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Polyethylene Household Waste Recycling and Enhancing by Using Pyrolized Black Carbon

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Objective

- The main objective of this study is recycling of waste polyethylene and enhancing by using pyrolyzed black carbon.
- To accomplish this main objective, the following specific objectives are to be conducted:
 - Study effect of recycling on mechanical properties of polyethylene.
 - Study effect of using pyrolyzed black carbon on recycled polyethylene.
 - Study effect of temperature and ultraviolet on recycled polyethylene.
 - Study the effect of screw speed on extrudate recycled polyethylene.

Content layout

- Introduction.
- Problem.
- Conventional methods of plastic waste disposal.
- Pyrolized Black Carbon (PBC).
- Extrusion.
- Mechanical properties.
- Environmental factor.
- Methodology and Experimental Work.
- Conclusion.

Introduction

- plastic are not biodegradable.
- Polymers are substances with high molar masses and are composed of a large number of repeating units.
- Polymers are formed by chemical reactions.
- Polymers are divided into two main groups, thermosets and thermoplastics.

- Polyethylene and Polypropylene are examples of the thermoplastic.
- Polyethylene is a polymer made of long chains of ethylene monomers.
- polyethylene obtained by polymerizing ethylene gas, $\text{H}_2\text{C}=\text{CH}_2$.
- It can be formed by a wide variety of thermoplastic processing methods.

- Types of polyethylene.
 - Low density polyethylene typically has a density value ranging from 0.91 to 0.925 g/cm³.
 - Linear low density polyethylene is in the range of 0.918 to 0.94 g/cm³.
 - High density polyethylene ranges from 0.935 to 0.96 g/cm³ and above.
- The use of polyethylene is growing worldwide at a rate of 12% per year.
- 140 million tons of synthetic polymers are produced worldwide each year.

What is the problem?

