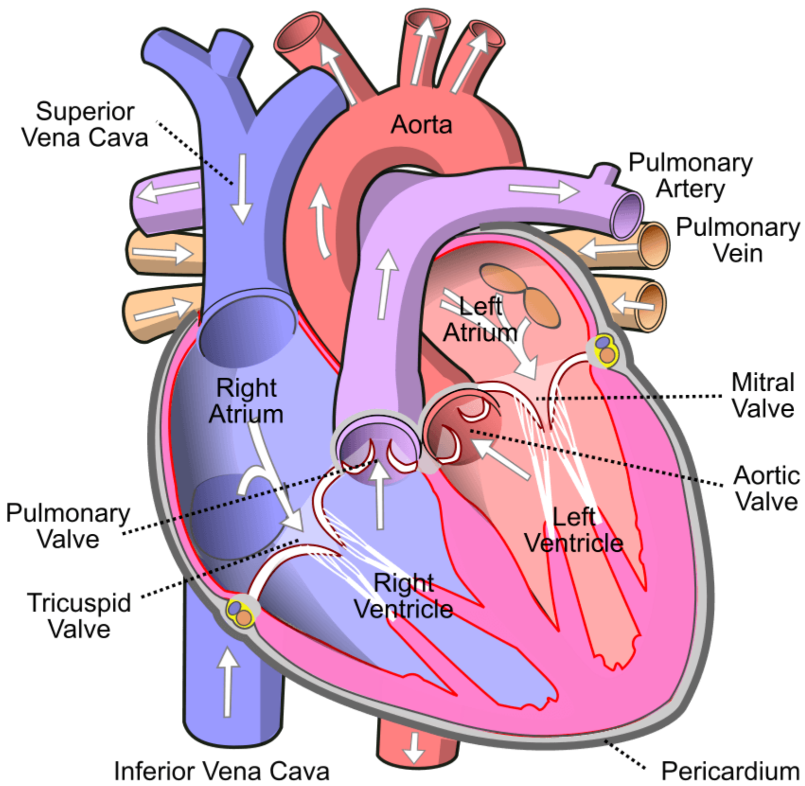
- ✓ When we put our hand on the left side of our chest, the reason for the sound coming from our heart is the opening and closing of the valves between the atria and the ventricles.

INTERNAL STRUCTURE OF THE HEART

Chambers

There are 4 chambers in the heart. These; right atrium, left atrium, right ventricle, left ventricle.

The right and left parts of the heart are completely separate from each other. The heart consists of four hollow chambers. The right side of the heart consists of the right atrium and right ventricle, where there is oxygen-poor blood. The left side of the heart is composed of the left atrium and left ventricle and contains oxygen-rich blood. In addition, due to the pumping function of the left ventricle, the wall structure is highly developed compared to other cavities.



Heart Valve

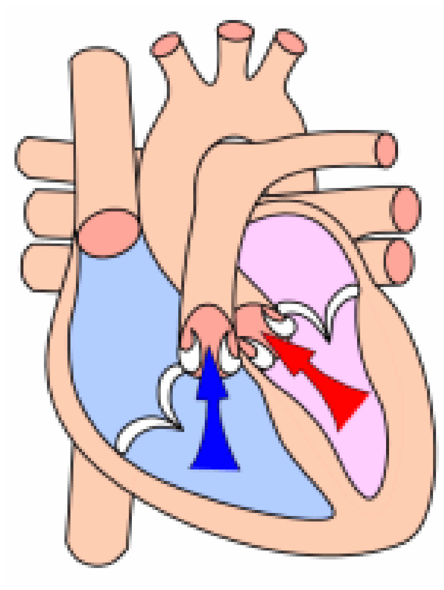
There are 4 valves in the heart, two of which are the valve separating the ventricle and the chamber, and two are the valves of the great vessels. There are valves between the atria and the ventricles and between the ventricles and the veins coming out of them. Valves serve to prevent the unidirectional flow of blood, that is, its return. Valves provide one-way blood flow to the ventricles, while at the same time providing one-way outflow.

