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Ministry of Higher Education and Scientific Research
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Project:

Study the Extrusion Process of Two Recycled Materials to Obtain a Materials with Good Properties

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بسم الله الرحمن الرحيم

يرفع الله الذين آمنوا منكم والذين أوتوا العلم درجات

صدق الله العظيم

الشكر و التقدير

لابد لنا ونحن نخطو خطواتنا الاخيرة في الحياة الجامعية من وقفة نعود إلى أعوام قضيناها في رحاب الجامعة مع أساتذتنا الكرام الذين قدموا لنا الكثير باذلين بذلك جهودا كبيرة في بناء جيل الغد لتبعث الامة من جديد ...

وقبل أن نمضي نتقدم بأسمى آيات الشكر والامتنان والتقدير والمحبة إلى الذين حملوا أقدس رسالة في الحياة...

إلى الذين مهدوا لنا طريق العلم والمعرفة ... إلى جميع أساتذتنا الأفاضل ....

الاهداء

هداء الى:

إلى صاحب السيرة العطرة، والفكر المُستنير؛
فلقد كان له الفضل الأوَّل في بلوغي التعليم العالي
(والدي الحبيب)، اطال الله بعمره.
إلى من وضعتني على طريق الحياة، وجعلتني رابط الجأش،
وراعتني حتى صرت كبيرًا
(أمي الغالية)، أطال الله في عُمرها
إلى إخوتي؛ من كان لهم بالغ الأثر في كثير من العقبات والصعاب.
إلى جميع أساتذتي الكرام؛ ممن لم يتوانوا في مد يد العون لي
أُهدي إليكم بحثي

The aim of project:

Is to study the extrusion process of two recycled materials:

- To know the physical phenomena that occur during extrusion,
- To obtain a material with good properties.

Chapter 1

INTRODUCTION:

Polymer processing may be divided into two broad areas. The first is the processing of the polymer into some form such as pellets or powder. The second type describes the process of converting polymeric materials into useful articles of desired shapes. Our discussion here is restricted to the second method of polymer processing. The choice of a polymer material for a particular application is often difficult given the large number of polymer families and even larger number of individual polymers within each family. However, with a more accurate and complete specification of end-use requirements and material properties the choice becomes relatively easier. The problem is then generally reduced to the selection of a material with all the essential properties in addition to desirable properties and low unit cost, but then there is usually more than one processing technique for producing a desired item from polymeric materials or, indeed, a given polymer. For example, hollow polymer articles like bottles or toys can be fabricated from a number of materials by blow molding, thermoforming, and rotational molding. The choice of a particular processing technique is determined by part design, choice of material, production requirements, and, ultimately, cost - performance considerations. The number of polymer processing techniques increases with each passing year as newer methods are invented and older ones modified. This chapter is limited to the most common polymer processing unit operations, but only extrusion and injection molding, the two predominant polymer-processing methods, are treated in fairly great detail. Our discussion is restricted to general process descriptions only, with emphasis on the relation between process operating conditions and final product quality. Polymer processing there are many processes for polymers [1].

Selection of a process depends on many factors including:

- Quantity and production rate,

- Dimensional accuracy and surface finish,

- Form and detail of the product,

- Nature of material - Size of final product In general.

Polymers processes have three phases:

1. Heating - To soften or melt the polymer,

2. Shaping\ Forming - Under constraint of some kind,

3. Cooling - So that it retains its shape Thermoplastics start as regular pellets or granules and can be remelted. Thermosetting materials start as liquids\ syrups, often called " resins ", as powders or partially cured products " preforms " which need heat for the shaping phase . The shaping is accompanied by a chemical reaction, which means that the material does not soften on reheating. The reaction may be exothermic (giving heat out), in which case cooling is required [2].

1. 1. Processes:

1. Thermoforming,

2. Compression and transfer molding,

3. Extrusion

4. Extrusion - based processes,

5. Injection molding,

6. Blow molding,

7. Polymer foam molding.

1. 2. Materials used in the project:

Polypropylene:

Polypropylene (PP) is a thermoplastic material that is produced by polymerizing propylene molecules, which are the monomer units, into very long polymer molecule or chains. There are a number of different ways to link the monomers together, but PP as a commercially used material in its most widely used form is made with catalysts that produce crystallizable polymer chains. These give rise to a product that is a semicrystalline solid with good physical, mechanical, and thermal properties. Another form of PP, produced in much lower volumes as a byproduct of semi-crystalline PP production and having very poor mechanical and thermal properties, is a soft, tacky material used in adhesives, sealants, and caulk products. The above two products are often referred to as ‘‘isotactic’’ (crystallizable) PP (i-PP) and ‘‘atactic’’ (non-crystallizable) PP (a-PP), respectively [3].

1. 3. MECHANICAL PROPERTIES:

The mechanical properties of most interest to the PP product design engineer are its stiffness, strength, and impact resistance. Stiffness is measured as the flexural modulus, determined in a flexural test, and impact resistance by a number of different impact tests, with the historical favorite being the Izod impact at ambient and at sub - ambient temperatures. These mechanical properties are mostly used to predict the properties of molded articles. Strength is usually defined by the stress at the yield point rather than by the strength at break, but breaking strength is usually specified for fiber or film materials under tensile stress.

To understand the use and comparison of mechanical property data, one must remember that mechanical properties are not measured on the resins themselves but instead on specimens fabricated from the resin, and it is from the physics governing the fabrication and mechanical testing procedures that the mechanical properties are derived. Because there are so many variables that can affect mechanical properties, consensus testing organizations like ASTM and ISO were formed to bring some uniformity and consistency to specimen preparation and mechanical testing, because the ASTM and ISO fabrication and testing methods allow some area within their guidelines, when one is asked what the mechanical properties of a material are, the first answer should be to ask by what tests, what specimens, and under what conditions. The latter includes such factors as the exact specimen type, age of specimen, how the specimen was conditioned, testing speed, testing temperature, data acquisition procedure, and method of calculation.

Flexural modulus or stiffness typically increases as the level of crystallinity increases in a PP product, but it also depends on the type of crystal morphology. Thus, stiffness generally decreases as the crystallizability (tacticity) decreases or, in random copolymers, as the ethylene content increases because this tends to decrease crystallizability [4].

Polyethylene:

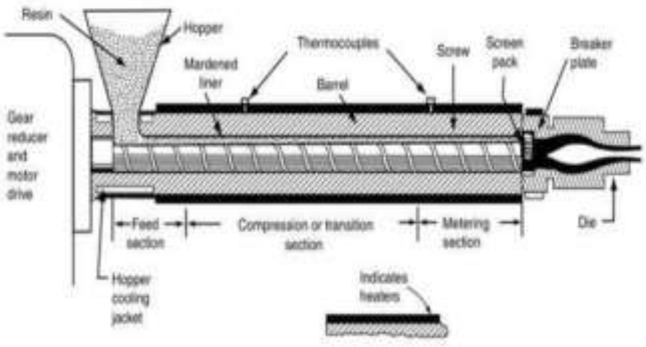
Polyethylene or polythene

PE- polyethene is the most common polymer in use today. It is a polymer, primarily used for packaging (polymer bags, polymer films, geomembranes and containers including bottles, etc.), as of 2017, over 100 million tones of polyethylene resins are being produced annually, accounting for 34% of the total Polymer market. Many kinds of polyethylene are known, with most having the chemical formula $(C_2H_4)_n$. PE is usually a mixture of similar polymers of ethylene, with various values of n. It can be low-density or high-density: low-density polyethylene is extruded [verification needed] using high pressure (1000 - 5000 atm) and high temperature (520 kelvins), while high-density polyethylene is extruded [verification needed] using low pressure (6-7 atm) and low temperature (333-343 K). Polyethylene is usually thermoplastic, but it can be modified to become thermosetting instead, [4].