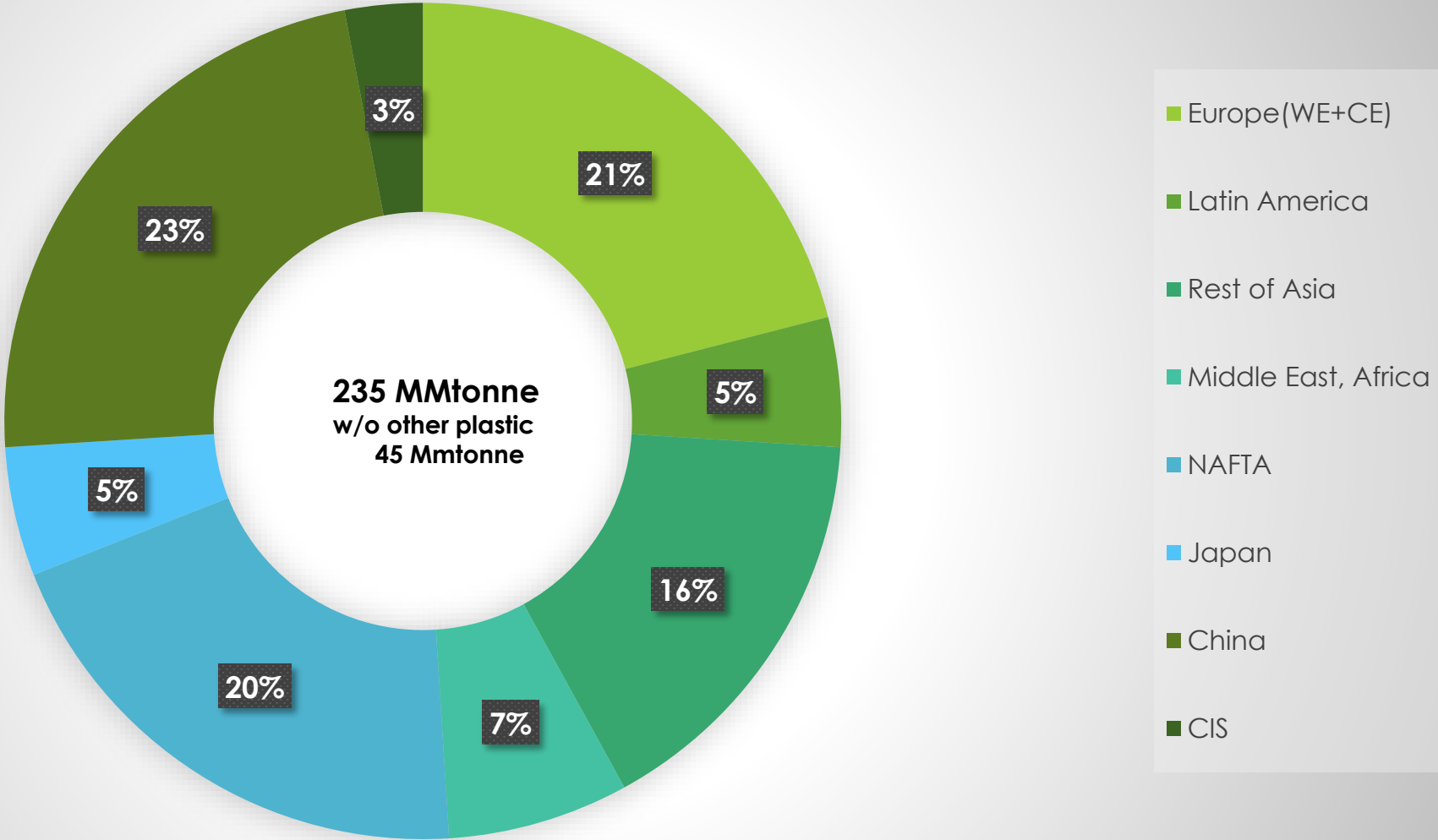


Figure 1 Worldwide plastic production, 2011.

Problem globally

- ❑ In 2010, Americans created 31 million tons of plastic waste.
- ❑ Only 8 percent of the total plastic waste generated in 2010 was recovered for recycling.

