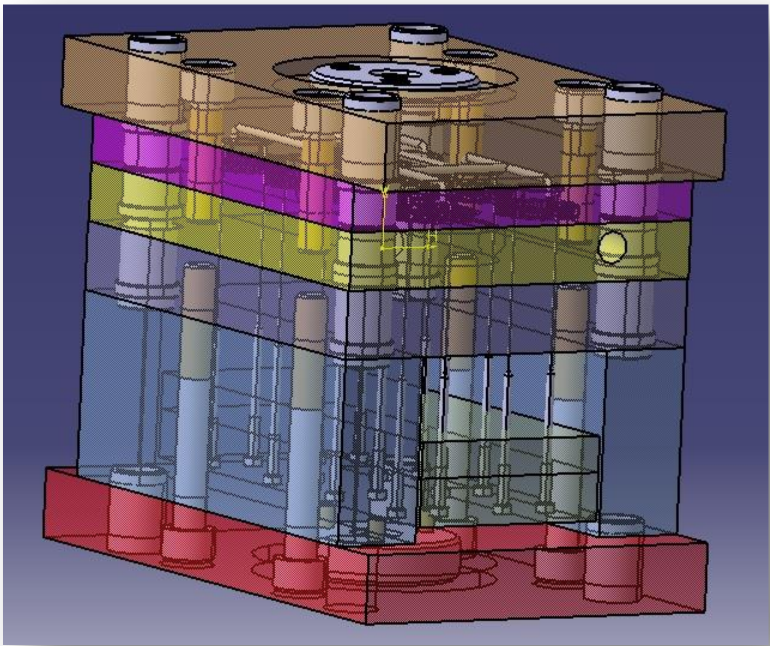
TECHNICAL UNIVERSITY

“GHEORGHE ASACHI”OF IASI

COMPUTER AIDED DESIGN OF AN INJECTION MOLD FOR A GEAR



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1.-Plastic

1.2. - Introduction

A century ago, the products that now we use everyday did not exit, but at finally these have imposed on our lives like daily element that are essential for our life. Some clear example are the plastic bags, plastic buckets, plastic cable coating, interior coating of refrigerators or compact discs.

Figure 1 Plastic's things (Alvarez)

Even so, the plastic materials are of a relatively recent use, it’s elaboration dates from century XIX, although it wasn’t until the decade of years 30 of century XX when it really won importance due to the formulation of its structural molding on the part of the chemical German H. Staudinger. However, its industrial boom didn’t come until after the Second World War.

The plastics materials can be defined like those whose components are formed by macromolecular organic substances that originate through synthesis or transformation of natural products. These materials are produced for the linking of very long molecules called macromolecules that are made up of a multitude of simple structural units called monomers. This is because plastic materials are often refered to as polymer.

Plastic materials come from raw material suches as oil, coal natural gas or other chemicals. In addition, one of the keys to its great use is that its production is very economical, it is possible to achieve a high production and can switch for other materials with the same benefits that are more expensive. The general properties of plastics are:

- Low electrical conductivity
- Low thermal conductivity
- Low density
- High resistance to oxidation and corrosion
- Low hardness
- Low heat resistance
- Recyclable

1.3. - Classification

There are three big groups of plastic materials. The thermoplastics, thermosets and elastomers, now we will be described.

1.3.1. - Thermoplastics

Thermoplastic materials are those whose macromolecules have consist in branched chains that keep their cohesion through intermolecular type forces. One of this main characteristic is that they can be melted and moulded or shaped repeatedly because their intermolecular forces are reduced by heat. Generally, they are soluble materials and a room temperature depending the types of properties they can behave as soft, hard and brittle or hard and tenacious.

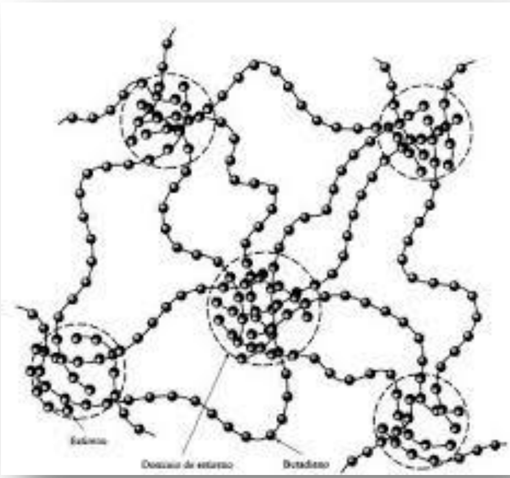


Figure 2 Thermoplastics structure (García, 2014)

The maxium working temperature for the moulded products are quiet lower that the softening or melting temperature, usually about one half the corresponding melting temperature. On the other hand, these plastics may have a partially crystalline or amorphous structure.

This influences its melting, solidification process and it can determinate the physics and mechanics proprieties. For example when these are amorphous they are usually transparent and in addition when performing any deformation forming process, it is necessary to know very clear the type of polymer that is because the process of this varies.

When they are crystalline, they cool their chains and they are ordered so they will produce a very orderly packing that is called crystallization. When they are amorphous, the molecules do not present any kind of order, they are located at random.The thermoplastic materials are those that represent the major part in the production of plastics worldwide. The most important for everyday use are:

1.3.1.1. - Acrylics

The most important of this group is methyl polymethacrylate (PMMA) and its structure is amorphous. Among its most important advantages are its excellent optical properties, slow ignition, good weartherability and UV radiation and high values of stiffness and impact resistance. Among the disadvantages are their low resistance values to solvents, the possibility of cracks occurring under tension and that the operating temperature is limited to around 93 ° C. The most important applications are related with its good optical proprieties such as use in lenses, skylights, window glazing and bathroom furniture.

1.3.1.2. - Acrylonitrile-Butadiene-Styrene (Abs)

It's a amorphous polymer and for its properties, it can be classified like a family inside the plastic materials. Among its most important advantages are its high impact strength with good toughness and rigidity, good adhesion with metallic type coatings, high corrosion resistance and low level of moisture absorption. Among the disadvantages are its low level of resistance to a solvents, its sensitivity to that attack of organic compounds of low molecular weight, low elongation values and low temperature of continuous service. The most important applications are the manufacture of automobile components, components of household appliances, handles and covers.

1.3.1.3. - Polyamides (Pa)

It is a polymer with crystalline structure that began to be marketed in the 1938 under the trademark "Nylon". There are a big number of polyamides such as 6 10,8,9,11,12 y 46 but the most used are polyamide 6 and 6,6.

Among their advantages are its high mechanical strength and impact resistance, its low coefficient of friction value, high abrasion resistance even at high temperature and its good corrosion resistance. Among the disadvantage are its high moisture absorption and therefore dimensional variation, their mechanical proprieties and the high shrinkage values when shaped by molding. The most important application are gears, bearings, rollers, zippers and closures.

1.3.1.4. - Polycarbonates (Pc)

In this case the PC is an amorphous polymer, for the PC generation there are two methods of obtaining, the first and most used is the reaction of bisphenol A (BPA), purified with phosgene (Cl2CO) under alkaline conditions, while the second involves the reaction of BPA by purifying it with carbonate Diphenyl chloride, carried out in vacuo and in the presence of catalyst.

Among its important advantages are its high impact strength, good creep resistance, temperature in service above 120 ºC and good dimensional stability.

Among the most important disadvantage are the high processing temperatures required, the low resistance of corrosion against basic media and its high sensitivity to cracking in contact with solvents. The most important application is safety glass, electrical components subjected to mechanical or thermal stresses, safety helmets and trays of frozen food, among others.

1.3.1.5. - Polyesters

Among the most common trademarks of saturated polyesters, we find trademarks as well-known as Dacron and Mylar. Among its most important advantages are the high values of toughness and rigidity and its simple processing. On the other hands, the disadvantages are the low resistance to temperature, the low resistance to corrosion against solvents and the ease of being attacked by the action of both acids and bases. The most important application of polyesters is their use in the form of upholstery fibres, their use in the form of films, such as gears, pump rotors…

1.3.1.6. - Polyethylene (Pe)

This polymer is a polyolefin that is abstained from the ethylene gas (ethene), which in turn is produced from natural gas or petroleum and is a crystalline polymer. Among its most important advantages are its low cost, good resistance to humidity, its wide variety of final properties because it can be manufactured in several levels of quality and the possibility of turning it into a thermostable material. As we mentioned, there are a multitude of polyethylene qualities but they can be divided into 4 big groups:

- Very low density polyethylene
- Low linear density polyethylene
- High density, high molecular weight polyethylene
- Ultra-high molecular weight polyethylene

Among the most important disadvantages are its high thermal expansion values, its low resistance to environmental exposure, its ease of cracking and its flammability. The most important applications are the manufacture of tetra briks, cable coating, toys and manufacture of different types of containers.

1.3.1.7.- Polyethylene terephalate (Pet)

It is a type of crystalline polymer that is very good for containing soft drinks due to its low permeability, reason why one of its habitual uses is the manufacture of bottles. In addition, other of its most important applications are the manufacture of containers of food, fibres of garments and carpets

1.3.1.8.- Polypropylene (Pp)

Polypropylene is a fairly similar polyolefin at the origin and manufacture of polyethylene. In addition, the propylene gas (CH3-CH=CH2) is cheaper than ethylene and it is obtained from petroleum. It is a polymer with a type of crystalline structure. Among its most important advantages are its low coefficient of fiction, good resistance to fatigue, good resistance to humidity, high resistance to abrasion and operating temperature values up to 126 ºC.

On the other hand, the disadvantages most important are that it is easily decomposed against the exposure of ultraviolet radiation, that is flammable, the difficulty of bonding with others parts and its susceptibility to oxidation, among others. The most important application are its use containers food, components of household appliances, components for the automotive sector such as instruments panels and electrical insulation of cables.

1.3.1.9. - Polystyrene (Ps)

Polystyrene is an amorphous polymer has as its starting monomer the vinyl benzene, and its most important advantages are its good optical and gloss proprieties, low weight and price, and good dimensional stability. Among the most important disadvantages are its flammability, low resistance to environmental exposure, low thermal stability and brittleness. The most important applications are its use as bubble wrappers, containers of all kinds, manufacture of sports articles, toys and applications of thermal insulation.

1.3.1.10.- Polyvinylchloride (Pvc)

PVC belongs to the group of polyvinyl together with other polymers such as polyvinyl acetate (PVAC). In addition it should be mentioned that this polymer is one of the highest volume of manufactured in Europe and EEUU and ia an amorphous polymer. Among the most important advantage are its good dimensional stability, low cost, good resistance to environmental exposure and wide range of properties with which it can be manufactured. The most important disadvantages are its low thermal resistance, high density compared with others plastics and that in its degradation gives off a toxic substance such as hydrochloric acid (HCl). The most important applications are the manufacture of pipes, coating of cables and imitation of skins from PVC.

1.3.2. - Thermosets

Thermosetting materials unlike thermoplastics are strongly crosslinked in all directions. They are chemically more stable materials and are hard and infusible. Unlike thermoplastics, they are resistant to high temperatures and can not be dissolved in contact with solvents and one of the major problems in that once they reach a crosslinked final state, it is impossible to re/melt them, so they are not good for the environment. In addition the finishes are usually poorer than for thermoplastics, and at room temperatures they are hard but fragile.

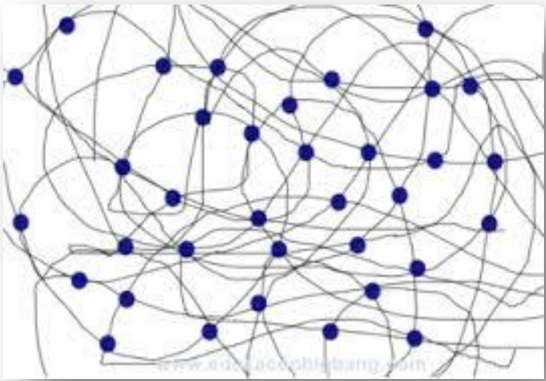


Figure 3 Thermosets structure (Alvarez)

The most important for everyday use are the next.

1.3.2.1. - Amyloplasts

These thermostats are produced by the interaction of amines (-NH2) with aldehydes (-CHO), the most commonly used begging the urea-formaldehyde (UF) and melamine-formaldehyde (MF). The most important advantages of these materials are that they have high hardness and scratch resistance, low cost, which are easy to archieve in wide range of colours and are self-extinguishing. On the other hand, among their disadvantages are that they have a low resistance to oxidation, which are susceptible to being attacked by strong acids and bases and that additives have to be used in order to conform them by molding. It's most common applications are the manufacture of bottle caps, such as surface coatings and their use for the manufacture of agglomerates and plywood, such as surface coatings and their use for the manufacture of furniture among others.

1.3.2.2. - Epoxies (EP)

Epoxy resins have the advantage that they have a wide range of curing temperatures easing their shaping and also the volatile substances are not released during curing. On the other hand, they have excellent surface adhesion properties as compatibility, can be reinforced with other materials and have very low contraction value. Among their disadvantage it should be highlight that they are sensitive to moisture, have a hish cost. Among the most common applications of epoxy resins are many coatings, their use in manufacture of boats, pavements, wooden furniture, as well as their use as an adhesive especially in the aerospace and automotive industry.

1.3.2.3. - Silicone (SI)

Finally, the thermosets include silicones. In practice a silicone is any type of polymer containing silicon atoms. Generally, there are manufactured in the form of liquids composites, lubricants, resins and elastomers. The most significant advantages are that they have a wide range of resistance to temperature from -73 to 315 ° C. On the other hand, they have a good waterproofing properties, great flexibility, low water absorption value and good chemical resistance. The disadvantages are its low value of mechanical resistance, a high cost and that can be attacked by halogenated solvents. Among its most used applications are sealing of joints, the surgical implants in cosmetic and plastic surgery as well as lubricants at high temperature. In addition, they can be reinforced with glass fiber.

Among the most common applications of epoxy resins are multitude of coatings, its use in the manufacture of boats, floors and furniture.

1.3.3. - Elastomers

Elastomers are chemical compounds whose molecules consist of several thousand monomers that are joined together into large chains which are highly flexible, disordered and intertwined. When subjected to great efforts, the molecules are brought into alignment and often take a very orderly (crystalline) distribution but when they are no longer stressed they spontaneously return to their natural disorder, a state in which the molecules are entangled. The crosslinking or curing that applied to the elastomers is similar to the thermosets but in this case the crosslinking is much less since it has to be sufficiently spaced.

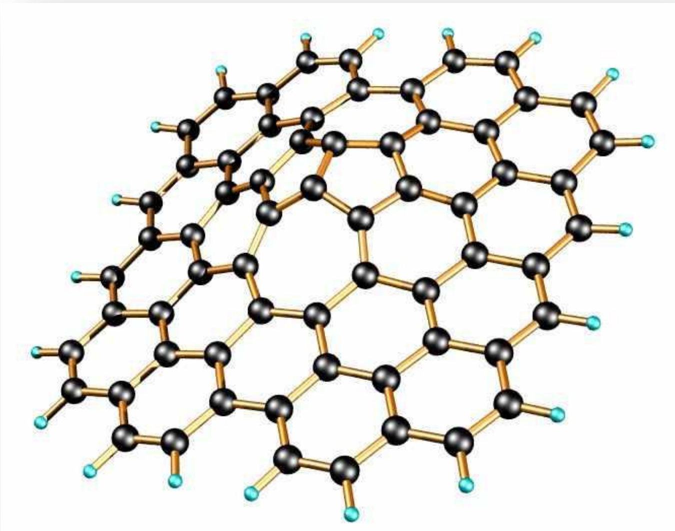


Figure 4 Elastomers structure (Elizburu, 2015)

Generally, they are very tenacious materials, resistant to oils and have a good flexibility at low temperatures. In fact, the elastomers have a glass transition temperature below room temperature.

Even so, they have as disadvantage as thermostats that need a hish amount of energy to process them and are not recyclable. Among the most important elatomers you can find are.

1.3.3.1. - Rubbers

There are a multitude of rubbers, although the two major groups that can be differentiated are natural and synthetic rubbers. The natural rubbers is obtained from latex, which is obtained from a tree called "Hebea Brasiliensis" that is typical of tropical climates. Obtaining natural rubber from latex was invented by Charles Goodyear in the year 1884. This process is called vulcanization and consists of mixing the latex with sulfur and several chemicals to later heat and obtain the final product. The effect that is ransverse crosslinking, increasing hardness and mechanical strength while maintaining ductility.

Natural rubber has the advantage of good resistance to wear and fatigue but the problem is that its degrades easily when exposed to heat ultraviolet radiation and oxygen.

Among its most common applications are the manufacture of tires, gaskets, heels, shoe soles and vibration absorbers. On the other hand, there are synthetic rubbers. The most important are.

- Styrene butadiene rubber (SBR)
- Polybutadiene rubber (BR)
- Butyl rubber (GDP)
- Chloroprene or neoprene rubber (CR)
- Ethylene propylene rubber (EPDM)
- Isoprene rubber (IR)
- Nitrile or butadiene acrylonitrile rubber (NBR)

Compared with natural rubber, they show a higher resistance to heat, exposure to gasoline, chemicals as well as a wider range of temperatures. The predominant application of synthetic rubbers is the manufacture of tires as they have a better performance against the environment. Still other applications in which their are used are gasoline hoses, footwear, inflatable products and insulation of cables.

Finally, comment that among the rubbers, the most used is the rubber SBR with a 40% of market share, followed by natural rubber with 22% and BR with 12%. The other types of rubber have a market share of less than 5%.

1.3.1.2. - Polyurethane elastomers (PUR)

The polyurethane as such is a thermoset polymer but if its degree of cross-crosslinking is minimized, it behaves like an elastomer. Therefore, the degree of crosslinking can be adjusted to obtain the properties required for each application and its form it can be shaped by molding. Among its advantages are its good mechanical properties such as rigidity, hardness and resistance to abrasion. In addition, it has very good resistance to aging due to exposure to ozone.

The biggest disadvantage of this type of elastomer compared to others is its high cost, although their are the best properties. Inside the most common applications can find the manufacture of mattresses and furniture or cars. This is because one of the most usual ways of its manufacture is the form of flexible foam, although it can be rigid or semi-rigid according to needs. Another of its unusual applications is in the manufacture of membranes to make conformed with the rubber's matrix which is a process of plastic deformation like to hydro form.

1.4. - Thermoplastic forming processes

1.4.1.- Extrusion Molding

This forming process is also commonly used in metals and is a continuous process in which the material is forced to flow through the orifice of a die to generate a product whose cross-section shape is determined by the shape of orifice. According the product flows through the hole, the extrudate is cut to obtain the desired lengths.

It is a very common forming process in thermoplastics and elastomers but is rarely used with thermosetting materials, for this the raw material is melted by temperature and friction and is given the desired shape. The extrusion equipment is often referred like an extruder and is intended to transform the initial raw material in a homogeneous melt by passing it through the die.

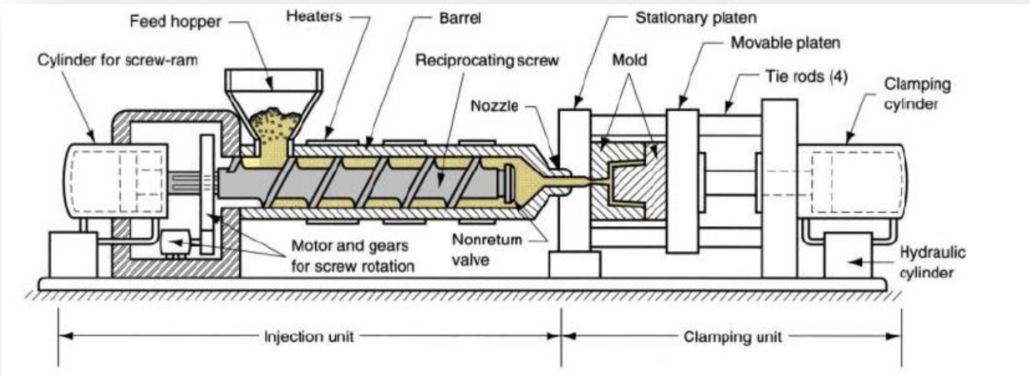


Figure 5 Injection molding (Menges, 1992)

An extrusion machine consists of a central metal shaft with helical blades called a spindle called a spindle, installed inside a metal cylinder and coated with a heating mantle of electrical resistors. At one end of the cylinder is a hole's inlet for the raw material where there is a feed hopper, generally of conical shape. In the same place is the spindle drive system, composed of an engine and a speed reduction system. At the tip of the screw, the material outlet and the profile that gives the final shape to the plastic product is located.

Hopper: It is the element in charge of supplying to the extruder the plastic material to be conformed. The material is supplied in the form of pellets which is introduced by the force of gravity and a vibratory mechanism.

Spindle or Screw: It is a fundamental element because it performs various functions such as material loading, transport, melting and homogenization. The most used spindle is the three-zone spindle because it allows to satisfactorily transform most of the thermoplastic materials. This zone of compression-fusion and the area of plastification or pumping.

Cylinder or Barrel: The cylinder is the element that contains the extruder spindle. It is an important element because there are different types of machine depending it. The machines are denominated in function of the single spindle cylinder and conventional cylinder, single spindle and cylinder of high performance, double spindle and with counter rotation and double spindle and with parallel rotation.

Heating and cooling system: These systems are divided into several zones and are responsible for heating or cooling independently. Usually, electric heating bands are used although others cooling modes such as refrigerated spindles can also be used. The most important requirement of the materials to be extruded is that their have to have a high viscosity. It is used for the large-scale manufacture of parts such as pipes, hoses or structural profiles as well as cables coatings.

1.4.2. - Blow molding

Blow molding is a manufacturing process in which pressurized air is used to produce hollow parts by expanding the plastic material inside a mold. A pressure is between 300 and 700 KPa to produce pieces of little thickness such as bottles and similar containers. The production is usually carried out in large volumes. The blow molding consists of two clear parts. The first stage is the manufacture of an initial preform and this can be manufactured by extrusion or injection molding giving rise to the two most important variants extrusion and blow molding and injection and blow molding. The second stage deals with blowing the tubular preform to obtain the final shape of the piece. Therefore we can divide the process in 4 phases:

- Manufacture of the preform
- Mold closure
- Blown
- Opening the mold

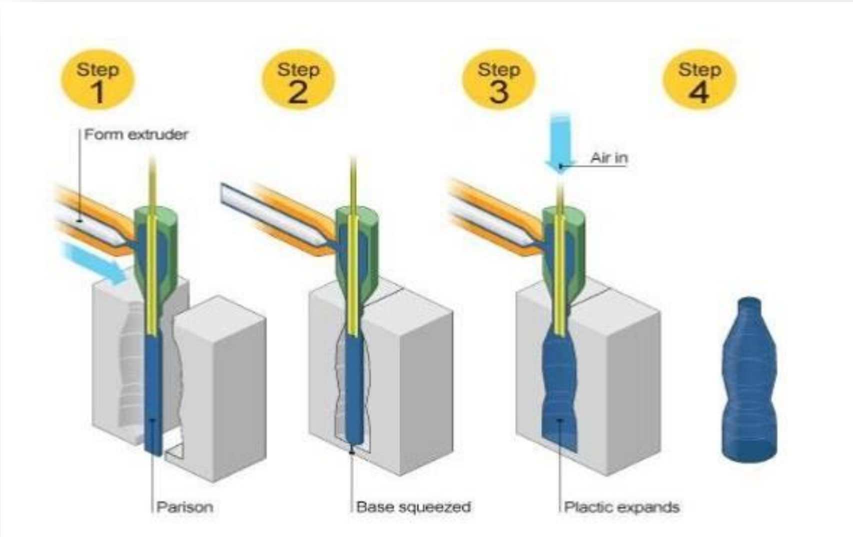


Figure 6 Steps of blow molding (Sánchez, 2009)

The injection and blow molding has a lower production rate than the rxtrusion variant, so it is less widely used.

This process is generally limited to the thermoplastic materials and the most common material is polyethylene (PE) and in particular high density (HDPE) and high molecular weight (HMWPE) materials. Even so there are other materials such as PP,PVC and PET. The most commonly used application for this type of forming is to make disposable containers for liquid products, although it can also be used to manufacture toys or gas tanks.

Figure 7 Product blow molding (Rosell, 2010)

1.4.3. - Thermoforming

Thermoforming is a process used in forming a sheet of thermoplastic material on a mold by the application of heat and pressure. The thermoforming consists mainly of two parts, the heating and ther forming. First the plastic sheet is heated by ovens or electric radiators huntil the softening of the material is produced. After this, the forming is performed. The forming can be performed by three types of systems each with its advantages and disadvantages.

Vacuum thermoconforming: It is the oldest of all and consists of using a vacuum pressure so that the preheated sheet adheres to the surface of the mold.

Pressure thermoforming: In this case a positive pressure is used to push the mold against the mold. The advantage over vacuum thermoforming is that higher pressures can be used.

Mechanical thermoforming: Unlike the previous ones, in this case two molds or dies are used to form the preheated sheet. It is performed by a force that exerts one part against the other and its main advantage is the good dimensional control. Its advantage is its higher higher cost due to the mechanization of two matrices. Therefore the thermoforming can be divided in 4 phases:

- Heating
- Placing the sheet on the mold
- Pressure or force
- Hardening and extraction

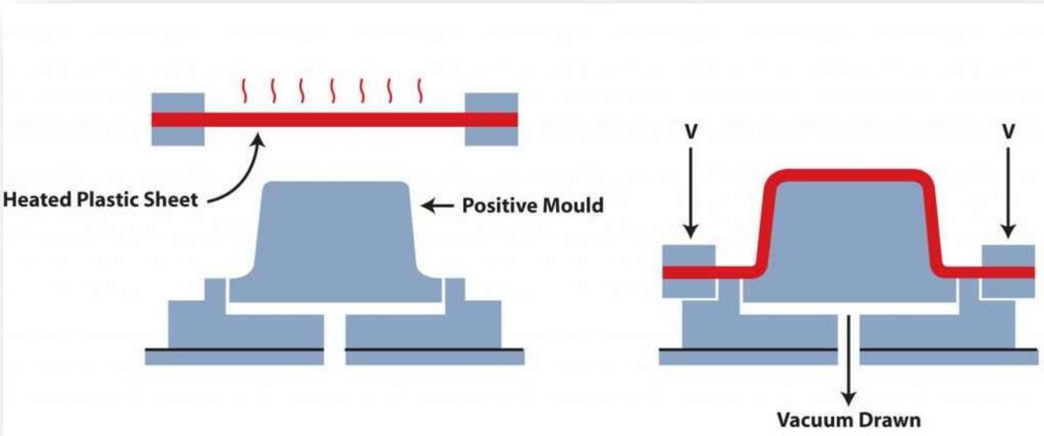


Figure 8 Thermoform (Sánchez, 2009)

In this case, only thermoplastic materials can be formed because they are the only that soften on heating and those which are most commonly used are polystyrene, cellulose acetate, acrylonitrile-butadiene-styrene, methyl polymetha crylate and polypropylene. Examples of applications of this forming process are bathtubs, skylights, interior linings of refrigerators.