Mechanical Properties:

Polyethylene is of low strength, hardness and rigidity, but has a high ductility and impact strength as well as low friction. It shows strong creep under persistent force, which can be reduced by addition of short fibers. It feels waxy when touched [5].

Extrusion:



The extrusion process is designed to continuously convert a soft material into a particular form. An oversimplified analogy may be a house-hold meat grinder. However, unlike the extrudate from a meat grinder, polymer extrudates generally approach truly continuous formation. Like the usual meat grinder, the extruder (**Fig.** 1. 1) is essentially a screw conveyor. It carries the cold polymer material

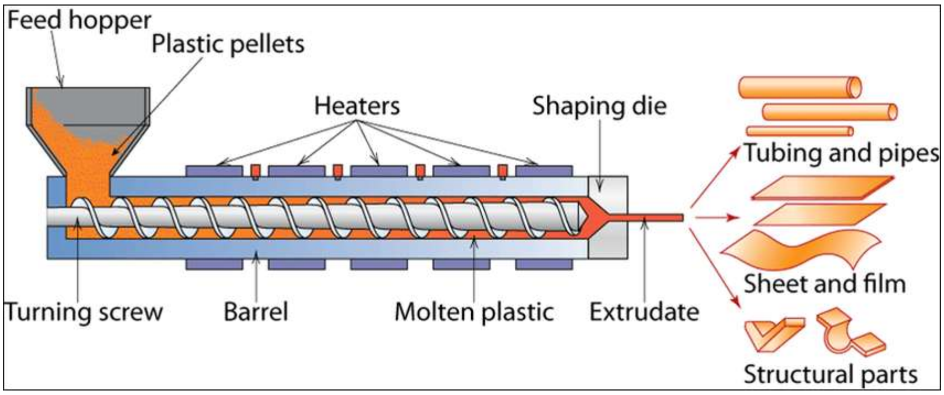


Fig. 1.1 Scheme for a typical single-screw extruder showing extruding pipe [6].

In granular or powdered form, forward by the action of the screw, squeezes it, and, with heat from external heaters and the friction of viscous flow, changes it to a molten stream. As it does this, it develops pressure on the material, which is highest right before the molten polymer enters the die. The screen pack, consisting of a number of fine or coarse mesh gauzes supported on a breaker plate and placed between the screw and the die; filter out dirt and unfused polymer lumps. The pressure on the molten polymer forces it through an adapter and into the die, which dictates the shape of the fine extrudate, a die with a round opening as shown in F**ig.** 1. 1, produces pipe; a square die opening produces a square profile, etc. Other continuous shapes, such as the film, sheet, rods, tubing, and filaments, can be produced with appropriate dies. Extruders are also used to apply insulation and jacketing to wire and cable and to coat substrates such as paper, cloth, and foil.

When thermoplastic polymers are extruded, it is necessary to cool the extrudate below T_m or T_g to impart dimensional stability. This cooling can often be done simply by running the product through a tank of water, by spraying cold water, or, even more simply, by air cooling. When rubber is extruded, dimensional stability results from cross-linking (vulcanization). Interestingly, rubber extrusion for wire coating was the first application of the screw extruder in polymer processing.

Extruders have several other applications in polymer processing: in the blow-molding process they are used to make hollow objects such as bottles; in the blow-film process they are used for making wide films; they are also used for compounding (i.e., adding various ingredients to a resin mix) and for converting polymer into the pellet shape commonly used in processing. In this last operation specialized equipment, such as the die plate-cutter assembly, is installed in place of the die, and an extrusion-type screw is used to provide plasticated melt for various injection-molding processes [7].

Extruder Design and Operation:

The most important component of any extruder is the screw. It is often impossible to extruder satisfactorily one material by using a screw designed for another material. Therefore screw designs vary with each material.

Typical Screw Construction.

The screw consists of a steel cylinder with a helical channel cut into it (Fig. 1. 2). The helical ridge formed by the machining of the channel is called the flight, and the distance between the flights is called the lead. The lead is usually constant for the length of the screw in single-screw machines. The helix angle is called pitch. Helix angles of the screw are usually chosen to optimize the feeding characteristics. An angle of 17.58 is typical, though it can be varied between 12 and 208. The screw outside diameter is generally just a few thousandths of an inch less than the ID of the barrel. The minimal clearance between screw and barrel ID prevents excessive buildup of resin on the inside barrel wall and thus maximizes heat transfer. The screw may be solid or cored. Coring is used for steam heating or, more often, for water cooling. Coring can be for the entire length of the screw or for a portion of it, depending on the particular application. Full length coring of the screw is used where large amounts of heat are to be removed. The screw is cored only in the initial portions at the hopper end when the objective is to keep the feed zone cooler for resins which tend to soften easily. Screws are often fabricated from 4140 alloy steel, but other materials are also used. The screw flights are usually hardened by flame-hardening techniques or inset with a wear resistant alloy [8].

Screw Zones:

Screws are characterized by their length-diameter ratio (commonly written as L/D ratios). L/D ratios most commonly used for single-screw extruders range from 15:1 to 30:1. Ratios of 20:1 and 24:1 are common for thermoplastics, whereas lower values are used for rubbers. A long barrel gives a more homogeneous extrudate, which is particularly desirable when pigmented materials are handled. Screws are also characterized by their compression ratios-the ratio of the flight depth of the screw at the hopper end to the flight depth at the die end. Compression ratios of single-screw extruders are usually 2:1–5:1 [9].

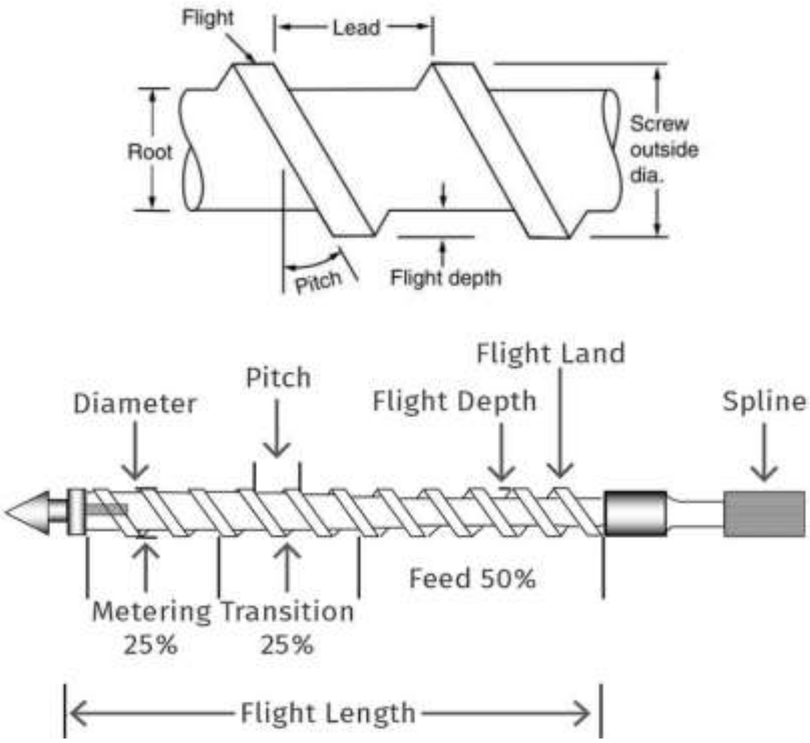


Fig. 1. 2. Detail of screw [10].