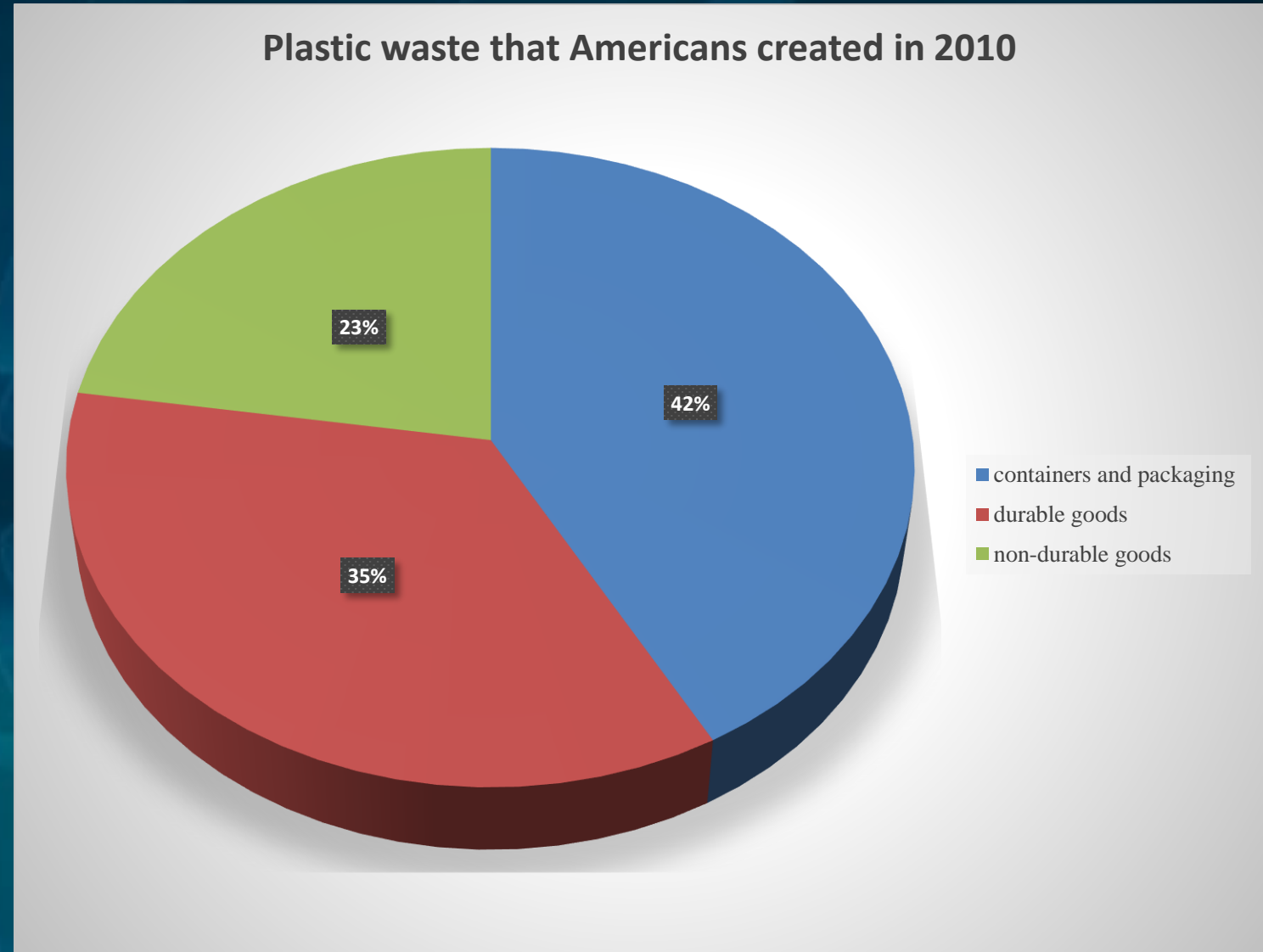


Figure 2 plastic waste generated in America,2010.

Problem locally

- ❑ According to ; the amount of household waste which is produced daily in West Bank is 1274.7 ton.
- ❑ This main that the plastic waste amount is 32500 ton yearly.