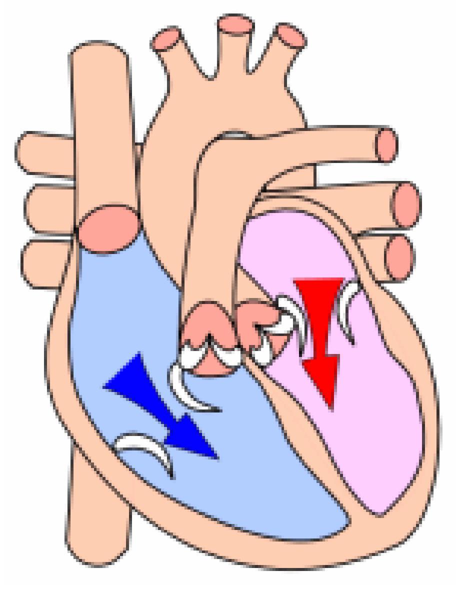
Tricuspid valve: Located between the right atrium and right ventricle.

Pulmonary valve: Three half-moon-shaped valves between the right ventricle and the pulmonary artery that prevent the return of blood pumped from the right ventricle.

Mitral valve: Located between the left ventricle and left atrium.

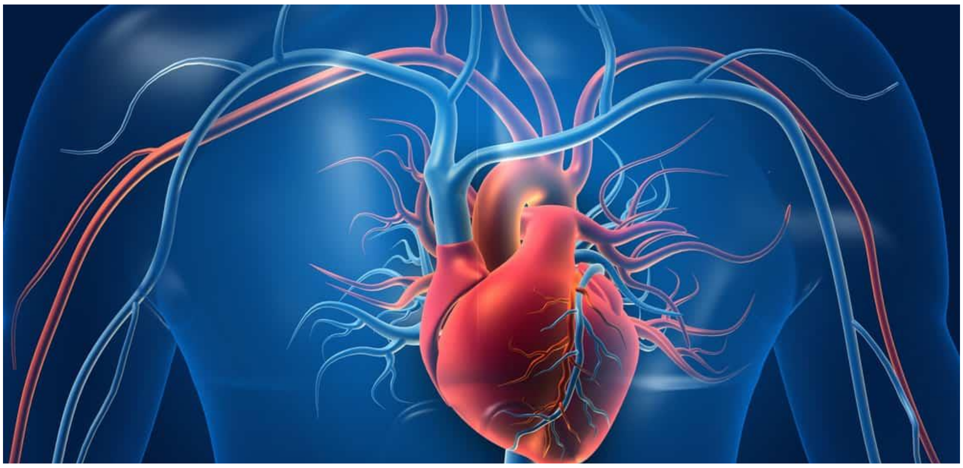
Aortic valve: Located between the left ventricle and the aorta. These valves prevent the return of blood pumped from the left ventricle.





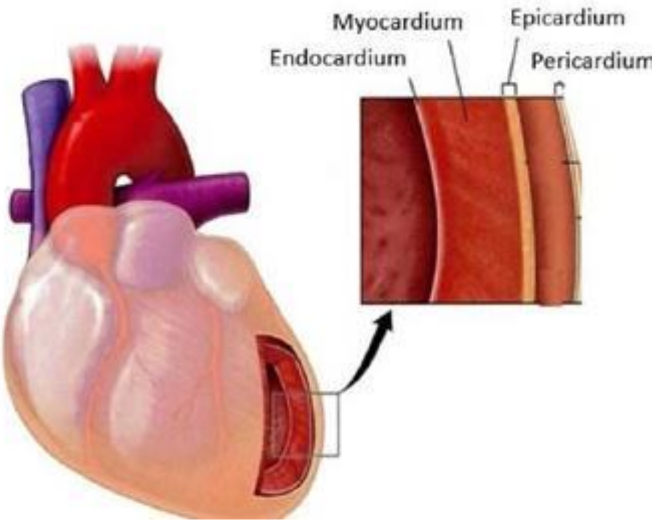
Veins

Although the heart is filled with blood, it is fed not by the blood inside, but by the right and left heart arteries that separate from the aorta. These vessels, which are in the form of two main branches at the beginning, then divide into branches and branches and feed the heart.