The screw is usually divided into three sections, namely, feed, compression, and metering (**Fig.** 1.2). One of the basic parameters in screw design involves the ratio of lengths between the feed, compression (or transition), and metering sections of the screw. Each section has its own special rate. The feed section picks up the powder, pellets, or beads from under the hopper mouth and conveys them forward in the solid state to the compression section. The feed section is deep flighted so that it functions in supplying enough material to prevent starving the forward sections. The gradually diminishing flight depth in the compression section causes volume compression of the melting granules. The volume compression results in the trapped air being forced back through the feed section instead of being carried forward with the resin, thus ensuring an extrudate free from porosity. Another consequence of volume compression is an increase in the shearing action on the melt, which is caused by the relative motion of the screw surfaces with respect to the barrel wall. The increased shearing action produces good mixing and generates frictional heat, which increases fluidity of the melt and leads to a more uniform temperature distribution in the molten extrudate. The resin should be fully melted into a reasonably uniform melt by the time it enters the final section of the screw, known as the metering section. The function of the metering section is to force the molten polymer through the die at a steady rate and iron out pulsations. For many screw designs the compression ratio is 3–5; i.e., the flight depth in the metering section is one-third to one-fifth that in the feed section [11].

Motor Drive (Power):

The motor employed for driving the screw of an extruder should be of more than adequate power required for its normal needs. Variable screw speeds are considered essential. Either variable-speed motors or constant-speed motors with variable-speed equipment, such as hydraulic systems, step-change gear boxes, and infinitely variable-speed gear boxes may be used. Thrust bearings of robust construction are essential because of the very high back pressure generated in an extruder and the trend towards higher screw speeds. Overload protection in the form of an automatic cut-out should be fitted [12].

Heating:

Heat to melt the polymer granules is supplied by external heaters or by frictional heat generated by the compression and shearing action of the screw on the polymer. Frictional heat is considerable, and in modern high-speed screw extruders it supplies most of the heat required for steady running. External heaters serve only to insulate the material and to prevent the machine from stalling at the start of the run when the material is cold. The external heater may be an oil, steam, or electrical type. Electrical heating is most popular because it is compact, clean, and accurately controlled. Induction heating is also used because it gives quicker heating with less variation and facilitates efficient cooling.

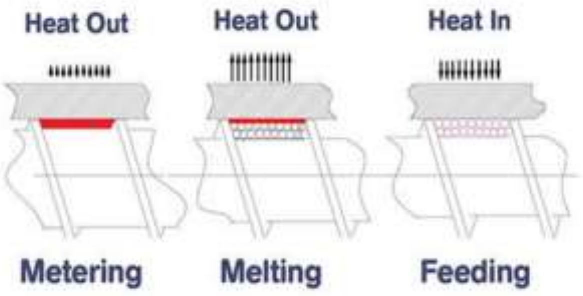


Fig 1. 3 It shows the areas of the heaters and the three screw areas

The barrel is usually divided into three or four heating zones; the temperature is lowest at the feed end and highest at the die end. The temperature of each zone is controlled by carefully balancing heating and cooling. Cooling is done automatically by either air or water. (The screw is also cored for heating and cooling.) The screw is cooled where the maximum amount of compounding is required, because this improves the quality of the extrudate [13].

Screw Design:

The screw we have described is a simple continuous-flight screw with constant pitch. The more sophisticated screw designs include flow disrupters or mixing sections (Figure 1.3). These mixer screws have mixing sections which are designed as mechanical means to break up and rearrange the laminar flow of the melt within the flight channel, which results in more thorough melt mixing and more uniform heat distribution in the metering section of the screw.

Mixer screws have also been used to mix dissimilar materials (e.g. , resin and additives or simply dissimilar resins) and to improve extrudate uniformity at higher screw speeds (100 rpm). A few typical mixing section designs are shown in **Fig.** (1. 4). The fluted-mixing-section-barrier-type design **Fig** 1.5a has proved to be especially applicable for extrusion of polyolefins. For some mixing problems, such as pigment mixing during extrusion, it is convenient to use rings **Fig.** 1.5b or mixing pins **Fig.** 1.5 c and sometimes parallel interrupted mixing flights having wide pitch angles **Fig.** 1.5d.

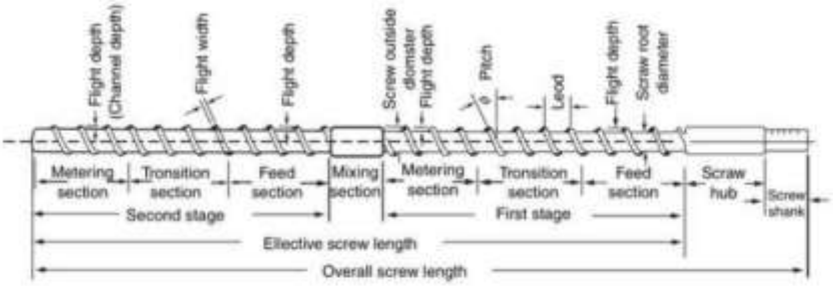
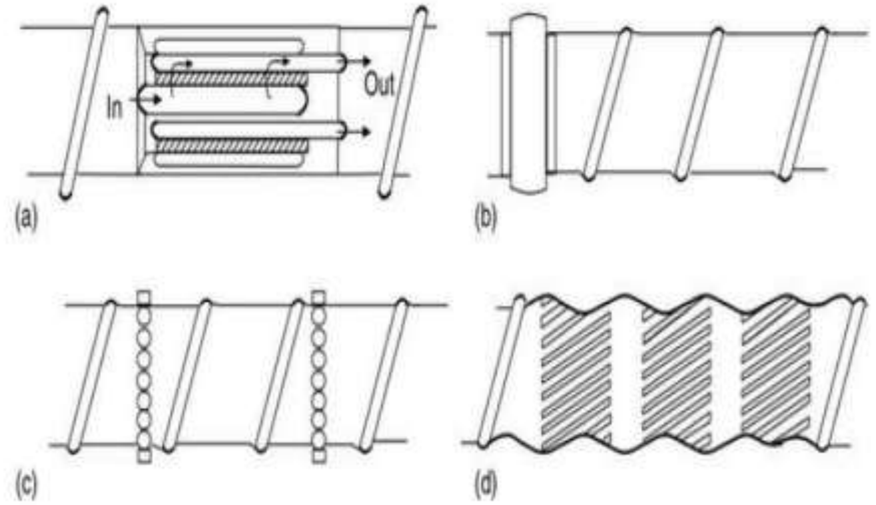


Fig. 1. 4. Single-flight, two-stage extrusion screw with mixing section [14].