Figure 9 Product thermoforming (Menges, 1992)

1.4.4.- Injection molding

I explain in the next point.

2. - Injection molding

2.1. - Working

Injection molding consists of melting a plastic material under suitable conditions and introducing it under pressure into that cavities of a mold where it is cooled to a temperature at which the parts can be extracted without deforming. Usually, it is applied to thermoplastic materials, although it can also be applied to thermosetting materials and to synthetic elastomers. In injection molding, a non-Newtonian liquid and hot polymer flows through conduits or channels by filling a mold having the cold walls. This process will be used for the manufacture of polyamide gears. It is the most important plastic material manufacturing process because 60% of the plastic materials processing equipment in the world are injection molding. Though this type of forming can be manufactured pieces of great diversity of size and can be made several pieces in each injection cycle. We can be made complex manufactured and due to the high cost of tools and mold, it is usually used when a large number of pieces are made. The injection time usually is between 10 and 30 seconds, although depending on the parts can be higher even to 1 minute.

Throughout history, different types of injection machines have been used, such as piston machines, preplasticized piston machines and spindle machines.

Nowadays, the most used are the so-called “Spindle machines”, which are the ones that provide a uniform heating of the material as well as a homogeneous and more efficient mixing. In these machines, the injection of the material is carried out from the plastification chamber which is provided with spindle. To heat the material, the rotation of the spindle transform part of the mechanical energy in heat by friction, in addition the heating produced by the hot walls of the cylinder giving a good heat transfer efficiency.

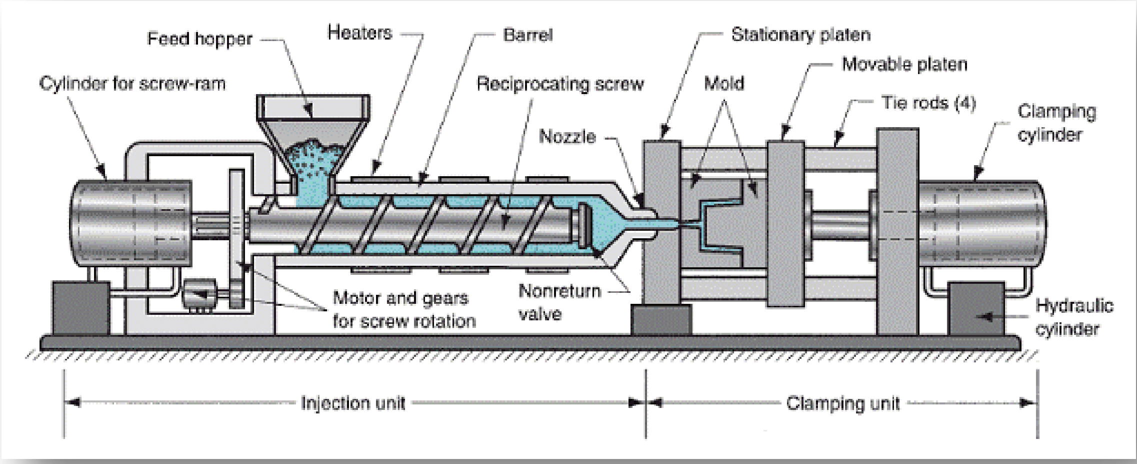


Figure 10 Injection molding machine (Elizburu, 2015)

In these machines the spindle rotates and the machine produces molten material that accumulates at the first of the machine. To accommodate the molten material, the spindle retreats slowly and stops when there are enough molten material inside the spindle. Once it is stopped, an axial forward movement is made the injection of the molten material.

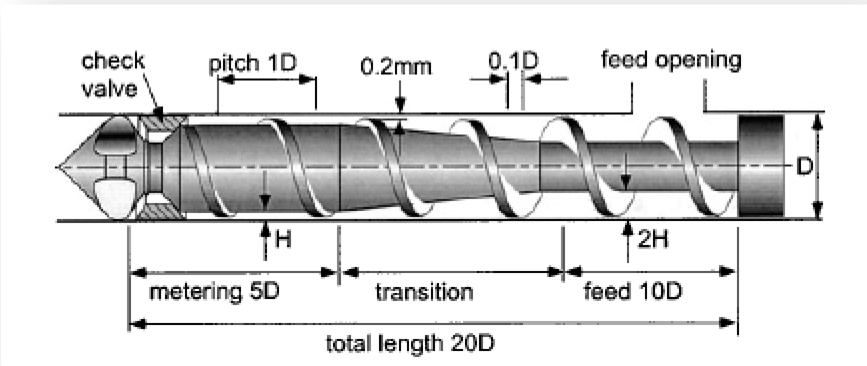


Figure 11 Spindle (Barrocal)

2.2. - Types of machines

2.2.1. - Piston machines

In the first machines used, the fusion phase was carried out in a cylindrical chamber of heating. The material is heated and melted in the heating cylinder at the same time that it flows towards the front part of this, pushed in successive times by the strokes of a piston that moves tightly in the cylinder of heating. This piston acts as an injection piston and forces the molten material to pass from the heating cylinder to the mold cavities, thus performing the second stage of the process. Therefore, in these machines, both injection and fusion are performed in a single cylinder designed to make these two purposes.

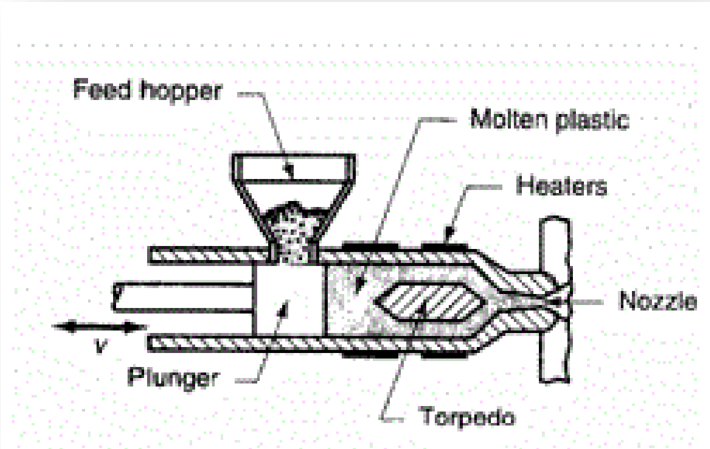


Figure 12 Piston machine (Rosell, 2010)

The machine has these basic elements:

- A feeding and dosing system
- An injection piston which pushes the material into the heating chamber and gives it the pressure to enter the mold
- A heating chamber
- The mold in which the material is injected

- A closure mechanism holding the two halves of the mold together
- A system of controls so that the different mechanisms act in the proper sequence these injection machines were used for many years.

  They present a number of disadvantages:

  - The heat transfer in the heating cylinder is deficient.

  - The injection unit is constituted by the cylinder itself in which the material is heated.

  - The speed of injection in the machines with piston is limited by the design of the heating chamber.

2.2.2.-Piston machines with preplasticization

In this machine the stages of fusion and plastification are independent, so that the design of each one of the zones of the machine is more suitable. The idea of preplasticizing consists of heating the material in a heating chamber or cylinder and transferring the hot material from this chamber to the injection cylinder.

We can distinguish two types of preplasticizing machines:

- **Machines with piston in angle:** In these machines the plastic material is transferred to the injection cylinder when it is empty.

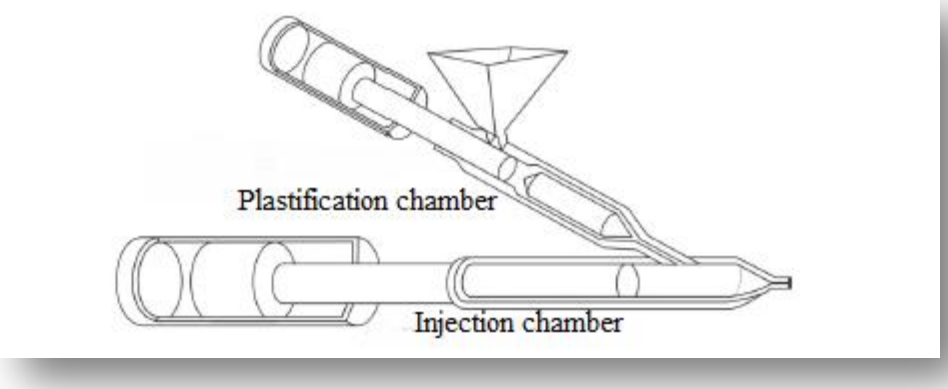


Figure 13 Machine with piston in angle (García, 2014)

- **Machines with piston in line:** In these machines the preplastic cylinder body acts as an injection piston once the injection cylinder has been completed to fill

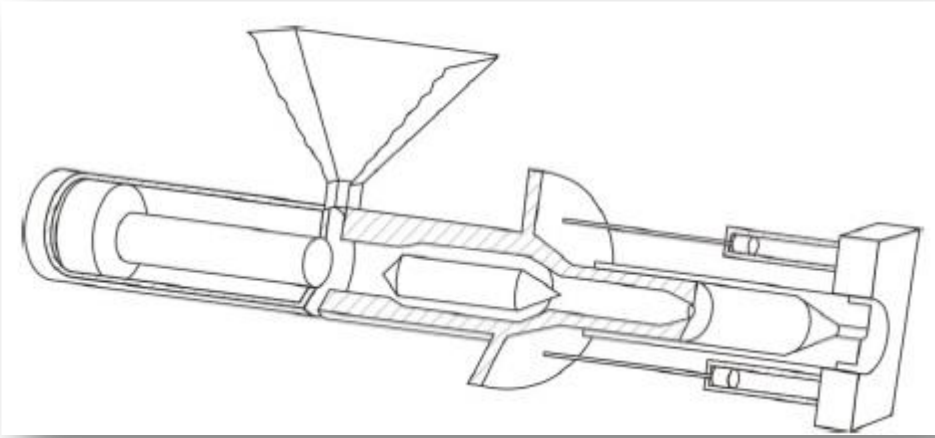


Figure 14 Machines with piston in line (García, 2014)

Machines of the last type offer the following advantages:

- The symmetry
- Build compact machines
- More economical

2.2.3.-Spindle machines

The spindle machines provide uniform heating of the material as well as homogeneous mixing. In these machines the injection of the material is realized from the camera of plastificacion that is provided with a spindle similar to the one of the machines of extrusion.

The efficiency in the heat transfer of these machines is very high compared to the machines with piston. They are the most used.

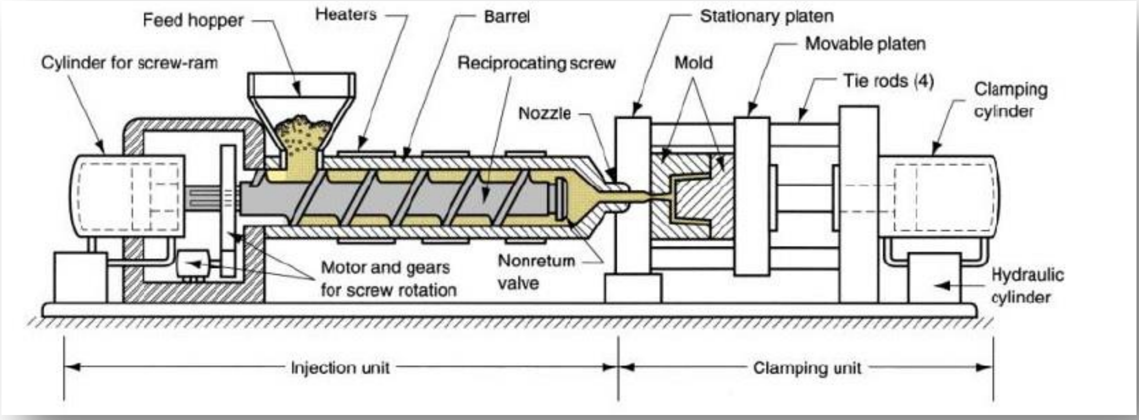


Figure 15 Injection molding machine (Rosell, 2010)

In these machines as the screw rotates the machine produces molten material that accumulates. The screw should retract slowly as it rotates to house the molten material inside the dilator, then the injection of the molten material.

2.2. - Basic machine characteristics.

2.2.1. - Injection capacity

Maximum amount of material that a machine is capable of injecting at one time in a mold with one pressure.

It depends on the diameter, injection spindle, type of mold used, temperature that reaches the molten polymer, the pressure to which it is injected.

In the manufactures' catalogues of injection machines it is indicated as the maximum weight that the machine can inject in a single cycle.

2.2.2. - Plastification capacity

Maximum quantity of material that the machine can plasticize for unit of time.

It depends on the heating efficiency of the plastification chamber and the thermal properties of the polymer that being heated.

In the manufactures' catalogues of injection machines is indicated as máximum plasticized flow of a material.

2.2.3. -Injection pressure

The measurement on the front face "a" of the injection piston or spindle

2.2.4. -Injection rate

Flow of material leaving the machine during the injection period and it is a measure of the speed which a given mold can be filled, can also be expressed as the number of times that unit of time that the screw can carry out its complete path of Back and forth when the machine runs in a vacuum.

It depends on the injection pressure, the temperature of the heating chamber, the characteristics of the material used and the path that the polymer must travel.

2.2.5. -Closing force

It is the force that holds the two halves of the mold together while in the model cavity the maximum pressure develops as a result of its filling.

2.3. -Variables involved in the process

In this section we will consider four different variables, knowing that they are dependent variables and that the variation of one of them, varies the others.

2.3.1. - Injection temperatures

It is the temperature at which the material is heated to be introduced into the mold.

It must be below the temperature at which it begins to descompose but it must be high enough to allow the material to flow correctly.

2.3.2. - Mold temperature

It is the temperatura at which the Surface of the molding cavity.

It should be low enough to cool the molten material and get it to solidify

2.3.3. - Initial or filling pressure

It is the pressure that is applied initially to the molten material and it develops as a consequence of the forward movement of the screw.

It must be as large as possible, so that filling takes place as quickly as possible.

2.3.4. - Pressure of maintenance or compaction

It is the pressure that is applied at final of the injection of the material when the mold is almost completely full.

It should be enough for the mold to be filled and a piece of uniform density to be obtained.

2.3.5. - Rear or back pressure

It is the pressure that is applied to the screw while it recedes, once the compacting stage is finished.

2.3.6. - Initial injection time

It depends on numerous factors such as how much material is being injected, its viscosity, mold characteristics and percentage of the injection capacity being used.

2.3.7. - Maintenance or compaction time

It is the time that after the initial injection of the material, the screw remains in an advanced position to maintain the pressure of the material inside the mold.

2.3.8. - Cooling time

The time the piece requires to cool until it is solidied and it is also acquired sufficient rigidity to be able to be extracted from the mold without deforming it.

2.4. -Injection machine components

We must bear in mind that it will be constituted by two fundamental units, the closing system and the injection unit. The arrangement of these two will allow to distinguish between machines with vertical or horizontal injection systems.

The fact to consider independent the units of closing and injection allows the construction of machines to measure.

2.4.1. - Injection unit

It consists of a feeding system (Hopper) and the cylinder-srew system. In the process of extrusion the material leaves the machine by the nozzle which has a design of that part of the machine is made taking into account exclusively thermal and flow characteristics of the material.

2.4.1.1. - Non-Return valves

They are the most used machines and are constituted by a ring that must slide on the cylinder with very little clearance on it.

2.4.2. - The closure unit

A perfect closure of the mold has a great importance on the quality of the molded part and can make unnecessary secondary operations of elimination of burrs of the produced articles.

The locking systems generally consist of two plates joined by hard alignment columns.

Three basic types of locking systems are usually distinguished:

2.4.2.1. - Mechanical systems

These systems employ a mechanical action for mold closure and are found in small experimental machine in the laboratory.

2.4.2.2. - Hydraulic systems

The direct hydraulic piston is the simplest locking system and the first one used. The high closing force that you can develop is your best virtue.

2.4.2.3. - Mechanical- hydraulic systems

The machines with mechanical-hydraulic systems are based on the use of the knees actuators by a hydraulic system, in machines of small and medium size. They have a great speed of closing using a piston smaller.

3.-Selection and design the piece

3.1.-Objective

Our objective is to carry out the design and manufacture of an injection mold plastic. I will explain the manufacturing process of said mold, the material used , tolerances and others things. After this process I will realize a real test of mold filling to verify its correct manufacture.

During the design of the mold, I need the help of a computer program for the modelling and simulation of the filling.

3.2.-Description of the piece

I decide to design a gear, it used in a toy's car to send the movement. When I will design the gear, it is necessary to take into account its characteristics such as the different diameters, the number of teeth, the thickness of the piece and other things. The gear will be manufactured by the injection molding process so is important to design and manufacture this mold to realize the gear of a correct form complying with the requirements that are necessary.

The design of the mold is this:

Figure 16 Gear

3.3.-Selection of material

The first characteristics that I need to decide is the material, I have seen the different thermoplastics and now I choose 3 different I take three different materials and contrast them. Then I decide the best for do the piece, the materials that I choose are Polypropylene (Pp), Acrylonitrile-Butadiene-Styrene (Abs) and Polyethylene terephalate (Pet) :

Table 1 Characteristics of different materials (www.fuchs.es)

Material	PP	ABS	PET
Density (Kg/m3)	0,9	1,02 - 1,07	1,3 - 1,35
Tensile Modulus (GPa)	1,0 - 1,7	1,4 - 2,8	2,5 – 3
Tensile Strength (MPa)	25 - 40	21 - 63	55 – 75
Elongation at break (%)	300 - 700	75	20 - 100
Izod Impact strength (J/m)	150	350	55
Distortion Temp (ºC)	50 - 65	105 - 120	70
Thermal expansion (10-6ºC)	100 – 120	70 - 100	80 – 100
Thermal conductivity (W/m ºC)	0,16	0,13 - 0,2	0,13

Mine piece need to withstand high mechanical stress so the principal characteristics are:

- High mechanical resistant
- Izod impact strength
- Distortion temperature

After see the chart I choose ABS (Acrylonitrile Butadiene _styrene) plastic.

3.3.1. - ABS properties

I have already told about this material, now I explaine why I choose this to do my gear. It is a amorphous polymer and for its properties, it can be classified like a family inside the plastic materials.

Among its most important advantages are:

- High impact strength with good toughness and rigidity
- Good adhesion with metallic type coatings
- Easy to paint and glue
- Low cost

The most important applications are the manufacture of automobile components, components of household appliances, handles and covers.

The properties:

1. *-Mechanical properties:*

Table 2 Mechanical properties (www.fuchs.es)

	Metric	English
Hardness, Rockwell R	103-112	103-112
Tensile Strengh, Yield	42.5 – 44.8 MPa	6160 – 6500 psi
Elongation at Break	23 – 25%	23 – 25%
Flexural Modulus	2.25 – 2.28 GPa	326 -331 ksi

Flexural Yield Strength	60.6 – 73.1 MPa	8790 – 10600 psi
Izod Impact, Notched	2.46 – 2.94 J/cm	4.61 – 5.51 ft-Ib/in

1. - Thermal properties:

Table 3 Thermal properties (www.fuchs.es)

	Metric	English
Maximum Service Temperature, Air	88 – 89 ºC	190 – 192 ºF
Deflection Temperature at 1.8 MPa	88 – 89 ºC	190 – 192 ºF
Vicat Softening Point	100 ºC	212 ºF
Flammability, UL94	HB	HB

2. - Electrical properties:

Table 4 Electrical properties (www.fuchs.es)

	Metric	English
Arc Resistance	120 sec	120 sec
Comparative Tracking Index	600 V	600V
Hot Wire Ignition, HWI	15 sec	15 sec
High Amp Arc Ignition, HAI	120 arcs	120 arcs
High Voltage Arc-Tracking Rate, HVTR	25 mm/min	0.984 in/min

3. - Physical properties:

Table 5 Physical properties (www.fuchs.es)

	Metric	English
Hardness, Rockwell R	103 - 112	103 – 112
Tensile Strengh, Yield	42.5 – 44.8 MPa	6160 – 6500 psi
Elongation at Break	23 – 25 %	23 – 25 %
Flexural Modulus	2.25 – 2.28 GPa	326 – 331 ksi
Flexural Yield Strength	60.6 – 73.1 MPa	8790 – 10600 psi
Izod Impact. Notched	2.46 – 2.94 J/cm	4.61 – 5.51 ft-Ib/in

4. - Calculations of mold design and injection machine

4.1.-Weight of the piece

We realise the piece in CATIA v5r19, design programme. When we finish to design my piece, we give it the material and we get the characteristics about it:

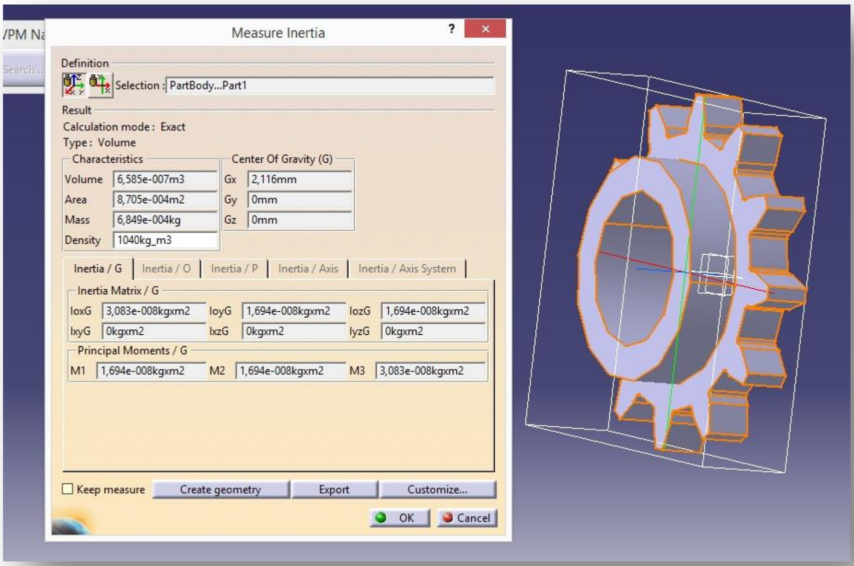


Figure 17 Characteristics of the gear

We can see:

- Total volume of the piece: $V_{TOTAL} = 6.585*10^{-7}\, m^3$
- ABS density: $\rho = 1.04\, g/cm^3$

If we known this characteristics, we can estimate the final weight of the piece.

$$\mathbf{Weight = V_{TOTAL} * \rho}$$

$$Weight = 0.6585cm^3 * 1.04\ g/cm^3 = 0{,}6849\ g$$

4.2. - Required closing force

Now, I want to estimate the required closing force to mine piece, I will use this formula:

$$\mathbf{F = \frac{P \times A \times S}{100}}$$

Where:

- **F** -> Required closing force in kN
- **A ->** Projected area in cm^2
- **P** -> Pressure in the mold cavity
- **S** -> Security factor

We estimate the project area in the programme:

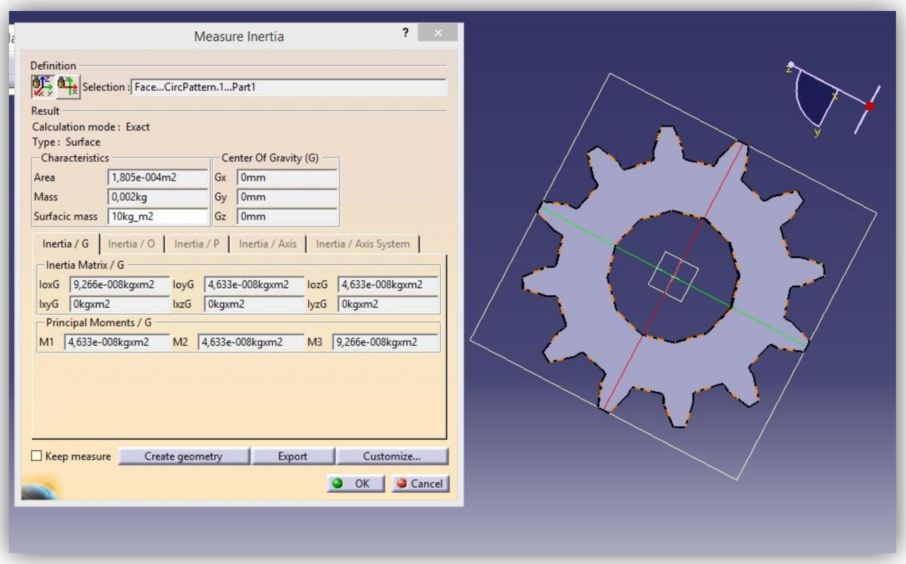
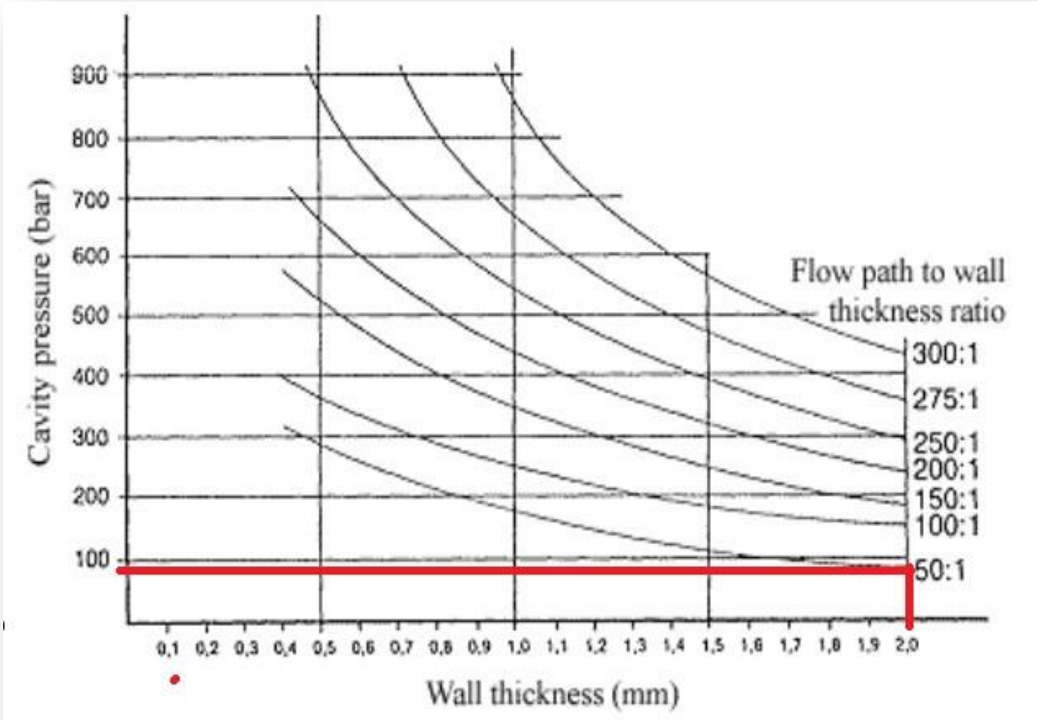


Figure 18 Characteristics of the gear

So we can see that the area is 1,805 cm^2.