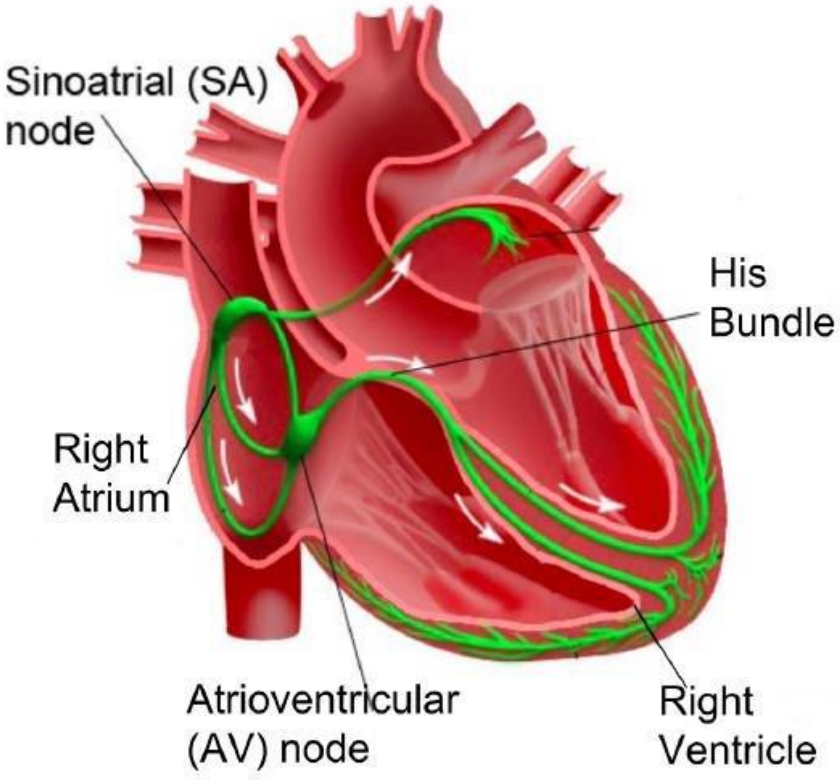
Layers

The heart consists of 3 layers. From the outside to the inside, it is called the pericardium, myocardium and endocardium. The thickest layer of the heart is the myocardium. The ventricles, which serve as pumping, are thicker than the atria, especially in the left ventricle.



Message system

The heart, by contracting, acts as a pump and delivers the blood coming to it to the body, by the contraction of electrical currents. A heartbeat is initiated by electrical stimulation of the right atrium of the heart.

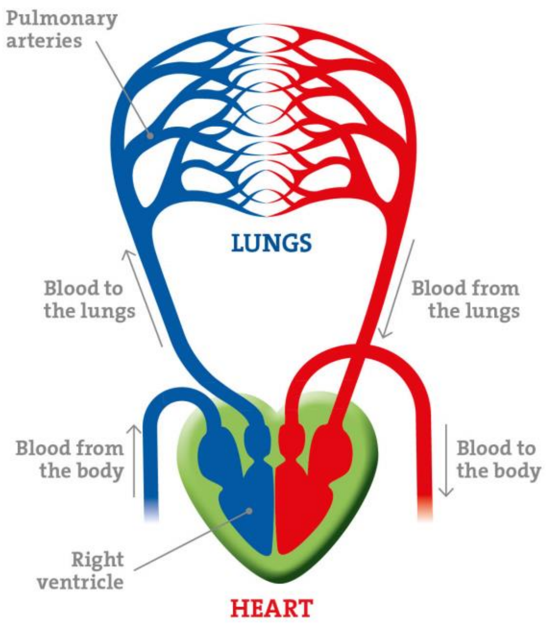


Blood Circulation System

The circulation starts with the blood coming from the body entering the right atrium thanks to the upper and lower main veins and continues with the passage to the right ventricle thanks to the triscuspid valve.

From here, it passes through the pulmonary valve and goes to the lungs via the pulmonary artery. After the blood is enriched with oxygen in the lungs, it enters the left atrium through the pulmonary vein to the heart. It crosses the mitral valve and enters the left ventricle.

When the muscles of the left ventricle contract, the oxygen-rich blood passes through the aortic valve and disperses with the main artery called the aorta and its branches, meeting the needs of our body.



WHAT IS THE 3D PRINTER?