A later development in extruder design has been the use of venting or degassing zones to remove any volatile constituents from the melt before it is extruded through the die. This can be achieved by placing an obstruction in the barrel (the reverse flights in **Fig.** 1. 6.) and by using a valve bypass section to step down the pressure developed in the first stage to atmospheric pressure for venting. In effect, two screws are used in series and separated by the degassing or venting zone. Degassing may also be achieved by having a deeper thread in the screw in the degassing section than in the final section of the first screw, so the polymer melt suddenly finds itself in as increased volume and hence is at a lower pressure. The volatile vapors released from the melt are vented through a hold in the top of the extruder barrel or through a hollow core of the screw by way of a hole drilled in the trailing edge of one of the flights in the degassing zone. A vacuum is sometimes applied to assist in the



extraction of the vapor. Design and operation must be suitably controlled to minimize plugging of the vent (which, as noted above, is basically an open area) or the possibility of the melt escaping from this area. Many variations are possible in screw design to accommodate a wide range of polymers and applications. So many parameters are involved, including such variables as screw geometry, materials characteristics, operating conditions, etc., that the industry now uses computerized screw design, which permits analysis of the variables by using mathematical models to derive optimum design of a screw for a given application.

Fig. (1.5) Mixing section designs: (a) fluted-mixing-section-barrier type; (b) ring-barrier type; (c) mixing pins; (d) parallel interrupted mixing flights [15].

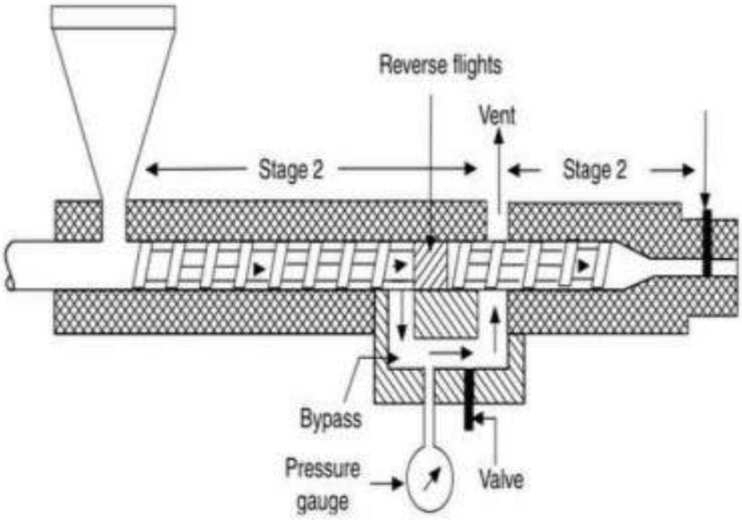


Fig. 1. 6 A two-stage vented extruder with a valved bypass [16].

Various screw designs have been recommended by the industry for extrusion of different plastics. For polyethylene, for example, the screw should be long with an L/D of at least 16:1 or 30:1 to provide a large area for heat transfer and plastication. A constant-pitch, decreasing-channel-depth, metering-type polyethylene screw or constant-pitch, constant-channel-depth, metering-type nylon screw with a compression ratio between 3–1 and 4–1 **Fig.** 1. 7 is recommended for polyethylene extrusion, the former being preferable for film extension and extrusion coating. Nylon-6, 6 melts at approximately. Therefore, an extruder with an L/D of at least 16:1 is necessary. A screw with a compression ratio of 4:1 is recommended.

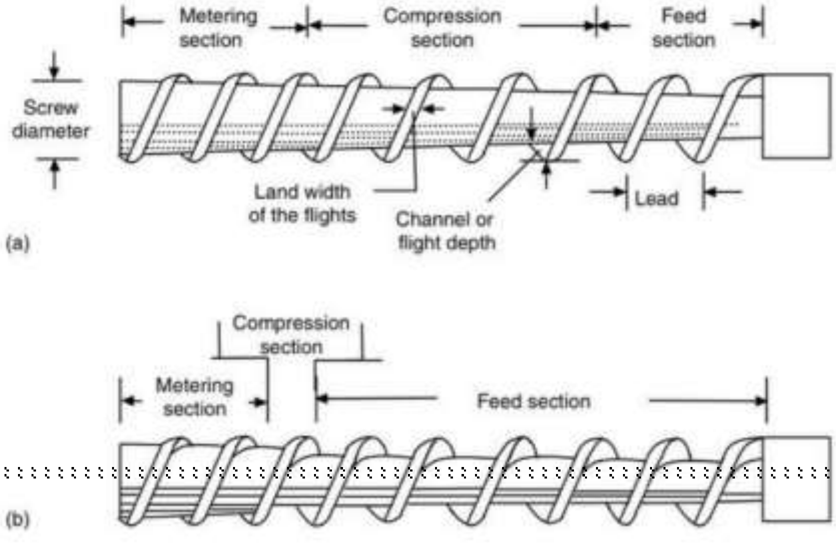


Fig. 1.7: (a) Constant pitch, decreasing channel depth, metering-type polyethylene screw. (b) Constant pitch, constant-channel-depth, metering-type nylon screw (not to scale) [17].

Multiple-Screw Extruder:

Multiple-screw extruders (that is, extruders with more than a single screw) were developed largely as a compounding device for uniformly blending plasticizers, fillers, pigments, stabilizers, etc., into the polymer. Subsequently, the multiple-screw extruders also found use in the processing of polymer single _screw extruders differ significantly from single-screw extruders in mode of operation. In a single-screw machine, friction between the resin and the rotating screw, makes the resin rotate with the screw, and the friction between the rotating resin and the barrel pushes the material forward, and this also generates heat. Increasing the screw speed and/or screw diameter to achieve a higher output rate in a single-screw extruder will therefore result in a higher buildup of frictional heat and higher temperatures. In contrast, in twin-screw extruders with intermeshing screws the relative motion of the flight of one screw inside the channel of the other pushes the material forward almost as if the machine were a positive-displacement gear pump, which conveys the material with very low friction.

In two-screw extruders, heat in therefore controlled independently from an outside source and is not influenced by screw speed. This fact become especially important when processing a heat-sensitive plastic like poly (vinyl chloride) (PVC). Multiple-screw extruders are therefore gaining wide acceptance for processing vinyl’s, although they are more expensive than single-screw machines. For the same reason, multiple-screw extruders have found a major use in the production of high-quality rigid PVC pipe of large diameter.

Several types of multiple-screw machines are available, including intermeshing corotating screws (in which the screws rotate in the same direction, and the flight of one screw moves inside the channel of the other), intermeshing counterrotating screws (in which the screws rotate in opposite directions), and nonintermeshing counterrotating screws.

Multiple-screw extruders can involve either two screws (twin-screw design) or four screws. A typical four-screw extruder is a two-stage machine, in which a twin-screw plasticating section feeds into a twin- screw discharge section located directly below it. The multiple screws are generally sized on output rates (lb/h) rather than on L/D ratios or barrel diameters [5, 7].