Now, we estimate the pressure in the mold cavity, we need a graphical to find it:

Table 6Injection pressure vs Thickness (Barrocal)



In the graphical we can see the relation between cavity pressure and thickness, mine data are:

Length of piece: 20.52 mm

Thickness of piece: 2.5 mm

Mine relation is 20.5:2.5 so I will use 50:1 because it is the most similar to estimate the pressure in mine cavity mold. If I see the graphical I can see that for my thickness (2.5 mm) there isn't curve but for thinkness higher than 2 mm the pressure is the same.

I use the 50:1 curve and my thickness, I watch that my pressure is 90 bar more or less.

The cavity pressure: *P= 90 bar*

Now we estimate the required closing force but before we need to choose the security factor. It will be 1.2 because we want an oversized calculation.

The data to estimate are:

- Projected area: *A= 1.805 cm²*
- Pressure in the mold cavity: *P= 90 bar*
- Security factor: *S= 1.2*

We estimate:

$$\mathbf{F} = \frac{\mathbf{P \times A \times S}}{\mathbf{100}}$$

$$\boldsymbol{F} = \frac{\mathbf{1.805 \times 90 \times 1.2 \times 8}}{\mathbf{100}} = \mathbf{15{,}5952\ kN} \qquad F = 1{,}56\ Tn$$

This force is little so the majority of market machine can do it, when I will chose the machine I will take into account others parameters.

4.3.-Cooling time

In this point I try to estimate the cooling time, this is the time until the mold opens and the molding is ejected.

The cooling time is very important to the produce's time parts injected with thermoplastic, for short cooling times are achieved economic advantages but also disadvantages in terms of the final quality. On the other hand, the long cooling time produce economic and productive disadvantages but in final quality with good fluidity, little tension and with little contraction.

I used these proprieties of ABS:

- Density: $\rho = 1.04\ g / cm^3$
- Injection temperature: $(\theta_M$=220-260ºC$)$: $\theta_M =$ 220ºC
- Mold wall temperature: $(\theta_w$=60-80ºC$)$: θ_w= 60ºC
- Average demolding temperature: $(\theta_E$=80-100ºC$)$: θ_E = 75 ºC
- Thermal conductivity (λ): $\lambda = 0.16\ W / Km$
- Specific heat capacity (c): $c = 1.25\ J / gK$

To estimate the average demolding temperature (θ_E):

Maximum demoulding temperatures:

ABS	100 °C	PE-HD	110 °C
CA	90 °C	PE-LD	80 °C
CAB	90 °C	PMMA	100 °C
CP	90 °C	POM	150 °C
PA 6	200 °C	PP	110 °C
PA 6.6	200 °C	PS	80 °C
PA 6.10	200 °C	SAN	110 °C
PA 11	200 °C	SB	90 °C
PC	140 °C	PVC	70 °C

Figure 19Maximum demoulding temperatures (www.fuchs.es)

$$\boldsymbol{\theta_E} = \frac{\boldsymbol{\theta_{E\,max} - \theta_W}}{\mathbf{2}} + \boldsymbol{\theta_W} \qquad \theta_E = \frac{100-50}{2} + 50 = 75\ ºC$$

First, I estimate the conductibility:

$$\textbf{Conductibility} = \frac{\boldsymbol{\lambda}}{(\boldsymbol{\rho} \times \mathbf{c})}$$

$$Conductibility = \frac{0.016}{1.04 \times 1.25} = 0.00123\ {cm^2}/{s}$$

$$Conductibility = 12.3e - 4\ {cm^2}/{s}$$

When I have estimated the conductibility, I will estimate T, with this date, the conductibility and thickness of piece, I estimate the cooling time with the helping of graphical.

$$\mathbf{T} = \left(\frac{\boldsymbol{\theta_M - \theta_W}}{\boldsymbol{\theta_E - \theta_W}}\right) \qquad T = \left(\frac{220-50}{75-50}\right) = 6.8s$$

Now, I have the last datum “T” and with previous data I use the monogram to get the cooling time.

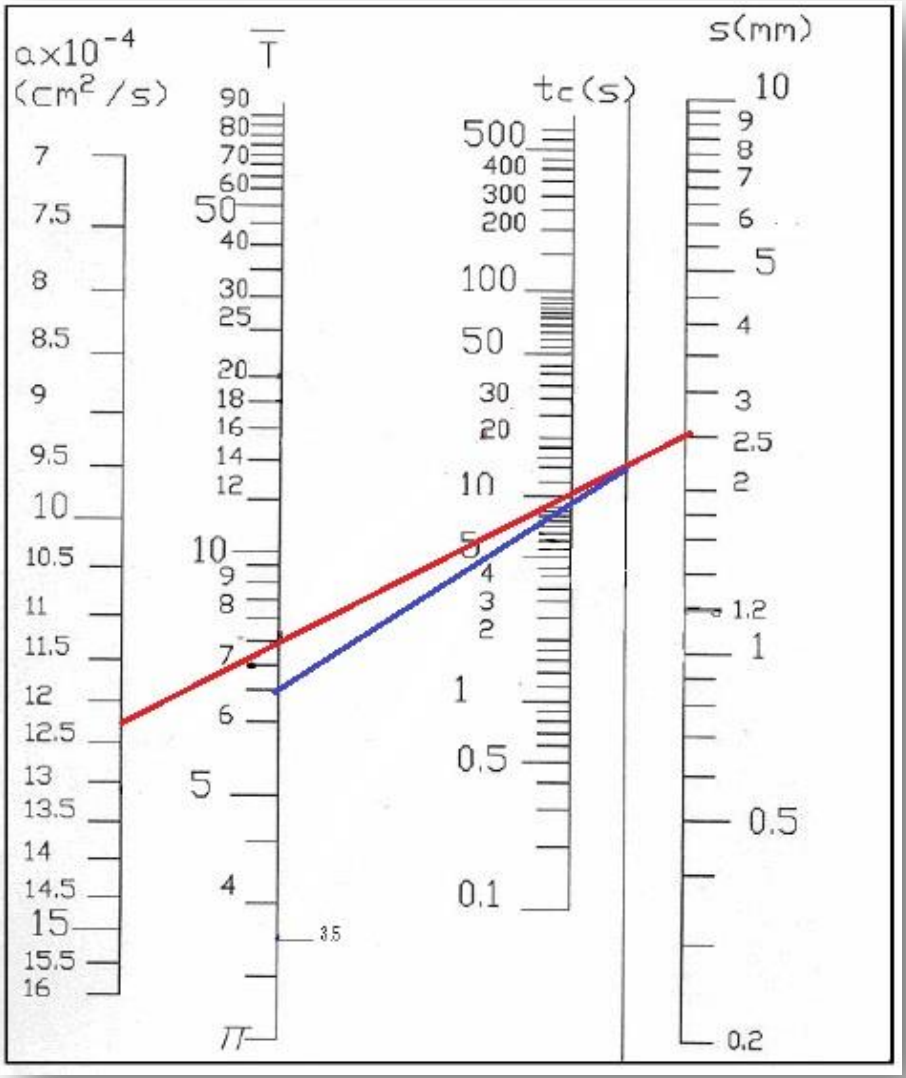


Figure 20 Monogram for the determination of cooling time (Barrocal)

In the graphical can I see that the cooling time is t= 10s

4.4.-Determination of the heat to be dissipated from the piece

When the piece is demolded is importante know the heat to be dissipated. If the dissipated heat does not it is enough, the melt of the thermoplastic is very hot and is impossible unmold the piece. On the other hand if the dissipated heat is excessive, the piece inside the cavity will be much stiffness and is impossible unmold the piece too.

The heat that must be dissipated from the piece depends on the mass of the mold, the temperature od unmold temperature, so to estimate the datum I need:

- Injection temperature $(\theta_M = 220\text{-}260ºC)$: $\theta_M = 220ºC$
- Average demolding temperature $(\theta_E = 80\text{-}100ºC)$: $\theta_E = 75\ ºC$
- *Weight= 0,685 g*
- Cycle time: t_{cycle}= *Injection time + Cooling time + Opening time= 18s*

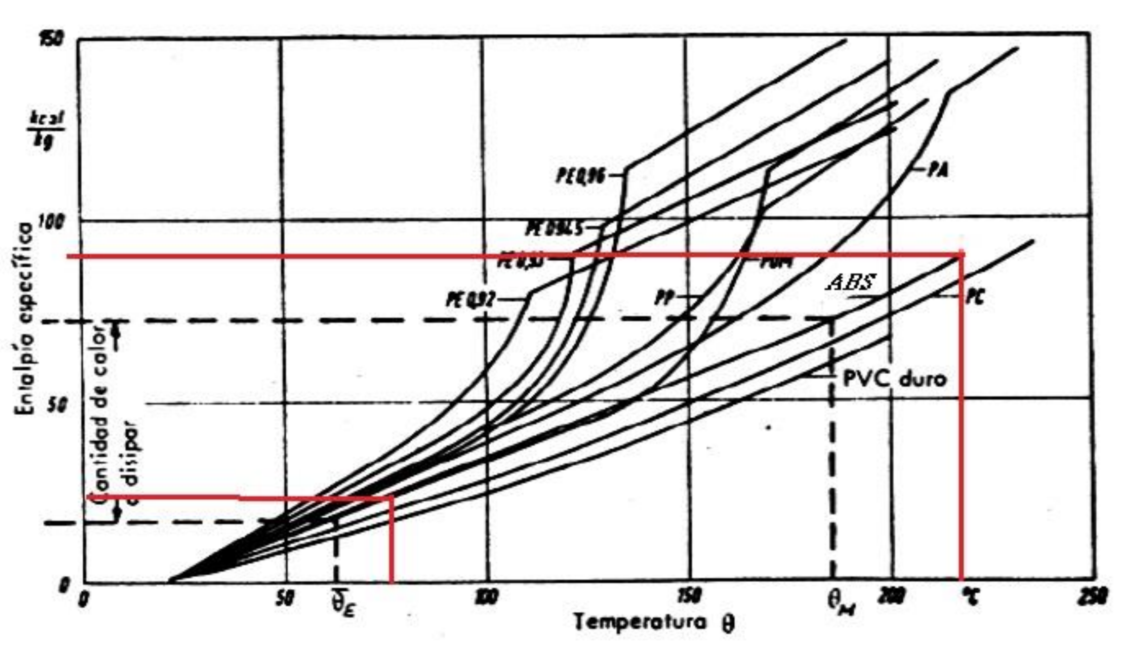


Figure 21 Specific enthalpy for some plastic materials (www.meusburguer.com)

Using the data in the graphical, I can estimate the enthalpy increase. The graphic result is:

$$\Delta h = 80\text{-}20 = 60\ kcal/Kg$$

When I estimate the enthalpy increase, I calculate the heat that must be dissipated with this operation:

$$\mathbf{Q_{k_u}} = \frac{\mathbf{\Delta h \times Weight}}{\mathbf{t_{cycle}}}$$

$$Q_{k_u} = \frac{60\ kcal/kg \times 0.03776kg \times 8}{50s} = 0.090624\ kcal/s$$

4.5.-Projection of the mold cooling system

In this point I try to solve the problems derived from the refrigeration of the piece for the cooling of the mold I use a dissipating agent. It is the agent that has the mission of dissipating heat of the mold for the correct production of the piece.

The most common coolant are:

Table 7 Dissipating Agent (www.fuchs.es)

Coolant	Temperature
Water	50 to 90ºC (under pressure to 120ºC)
Water-alcohol mixed	< 5ºC
Water-salt mixed	< 5ºC
Oil	90 to 300ºC

After I search differents coolant I decide to use oil, I will use THERMISOL HT 200. It can be find in the company that it name is FUCHS.

The information that the company give me is:

Table 8 Thermisol HT 200 (www.fuchs.es)

Product	Nature	Process	Properties and Applications
THERMISOL HT200	Synthetic Fluid	Open circuit: Up to 150 ºC Closed circuit: up to 300ºC	Thermal fluids for transfer systems of heat

The refrigeration of the mold must be inside the mold so it is important that I would have a reservoir and a pump that maintains the fluids in recirculation.

I need to choose a temperature control unit of the brand REGOPLAS, it is specific for oil, with the next characteristics:

Table 9 Regoplas 150 smart (www.fuchs.es)

REGOPLAS 150smart	
Heat transfer fluid	Oil
Outlet temperature max.	150ºC
Heating capacity at 400 V	kW
Cooling capacity	29 kW/1K
Pump capacity	60 l/m 3,8 bar

Figure 22 Temperature unit control

Now we proceed to calculate the heat exchange with coolant by the next formula:

$$\mathbf{Q_u = \alpha_L \times F_{wo} \times (\theta_u - \theta_{TM})}$$

$$Q_u = 6\,{}^{kcal}/_{m^2h{}^{\circ}C} \times 0.091m^2 \times (20 - 100)^{\circ}C = -43.7\ kcal/h$$

Where:

- $\boldsymbol{\alpha_L}$ Heat transfer coefficient (≈ 6kcal/m²hºC)
- $\mathbf{F_{wo}}$ External Surface of the mold (F_{wo} =0.2337 m²)
- $\boldsymbol{\theta_u}$ Room temperature (θ_u=20 ºC)
- $\boldsymbol{\theta_{TM}}$ Temperature dissipating (θ_{TM} =100 ºC)

We estimate the thermal balance for calculation of the heat to be cooled as follows:

$$\mathbf{Q_{TM} = Q_{KU} + Q_U}$$

$$Q_{TM} = 90.624\,{}^{kcal}/_{h} - 43.7\ kcal/h\ = 47\ kcal/h$$

Now, we have all the data for estimate the minimum speed of recirculation of the dissipating agent of the temperature:

$$\mathbf{V_{TM} = \frac{Q_{TM}}{\rho_{TM} \times A_{KK} \times (\theta_{TM} - \theta_U) \times C_{TM}}}$$

$$V_{TM} = \frac{47\ kcal/h}{818Kg/m^3 \times 5{,}027e^{-5}m^2 \times (100 - 20)^{\circ}C \times 0.517\ Kcal/Kg^{\circ}C}$$

Where:

Q_{TM} The heat exchanged with the refrigerant ($Q_{TM} = 47\ Kcal/h$)

ρ_{TM} Density of the refrigerant at 100ºC ($\rho_{TM} = 818\ Kg/m^3$)

A_{KK} Section of the cooling channel ($A_{KK} = 5{,}027e^{-5} m^2$)

C_{TM} Heat capacity of the conditioning agent at 100ºC ($C_{TM} = 0.517\ Kcal/KgºC$)

The minimum speed for the recirculation of the tempering oil shail be:

$$V_{TM} = 27{,}637\ {}^{cm}/_{s}$$

4.6. -Calculation of maximum theoretical weight of injection.

In this point we will try to calculate the ideal theoretical maximum injection weight for the characteristic of our piece. This datum will use to design the injection machine and give us an idea of the machine characteristics necessary for the correct production of the piece.

Rohstoff	PS	PE	PP	ABS	PC	PA	PMMA	POM	CA	PVC-W
F2	0,91	0,71	0,73	0,88	0,97	0,91	0,94	1,15	1,02	1,02

Figure 23 F2 of different materials (Barrocal)

$$\mathbf{V_{shot}(req.)} = \frac{\mathbf{Weight}}{\mathbf{F2}} \qquad V_{shot}(req.) = \frac{0{,}6849 \times 8}{0{,}88} = 6{,}2263\ g$$

We will have to take into account that the theoretical maximum weight of injection is eight times that of a piece because we make eight pieces at the same time, with this datum we will have to choose the injection machine and the diameter of the spindle.

4.7.-Cheking the guide colums

Now, We know that the maximum stresses in the injection cycle supported by the guide colums so when the mold closes and the entire mass of the plates transported by the injection machine moves to start its new injection cycle, the calculation for checking the guide colums will be compression, the calculation is the next :

Data of guide colums:

- Diameter guide column $D = 10\ mm$
- Guide column material 1.7242 $\sigma_{adm} = 200\ N/mm^2$
- Closing force of the machine $F = 62\ kN$

$$\boldsymbol{\sigma}_{\mathbf{compression}} = \frac{\mathbf{F_{machine}}}{(\mathbf{Guide\ area}) \times \mathbf{4}}$$

$$\sigma_{compression} = \frac{62000\ N}{4 \times \pi \times (5mm)^2} = 197{,}35\ {}^{N}/_{mm^2}$$

4.8.-Checking support columns

The support columns are designed to withstand the pressures suffered by the mold during the cycle of injection. The maximum stress calculation for the support columns will be the same as for the columns guide, being this to compression.

Dates of colums guide:

- Diameter guide column $D= 14\ mm$
- Guide column material 1.1730 $\sigma_{adm} = 200\ N/mm^2$
- Closing force of the machine $F=62\ kN$

$$\boldsymbol{\sigma}_{\mathbf{compression}} = \frac{\mathbf{F}_{\mathbf{machine}}}{(\mathbf{Guide\ area}) \times \mathbf{4}}$$

$$\sigma_{compression} = \frac{62000\ N}{4 \times \pi \times (7mm)^2} = 100{,}7\ {}^{N}/_{mm^2}$$

4.9. -Calculation of the maximum pressure in the spindle

The maximun pressure in the spindle is usually three or four times higher than the pressure cavity in full production.

$\mathbf{p}_{(\mathbf{spec})} \sim (\mathbf{3} - \mathbf{4}) \times \mathbf{P}$ cavity pressure of the mold P =90 bar

For the calculation of the maximum pressure in the spindle we will consider that it is 3.5 times superior to the pressure in the cavity of the mold, since we have eight cavities, the calculation will be conditioned taking into account, the calculation will be:

$$p_{(spec)} \sim 3.5 \times 90 \times 8 = 2520 \; bar$$

This data will also be useful for the dimensioning of the injection machine, this data will allow us, together with the theoretical maximum injection weight, to choose the diameter of ideal spindle for the injection of our mold in question.

4.10. -Choice of injection machine.

After all the above calculations, we have all the necessary information for the dimensioning of the injection machine, the data to be taken into account are:

- Closing force of the mold F= 1,56 Tn in this data is not relevant when dimensioning the machine, it is not a too important force demand.
- Maximum theoretical injection weight V_{shot} (req.) ≈ 6,22g
- Maximum spindle pressure $p_{(spec)}$ ≈ 2520 bar

With these values we have the necessary data for the correct dimensioning of the machine. So the Machine that we choose is the BABYPLAST 610P of the BABYPLAST brand and the characteristics of the machine.

Babyplast 610P is one of the smallest, fully hydraulic, injection moulding machines. Thanks to the unique concept of the machine platens which act as mold bolsters the cost and dimension of the molds are reduced considerably. Babyplast 610P occupies less than 0,6 m^2 of floor space and is extremely quiet (<68dB).

Figure 24 Babyplast 610P (www.fuchs.es)

Babyplast 610P guarantees the highest precision thenks to the injection piston and the preplastification of the material. To obtain the optimum volume of material there are five interchangeable pistons available. It is also possible to move the injection unit off centre.

The technical features are in the following table:

Table 10 Characteristics of Babyplast 610P (www.fuchs.es)

Piston diameter (mm):	10	12	14	16	18
Injection volume (cm3):	4	6.5	9	12	15

Injection pressure (bar):	2030	1850	1340	1030	815
Clamping force:	62kN				
Min. dist. Between platens:	30 mm (55mm)*				
Max. dist. Between platens:	140 mm (165 mm)*				
Opening stroke:	110 mm				

Table 11 Characteristics of Babyplast 610P (www.fuchs.es)

Ejector force:	7,4 kN
Ejector stroke:	45 mm
Oil tank capacity:	16 l
Power consumption:	3 kW
Weight:	150 Kg
Mould dimensions:	$75 \times 75 \times 70\ mm\ (min.)$
Power supply:	400 V 50 Hz

4.11.-Supply system

4.11.1.-Sprue

We going to use standardized elements from companies like Meusburger but first we need to know the mold necessities.

At first we going to calculate the entrance sprue diameter. To calculate d_A we can use the next graphic or we can calculate the nozzle diameter.

Using the graphic, we need the injection weigh. The injected volume is the part volume V_p plus the runner channels volume V_c , we don't yet V_c so we will use that, V_c usually estimate as the 7% of the part volume. With Catia V5r19 results:

- Parts volume is $V_P = 6750\ mm^3$
- Runner channels volume is $V_C = 769\ mm^3$
- Total volume $V_T = 10985\ mm^3$

The ABS density is 1040 kg/m^3, so the injected weigh is 5,47 g.

The diameter range in the graphic is (2.5-3.5 mm). We choose d_A = 3mm.

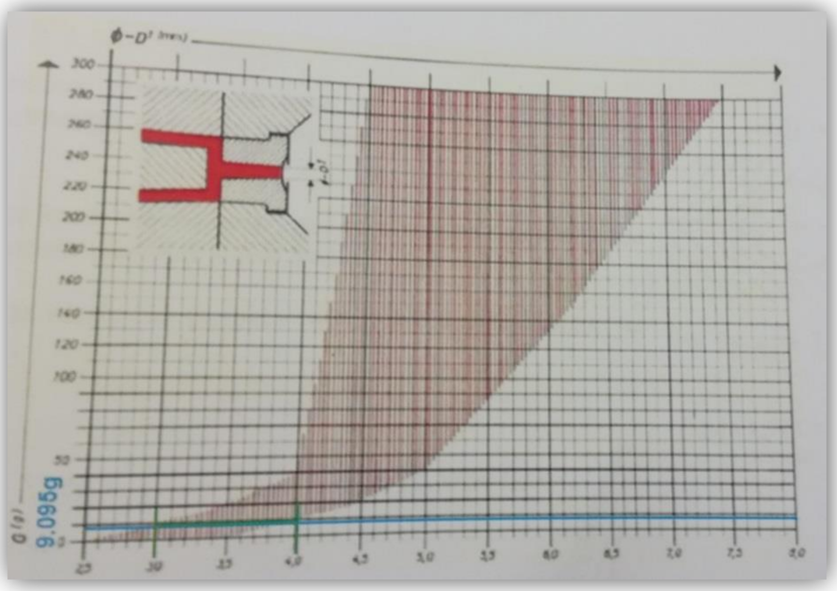


Figure 25 Graphic for calculate the sprue diameter (Barrocal)

Using the relation:

$$\mathbf{d_D + 1 \leq d_A}$$

We calculate the nozzle diameter that must be less or equal than 2 mm.

After that we going to calculate the final diameter D_F from the maximum part thickness S_{max} = 2 mm using the expression:

$$\mathbf{D_F = S_{max} + 1,5\ mm} \qquad D_F = 3,5\ mm$$

The angle must be between 1º- 2º and the sprue length between

$$\mathbf{5 \times D_F \le L \le 9 \times D_F} \qquad 17.5\ mm \le L \le 31.5\ mm$$

With this requirements we look for a normalized elements with these features, we going to use a sprue from MEUSBURGUER

Table 12 Sprue dimensions

D_A	D_F	α	L
3	3.6695	1º	27

All the dimension and the tolerance are in the annex.

4.11.2. - Runners

For the runner channels we have chosen the circular shape because although it is the most expensive it is the optimal section.

We need to know the diameter, the maximum thickness is 2 mm so the channels diameter is D= 3.5 mm.

We can also verify the diameter with the following graphic for ABS:

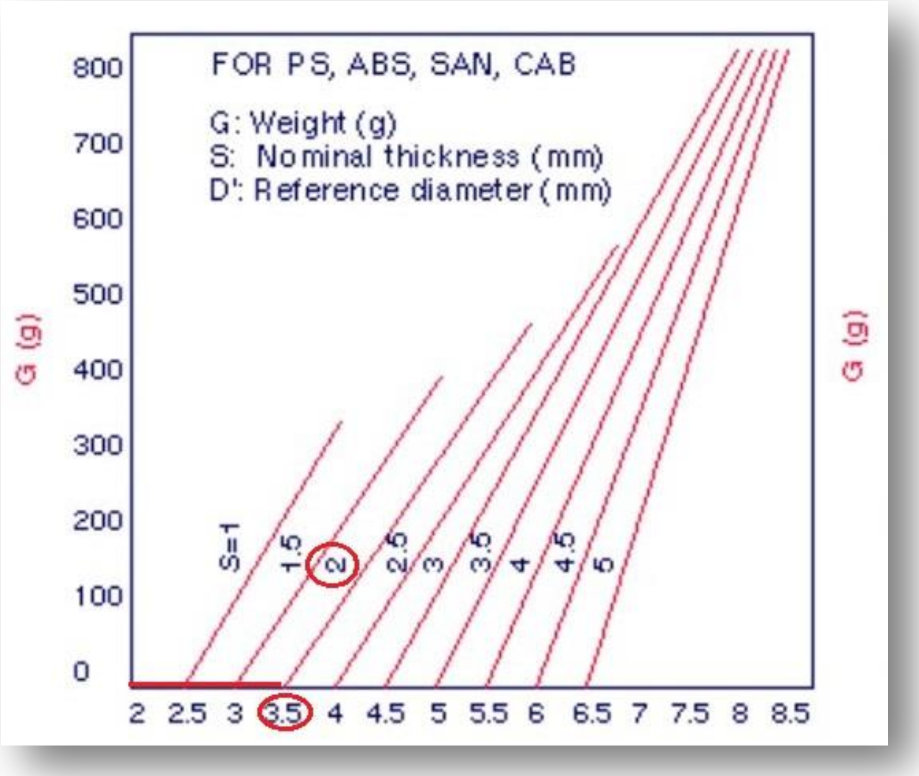


Figure 26 Weight vs Runner diameter (Rosell, 2010)

The layout chosen is an H system, we put a hole under the sprue and at the end of the runner channels for keep the plastic that could remain into the nozzle after the cooling and ejection phases.