Three-dimensional printing is the process of producing three-dimensional solid objects from a three-dimensional file (CAD drawings) prepared in the digital environment. Machines that perform these operations are called three-dimensional printers.

A 3D printer is a machine that transforms computer data into real tangible objects. These machines can produce parts with complex geometry that cannot be produced using traditional manufacturing methods.

In order to perform the three-dimensional printing process, first of all, computer data is created with the help of three-dimensional design programs or three-dimensional scanning systems of the part or parts to be manufactured. The modeled part is usually saved as an STL file and transferred to the three-dimensional printer control program. The model is sliced into layers in the three-dimensional printer control program and a “G code” file is created. Then, the "G code" file is transferred to the three-dimensional printer with the help of a memory card or a direct computer connection and printing is performed. In the three-dimensional printing process, the object is created by laying on top of each other in layers. Different methods can be used to create these layers. These are methods such as plastic melting, laser sintering, stereolithography.

There are varieties of 3D printers such as cartesian printer, delta printer and core xy printer. Three-dimensional printers operating in the Cartesian logic generally consist of a thermoplastic injector connected to the computer-controlled xyz cartesian platform. The skeletons of these printers are made of steel bars or profiles. Fasteners are plastic parts that are used either by conventional means or manufactured by another three-dimensional printer. The movements in the X and Y axis are provided by the eccentric timing belt, while the movement in the Z axis is controlled by two stepper motors using ball screws.

The main difference that distinguishes Delta printers from other printers is that they are driven by a stepper motor from three places to provide movement in the vertical Z axis. This is due to the triangular shape of delta printers.

In three-dimensional printers working with Core XY logic, X and Y axis movement is realized with the help of belt pulleys. Here, the melting head is connected to the XY coordinate system. Z axis movement is given to the table. The table is controlled by stepper motors via ball screws.

Today, there are also three-dimensional printers whose raw material is metal. However, these printers are used by large companies as they are quite expensive in terms of cost. Some techniques are being developed to popularize metal printing. One of these developed methods is that a welding robot stacks metal as if welding on a metal surface. The printed metal does not need support as it solidifies and hardens quickly. Instead of purchasing and using an expensive technology to print metal structures on 3D printers, this newly developed method eliminates large investment costs.

WHAT IS THE FILAMENT

Filament is a thermoplastic raw material used for modeling of 3D printers. There are many types of filaments that need to be worked with different properties and different temperatures. The filament used in the 3D printing process is at least as important as the 3D printer. Filament quality and technical features directly affect the print quality. There are two different diameters of filament: 1.75 mm and 2.85 mm/3 mm.

3D Printer Filament Types and Properties:

- PLA (Polyactic Acid)
- ABS (Acrylonitrile Budadiene Styrene)
- PETG (Polyethylene Terephthalate Glycol-Modified)
- Flexible (Flex)
- TPU (Thermoplastic Polyurethane)
- TPE
- PVA
- Polyamide
- Wood, wooden, plank, bamboo
- Transparent
- Antibacterial
- Special Filaments

What is PLA Filament? What are its features?

When 3D printers first came out, there were only two types of structural materials, PLA and ABS. PLA is characterized as a filament type of organic origin. PLA is the most popular of the filament varieties. It is the most commonly used type for printing at home.

PLA filaments are printed at lower temperatures than ABS. It has a biodegradable structure and with this feature, it is much more environmentally friendly than many filament types. Another feature is that it does not emit bad odors during printing. It is very easy to print compared to ABS.

PLA has a hard structure and is resistant to impacts. However, it is slightly flexible and fragile. The printing temperature is between 190°C – 220°. Bearing temperature is recommended in the range of 50°C – 70°C.

If we talk about the areas of use, they can be used in products that can come into contact with the human body, since it is not a substance harmful to health. In addition, because they have a bright structure, they are generally preferred for use in products that appeal to the eye.

What is ABS Filament? What are its features?