Chapter 2

2. Practical part:

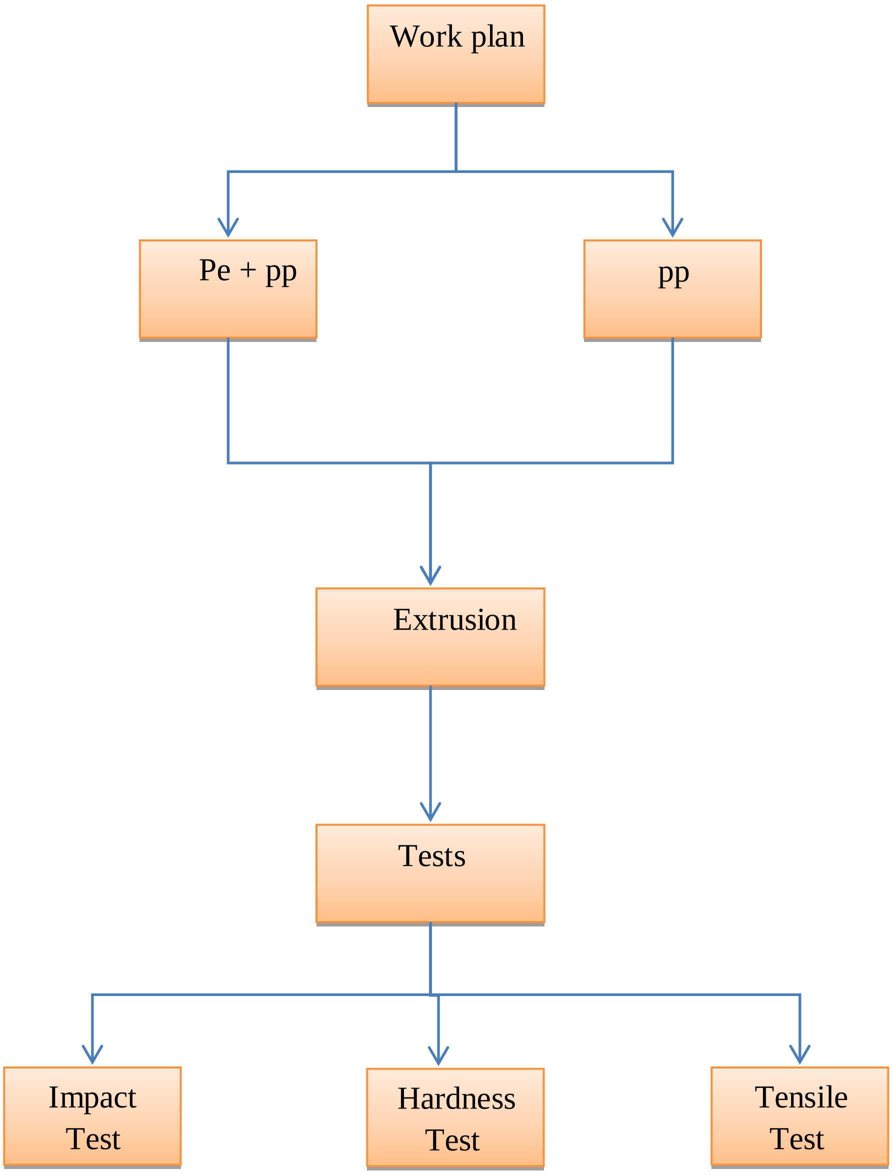


Fig. 2. 1 Diagram showing the step of the work

The method of work:

1- Sheets were taken from polypropylene and recycled polyethylene,

2- Then the plates were cleaned and dried, 3- They were placed in a cutting machine and turned into granules for the purpose of forming,

4- The polypropylene sample was first extruded in the extrusion machine at a temperature 175 and at a different speed 20-30-40 rpm,

5- Then both materials were extruded together at the same temperature and different speeds,

6- Samples were made for testing: a tensile test, a hardness test, and a shock test

7- The three tests were carried out on the samples,

Tests:

Tensile test:

In the tensile test, samples were cut with standard dimensions according to ASTM (D1708-02a). This test is done at University of Babylon/ College of Materials Engineering/ Polymer Engineering Department using the model (WDW-5E, China) as shown in figure. The two ends of the sample were connected to the jaws of the device to start a tensile test at room temperature by computer control, where a tensile force was applied to the sample by (5kN) and quickly (10mm/ min) until the failure occurred in the sample.

Fig. 2. 2. The tensile test device [2, 1].

The concept of tensile testing Tensile testing is one of the most important and simple physical tests that are carried out on a different set of materials, in order to determine their suitability for use in various engineering and construction applications to ensure the safety and quality of those applications. This is done by holding its opposite ends with special equipment and pulling it out, and it is worth noting that the process of applying force in an axial (longitudinal) way continues in this way until the sample is broken, then a number of its characteristics can be determined, including the amount of stress, pressure, deformation and many other characteristics that Distinguish the sample from others. The steps of conducting a tensile test. The process of conducting a tensile test on a sample includes a set of steps, and the following will be mentioned in detail: [9, 10] Preparation of equipment and tools for conducting a tensile test, which includes the following: A tensile testing machine that fits the nature and type of the sample to be tested . Dilation meter monitors the expansion phases of the sample while the test is being performed. Special electronic devices or software to operate the tensile testing machine and record measurements and results while the test is being carried out. Tension handles suit the nature and type of the sample, as the handles differ according to their working principle and the nature of the face they have. Types of handles, according to their working principle, are wedge handles, selftightening or scissors, while the handles are usually serrated in order to hold the two ends of the sample tightly. Preparation of the test sample by pouring the sample material into special molds whose shape suits the requirements of the tensile test device to be used, which is usually in the form of a dog bone. Putting the upper (fixed) and lower (moving) handles designated for conducting the tensile test in the device, as their type and location are compatible with the nature and length of the sample. Placing the specimen in its correct position between the handles to avoid the application of lateral tension forces that would cause the specimen to bend during the test, which would ultimately adversely affect the validity and accuracy of the results. Delivery of the dilation gauge along the sample to monitor and quantify the change in its length during the test. Start the test by separating the tension knobs at a constant speed depending on the size and shape of the sample. During the test, the sample will expand and then begin to deform until it is broken. Once the sample is broken, the tension test ends. Abstract The tensile test is used to verify the strength and durability of many materials used in engineering applications such as buildings, and it works on the principle of exposing these materials to a strong force to make sure that they break, and then several measurements can be taken, and used in equations, then arriving at the strength of the material and its conformity with specifications and standards Security required [18].

Hardness test:

The (shore D) device was used to determine the hardness of samples cut into different sizes (different shapes) for recycled polyethylene. Where the samples were cut with standard dimensions according to ASTM (D2240). This test is carried in the University of Babylon, College of Materials Engineering, Department of Polymers and Petrochemical Industries with the model (TH 210 FJ, Germany). The (shore D) device contains a needle like indenter at the end of the measuring tool to determine the hardness of the samples, and the needle is directed in a direction perpendicular to the sample and the device is controlled by the lever and when performing the hardness test for samples at room temperature, from the start of the test and an average of four readings of each sample in different locations of the samples calculated to obtain the required accuracy.

Fig. 2. 3. The hardness test device using (shore D) [2, 2].