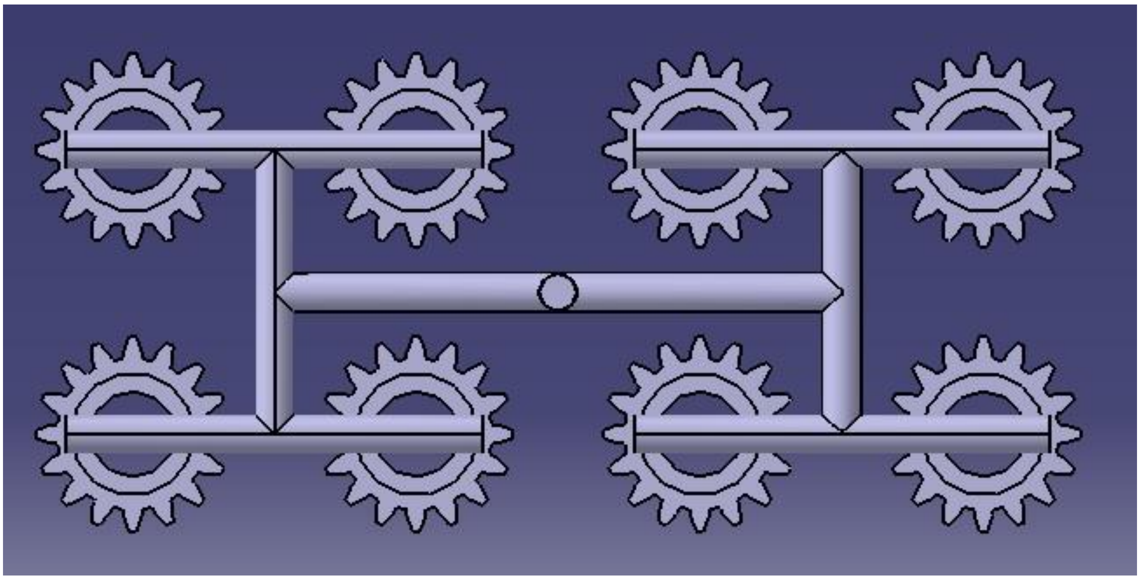


Figure 27 Layout channels

5. - Mold

In this section we will try to talk about each one of the parts of the mold.

We will talk about all the elements that make up our mold and explain everything related to these elements to better understand and analyze if it has been chosen correctly.

5.1. - Injection Side

Mold top, area where the plastic material is injected. It is formed by:

- Clamping plate
- Locator ring
- Cavity bushing
- Cap screw clamping
- Cavity plate

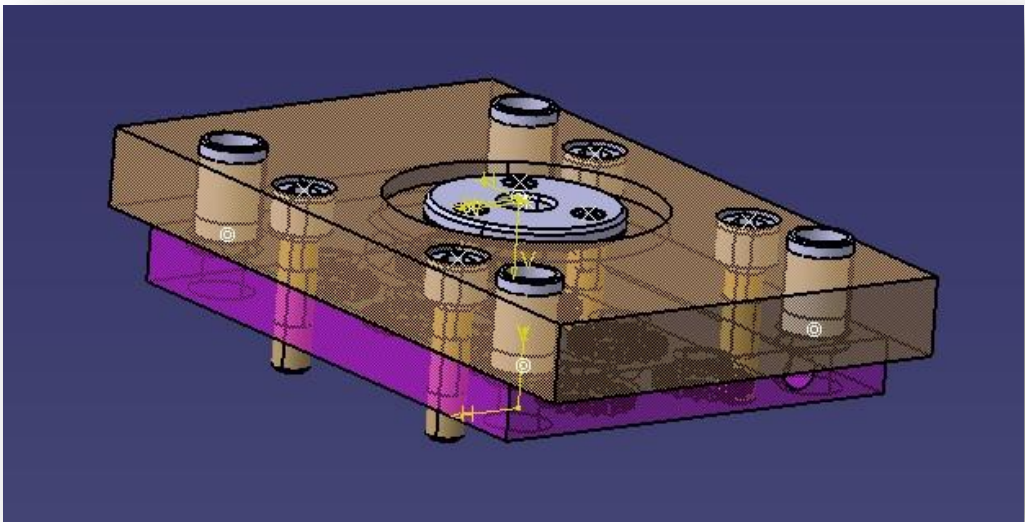


Figure 28 Injection Side

5.1.1. - Clamping plate

The function of clamping plate is to join the mold with the injection machine. We need to do a different operation. We will make a drill to introduce cavity bushing (E1160 / 14×20), cap screw clamping (E1200 / 8×30) and locator ring (E1312 / 42×4).

We use the clamping plate by MEUSBURGUER with this name F20/96 126/17/1730:

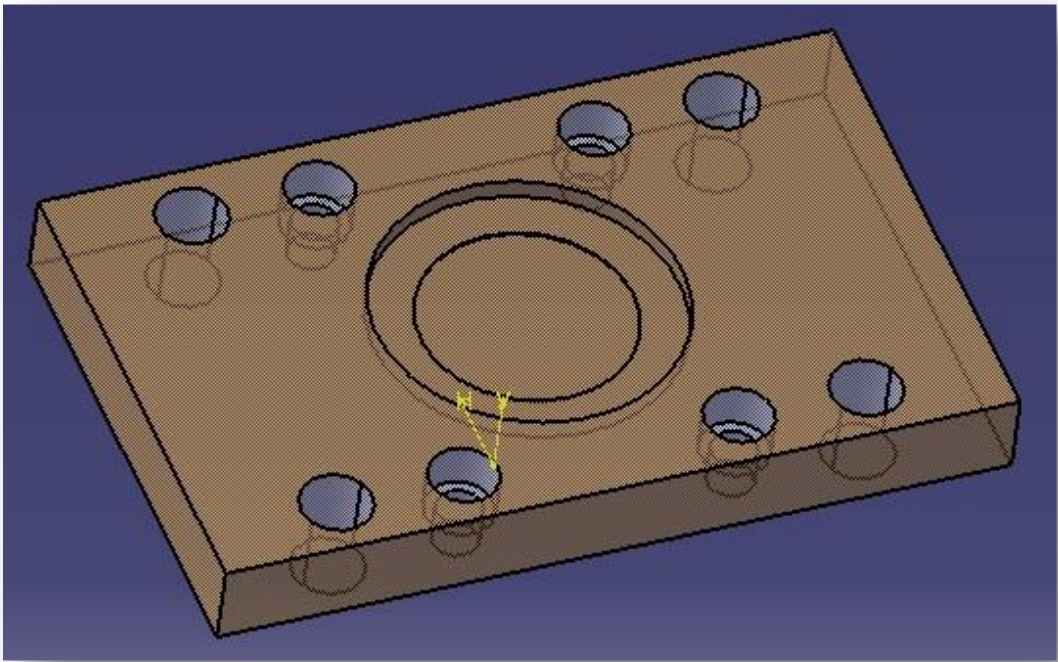


Figure 29 Clamping plate

5.1.2. - Locator ring

We take the locator ring from MEUSBURGUER S.A. company made of DIN 1.1

The locator ring is up to the clamping plate, its main function is the reception of the spindle nozzle each injection cycle. We use the locator ring by MEUSBURGUER with this name E1312 / 42×4:

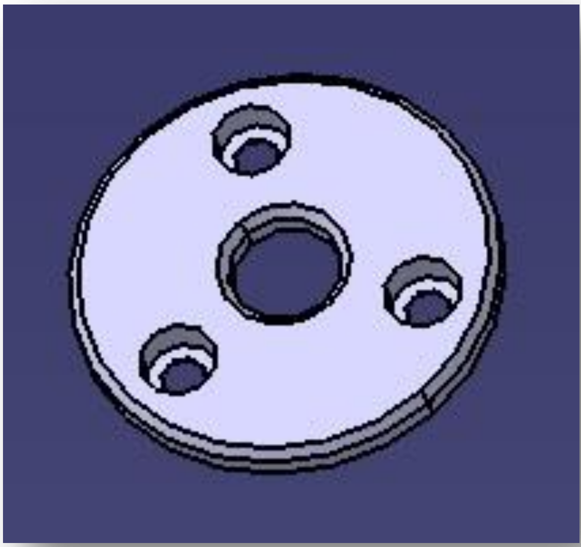


Figure 30 Locator ring

5.1.3. - Cavity bushing

Inside the cavity bushings there are the guide pins and it is used to reduce the friction. In our case the guide pin contact with the cavity plate, core plate, core support plate and with the riser bars.

We take the cavity bushings from MEUSBURGUER catalogue, they are E1160/ 14×20, it is made with 1.7131.

Figure 31Cavity bushings

5.1.4. - Cap screw clamping

We use seven different screw to fixed in first case the locator ring with the clamping plate and in the second case the clamping plate with the cavity plate.

We search in the MEUSBURGUER catalogue and we decide to use in ths first case E1200 /4×8 of DIN 912, the dimension and the tolerance are in the annex.

The other kind of screw we search in the same catalogue and we decide to use E1200 /8×30 with the same material, the dimension and the tolerance are in the annex.

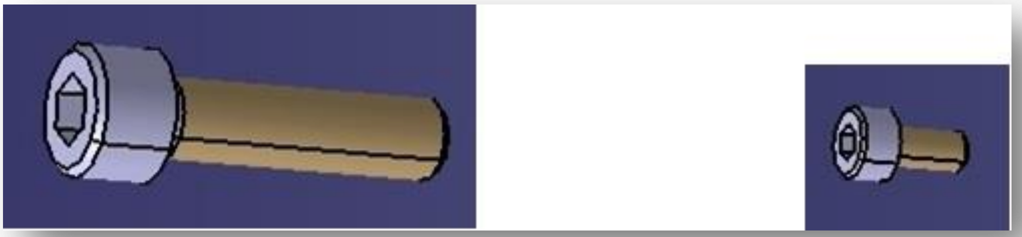


Figure 32 Cap screw clamping

5.1.5. - Cavity plate

This cavity plate has some hole for the cavities bushing and the screw,it has four holes with the guide bushing dimensions and other four holes with the screws, more details in the drawing document.

The cavity is a complex plate because it has a several aims, six gears. The cavity, in our case the part is defined all in the cavity plate.

We take a plate from MEUSBURGUER catalogue with 96×126 mm and 12 mm of thickness, it is made with 1.1730 material.

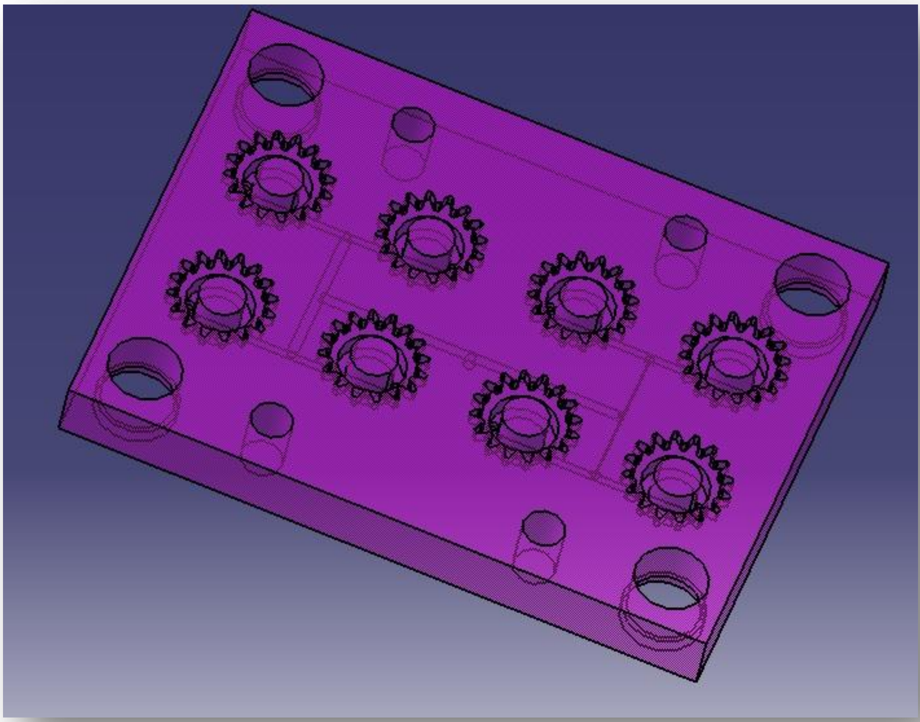


Figure 33 Cavity plate

5.2. - Ejection side

In this part there are the next parts:

- Guide pin
- Cap screw
- Core support plate
- Rise bar
- Setting plate

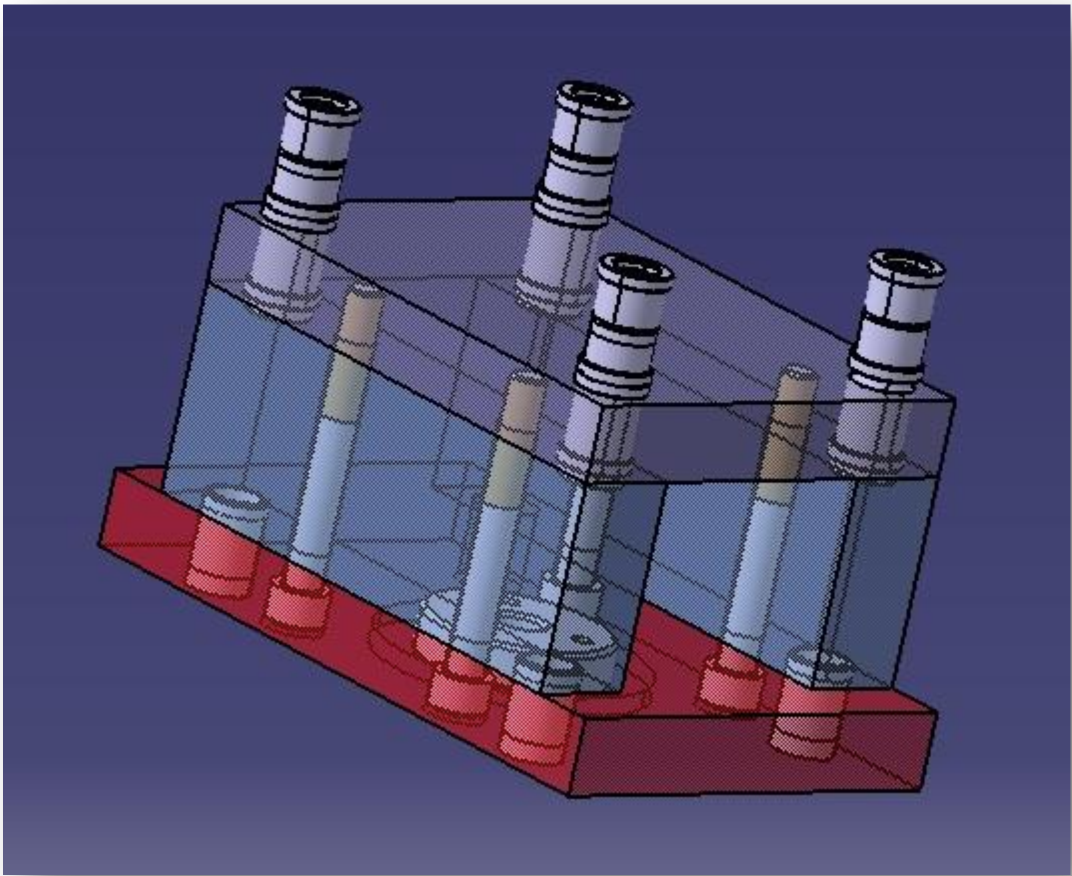


Figure 34Ejection side

5.2.3. - Guide pin

The guide are fixed in the injection mold half, between the cavity support plate and the setting plate. The recommended guide pins by the mold manufactured, MEUSBURGUER, are E1000/10 – 17/25 with a total length of 48 mm and with a diameter of 10 mm. The pins are made by the material 1.7131, more details in the annex.

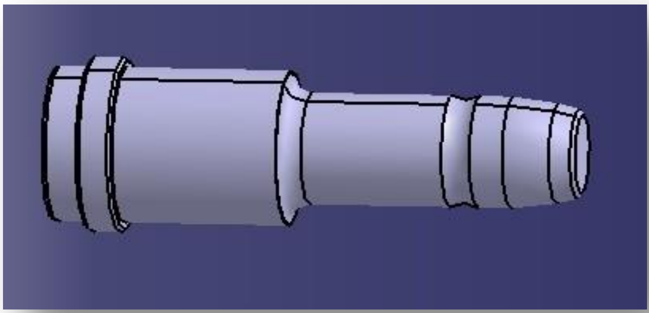


Figure 35 Guide pin

5.2.4. - Cap screw

We use four different screw to fixed the setting plate with core support plate and rise bar.

We search in the MEUSBURGUER catalogue and we decide to use E1200 /4×12 of DIN 912, the dimension and the tolerance are in the annex.

Figure 36 Cap screw setting

5.2.5. - Core support plate

The core support plate is standardized plate from MEUSBURGUER catalogue, made of 1.1730 material and with 96 × 126 mm with a thickness of 14,4 mm.

The core support plate has sixteen holes for the injection pins with a diameter of 0,8 mm.

There are four holes and M4 diameter due to the cap strew that fix the plate with the core plate, rise bar and setting plate.

Also the plate has four holes to place the guide bushing of the guiding unit.

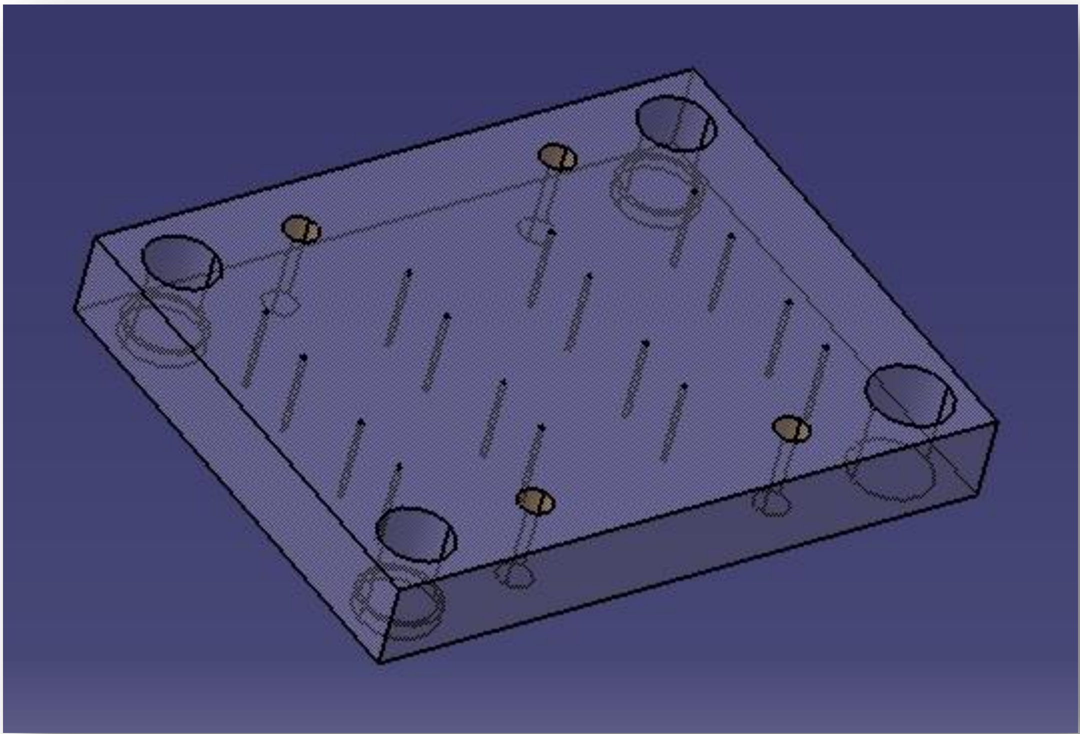


Figure 37 Core support plate

5.2.6. - Rise bar

The rise bars create the gap for the ejection plates movement. The rise bar are also from MEUSBURGUER catalogue, they size 22×126 mm and 46 mm of thickness with a gap 52 mm. They are made of 1.1730 material.

Each rise bar has two holes with diameters 14 mm for the guide bushing and two threated holes M8 for the cap screw that join together the core, core support, rise bars and setting plate.

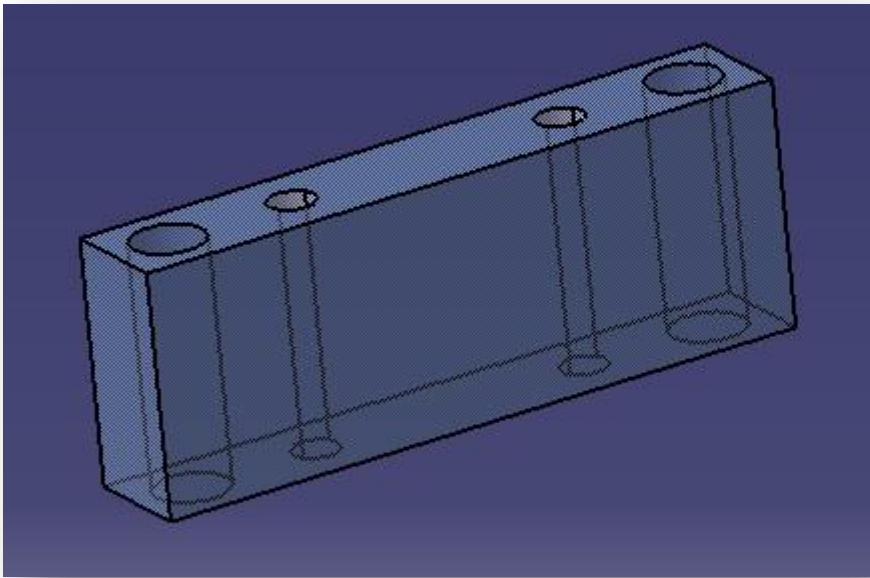


Figure 38 Rise bar

5.2.7. - Setting plate

Here we can see the last plate, we decide to use it from MEUSBURGUER catalogue. The size are 156×96 mm and 17 mm of thickness, it is made with 1.1730 material.

We made four holes for the cap screw of 9 mm with their head shape, M8.

In the midpoint of the plate there is a hole of 60 mm.

Also there are four holes for the cavity bushings, they have 14 mm of diameter.

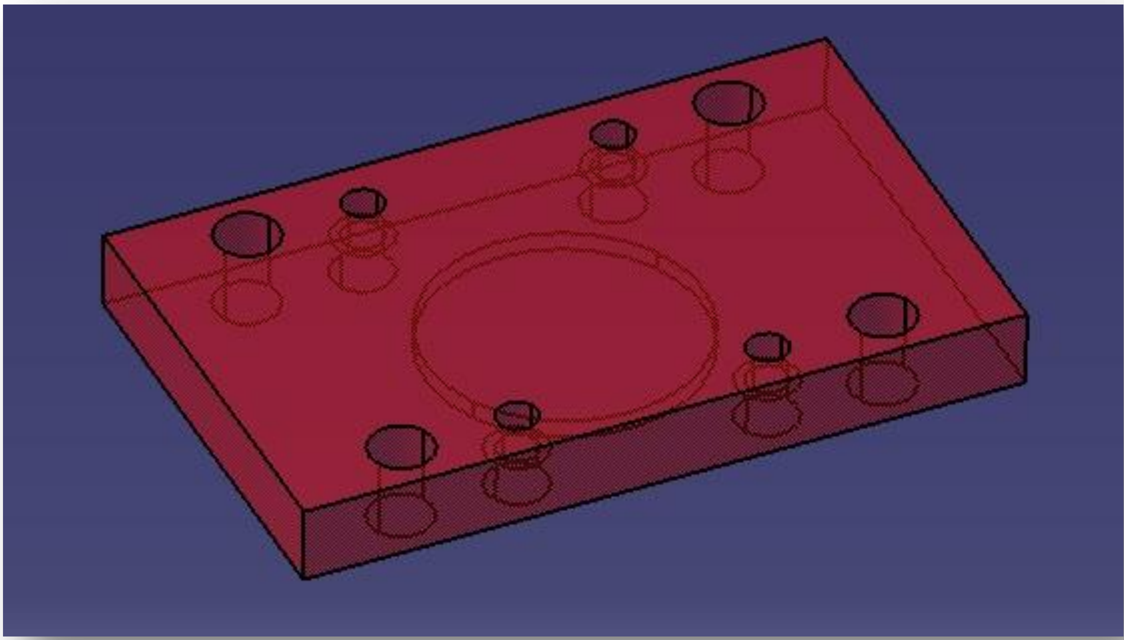


Figure 39 Setting plate

5.3.- Ejector system

In this section there are the next parts:

- Core plate
- Ejector pin
- Ejector plate

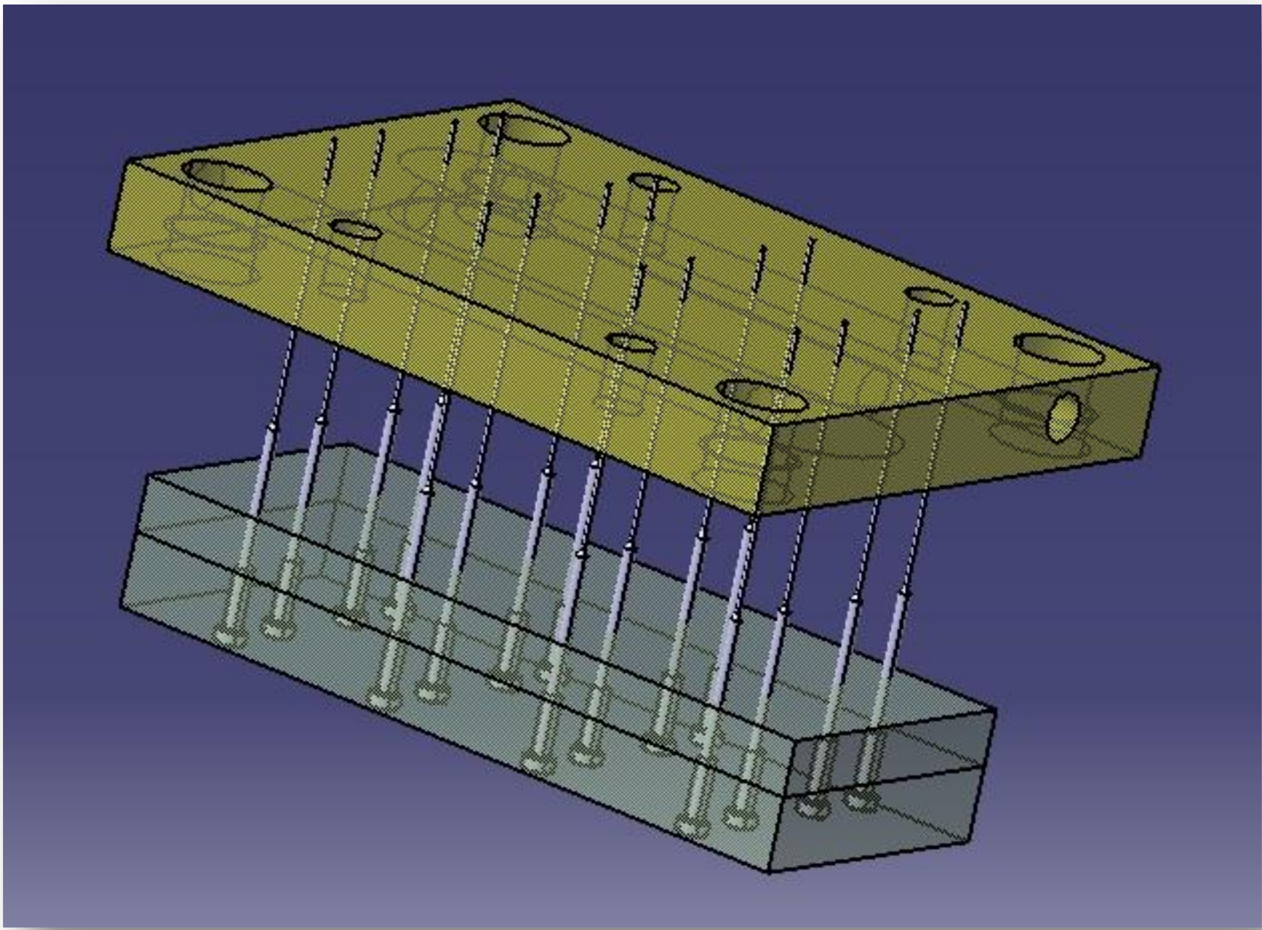


Figure 40 Ejector system

5.3.1.- Core plate

The core plate is a standardized from MEUSBURGUER catalogue, made of 1.1730 material and with a dimensions of 96×126 mm with a thinkness of 14, 4 mm.