After PLA, the most popular filament type is ABS. Although it is a little more difficult to print than PLA due to its raw material properties, it is superior to PLA in many aspects in terms of technical properties. For this reason, there are generally ABS raw material products in household goods and consumer products. It has high durability and prints at high temperatures. Since it is processed at high temperature, the 3D printer user should pay attention to the smoke that occurs during printing and the bending orientation in the printing. It must be printed in a well-ventilated area with a heating bed. It has low flexibility. Due to its raw material feature, it is not recommended to be used with food and beverages. The printing temperature is between 230°C – 260°C. It is recommended that the bearing temperature be between 80°C and 120°C. In terms of its technical features, ABS has a more general purpose usage area. ABS is used in LEGOs, phone cases, toys, automobiles, electrical equipment and many other areas.

What is PETG Filament? What are its features?

PET (Polyethylene terephthalate) is the most widely used plastic type in the world. It has a wide range of uses such as water and beverage bottles, kitchen utensils, cookie molds, clothing fibers. It is as easy to print as PLA and is fully recyclable as a raw material. It is described as the middle ground between PLA and ABS because it is easier to use than PLA and more durable than ABS. It also has a light and flexible structure. PETG absorbs moisture from the air, so the filament must be kept in a cool and dry environment. The printing temperature is between 220°C–250°C. It is recommended that the bed temperature be between 60°C–70°C.

Flexible Or TPU Filaments

TPU (Thermoplastic Polyurethane), TPE (Thermoplastic Elastomers) and TPC (Thermoplastic Copolyester) types are frequently encountered as flexible filament types. TPE has properties similar to rubber properties. They are generally used in automotive, household appliances and medical supplies. TPU is a special kind of TPE and 3D printer filament. It has a slightly more rigid structure than TPE in general. It has the feature of better protecting its flexibility in the cold. TPC, on the other hand, is not as common as TPU. Its main privilege is its exposure to chemicals and ultraviolet rays and its resistance to high temperatures. The printing temperature is between 210°C–235°C. Bearing temperature is recommended between 60°C–70°C. They have usage areas such as wearable materials (shoes, wristbands, etc.), toys and phone cases.

Wood, Wooden, Bamboo Filaments

They are materials that are a mixture of wood fiber and PLA. When handled, they give the feeling of wood and create objects with a pleasant appearance. They are filament types that are used less in places where their functional properties such as flexibility and tensile strength are considered, and more in places where their appearance is considered.

They are often used in home decorations and trinkets. Printing temperatures are between 195°C–220°C. Bearing temperature is recommended between 60°C–70°C.

Transparent Filaments

There are improved PLA and PETG filaments used in printing to create transparent (transparent) products. For this reason, they have the same properties as these raw materials in terms of technical properties. The point to be considered in printing when using this type of filament is that the wall thickness of the product to be printed is greater than the nozzle diameter of your 3D printer, the lower the transparency in the object.

Antibacterial Filaments

It is a type of PLA doped filament. They do not contain bacteria on the part they are used on. In terms of technical features, it is almost the same as PLA. They are used in the education and food sectors, kitchens and bathrooms, especially in environments that can harbor bacteria. Due to the fact that the raw material is PLA, they do not go through a process that is harmful to health at the time of printing. Printing temperatures are between 185°C–195°C. The bed temperature is recommended to be 60°C–70°C.

WHAT IS PVA FILAMENT?

Although PVA (PolyVinyl Alcohol) is known as the 3D printer filament, it is also referred to as the melt-in-the-wash material in laundry detergent dispensers. The same principle was used to create soluble support material.

When to Use PVA Filament

First, to use PVA, a double head (extrusion) 3D printer must be used. Only PVA should be used with PLA as the main material. Since PLA filament is suitable for production at similar temperatures to PVA, beautiful prints can be obtained. Solvable supports are the most ideal solution to get rid of surface roughness, which is frequently encountered in the model's complex details, internal cavities/cavities that can be supported with a single material and are difficult to clean, or in the support structures produced with a single material in the model.

Let's imagine that you had to print a tubular spiral structure with the support produced with the same material. At a certain point the supports will be cleared and the exterior of the model will have traces where the support material meets the main model. However, by using the PVA soluble filament in supported structures and then soaking the model in water, a clean model can be achieved within hours.

When to Use a Different Support Material?

3D printer filaments produced at high temperatures; Filaments such as ABS, PETG, Nylon (PA) or Flexible (Flex) cannot be used with PVA filament. In other filaments, support structures must be produced from their own material. An excellent support for ABS, HIPS costs more than regular filaments such as PVA. For this reason, 3D prints can be produced with a single material if a very simple model or an easy-to-clean supported model is to be produced.