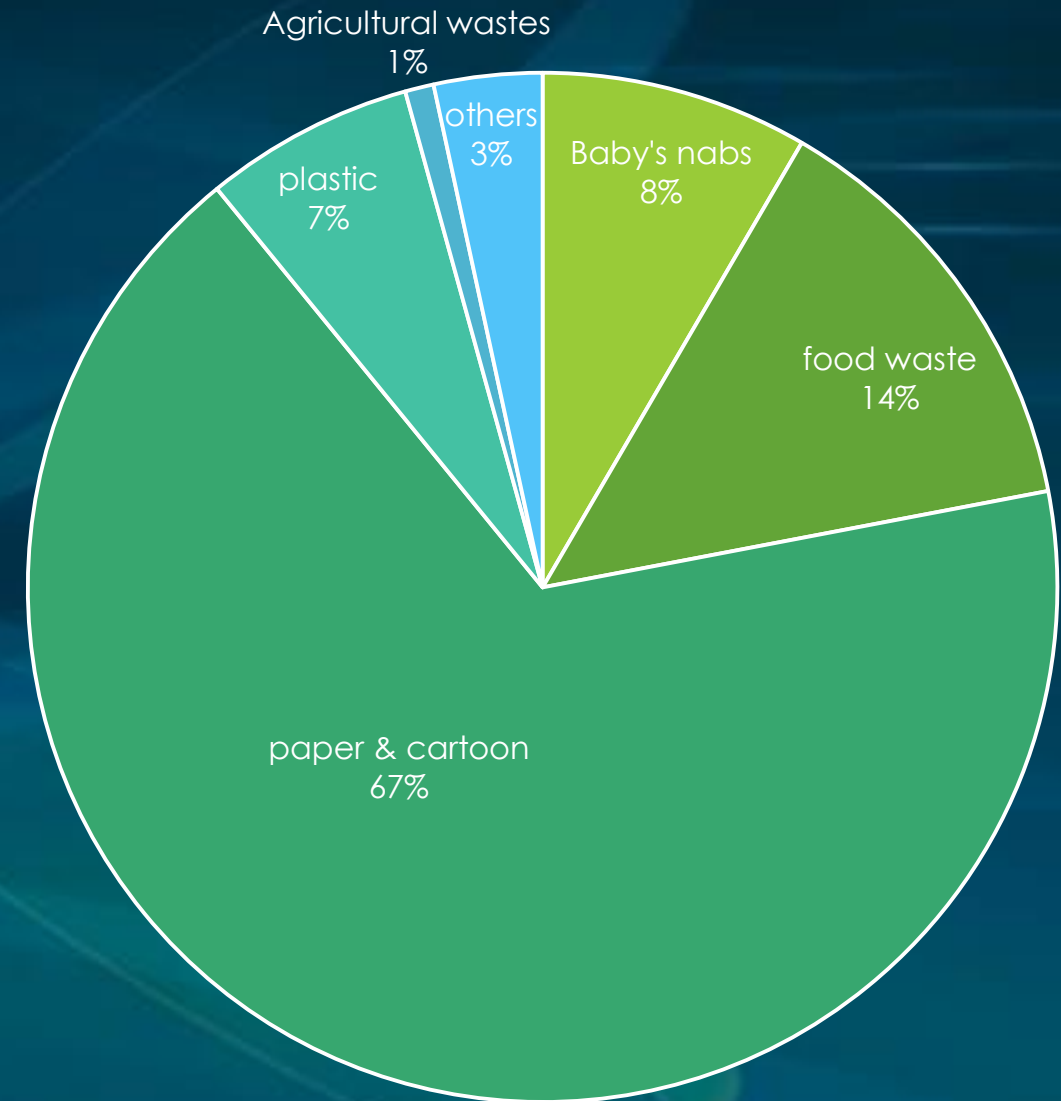


Figure 3 solid waste household percentage in West Bank

Conventional methods of plastic waste disposal

- There are different methods for plastic disposal; including
 1. Plastic in landfill .
 2. Burning plastic .
 3. Recycling.

What is the solution ?

- Recycling is a possible solution.
- Recycling is a process to change materials (waste) into new products in order
 - to prevent waste of potentially useful materials.
 - reduce the consumption of fresh raw materials.
 - reduce energy usage.
 - reduce air pollution and water pollution.

- Typically, recycling of plastics is carried out in a five step process which as follows
 - Plastics collection
 - Manual sorting
 - Cutting the sorted plastic.
 - Washing .
 - The plastic is then melted down and extruded into small pellets ready for reuse .

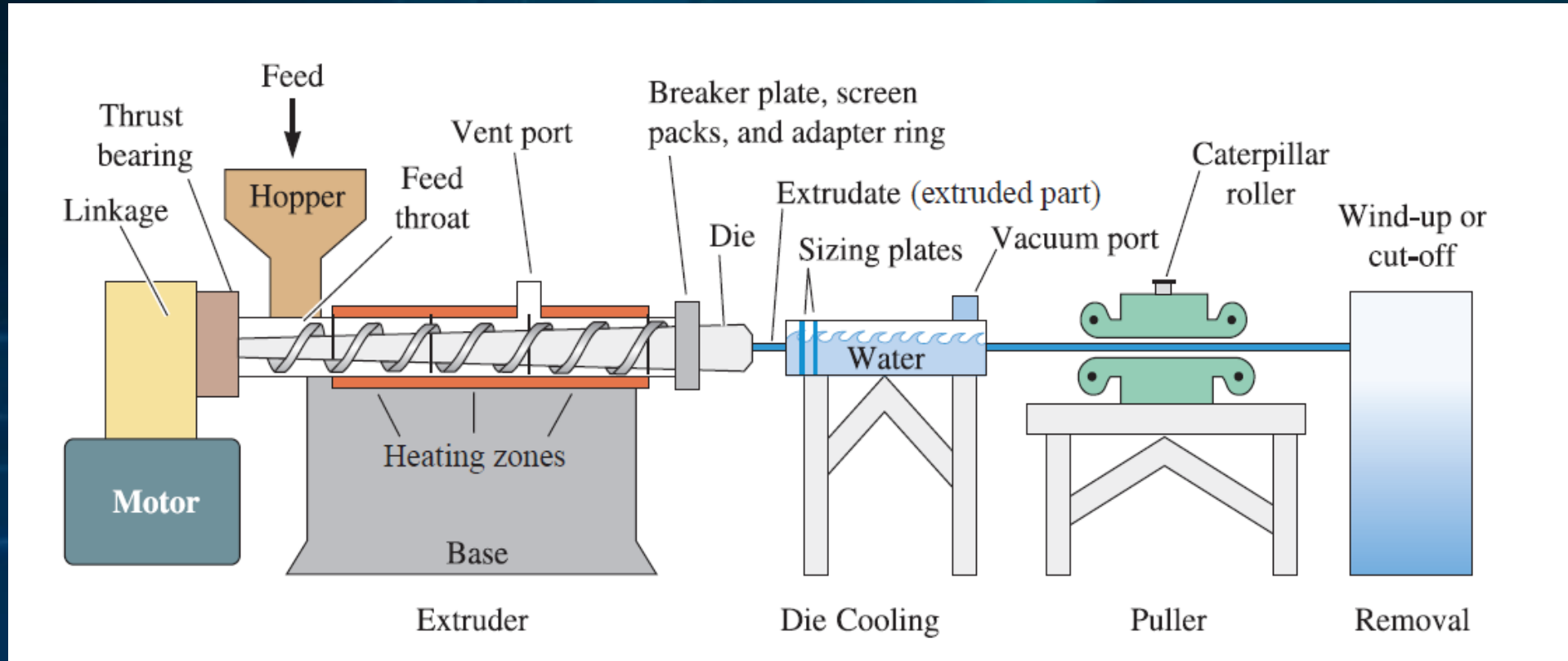
How to enhance recycled Polyethylene?