In this plate we have cooling tube, where inside it, the coolant flows.

The core plate is fixed with the core support plate, the riser bars and the setting plate. All of that and the ejector plates are the mobile part. They are fixed with four cap screws E1200 /8×65 with M8 from MEUSBURGUER catalogue, the cap screws standardized DIN 912. They are placed two in each rise bar for more details about the position see the annex.

At least the core plate has four holes with the bushings shape because it goes together with the core support and setting plate so we going to put bushing for all plates, the bushing length have to be enough to cover the guide pins in the close position.

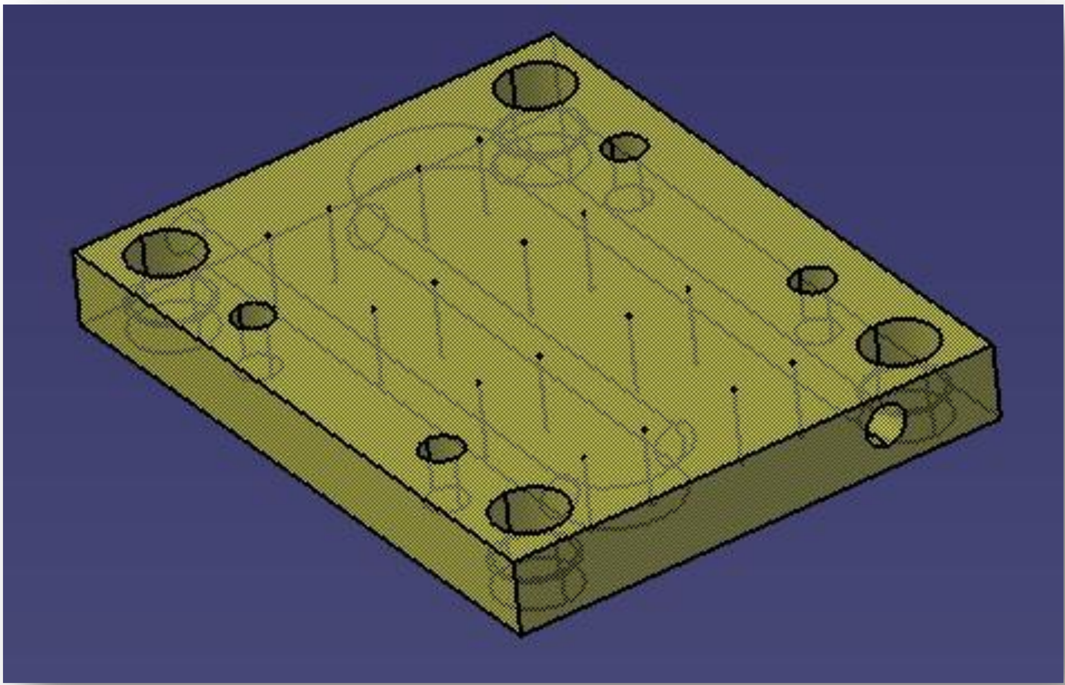


Figure 41 Core plate

5.3.2. - Ejector pin

The ejector pins always leave a mark so we have to choose carefully the pins action points. The molding has to be symmetrical avoiding deformation, for this reason we are going to place 2 pins per gear, we can show in the figure 40.

The pins diameter are less than 0,8 mm and the length is the required to fit the part from the ejection plates in our case 80mm. The sizes and the tolerances are detailed in the annex.

We take 16 ejector pins E1700 /0.8×80 from MEUSBURGUER catalogue. The material is 1.2516. The head hardness is 45HRC and the rod hardness is 60HRC.

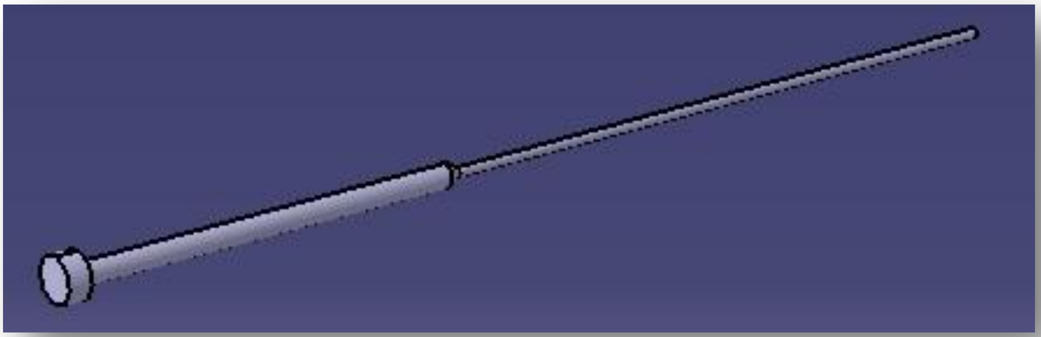


Figure 42 Ejector pin

5.3.3. - Ejector plate

We have two injection plates A and B, they are fixed together. The ejection plate A has the holes for the ejection and the ejection plate B support the pins.

We decide to use two plates from the MEUSBURGUER catalogue, the ejection plate A thickness of 9 mm and the ejection plate B a thickness of 12 mm. Both have the same size 50×126 mm.

The plates are made of 1.1730 material.

5.3.3.1.- Plate A

In this plate we can see the holes for the ejector pins, sixteen holes with a diameter of 0,8 mm for the body, the dimension and the tolerance in the annex.

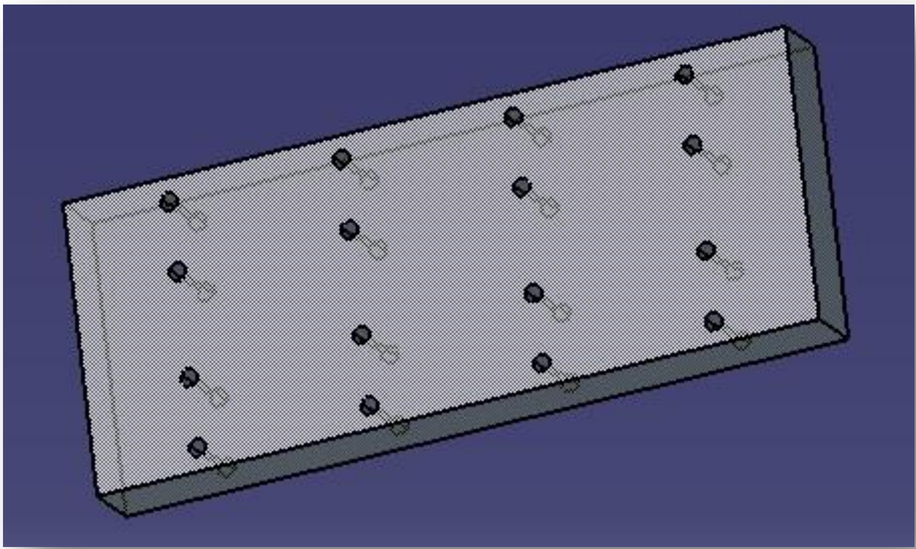


Figure 43Ejector plate A

5.3.3.2. - Plate B

In this plate we can see the holes for the ejector pins with their head shape, sixteen holes with a diameter of 0, 8 mm for the body and 4 mm for the head, the dimension and the tolerance in the annex.

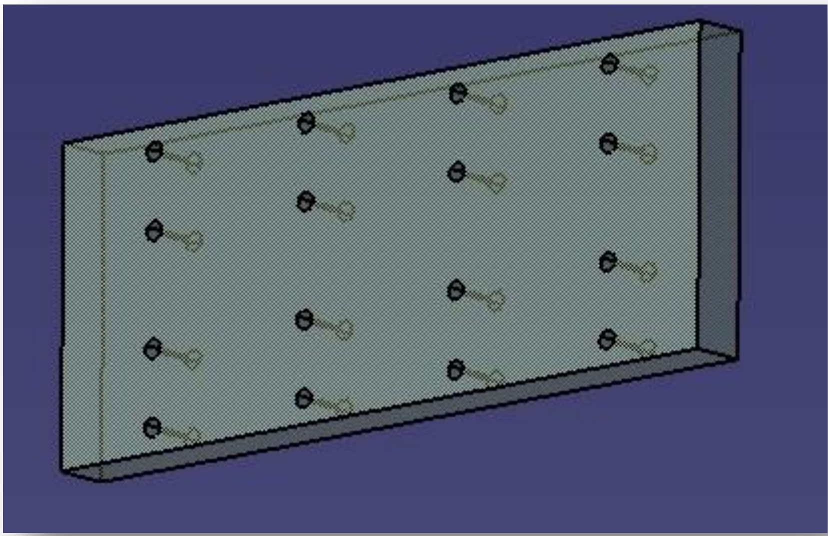


Figure 44 Ejector plate B

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7. –Annex

7.1. - Material Annex

7.1.1. - Material 1.1730

7.1.2. - Material 1.1731

7.1.3. - Material 1.2085

7.1.1. - Material 1.1730

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Material No.: **1.1730**

Designation
DIN: C 45 U
AFNOR: XC 48
UNI: -
AISI: 1045

Indicatory analysis:

C	0.45
Si	0.30
Mn	0.70

Strength: ≈ 640 N/mm^2

Thermal conductivity at 20 °C: $50 \frac{W}{m\,K}$

Character: unalloyed **tool steel** with excellent machinability; chilled cast steel, suitable for flame and inductive hardening

Application: unhardenend parts for mould and jig construction or plates and frames for tools and dies

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Treatment by

Polishing:
Etching:
EDM:
Nitriding:
Hard chroming:

$\Big\}$ not usual

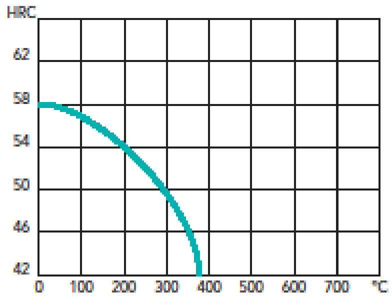
Heat treatment:

Soft annealing:
680 to 710 °C for about 2 to 5 hours
slow controlled cooling of 10 to 20 °C per hour to about 600 °C;
further cooling in air, **max. 190 HB**

Hardening:
800 to 830 °C
quenching in water
obtainable hardness: **58 HRC**
hardening depth: 3–5 mm
max. 15 mm through hardening thickness

Tempering:
slow heating to tempering temperature immediately after hardening, to 180 to 300 °C depending on desired hardness
1 hour per 20 mm: min. 2 hours

Tempering chart:



7.1.2. - Material 1.1731

Material No.: **1.7131**

Designation
DIN: 16 MnCr 5
AFNOR: 16 MC 5
UNI: -
AISI: 5115

Indicatory analysis:

C	0.16
Si	0.25
Mn	1.15
Cr	0.95

Strength: 660 N/mm²

Thermal conductivity at 20 °C: $44 \frac{W}{m\,K}$

Character: **Steel for case hardening** for parts requiring a core strength of 800 to 1000 N/mm² and high wear resistance

Application: guiding elements, cores and machine parts with high surface hardness; synthetic resin press moulds for processing thermoplastics and thermosetting plastics

Treatment by
Polishing:
Etching:
EDM:
possible
Nitriding:
Usually, hardened parts are not nitrided → loss of hardness.
Hard chroming:
recommended, increases wear and corrosion resistance

Heat treatment:
Annealing:
670 to 710 °C for about 2 to 5 hours
slow controlled cooling, further cooling in air, **max. 205 HB**

Carburising:
900 to 950 °C. The choice of the carburising means and carburising temperature depends on the desired surface carbon content, the carburising graph and the required case depth.

Case hardening:
870 to 930 °C in powder/salt bath, cooling in oil/hot bath at 160 to 250 °C

Intermediate annealing:
630 to 650 °C, for about 2 to 4 hours with slow furnace cooling

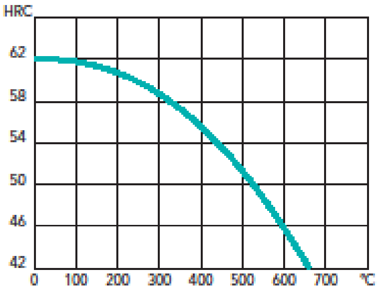
Preheating:
350 °C depending on dimensions

Hardening:
curing temperature 810 to 840 °C harden in 60 °C hot oil

Cooling:
down to about 100 °C in oil, then in air to about 50 °C

Tempering:
1 hour per 20 mm part thickness, min. 2 hours

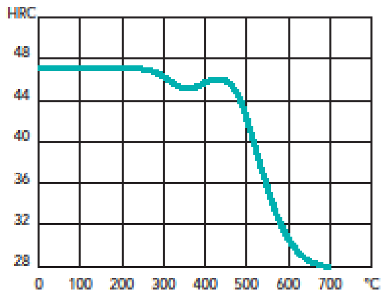
Tempering chart:



7.1.3. - Material 1.2085

meusburger.com

Material No.:	**1.2085**
Designation	**DIN:** X 33 CrS 16 **AFNOR:** Z 35 CD 17.S **UNI:** - **AISI:** ≈ 422 + S
Indicatory analysis:	C 0.33 Si 0.30 Mn 0.80 Cr 16.00 Mo 1.20 S 0.06 Ni 0.30
Strength:	≈ 1080 N/mm²
Thermal conductivity at 100 °C:	$18 \frac{W}{m\,K}$
Character:	corrosion resistant, high-alloy, pre-toughened **tool steel** with good machinability due to Sulphur (S) additive
Application:	Plates for corrosion resistant mould tools and die sets; moulds for corrosive plastics; the expense for protection and care of mould tools is reduced thanks to increased corrosion resistance; not suitable for mould inserts
Treatment by	Polishing: Etching: EDM: Nitriding: Hard chroming: } not recommended
Heat treatment:	Usually no heat treatment is required. Annealing: 850 to 880 °C for about 2 to 5 hours slow controlled cooling; hardness **max. 240 HB** Hardening: 1000 to 1030 °C 30 minutes keeping curing-temperature quenching in oil is preferable obtainable hardness: **48 HRC** Tempering: slow heating to tempering temperature immediately after hardening; minimum time in furnace: 2 hour per 20 mm part thickness; tempering twice is recommended Tempering chart:



7

7.2. - Standardized elements annex

7.2.1. - Guide pillar

7.2.2. - Cavity bushing

7.2.3. -Cap screw

7.2.4. -Ejector pin

7.2.5. –Sprue bush

7.2.6. - Spacer disk

7.2.1. - Guide pillar

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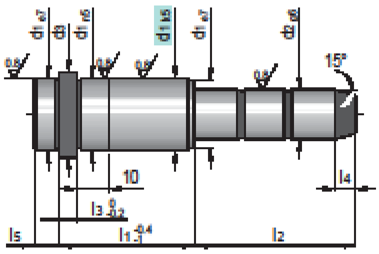
E 1000

Führungssäule mit Zentrierbund

Guide pillar with centering collar



Mat.: 1.7131 ~60 HRC

l_3	l_4	l_5	d_3	d_1	d_2	l_1	l_2	Nr. /No.	d_2	Nr. /No.
3	4	3	16	14	9	12	25	E 1000/ 9- 12/ 25	10	E 1000/10- 12/ 25
							35	E 1000/ 9- 12/ 35		E 1000/10- 12/ 35
							55	E 1000/ 9- 12/ 55		E 1000/10- 12/ 55
						17	25	E 1000/ 9- 17/ 25		E 1000/10- 17/ 25
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						22	25	E 1000/ 9- 22/ 25		E 1000/10- 22/ 25
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							135	E 1000/14- 46/135		E 1000/15- 46/135
						56	35	E 1000/14- 56/ 35		E 1000/15- 56/ 35
							55	E 1000/14- 56/ 55		E 1000/15- 56/ 55
							75	E 1000/14- 56/ 75		E 1000/15- 56/ 75
							95	E 1000/14- 56/ 95		E 1000/15- 56/ 95
							115	E 1000/14- 56/115		E 1000/15- 56/115

l_3	l_4	l_5	d_3	d_1	d_2	l_1	l_2	Nr. /No.	d_2	Nr. /No.
6	5	9	25	20	14	56	135	E 1000/14- 56/135	15	E 1000/15- 56/135
						66	35	E 1000/14- 66/ 35		E 1000/15- 66/ 35
							55	E 1000/14- 66/ 55		E 1000/15- 66/ 55
							75	E 1000/14- 66/ 75		E 1000/15- 66/ 75
							95	E 1000/14- 66/ 95		E 1000/15- 66/ 95
							115	E 1000/14- 66/115		E 1000/15- 66/115
						76	55	E 1000/14- 76/ 55		E 1000/15- 76/ 55
							75	E 1000/14- 76/ 75		E 1000/15- 76/ 75
							95	E 1000/14- 76/ 95		E 1000/15- 76/ 95
						86	55	E 1000/14- 86/ 55		E 1000/15- 86/ 55
							75	E 1000/14- 86/ 75		E 1000/15- 86/ 75
							95	E 1000/14- 86/ 95		E 1000/15- 86/ 95
						96	55	E 1000/14- 96/ 55		E 1000/15- 96/ 55
							75	E 1000/14- 96/ 75		E 1000/15- 96/ 75
							95	E 1000/14- 96/ 95		E 1000/15- 96/ 95
6	7	9	31	26	18	17	35	E 1000/18- 17/ 35	20	E 1000/20- 17/ 35
							55	E 1000/18- 17/ 55		E 1000/20- 17/ 55
							75	E 1000/18- 17/ 75		E 1000/20- 17/ 75
							95	E 1000/18- 17/ 95		E 1000/20- 17/ 95
							115	E 1000/18- 17/115		E 1000/20- 17/115
						22	35	E 1000/18- 22/ 35		E 1000/20- 22/ 35
							55	E 1000/18- 22/ 55		E 1000/20- 22/ 55
							75	E 1000/18- 22/ 75		E 1000/20- 22/ 75
							95	E 1000/18- 22/ 95		E 1000/20- 22/ 95
							115	E 1000/18- 22/115		E 1000/20- 22/115
							135	E 1000/18- 22/135		E 1000/20- 22/135
						27	35	E 1000/18- 27/ 35		E 1000/20- 27/ 35
							55	E 1000/18- 27/ 55		E 1000/20- 27/ 55
							75	E 1000/18- 27/ 75		E 1000/20- 27/ 75
							95	E 1000/18- 27/ 95		E 1000/20- 27/ 95
							115	E 1000/18- 27/115		E 1000/20- 27/115
							135	E 1000/18- 27/135		E 1000/20- 27/135
							155	E 1000/18- 27/155		E 1000/20- 27/155
							195	E 1000/18- 27/195		E 1000/20- 27/195
							235	E 1000/18- 27/235		E 1000/20- 27/235
						36	35	E 1000/18- 36/ 35		E 1000/20- 36/ 35
							55	E 1000/18- 36/ 55		E 1000/20- 36/ 55
							75	E 1000/18- 36/ 75		E 1000/20- 36/ 75
							95	E 1000/18- 36/ 95		E 1000/20- 36/ 95
							115	E 1000/18- 36/115		E 1000/20- 36/115
							135	E 1000/18- 36/135		E 1000/20- 36/135
							155	E 1000/18- 36/155		E 1000/20- 36/155
							195	E 1000/18- 36/195		E 1000/20- 36/195
							235	E 1000/18- 36/235		E 1000/20- 36/235
						46	35	E 1000/18- 46/ 35		E 1000/20- 46/ 35
							55	E 1000/18- 46/ 55		E 1000/20- 46/ 55
							75	E 1000/18- 46/ 75		E 1000/20- 46/ 75
							95	E 1000/18- 46/ 95		E 1000/20- 46/ 95
							115	E 1000/18- 46/115		E 1000/20- 46/115
							135	E 1000/18- 46/135		E 1000/20- 46/135
							155	E 1000/18- 46/155		E 1000/20- 46/155
							195	E 1000/18- 46/195		E 1000/20- 46/195
							235	E 1000/18- 46/235		E 1000/20- 46/235
						56	35	E 1000/18- 56/ 35		E 1000/20- 56/ 35
							55	E 1000/18- 56/ 55		E 1000/20- 56/ 55
							75	E 1000/18- 56/ 75		E 1000/20- 56/ 75
							95	E 1000/18- 56/ 95		E 1000/20- 56/ 95
							115	E 1000/18- 56/115		E 1000/20- 56/115
							135	E 1000/18- 56/135		E 1000/20- 56/135
							155	E 1000/18- 56/155		E 1000/20- 56/155
							195	E 1000/18- 56/195		E 1000/20- 56/195

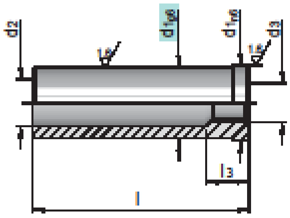
7.2.2. - Cavity bushing

meusburger.com

E 1160

Zentrierhülse mit zwei Passdurchmessern

Centering bush with two fitting diameters



Mat.: 1.7131 ≈ 60 HRC

l_3	d_2	d_3	d_1	l	Nr. /No.
8	11	M 8	14	20	E 1160/14 x 20
				30	E 1160/14 x 30
				40	E 1160/14 x 40
				50	E 1160/14 x 50
				60	E 1160/14 x 60
				70	E 1160/14 x 70
				80	E 1160/14 x 80
				100	E 1160/14 x 100
14	16	M12	20	30	E 1160/20 x 30
				40	E 1160/20 x 40
				50	E 1160/20 x 50
				60	E 1160/20 x 60
				80	E 1160/20 x 80
				100	E 1160/20 x 100
				120	E 1160/20 x 120
				140	E 1160/20 x 140
				160	E 1160/20 x 160
14	21	M12	26	30	E 1160/26 x 30
				40	E 1160/26 x 40
				50	E 1160/26 x 50
				60	E 1160/26 x 60
				80	E 1160/26 x 80
				100	E 1160/26 x 100
				120	E 1160/26 x 120
				140	E 1160/26 x 140
				160	E 1160/26 x 160
				180	E 1160/26 x 180
14	25	M12	30	40	E 1160/30 x 40
				50	E 1160/30 x 50
				60	E 1160/30 x 60
				80	E 1160/30 x 80
				100	E 1160/30 x 100
				120	E 1160/30 x 120
				140	E 1160/30 x 140
				160	E 1160/30 x 160
				180	E 1160/30 x 180
				200	E 1160/30 x 200
				220	E 1160/30 x 220
18	33	M12	42	60	E 1160/42 x 60
				80	E 1160/42 x 80
				100	E 1160/42 x 100
				120	E 1160/42 x 120
				140	E 1160/42 x 140
				160	E 1160/42 x 160
				180	E 1160/42 x 180
				200	E 1160/42 x 200
				220	E 1160/42 x 220
				240	E 1160/42 x 240
				280	E 1160/42 x 280
18	43	M12	54	80	E 1160/54 x 80
				120	E 1160/54 x 120
				160	E 1160/54 x 160
				180	E 1160/54 x 180
				200	E 1160/54 x 200
				220	E 1160/54 x 220
				240	E 1160/54 x 240
				260	E 1160/54 x 260
				280	E 1160/54 x 280
				300	E 1160/54 x 300
				320	E 1160/54 x 320
				340	E 1160/54 x 340

l_3	d_2	d_3	d_1	l	Nr. /No.
18	43	M12	54	360	E 1160/54 x 360
				380	E 1160/54 x 380
26	54	M12	66	80	E 1160/66 x 80
				120	E 1160/66 x 120
				160	E 1160/66 x 160
				180	E 1160/66 x 180
				200	E 1160/66 x 200
				220	E 1160/66 x 220
				240	E 1160/66 x 240
				260	E 1160/66 x 260
				280	E 1160/66 x 280
				300	E 1160/66 x 300
				320	E 1160/66 x 320
				340	E 1160/66 x 340
				360	E 1160/66 x 360
				380	E 1160/66 x 380