A Shore-D device (Shore Duro-meter) was used to measure the hardness of thermally hardened polymeric materials, which is a compass-like device and contains a needle in the middle. Measure its hardness so that it is in contact with the surface of the sample whose hardness is to be measured in order for the needle to be inserted into the surface of the material and for a waiting period of about three seconds, after which the value of the hardness is taken from the device. Regarding the Shore D hardness, no less than six readings were taken in different places on the surface of the sample، The sample used for this test has a diameter of (40 mm) and a height of (5 mm).

Impact test:

A Charpy method was used to determine the impact strength of samples cut into different sizes (different shapes) for recycled polyethylene. In this way, impact load is suddenly applied to samples. Where the samples were cut with standard dimensions according to ASTM (D-22885). This device is available at the University of Babylon/ College of Materials Engineering/ Department of Polymers Engineering and Petrochemical Industries, specifically the with the model (pendelschlagwerk, gunt, Hamburg/ Germany), calculates the energy needed for the fracture through the energy indicator, as the impact **strength (I. S.)** is calculated for each sample through the following equation:

$$\mathbf{I.\ S. = U_C / A}$$

Where:

U_C: Is the fracture energy (joule) measured by the Charpy impact test instrument.

A: Is the cross-sectional area for the sample.

Impact test determines the amount of energy absorbed by a material during fracture. This absorbed energy is a measure of a given material's toughness and acts as a tool to study temperature-dependent brittle-ductile transition. It is to determine whether the material is brittle or ductile in natureIn the project we used Charpy V-notch test. The Charpy impact test, also known as the Charpy V-notch test, is a high strain-rate test that involves striking a standard notched specimen with a controlled weight pendulum swung from a set height. The impact test helps measure the amount of energy absorbed by the specimen during fracture [19].

Fig. 2. 4. The impact test device by a charpy method [2, 3].

Fig. 2. 5. The twin-screw extruder device [2-4].

Test result:

Tensile test result

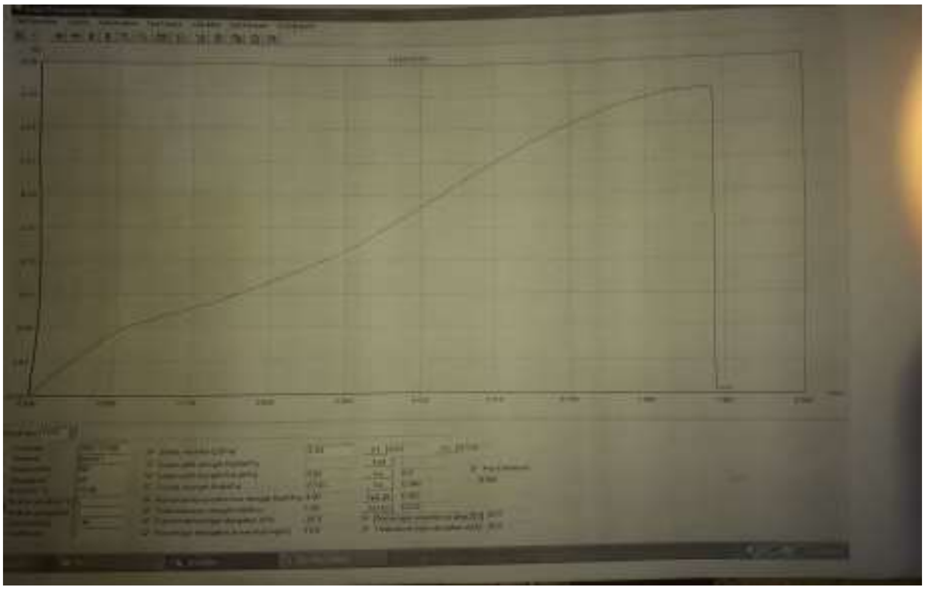


Fig 2. 6. The tensile test inspection of pp + pe speed 40-

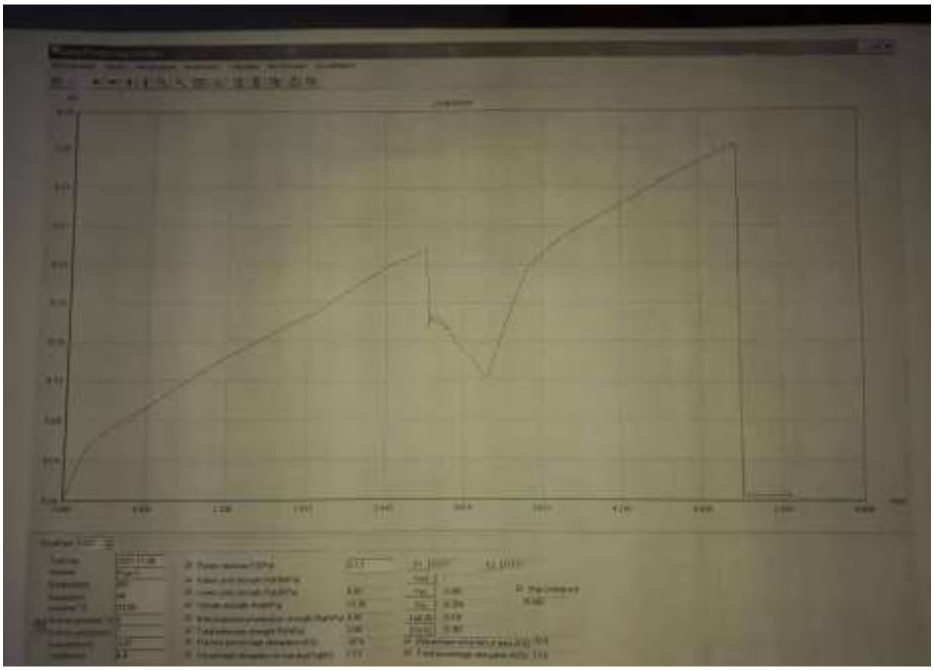


Fig. 2. 7. The tensile test inspection of pp shows a speed of 40-

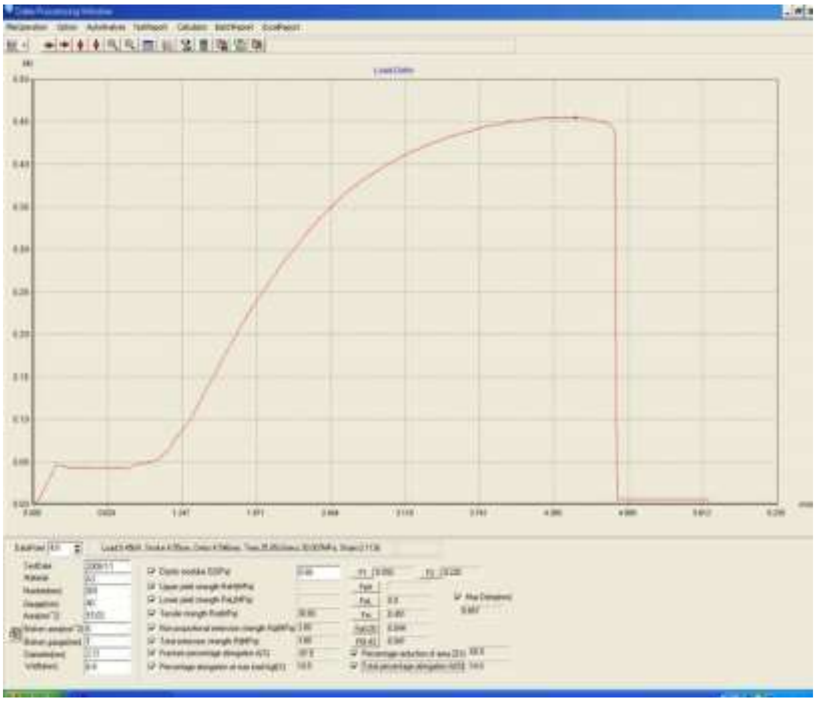


Fig. 2. 8. The tensile test inspection of pp shows a speed of 20

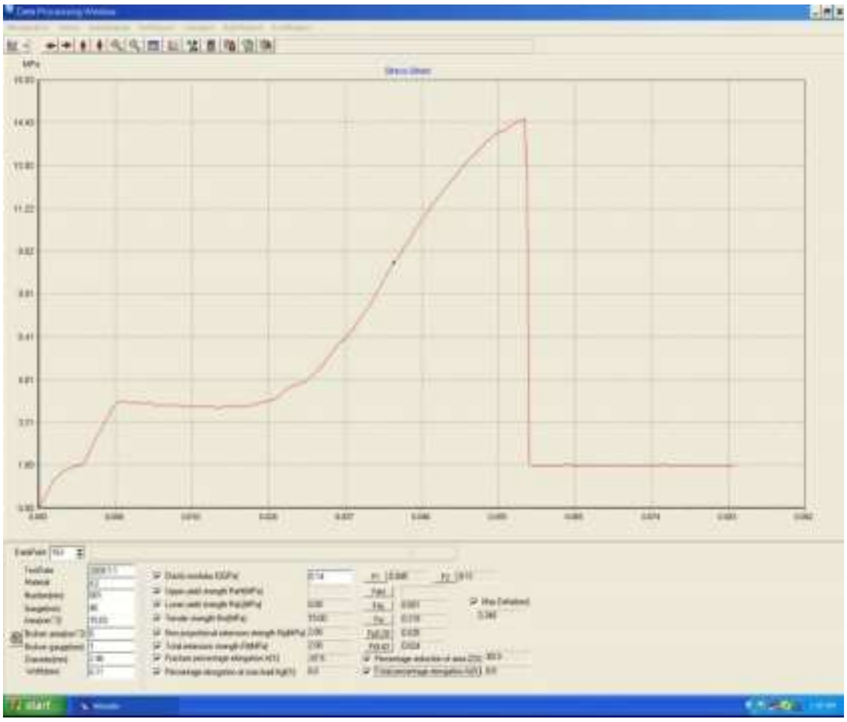


Fig. 2. 9. The tensile test inspection of PP+PE shows a speed of 20

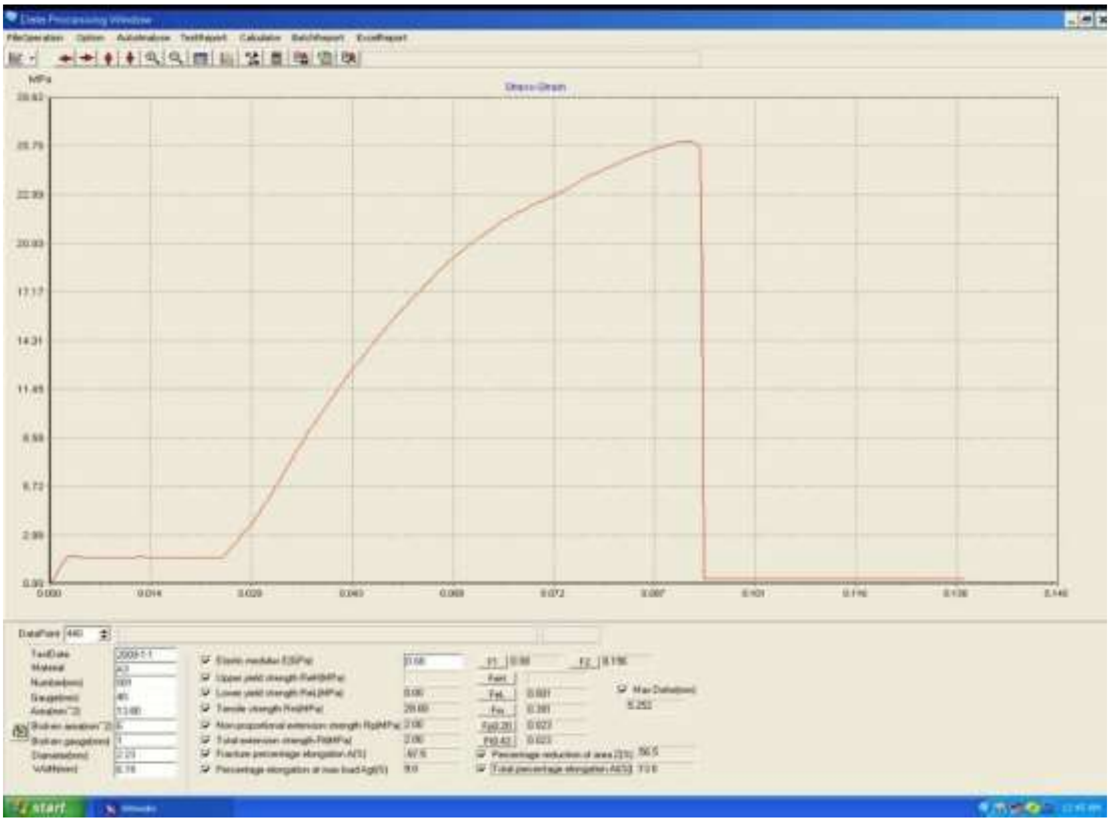


Fig. 2. 10. The pp tensile test inspection shows a speed of 30

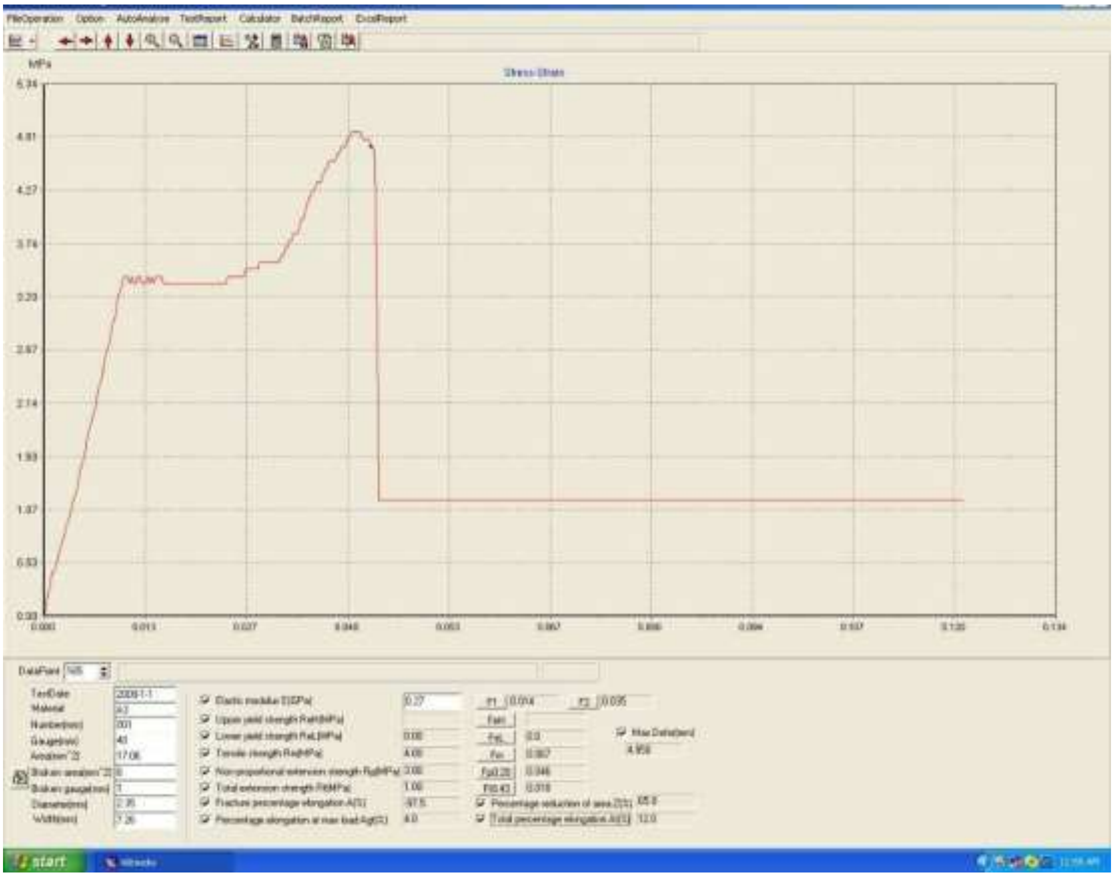


Fig. 2. 11. The tensile test inspection of PP+PE shows a speed of 30

Tesile test results:

Table 2. 1. It shows the value of the elastic modulus of the samples resulting from the tensile test

Name of sample	Elastic modulus E (Gpa)
Pp+pe20	0.14
Pp20	0.66
Pp+pe30	0.27
Pp30	0.68
Pp+pe40	0.09
Pp40	0.13

From the above table we note

The best speed for pure extrusion is 30, The best speed for extrusion of the mixture is 30, so the medium speed is suitable for obtaining a high modulus of elasticity for pure materials and composite materials. It has good mechanical properties

Hardness test results:

Table 2. 2. It shows the results of the hardness test of the samples

Sequence	pp 30	Pp+pe 40	Pp+pe 30	pp 40	Pp+pe 20	Pp 20
1	67.1	64.3	53.9	50.9	53.9	65
2	71	67	47.4	60	70	64.7

3	50.2	59.5	66.7	50	61.4	57.4
4	60.1	46.2	55.5	64	63.7	59.3
5	68.3	66.2	51.1	67.9	63	60.5
average	65.9	60.6	54.8	62.1	62.4	61.4

at speed 30; 20 We notice an increase in the curve in its strength at speed 30 more heightAs for the speed of 40, the results were canceled for it due to a failure in the samples, and this happens due to the frequent re-sampling and extrusion