- Pyrolyzed Black carbon.
- It is a by-product .
- It will be used as a filler in recycling polyethylene .
- It has size of 0.15 mm .
- different percentage and different size diameter of PBC will be added to polyethylene samples.

Extrusion

- Extrusion is the most widely used technique for processing thermoplastics.
- Extrusion can serve two purposes.
- it provides a way to form certain simple shapes continuously.
- Second, extrusion provides an excellent mixer for additives (e.g., carbon black).

Extrusion process



Extruder

- Plastic extruders are used to create a wide range of items, including plastic tubing, trims, seals, plastic sheets and rods.
- Extruder is the machine for producing more or less continuous lengths of plastic sections out of a selected type of plastic resin.
- Extruders divided into two general types which as follows
 - Single Screw Extruder.
 - Twin or Multiple Screw Extruders.

Mechanical Properties

- It depend on the composition and microstructure of materials.
- it can be determined by various parameter such as modulus of elasticity, yield strength, tensile strength and % elongation.
- Most thermoplastics exhibit a non-Newtonian and viscoelastic behavior. The behavior is non-Newtonian .
- The mechanical behavior is closely tied to the manner in which the polymer chains move relative to one another under load.

Environmental Factor

- The degradation of polymer can be caused by environmental effects.
- Temperature and sunlight are normally cited as the main environmental concerns.
- Degradation is leading to a loss of the mechanical properties of plastic products.

Temperature

- Polymers materials are sensitive to temperature and their mechanical properties changes as a function of this parameter.
- At lower temperature, the structure is much harder and more brittle than those at room temperature.

- High temperature can lead to two distinct changes in mechanical properties.

- when the temperature increased, this results significant elongation of material, at the same time, tensile strength decrease slightly.

- Also; acceleration of photo degradation, a process occurs upon plastic products exposure to sunlight.

UV Radiation

- Many polymeric material are sensitive to the effects of UV fraction of solar radiation .
- Polymer sensitivity to sunlight can be attributed to the fact that polyolefin contain some form of impurity or chromophores.
- These impurities can absorb UV radiation.
- It is therefore clear that photo degradation causes the chemical and physical changes of polymer associated with exposure to UV radiation.

Methodology and Experimental work

material and equipment used

- A locally fabricated single-screw extrusion machine.
- digital electric weighing balance.
- hot plate and caloric piston .
- A cooling bath.
- Polyethylene virgin which obtained from locally company .
- Recycled polyethylene that obtained from locally company.
- Pyrolized black carbon that have size diameter of 0.15 mm which obtain from locally waste tire plant.

Sample preparation

- The sample prepared as follows:
 - I. 50 g of virgin low density polyethylene was weighted.
 - II. Then the weighted polyethylene was introduced to the hopper of extruder which was operated for one and half hour before using it, to reach the required temperature which is 200 °C.
 - III. Then the extrudate was return back directly to hopper.
 - IV. After that extrudate was pulled by puller then cooling by using water bath.
 - V. Finally, a caloric piston was used at 180 °C to make the final shape of specimen that will be tested

Sample formulation

Table 2 Formulation of recycled polyethylene/PBC samples

Tray ID	Black carbon (% wt)	LDPE recycled (%wt)	PBC (g)	LDPE recycled (g)
1	0	100	0	50
2	2	98	1	49
3	4	96	2	48
4	10	90	5	45
5	50	50	25	25