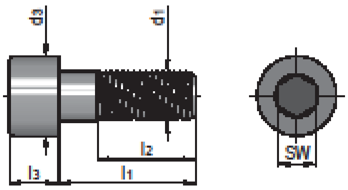
48

7.2.3. -Cap screw

E 1200

Zylinderkopfschraube mit Innensechskant

Cylinder head screw with hexagon socket



DIN 912 - 12.9

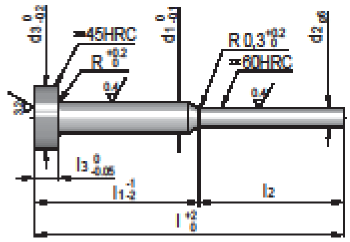
SW	l2	l3	d3	d1	l1	Nr. /No.
1.5	6	2	3.8	M 2	6	E 1200/ 2 x 6
	8				8	E 1200/ 2 x 8
	10				10	E 1200/ 2 x 10
	12				12	E 1200/ 2 x 12
	16				16	E 1200/ 2 x 16
	20				20	E 1200/ 2 x 20
2.5	6	3	5.5	M 3	6	E 1200/ 3 x 6
	8				8	E 1200/ 3 x 8
	10				10	E 1200/ 3 x 10
	12				12	E 1200/ 3 x 12
	16				16	E 1200/ 3 x 16
	18				20	E 1200/ 3 x 20
					25	E 1200/ 3 x 25
					30	E 1200/ 3 x 30
					35	E 1200/ 3 x 35
					40	E 1200/ 3 x 40
3	6	4	7	M 4	6	E 1200/ 4 x 6
	8				8	E 1200/ 4 x 8
	10				10	E 1200/ 4 x 10
	12				12	E 1200/ 4 x 12
	16				16	E 1200/ 4 x 16
	20				20	E 1200/ 4 x 20
					25	E 1200/ 4 x 25
					30	E 1200/ 4 x 30
					35	E 1200/ 4 x 35
					40	E 1200/ 4 x 40
					45	E 1200/ 4 x 45
					50	E 1200/ 4 x 50
4	8	5	8.5	M 5	8	E 1200/ 5 x 8
	10				10	E 1200/ 5 x 10
	12				12	E 1200/ 5 x 12
	16				16	E 1200/ 5 x 16
	20				20	E 1200/ 5 x 20
	22				25	E 1200/ 5 x 25
					30	E 1200/ 5 x 30
					35	E 1200/ 5 x 35
					40	E 1200/ 5 x 40
					45	E 1200/ 5 x 45
					50	E 1200/ 5 x 50
					55	E 1200/ 5 x 55
					60	E 1200/ 5 x 60
					65	E 1200/ 5 x 65
					70	E 1200/ 5 x 70
5	10	6	10	M 6	10	E 1200/ 6 x 10
	12				12	E 1200/ 6 x 12
	16				16	E 1200/ 6 x 16
	20				20	E 1200/ 6 x 20
	24				25	E 1200/ 6 x 25
					30	E 1200/ 6 x 30
					35	E 1200/ 6 x 35
					40	E 1200/ 6 x 40
					45	E 1200/ 6 x 45
					50	E 1200/ 6 x 50
					55	E 1200/ 6 x 55
					60	E 1200/ 6 x 60
					65	E 1200/ 6 x 65
					70	E 1200/ 6 x 70
					75	E 1200/ 6 x 75
					80	E 1200/ 6 x 80
					85	E 1200/ 6 x 85
					90	E 1200/ 6 x 90
5	24	6	10	M 6	95	E 1200/ 6 x 95
					100	E 1200/ 6 x 100
					105	E 1200/ 6 x 105
					110	E 1200/ 6 x 110
					120	E 1200/ 6 x 120
					140	E 1200/ 6 x 140
					160	E 1200/ 6 x 160
6	12	8	13	M 8	12	E 1200/ 8 x 12
	16				16	E 1200/ 8 x 16
	20				20	E 1200/ 8 x 20
	25				25	E 1200/ 8 x 25
	28				30	E 1200/ 8 x 30
					35	E 1200/ 8 x 35
					40	E 1200/ 8 x 40
					45	E 1200/ 8 x 45
					50	E 1200/ 8 x 50
					55	E 1200/ 8 x 55
					60	E 1200/ 8 x 60
					65	E 1200/ 8 x 65
					70	E 1200/ 8 x 70
					75	E 1200/ 8 x 75
					80	E 1200/ 8 x 80
					85	E 1200/ 8 x 85
					90	E 1200/ 8 x 90
					95	E 1200/ 8 x 95
					100	E 1200/ 8 x 100
					105	E 1200/ 8 x 105
					110	E 1200/ 8 x 110
					115	E 1200/ 8 x 115
					120	E 1200/ 8 x 120
					130	E 1200/ 8 x 130
					140	E 1200/ 8 x 140
					150	E 1200/ 8 x 150
					160	E 1200/ 8 x 160
					170	E 1200/ 8 x 170
					180	E 1200/ 8 x 180
					190	E 1200/ 8 x 190
					200	E 1200/ 8 x 200
					210	E 1200/ 8 x 210
					220	E 1200/ 8 x 220
8	16	10	16	M10	16	E 1200/10 x 16
	20				20	E 1200/10 x 20
	25				25	E 1200/10 x 25
	30				30	E 1200/10 x 30
	32				35	E 1200/10 x 35
					40	E 1200/10 x 40
					45	E 1200/10 x 45
					50	E 1200/10 x 50
					55	E 1200/10 x 55
					60	E 1200/10 x 60
					65	E 1200/10 x 65
					70	E 1200/10 x 70
					75	E 1200/10 x 75
					80	E 1200/10 x 80
					85	E 1200/10 x 85
					90	E 1200/10 x 90
					95	E 1200/10 x 95
					100	E 1200/10 x 100
					105	E 1200/10 x 105
					110	E 1200/10 x 110
					120	E 1200/10 x 120

7.2.4. -Ejector pin

E 1700

Auswerferstift gehärtet

Ejector pin through-hardened



Mat.: 1.2210

≈ISO 8694 (DIN 1530 C)
Form CH

R	l3	l1	l2	d3	d1	d2	l	Nr./No.
0.2	2	25	35	4	2	0.5	60	E 1700/0.5 x 60
		35	45				80	E 1700/0.5 x 80
		50	50				100	E 1700/0.5 x 100
			75				125	E 1700/0.5 x 125
		75	85				160	E 1700/0.5 x 160
0.2	2	25	35	4	2	0.6	60	E 1700/0.6 x 60
		35	45				80	E 1700/0.6 x 80
		50	50				100	E 1700/0.6 x 100
			75				125	E 1700/0.6 x 125
		75	85				160	E 1700/0.6 x 160
0.2	2	25	35	4	2	0.8	60	E 1700/0.8 x 60
		35	45				80	E 1700/0.8 x 80
		50	50				100	E 1700/0.8 x 100
			75				125	E 1700/0.8 x 125
		75	85				160	E 1700/0.8 x 160
			125				200	E 1700/0.8 x 200
		100	150				250	E 1700/0.8 x 250
0.2	2	25	35	4	2	0.9	60	E 1700/0.9 x 60
		35	45				80	E 1700/0.9 x 80
		50	50				100	E 1700/0.9 x 100
			75				125	E 1700/0.9 x 125
		75	85				160	E 1700/0.9 x 160
			125				200	E 1700/0.9 x 200
0.2	2	25	35	4	2	1	60	E 1700/1 x 60
		35	45				80	E 1700/1 x 80
		50	50				100	E 1700/1 x 100
			75				125	E 1700/1 x 125
		75	85				160	E 1700/1 x 160
			125				200	E 1700/1 x 200
		100	150				250	E 1700/1 x 250
		125	150				275	E 1700/1 x 275
0.2	2	25	35	4	2	1.1	60	E 1700/1.1 x 60
		35	45				80	E 1700/1.1 x 80
		50	50				100	E 1700/1.1 x 100
			75				125	E 1700/1.1 x 125
		75	85				160	E 1700/1.1 x 160
			125				200	E 1700/1.1 x 200
0.2	2	25	35	4	2	1.2	60	E 1700/1.2 x 60
		35	45				80	E 1700/1.2 x 80
		50	50				100	E 1700/1.2 x 100
			75				125	E 1700/1.2 x 125
		75	85				160	E 1700/1.2 x 160
			125				200	E 1700/1.2 x 200
		100	150				250	E 1700/1.2 x 250
		125	150				275	E 1700/1.2 x 275
0.2	2	25	35	4	2	1.3	60	E 1700/1.3 x 60
		35	45				80	E 1700/1.3 x 80
		50	50				100	E 1700/1.3 x 100
			75				125	E 1700/1.3 x 125
		75	85				160	E 1700/1.3 x 160
			125				200	E 1700/1.3 x 200
0.2	2	25	35	4	2	1.4	60	E 1700/1.4 x 60
		35	45				80	E 1700/1.4 x 80
		50	50				100	E 1700/1.4 x 100
			75				125	E 1700/1.4 x 125
		75	85				160	E 1700/1.4 x 160
			125				200	E 1700/1.4 x 200
0.3	3	25	35	6	3	1.5	60	E 1700/1.5 x 60
		35	45				80	E 1700/1.5 x 80
		50	50				100	E 1700/1.5 x 100
			75				125	E 1700/1.5 x 125

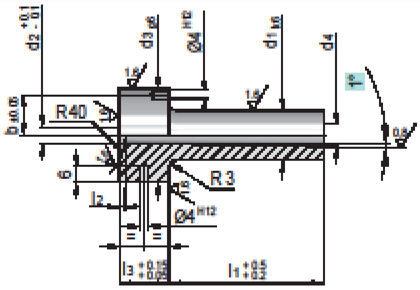
R	l3	l1	l2	d3	d1	d2	l	Nr./No.
0.3	3	75	85	6	3	1.5	160	E 1700/1.5 x 160
			125				200	E 1700/1.5 x 200
		100	150				250	E 1700/1.5 x 250
		125	150				275	E 1700/1.5 x 275
		160	155				315	E 1700/1.5 x 315
0.3	3	35	45	6	3	1.6	80	E 1700/1.6 x 80
		50	50				100	E 1700/1.6 x 100
			75				125	E 1700/1.6 x 125
		75	85				160	E 1700/1.6 x 160
			125				200	E 1700/1.6 x 200
0.3	3	35	45	6	3	1.7	80	E 1700/1.7 x 80
		50	50				100	E 1700/1.7 x 100
			75				125	E 1700/1.7 x 125
		75	85				160	E 1700/1.7 x 160
			125				200	E 1700/1.7 x 200
0.3	3	35	45	6	3	1.8	80	E 1700/1.8 x 80
		50	50				100	E 1700/1.8 x 100
			75				125	E 1700/1.8 x 125
		75	85				160	E 1700/1.8 x 160
			125				200	E 1700/1.8 x 200
0.3	3	35	45	6	3	1.9	80	E 1700/1.9 x 80
		50	50				100	E 1700/1.9 x 100
			75				125	E 1700/1.9 x 125
		75	85				160	E 1700/1.9 x 160
			125				200	E 1700/1.9 x 200
0.3	3	35	45	6	3	2	80	E 1700/2 x 80
		50	50				100	E 1700/2 x 100
			75				125	E 1700/2 x 125
		75	85				160	E 1700/2 x 160
			125				200	E 1700/2 x 200
		100	150				250	E 1700/2 x 250
		125	150				275	E 1700/2 x 275
		160	155				315	E 1700/2 x 315
0.3	3	35	45	6	3	2.2	80	E 1700/2.2 x 80
		50	50				100	E 1700/2.2 x 100
			75				125	E 1700/2.2 x 125
		75	85				160	E 1700/2.2 x 160
			125				200	E 1700/2.2 x 200
0.3	3	50	50	6	3	2.5	100	E 1700/2.5 x 100
			75				125	E 1700/2.5 x 125
		75	85				160	E 1700/2.5 x 160
			125				200	E 1700/2.5 x 200
		100	150				250	E 1700/2.5 x 250
		125	150				275	E 1700/2.5 x 275
		160	155				315	E 1700/2.5 x 315

7.2.5. –Sprue bush

E 1610

**Angussdüse 1°
mit Radius 40**

Sprue bush 1° with radius 40



Mat.: 1.2826 ▬54 HRC

b	l2	l3	d3	d4	d1	l1	d2	Nr. /No.
11	1.5	13	28	3.7	12	22	2.5	E 1610/12 x 22/2.5
				3.9		27		E 1610/12 x 27/2.5
				4.2		36		E 1610/12 x 36/2.5
				4.6		46		E 1610/12 x 46/2.5
				4.9		56		E 1610/12 x 56/2.5
				4.2		22	3	E 1610/12 x 22/3
				4.4		27		E 1610/12 x 27/3
				4.7		36		E 1610/12 x 36/3
				5.1		46		E 1610/12 x 46/3
				5.4		56		E 1610/12 x 56/3
				5.8		66		E 1610/12 x 66/3
				4.7		22	3.5	E 1610/12 x 22/3.5
				4.9		27		E 1610/12 x 27/3.5
				5.2		36		E 1610/12 x 36/3.5
				5.6		46		E 1610/12 x 46/3.5
				5.9		56		E 1610/12 x 56/3.5
15	3.0	18	38	4.4	18	27	3	E 1610/18 x 27/3
				4.7		36		E 1610/18 x 36/3
				5.1		46		E 1610/18 x 46/3
				5.4		56		E 1610/18 x 56/3
				5.8		66		E 1610/18 x 66/3
				6.3		76		E 1610/18 x 76/3
				6.7		86		E 1610/18 x 86/3
				7.0		96		E 1610/18 x 96/3
				7.7		116		E 1610/18 x 116/3
				5.4		27	4	E 1610/18 x 27/4
				5.7		36		E 1610/18 x 36/4
				6.1		46		E 1610/18 x 46/4
				6.4		56		E 1610/18 x 56/4
				6.8		66		E 1610/18 x 66/4
				7.3		76		E 1610/18 x 76/4
				7.7		86		E 1610/18 x 86/4
				8.0		96		E 1610/18 x 96/4
				8.7		116		E 1610/18 x 116/4
20	3.0	23	48	7.1	24	46	5	E 1610/24 x 46/5
				7.4		56		E 1610/24 x 56/5
				7.8		66		E 1610/24 x 66/5
				8.3		76		E 1610/24 x 76/5
				8.7		86		E 1610/24 x 86/5
				9.0		96		E 1610/24 x 96/5
				9.7		116		E 1610/24 x 116/5
				10.4		136		E 1610/24 x 136/5

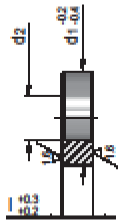
7.2.6. - Spacer disk

meusburger.com

E 1312

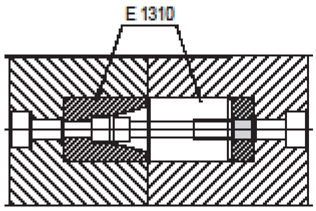
Distanzscheibe für Zentriereinheit

Spacer disk for centering unit



Mat.: 1.7131 ~800 N/mm²

d_2	d_1	l	Nr. /No.
4.5	10	3	E 1312/10 x 3
4.5	12	3	E 1312/12 x 3
		9	E 1312/12 x 9
5.5	14	3	E 1312/14 x 3
		9	E 1312/14 x 9
5.5	16	3	E 1312/16 x 3
		9	E 1312/16 x 9
8.5	20	3	E 1312/20 x 3
		9	E 1312/20 x 9
8.5	26	3	E 1312/26 x 3
		9	E 1312/26 x 9
11.0	30	4	E 1312/30 x 4
		10	E 1312/30 x 10
11.0	42	4	E 1312/42 x 4
		10	E 1312/42 x 10



7.3. - Coolant

REGLOPLAS

Datos técnicos		90smart	90S	90XL	150smart	150S	150	
Temperatura de salida máx.	°C	90	90	90	150	150**	90	150***
Fluido Volumen de llenado Volumen de expansión máx.	 l l	Agua 6,5 3,2	Agua 6,0 3,4	Agua 36,5 5,5	Aceite 12,0 4	Aceite 12,0 4	Agua 17,6 6	Aceite 17,6 6
Pot. de calentamiento a 400 V	kW	9	6; 9	20; 40; 60	6	6	12; 18	12
Potencia de enfriamiento a la temperatura de salida Número de refrigeradores (K) Curva característica (fig.)	kW °C	24 90 1 1	38 80 1 1	160 80 DK 3	28 140 1 5	28 140 1 5	50 | 70 80 | 40 1 | 2 1	58 | 70 140 | 60 1 | 2 5
Capacidad de la bomba/Tipo Caudal máx. Presión máx. Potencia absorbida Curva característica (fig.)	 l/min bar kW	TP20 60 3,8 0,5 2	TP20 TS22 60 70 3,8 5,4 0,5 1,1 2	IMZ-G 240 4,6 2,2 4	TP20 60 3,8 0,5 2	TP20 TS22 60 70 3,8 5,4 0,5 1,1 2	TP20 60 3,8 0,5 2	TS22 70 5,4 1,1 2
Regulación Principio de medición (estándar)		RT60 Pt100	RT32 RT50 Pt100	RT32* RT50 Pt100	RT60 Pt100	RT32* RT50 Pt100	RT32 RT50 Pt100	
Tensión de servicio (estándar)	V/Hz	400/50, 3 FT	400/50, 3 FT	400/50, 3 FT	400/50, 3 FT	400/50, 3 FT	400/50, 3 FT	
Conexiones Salida/retorno Red de agua de enfriamiento		 G ½" G ⅜"	 G ½" G ½"	 G 1½" IG G ¾"	 G ½" G ⅜"	 G ½" G ½"	 M 26 x 1,5 G ½"	
Dimensiones An/Al/P	mm	220/568/610	220/552/670	422/1352/1370	230/615/705	200/648/700	346/690/728	
Peso aprox.	kg	32	44	229	41	50	78	
Color Gris	RAL	9006/7016					7035/7024	
Temperatura ambiente máx.	°C	40						
Nivel de contam. acústica	dB (A)	<70						
Observaciones		* 90XL sólo con potencia de calentamiento 20 kW. 150S sólo con bomba TS22. ** Opcional hasta 180 °C; sólo con bomba TS22H. *** Opcional hasta 200 °C; sólo con bomba TS22H.				G: Rosca cilíndrica IG: Rosca interior DK: Enfriamiento directo		

Potencia de enfriamiento *P* en función de la temperatura de salida *ϑ*.

Datos del agua para el enfriamiento:
Temperatura de entrada +20 °C/15 °C 90smart.
Caudal 10 l/min: 90S; 150smart; 150S.
20 l/min: 90smart; 150.
36 l/min: 90XL.

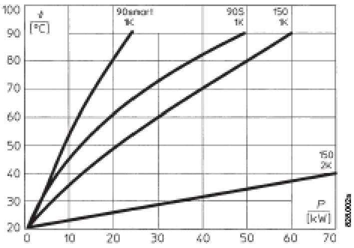


Fig. 1: Fluido agua 90smart; 90S; 150

Capacidad de la bomba. Caudal *V* en función de la presión *p*.

Bypass no incluido.

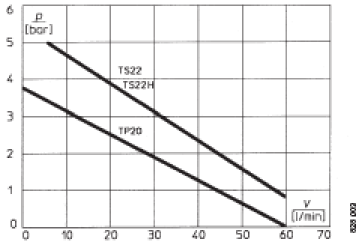


Fig. 2: 90smart; 90S; 150smart; 150S; 150

6

7.4. –Injection machine

babyplast

The ideal machine for the production of micro parts

Suitable for all types of *thermoplastic materials* up to 420° (PEEK), metals (MIM), ceramic (CIM), wax.

Micro-injection moulding machine 6/10P

Maximum performance minimum space

The smallest but greatest

Babyplast 6/10P is one of the smallest, fully hydraulic, injection moulding machines.
Thanks to the unique concept of the machine platens which act as mould bolsters, the cost and dimensions of the moulds are reduced considerably.
Babyplast 6/10P occupies less than 0,6m² of floor space and is extremely quiet (< 68dB)

Precision

Babyplast 6/10P Guarantees the highest precision thanks to the injection piston and pre-plastification of the material.
To obtain the optimum volume of material, there are 5 interchangeable pistons available.
It is also possible to move the injection unit off centre.

User friendly

- Touch screen colour display.
- Easy to consult pages and user friendly display
- Handles and stores over 100 tool settings
- Back-up on USB memory drive
- Record of last 20 cycles
- Ethernet connections: modbus TCP

Standard mould parts

Rotating table for 2 shot applications

Fixed platen

The difference between Babyplast (left) conventional (right)

Applications:

- Production of small precision parts
- Long and short production runs
- Laboratory tests / sample production
- Prototyping
- Medical products / clean room applications
- Technical training

Machine with accessories

- Bench
- Chiller
- Drier
- De-humidifier
- Temperature controller max. 90°C.
- Sprue separator

Foot print of only 0,7 mq.

Included:

- Quality control (Cycle time/cushion/injection time/injection pressure)
- Automatic shut down in case of alarm
- De-compression
- Two injection pressures
- Possibility for off centre injection
- Temperature tolerance band
- PID temperature control
- Stand-by temperature
- Speed control on all movements
- Mould safety
- 2 clamp speeds
- Central ejector with up to 9 strokes
- Speed and pressure control on ejector
- Removable tie bars
- Ejector return sensor
- Easy to consult pages and user friendly display
- Multi-lingual
- Handles and stores over 100 tool settings
- Part counter – settings for production batches
- Integrated 4 zone cooling water manifold
- USB socket
- Intrusion programme
- Hour meter
- Sprue break
- Injection and clamp positions monitored via transducers
- Electronic transducer for pressure control
- Inverter for motor speed control
- Colour touch screen display.
- 4th zone for mould temperature control
- Machine platens act as bolsters to reduce costs and time for mould construction
- Outputs for core pull

Optional:

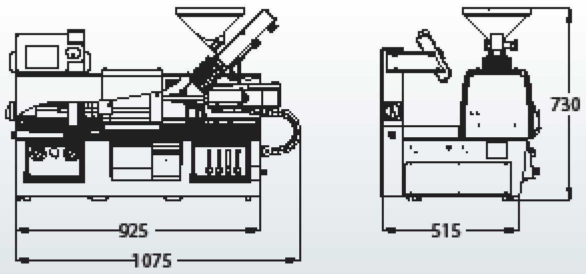
- Mixer nozzle (static mixer)
- Euromap 67
- Accumulator for injection speed.
- Shut off nozzle
- Nozzle with tip for injecting directly into part.
- 5th mould heater zone
- Hydraulic or pneumatic core pull
- Ethernet modbus
- Interface for second injection unit for 2 shot applications
- LSR injection unit
- Rotating table
- Air blow
- Cooling ring for moving platen
- Special spec. For high temperature materials
- Hot runners

Accessories:

- Bench with space for chiller
- Drier
- Loader for plastic materials (electric or Venturi)
- Temperature controller for moulds
- Sprue separator
- Electrical cabinet for accessories
- Set of drawers for moulds
- Reject part separator
- Sprue picker

The difference:

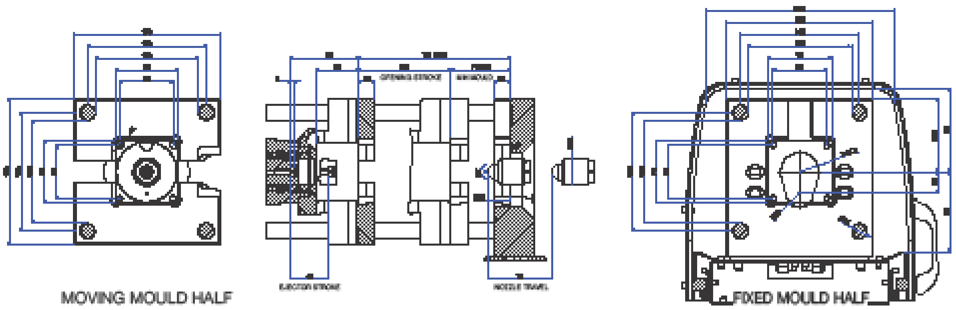
babyplast



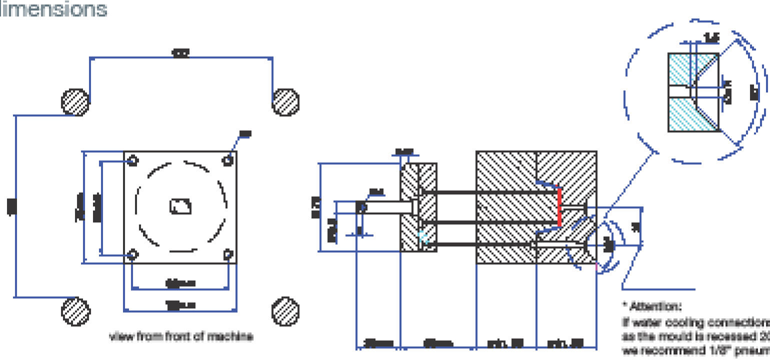
Micro-injection moulding machine 6/10P

technical data

Dimensions of machine platens



Mould dimensions



* Attention:
If water cooling connections are needed, seeing as the mould is recessed 20mm in the platen, we recommend 1/8" pneumatic quick release connections.