Best Printing Temperature for PVA Filament

The brand of filament used affects the printing temperature of PVA. Generally, prints can be obtained between 185°C and 215°C. It is not possible to print at higher temperatures than these, because PVA tends to bake and carbonize in the nozzle. In other words, the nozzle can easily become clogged. Therefore, it should be ensured that the printing temperature is within this range and that the filament does not stay in the nozzle when not in use.

WHAT IS SILICON?

Silicone is a polymer composed of siloxane. Liquid silicone rubber (LSR) is a two-part, platinum-cured, extreme weather and product aging resistant elastomer that manufacturers inject into mold cavities to create components. Elastomer is a polymer that has viscosity and elasticity in its structure. Their differences from thermoplastics in their molecular structure are due to the fact that the molecular chains consisting of elements that form organic compounds such as C, H, S, F, O or Cl are cross-linked from certain regions containing unsaturated C, albeit slightly. Silicones are usually colorless oils or rubber-like substances and are used in sealants, adhesives, lubricants, medicine, cookware, heat and electrical insulation. Some common forms include silicone oil, silicone grease, silicone rubber, silicone resin, and silicone caulk.

The most basic properties of silicones;

- Low thermal conductivity

- Low chemical sensitivity

- Electrical insulation

This versatile product remains useful in temperatures as low as -65°C and as high as 150°C. A few other key features like this make LSR the material of choice for many different applications and industries. Some notable examples are:

• Biocompatibility: LSR's elastomeric composition allows it to resist bacterial growth. It is completely tasteless and odorless, and tests have shown outstanding compatibility with human body fluids and tissue.

• Chemical Resistance: LSR can resist oxidation and corrosive chemicals.

• Temperature Resistance: LSR can withstand extremely low and high temperatures.

• Mechanical Properties: LSR offers high tear resistance and tensile strength as well as excellent flexibility and elongation capacities.

• Electrical Properties: LSR is a good insulator.

•Transparency and Pigmentation: Silicone is a transparent substance. Therefore, it is suitable for the production of colored and customized rubber molds. Recently, its use in the automotive industry is becoming more and more common.

CASTING OF POLYMERS

One of the methods of forming polymers is casting. Polymer casting is based on the principle of pouring the polymer in the liquid phase into the mold, filling the mold depending on gravity, and then solidification. Acrylic, polystyrene, polyamide (nylon) and vinyls (PVC) from thermoplastics are used in the method applied for both thermoplastics and thermosets. There are several methods for the conversion of molten resin to cured thermoplastic;

- Heating the polymer to a temperature that will enable it to reach high fluidity, pouring it into the mold and leaving the molten polymer to cool in the mold,

- Providing polymerization in mold to use low molecular weight monomer and become high molecular weight polymer,

- Plastisol (small particle suspension containing thermoplastic resin, plasticizer used in PVC) is poured into the mold, thus allowing the material to first gel and then solidify in the mold.

Materials such as polyurethane, unsaturated polyester, phenolic and epoxies are used in shaping thermoset polymers by casting. In the method, the cross-linking and polymerization of the poured melt thermoset takes place in the mold. Depending on the resin type, heat and/or catalyst are required for crosslinking to occur in the mold. This reaction must occur very slowly in order to complete the mold filling. In systems that react quickly, such as polyurethane, an alternative method is needed, such as reaction injection molding.

The biggest advantage of the casting method is that it is an alternative method to plastic injection. Apart from this advantage, the following advantages of the method can be listed;

- Mold is simple and less costly,

-The spilled product is trouble-free in terms of residual stresses and viscoelastic history,

- The method is suitable for manufacturing a small number of parts.

The casting method allows to obtain a high degree of flatness and good optical properties on the surfaces of the manufactured parts. It is impossible to see such a flatness in plates produced by extrusion. On the other hand, the casting method also has some disadvantages. In some applications, serious shrinkage occurs in the product. For example, acrylic plates are subject to 20% volumetric shrinkage when poured. This ratio is higher than in injection molding because in injection molding the shrinkage can be reduced due to the holding pressure. However, such a pressure situation is not in question in the casting method.

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