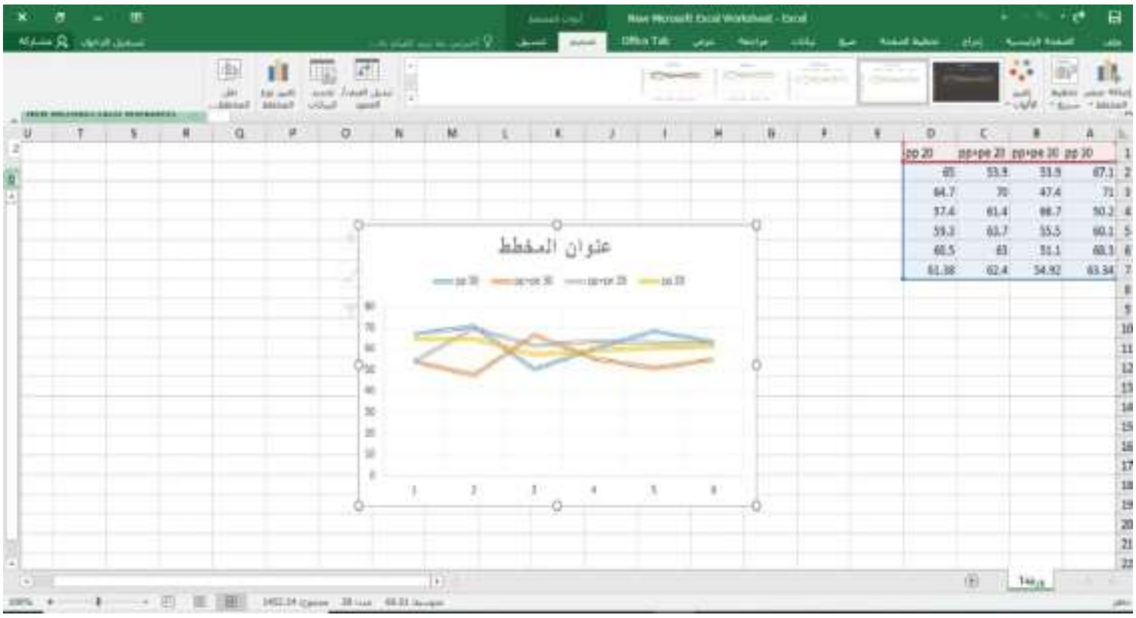


Fig. 2. 12. hardness test chart

Impact test:

A Table showing the results of the impact test:

Table 2. 3. hardness test chart

sample name+ Speed	Length	width	Thickness	i.e	i.s
Pp20	55	18.44	2.78	0.27	5.266
Pe+pp 30	55	16.02	2.14	0.22	6.185
Pp30	55	18.67	2.13	0.51	12.824
Pp+pe20	55	13.98	2.17	0.23	7.581
Pp40	55	16.3	3.48	0.8	14.10
Pp+pe 40	55	15.9	3.76	0.6	10.28
Pp+pe40	55	15.2	2.5	0.5	13.15
PP+pe40	55	12.9	3	0.4	10.33

Discussing test results:

The main reason for the fluctuation of results in the tensile, hardness and shock test is:

1- Not choosing the exact speed of the material.

2- Not choosing an ideal temperature for extrusion of the material.

3- The process of cutting samples is inaccurate according to the specifications, due to cutting them with a machine or saw, which caused a change in the physical properties of the material.

4- Not knowing the date of recycling the material.

5- Not knowing how many times the material was subjected to thermal decomposition.

Recommendations:

1- We recommend knowing the date of the material used.

2- It is preferable to use a precise extrusion machine with special spirals for this material, pp, pespecial tilt angles.

3- Use a proper sample cutting process.

4- Determining the error rate in laboratory equipment.

Conclusion:

Take two materials, PP and PE, and extrude them at a temperature of 175 at a different speed of 20. 30. 40. For both materials PP and PE once and again for PP, then the three tests were conducted: tensile, hardness and impact test and the results are shown above for all tests with a discussion of the reasons for which the results appeared

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