Piston diameter (mm):	10	12	14	16	18
Injection volume (cm3):	4	6,5	9	12	15
Injection pressure (bar):	2035	1650	1340	1030	815
Clamping force:	62 kN				
Opening stroke:	110 mm				
Ejector force:	7,5 kN				
Ejector stroke:	50 mm				
Oil tank capacity:	15 L				
Power consumption:	3 kW				

Weight:	150 kg
Min. Mould dimensions:	75 x 75 x 70 mm
Alimentation: 3~400V 50/60Hz + Neutral + earth	
3~230V 50/60Hz + earth	
1~230V 50/60Hz + earth	
Hydraulic pressure:	130 bar
Dry cycle:	2.4 sec
Noise level:	<70 db

Drawings are not to scale

updated 9/02/2015

We reserve the right to make modifications at any time

babyplast www.babyplast.com *International distributor:* RAMBALDI + Co I.T. Srl | Via Rossini, 7 | 23847 Molteno | (Lecco) Italy
Tel. 0039 031 3574961 | Fax 0039 031 3574982 | info@babyplast.com | Manufacturer: Cronoplast Sl

7.4. –Drawing

7.5.1. – Gear

7.5.2. –Assembly

7.35.3. –Explode

7.5.4. –Clamping plate

7.5.5. –Cavity plate

7.5.6. –Core plate

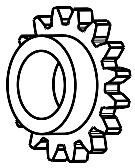
7.5.7. –Core support plate

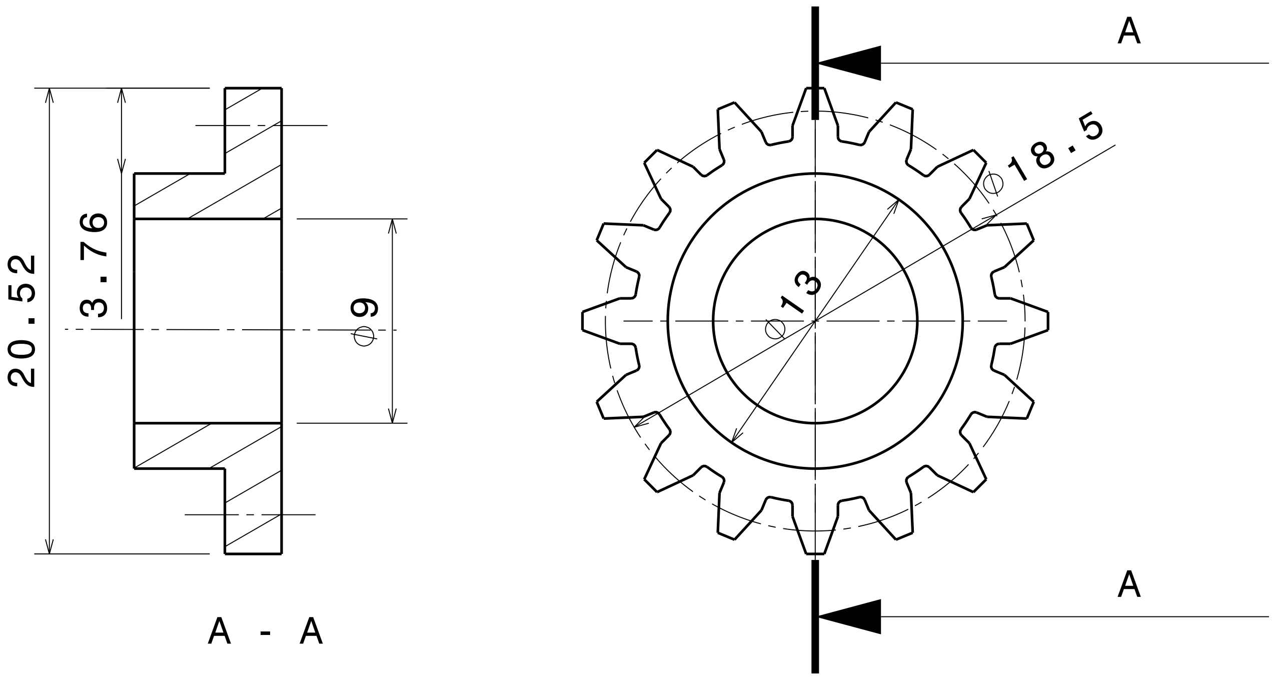
7.5.8. –Ejector plate A

7.5.9. –Ejector plate B

7.5.10. –Setting plate

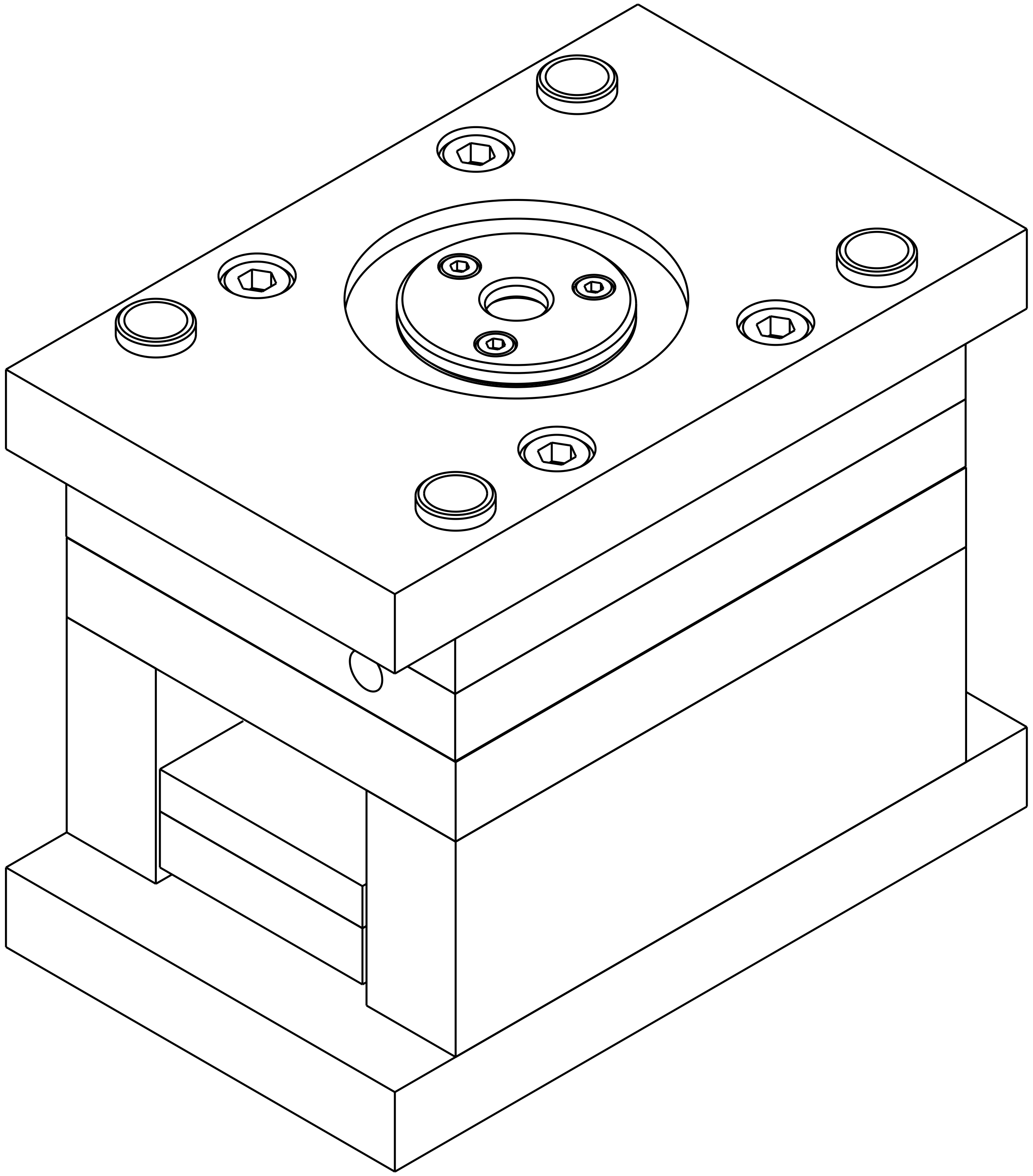
7.5.11. –Locator ring

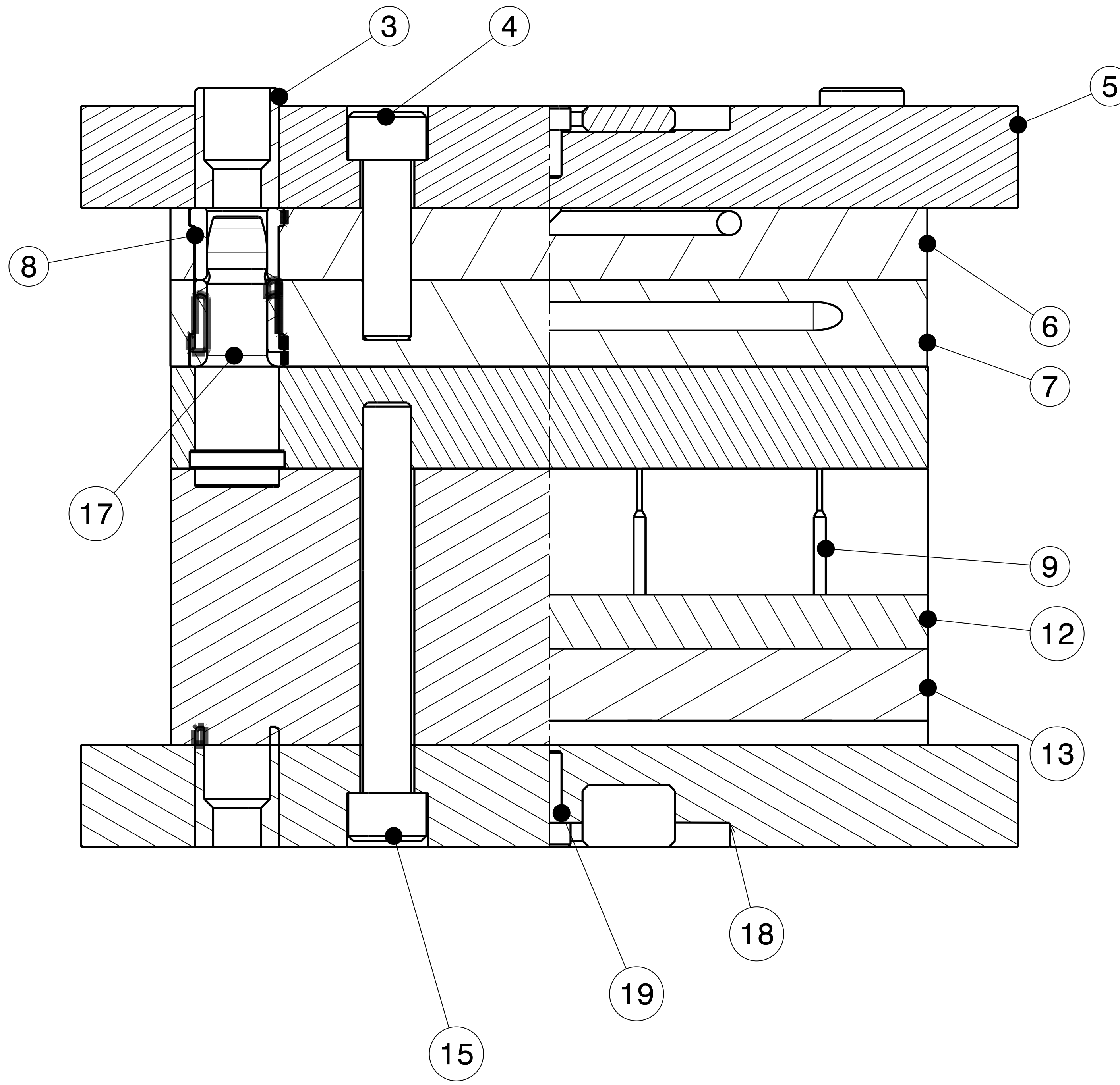




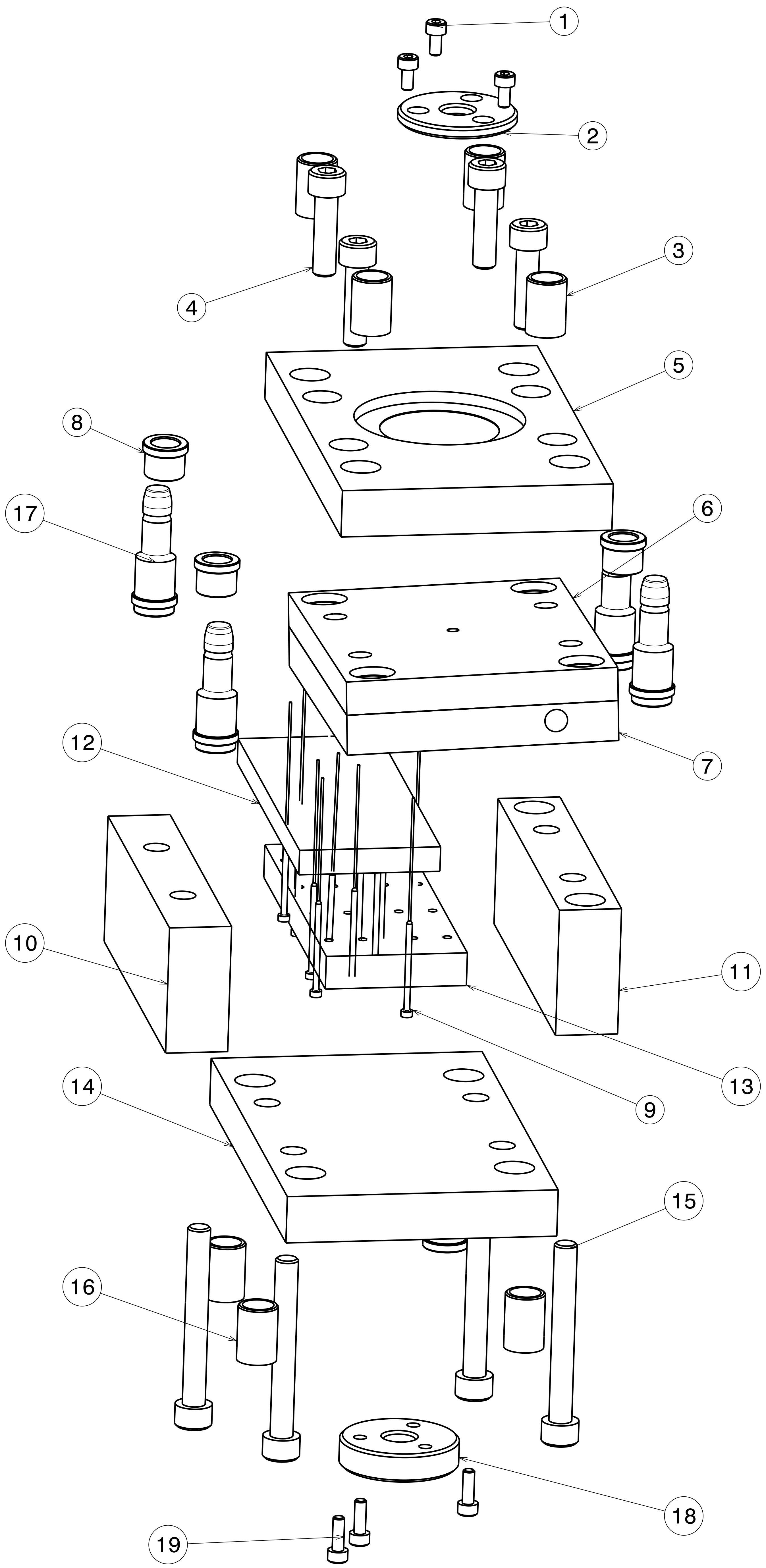
TECHNICAL UNIVERSITY "GHEORGHE ASACHI"

DRAWN BY SAMUEL BRAGADO	DATE 02/06/2017	DRAWING TITLE	GEAR
CHECKED BY FLORIN NEGOESCU	DATE 05/06/2017	SIZE A4	DRAWING NUMBER 1	REV X
DESIGNED BY SAMUEL BRAGADO	DATE 02/06/2017	SCALE 3:1	MATERIAL ABS	SHEET 1/1





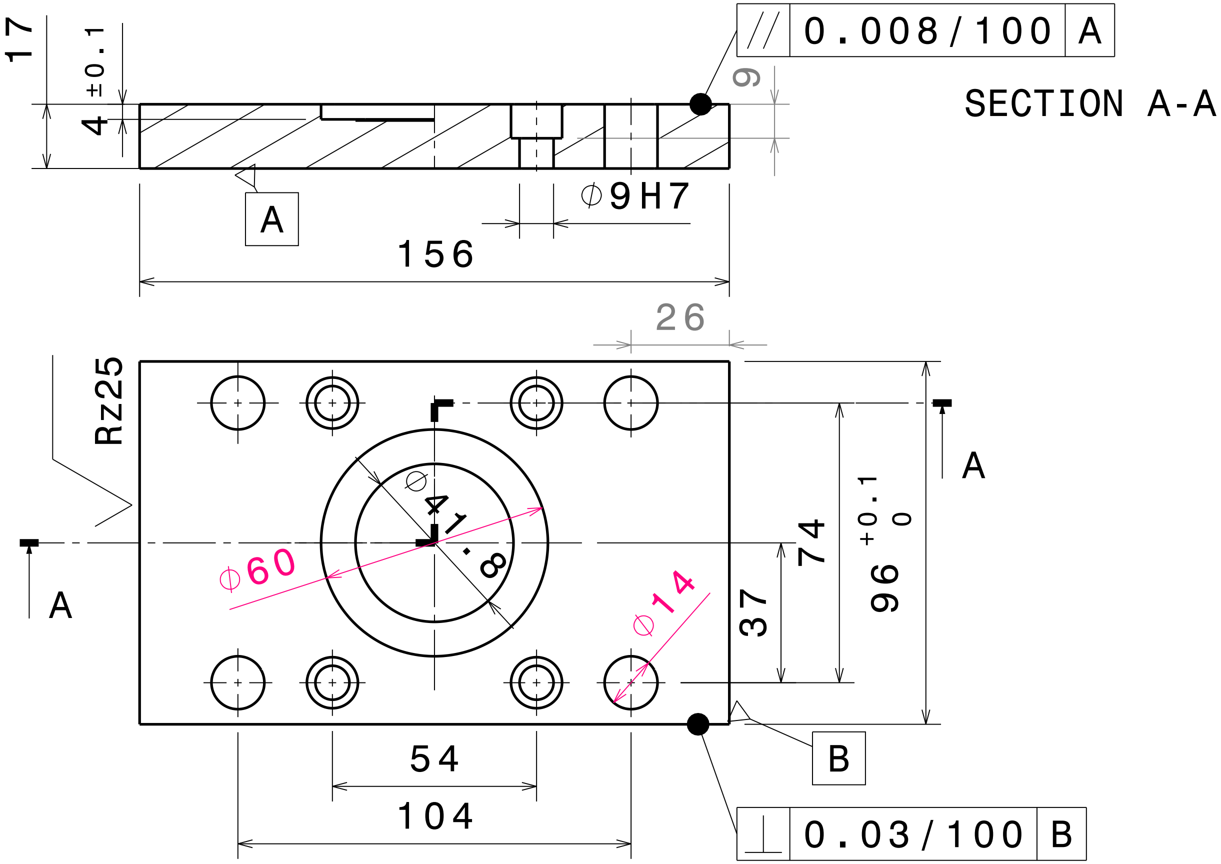
DRAWN BY SAMUEL BRAGADO	DATE 02/06/2017	TECHNICAL UNIVERSITY "GHEORGHE ASACHI"			
CHECKED BY FLORIN NEGURESCU	DATE 05/06/2017	DRAWING TITLE	ASSEMBLY		
DESIGNED BY SAMUEL BRAGADO	DATE 02/06/2017	SIZE A3	DRAWING NUMBER 2	REV	
		SCALE 1:1	MATERIAL		SHEET 1/1

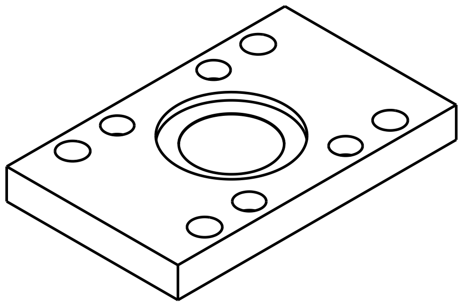


Number	Name	Quantity	Nomenclature	Material
1	Cap screw	3	E 1200/4x8	DIN 912
2	Locator ring	1	E 1312/42x4	1.7131
3	Cavity Bushing	4	E1160/ 14x20	1.7131
4	Cap screw clamping	4	E1200/ 8x30	DIN 912
5	ClampingPlate	1	F20/96 126/17/1730	1.1730
6	CavityPlate	1	F50/96 126/12/1730	1.1730
7	Core plate	1	F50/96 126/12/1730	1.1730
8	Cavity bushing	4	E1160/ 14x20	1.1731
9	Ejector pin	4	E1700/ 0.8x80	1.2516
10	Rise A	1	F70/96 126/22/46	1.1730
11	Rise B	1	F70/96 126/22/46	1.1730
12	Ejector plate A	1	F85/96 126/50/9	1.1730
13	Ejector plate B	1	F85/96 126/50/12	1.1730
14	Setting plate	1	F20/96 126/17/1730	1.1730
15	Cap screw	4	E1200/ 8x65	DIN 912
16	Centering bush	4	E1160/ 14x20	1.7131
17	Guide pillar	4	E1000/10 - 17/25	1.1731
18	Spacer disc	1	E1312/ 42x4	1.1731
19	Cap screw	3	E1200/ 4x12	DIN 912

TECHNICAL UNIVERSITY
"GHEORHE ASACHI"

DRAWN BY Samuel Bragado Cuesta	DATE 2/06/2017	DRAWING TITLE	ASSEMBLY
CHECKED BY Florin Negurecu	DATE 5/06/2017	SIZE A2	DRAWING NUMBER 2 / REV X
DESIGNED BY Samuel Bragado Cuesta	DATE 2/06/2017	SCALE 2:3	MATERIAL / SHEET 1/1

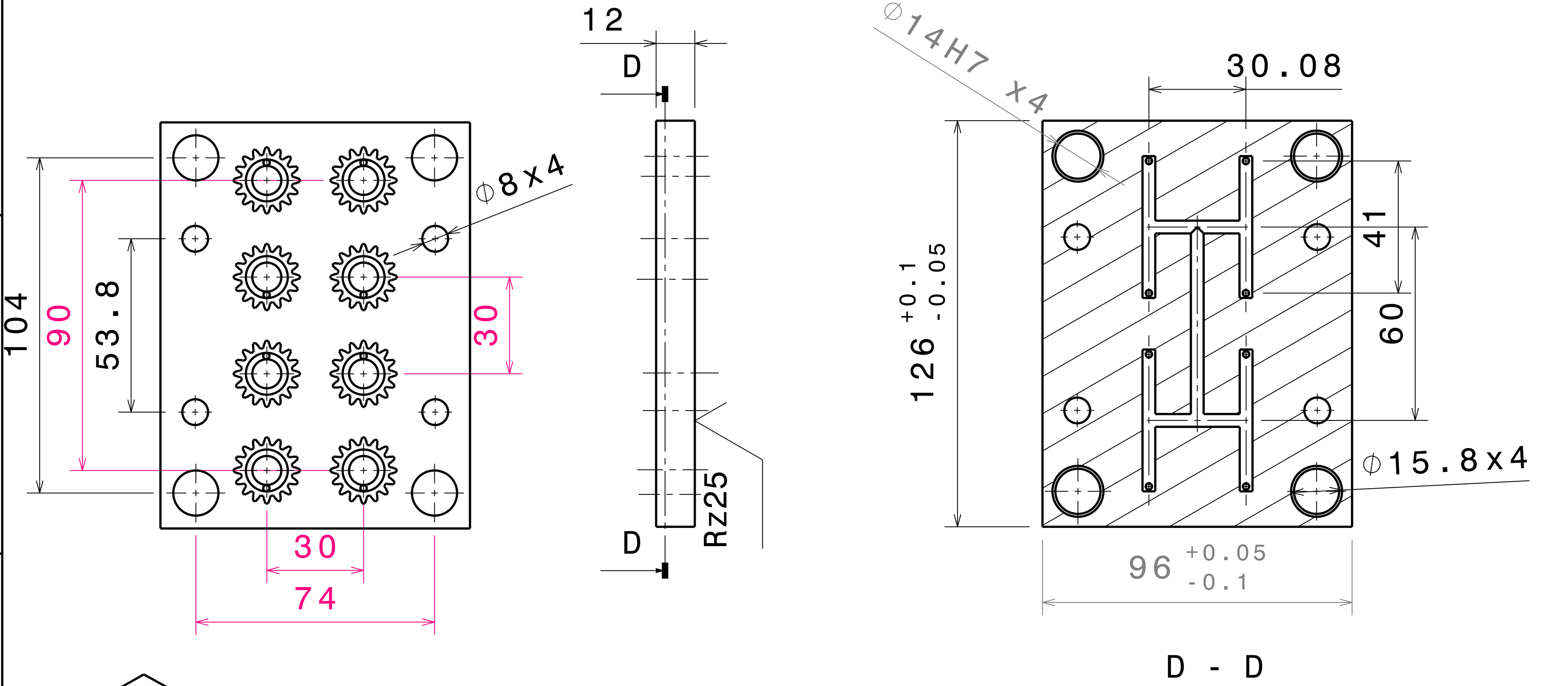


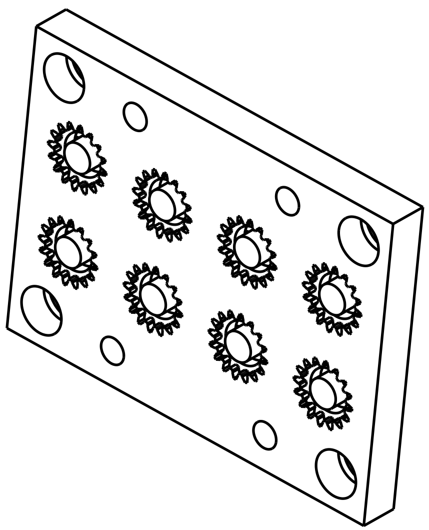


SCALE 1:1

TECHNICAL UNIVERSITY "GHEORGHE ASACHI"

DRAWN BY: SAMUEL BRAGADO	DATE: 02/06/2017	DRAWING TITLE	CLAMPING PLATE
CHECKED BY: FLORIN NEGURESCU	DATE: 05/06/2017	SIZE: A4	DRAWING NUMBER: 4 / REV: X
DESIGNED BY: SAMUEL BRAGADO	DATE: 02/06/2017	SCALE: 1:2	MATERIAL: 1.1730 / SHEET: 1/1