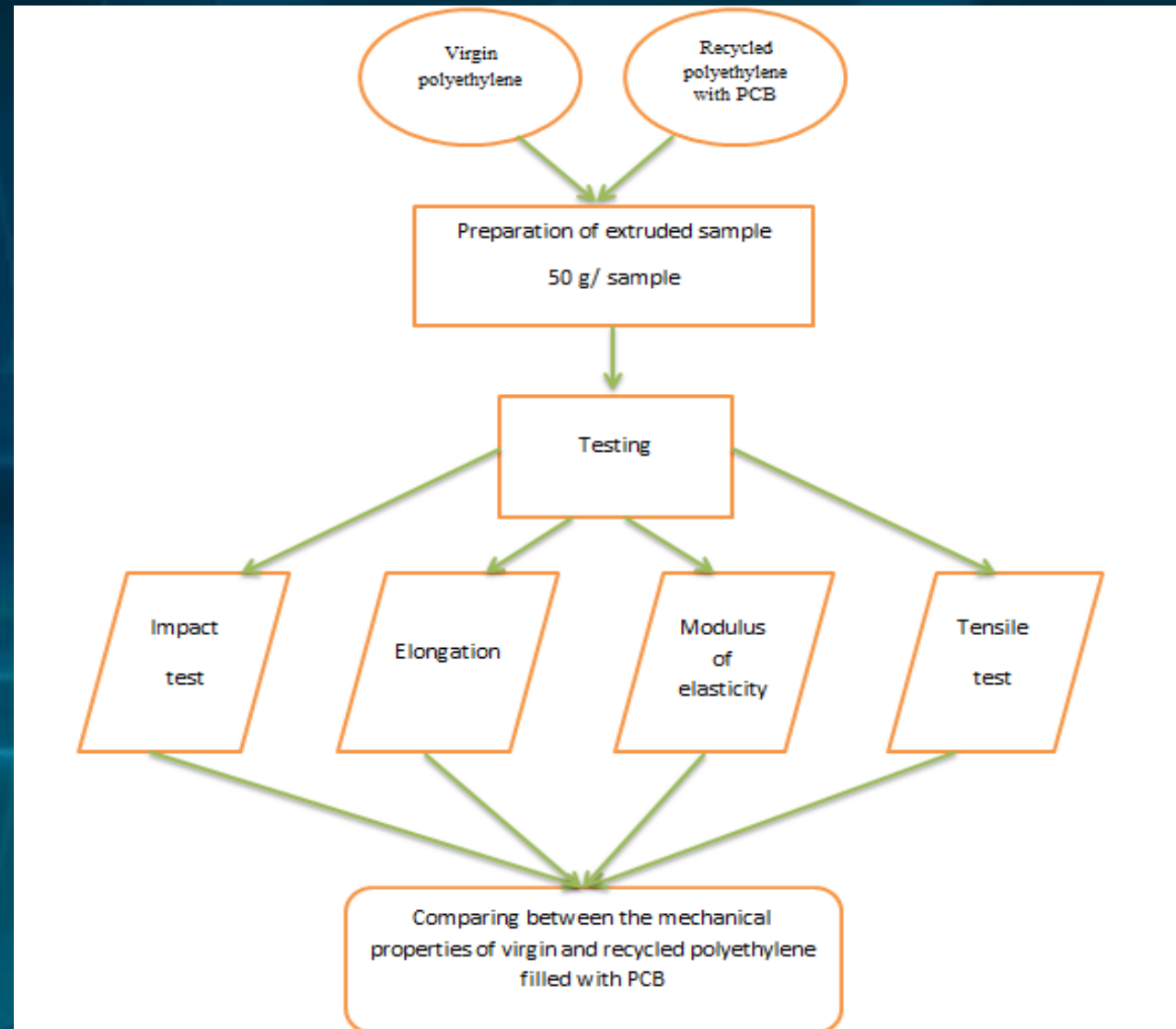
Table 1 Formulation of virgin polyethylene/PBC samples

Tray ID	Black carbon (% wt)	V.LDPE (%wt)	PBC (g)	V.LDPE(g)
1	0	100	0	50
2	2	98	1	49
3	4	96	2	48
4	10	90	5	45
5	50	50	25	25

Testing

- The prepared samples will be tested to examine their mechanical properties to compare the recycled polyethylene sample with virgin one.
- Standard tests will be used according to its availability.

Flow Chart



TIMELINE PROJECT PLANNING

2014