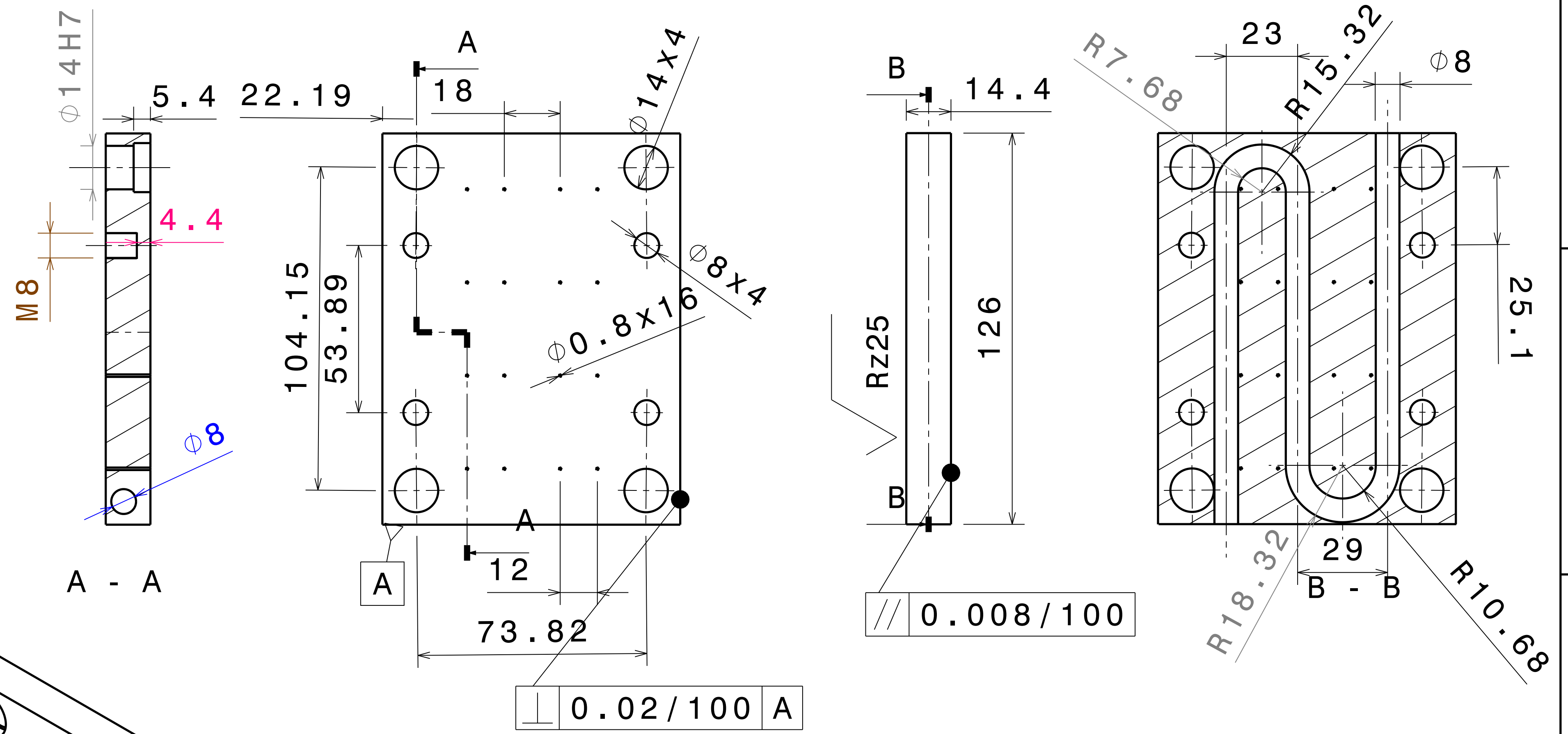


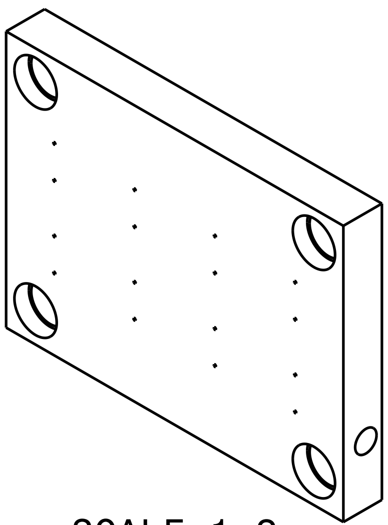


SCALE 1:2

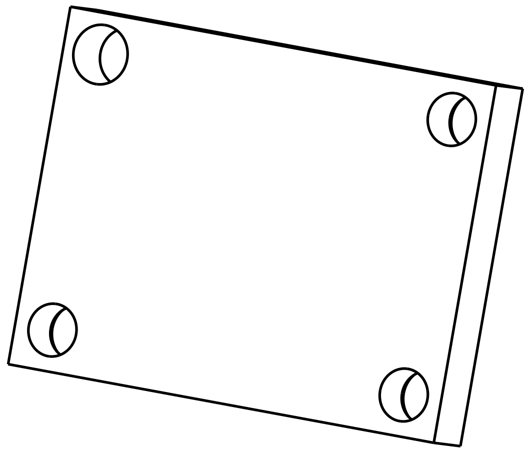
TECHNICAL UNIVERSITY "GHEORGHE ASACHI"

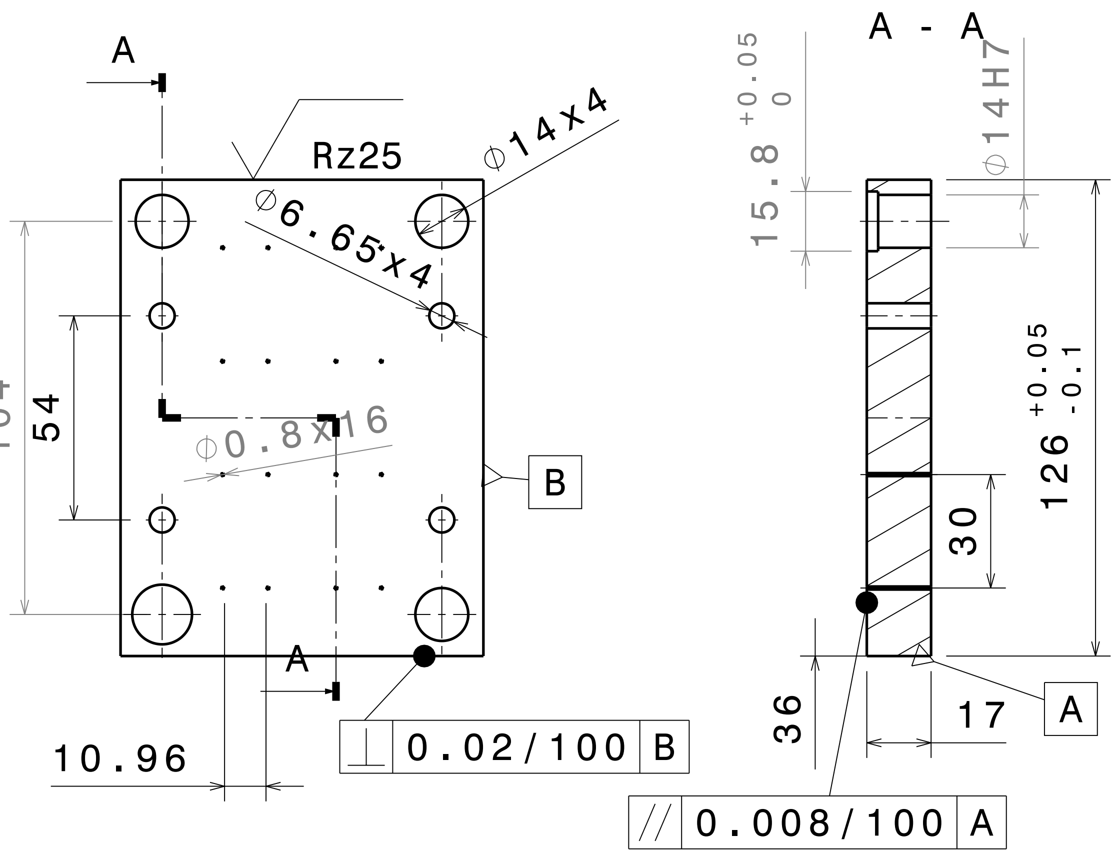
DRAWN BY	DATE	DRAWING TITLE	CAVITY PLATE
SAMUEL BRAGADO	02/06/2017		
CHECKED BY	DATE	SIZE	DRAWING NUMBER
FLORIN NEGURESCU	05/06/2017	A4	5
DESIGNED BY	DATE	SCALE 1:2	MATERIAL 1.2085
SAMUEL BRAGADO	02/06/2017	REV X	SHEET 1/1





		TECHNICAL UNIVERSITY "GHEORGHE ASACHI"
DRAWN BY SAMUEL BRAGADO	DATE 02/06/2017	DRAWING TITLE CORE PLATE
CHECKED BY FLORIN NEGURESCU	DATE 05/06/2017	SIZE A4 / DRAWING NUMBER 6 / REV X
DESIGNED BY SAMUEL BRAGADO	DATE 02/06/2017	SCALE 1:2 / MATERIAL 1.2085 / SHEET 1/1





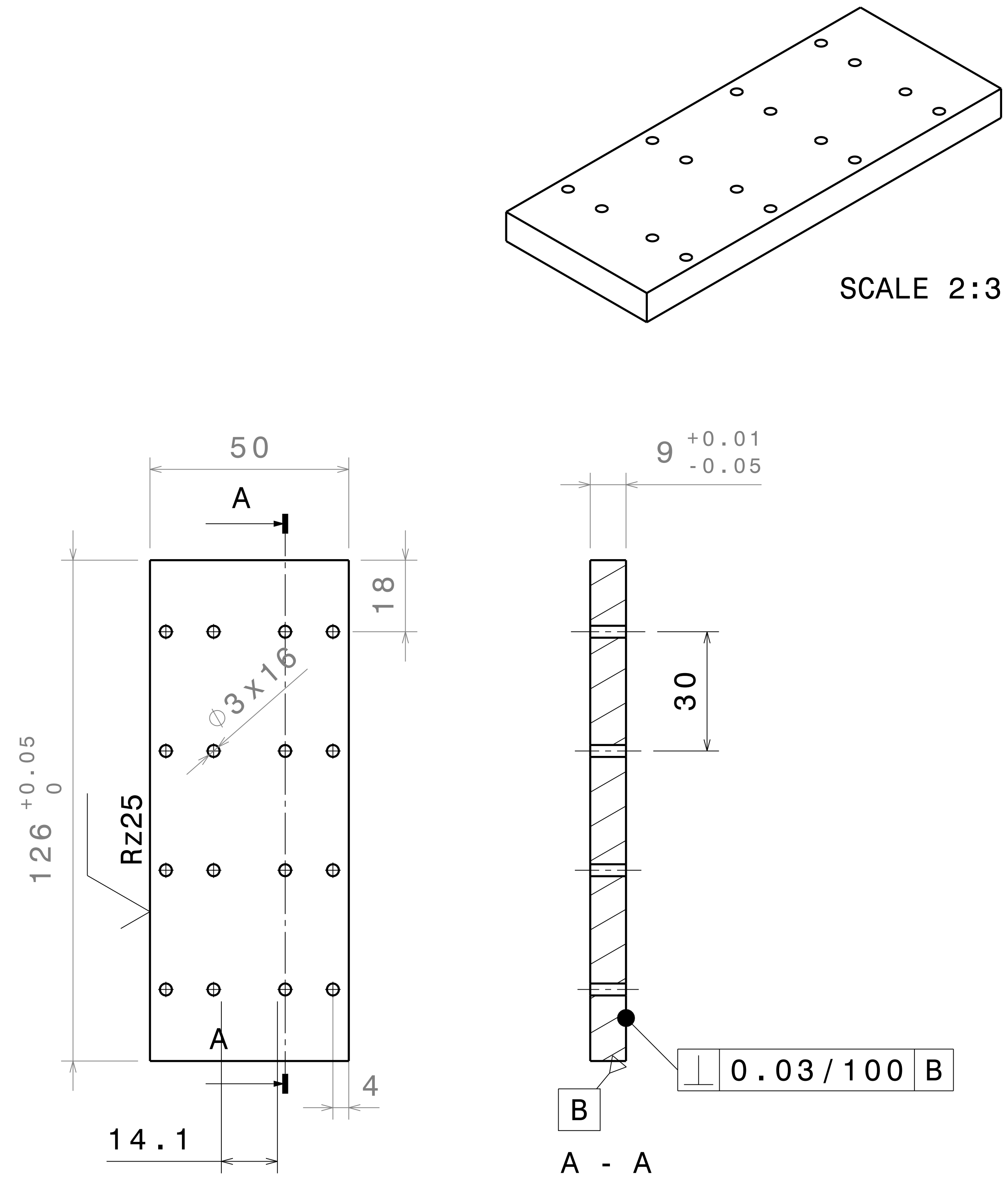
TECHNICAL UNIVERSITY "GEORGE ASACHI"

DRAWN BY	SAMUEL BRAGADO	DATE	02/06/2017
CHECKED BY	FLORIN NEGOESCU	DATE	05/06/2017
DESIGNED BY	SAMUEL BRAGADO	DATE	02/06/2017

DRAWING TITLE: CORE SUPPORT PLATE

SIZE	DRAWING NUMBER	REV
A4	7	X

SCALE	MATERIAL	SHEET
1:1	1.2085	1/1



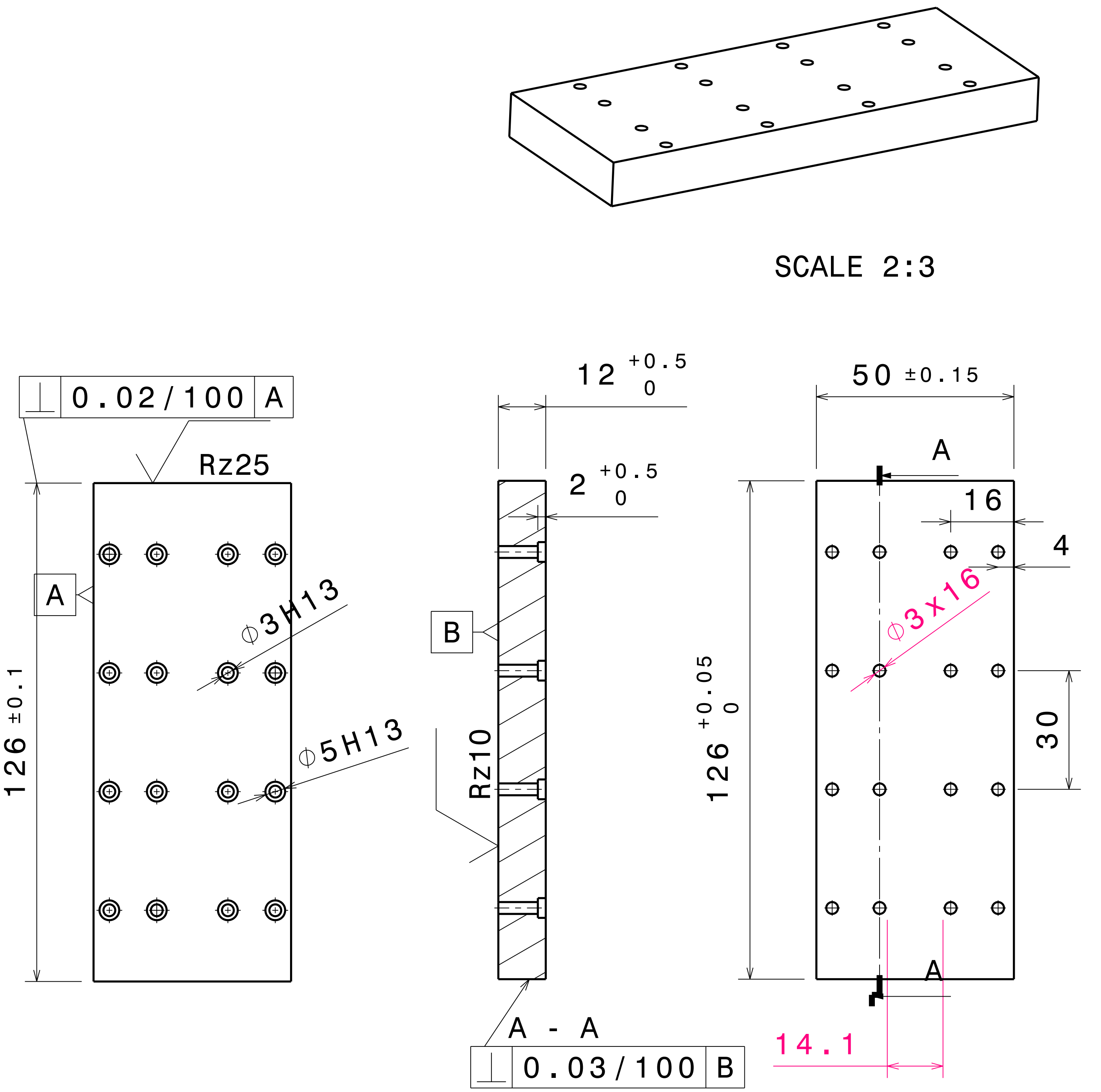
TECHNICAL UNIVERSITY "GHEORGHE ASACHI"

DRAWN BY: SAMUEL BRAGADO	DATE: 02/06/2017
CHECKED BY: FLORIN NEGOESCU	DATE: 05/06/2017
DESIGNED BY: SAMUEL BRAGADO	DATE: 02/06/2017

DRAWING TITLE: EJECTOR PLATE A

SIZE	DRAWING NUMBER	REV
A4	8	X

SCALE	MATERIAL	SHEET
2:3	1.1730	1/1



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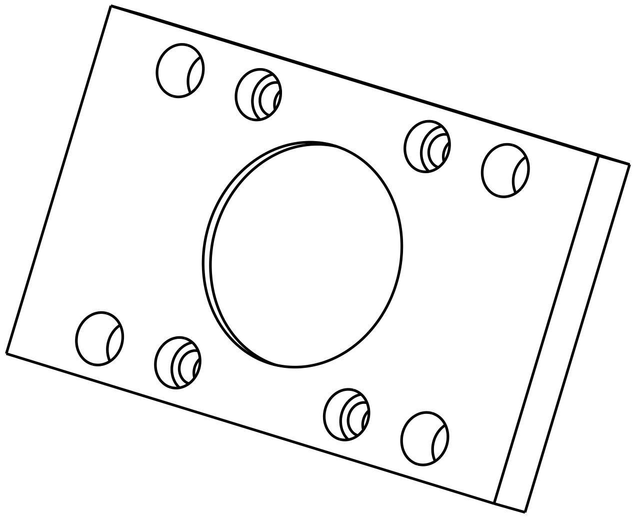
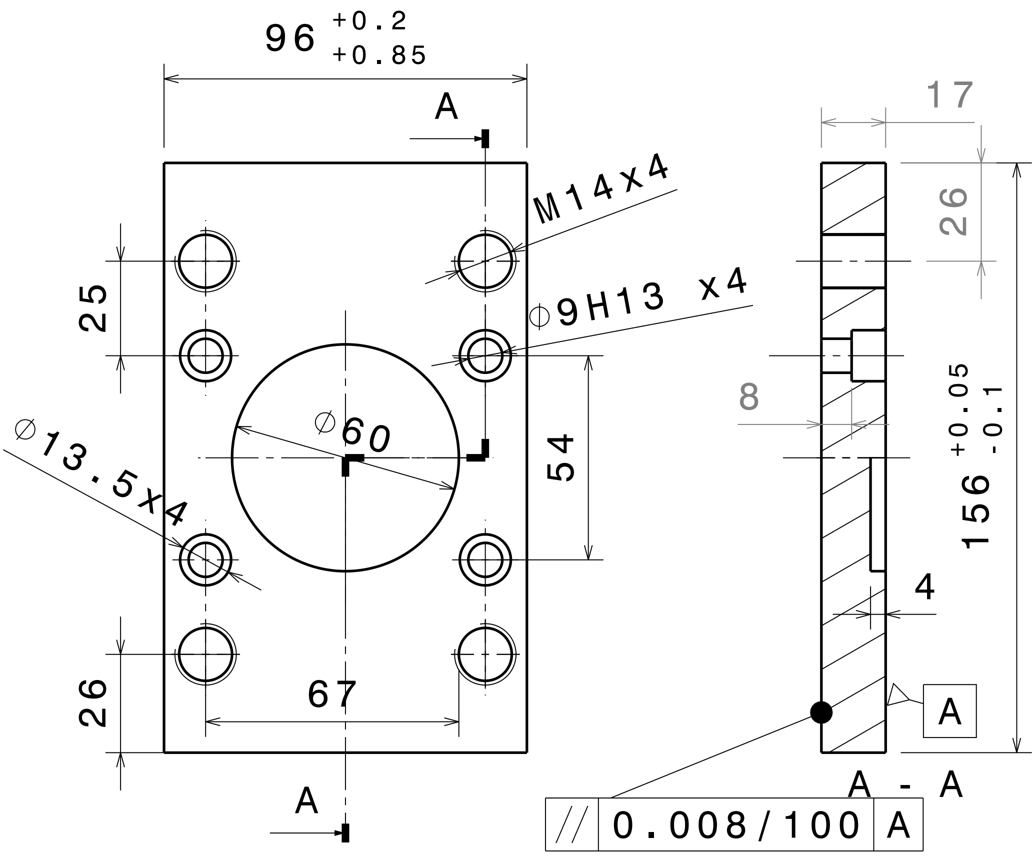
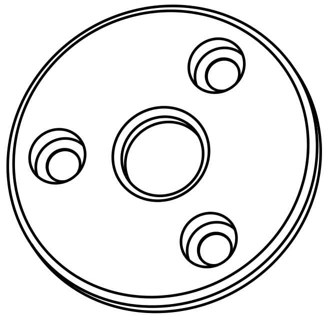
DRAWN BY SAMUEL BRAGADO	DATE 02/06/2017	DRAWING TITLE EJECTOR PLATE B			
CHECKED BY FLORIN NEGOESCU	DATE 05/06/2017	SIZE A4	DRAWING NUMBER 9		REV X
DESIGNED BY SAMUEL BRAGADO	DATE 02/06/2017	SCALE 2:3	MATERIAL 1.1730		SHEET 1/1



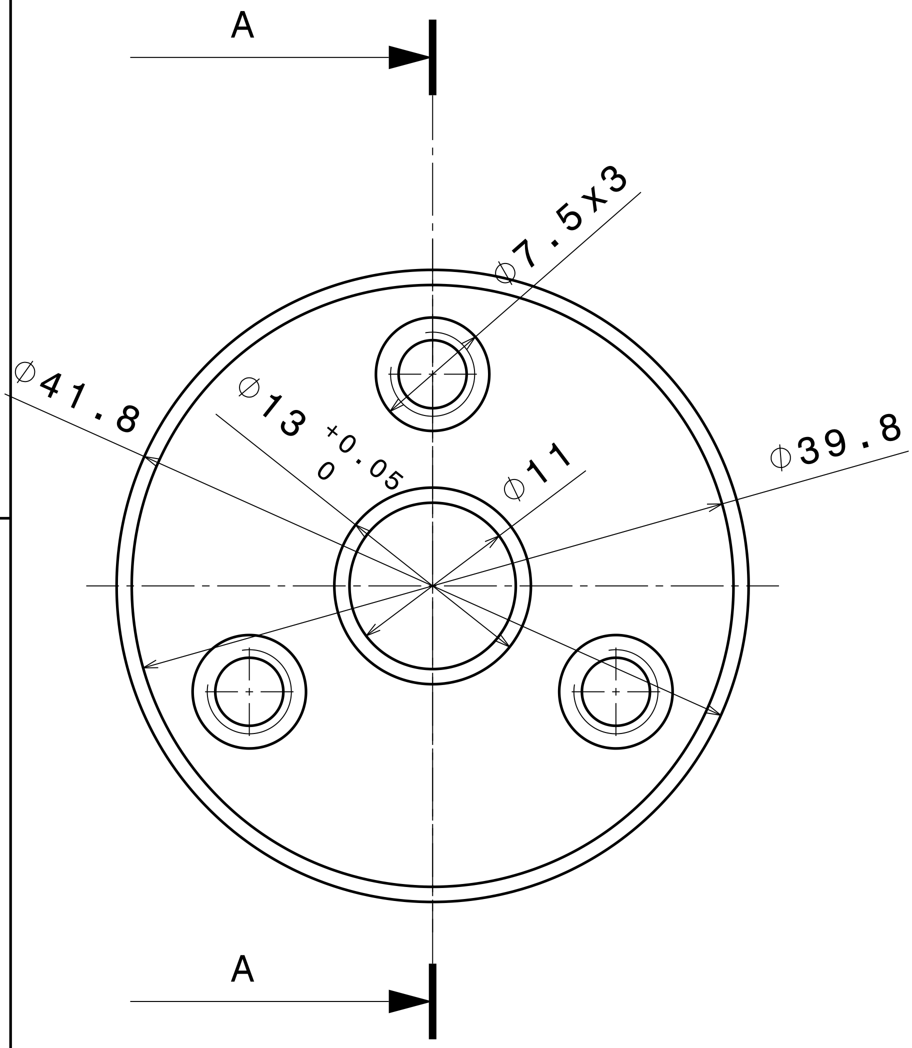
SCALE 1:2

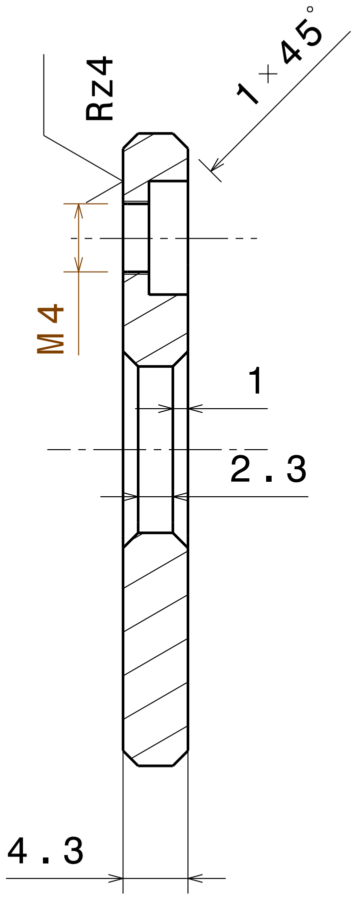


DRAWN BY: SAMUEL BRAGADO	DATE: 02/06/2017	TECHNICAL UNIVERSITY "GHEORGHE ASACHI"			
CHECKED BY: FLORIN NEGOESCU	DATE: 05/06/2017	DRAWING TITLE: SETTING PLATE			
DESIGNED BY: SAMUEL BRAGADO	DATE: 02/06/2017	SIZE: A4	DRAWING NUMBER: 10	REV: X	
		SCALE 1:2	MATERIAL 1.1730		SHEET 1/1



SCALE 1:1





A - A

TECHNICAL UNIVERSITY "GHEORGHE ASACHI"

DRAWN BY	DATE	DRAWING TITLE	LOCATOR RING
SAMUEL BRAGADO	02/06/2017		
CHECKED BY	DATE	SIZE	DRAWING NUMBER / REV
FLORIN NEGOESCU	05/06/2017	A4	11 / X
DESIGNED BY	DATE	SCALE 2:1	MATERIAL 1.1730 / SHEET 1/1
SAMUEL BRAGADO	02/06/2017		