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PREVENTION OF RODENT ATTACK ON TERTIARY PACKAGE AT STORAGE LEVEL

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ABSTRACT

Packaging is the science, art and technology of enclosing or protecting products for distribution, storage, sale, and use. Theses packaging are done at three levels they are namely primary, secondary and tertiary. Tertiary packaging is a type of wrapping which protects the manufactured products. It is used to smooth the progress of the transport and safe handling of goods.

The synthetic polymer is best suitable for packaging as they are having good strength properties. It is selected for packaging application based on their grade of suitability and recyclability towards product. The production of film for tertiary pack at storage level is mainly focused on availability and process capabilities.

The problem mostly arises in the case of tertiary packaging sector where the goods are packed and stored at warehouse.

The synthesis of film was carried out by blending linear low density polyethylene and essential oil as a plasticizer through solvent casting method. The synthesis is accomplished by formulating the elements certain percentage toproduce film suitable for packaging.

Thereafter testing was carried out and found that elongation has improvedfor LLDPE blends at a rate of 65.6% than LLDPE. The tensile strength was found to be reduced in LLDPE blends with value of 1.60Mpa. The contact angle was measured and it was found that the LLDPE film produce hydrophobicity than LLDPE with an increase of 3%. The UV spectroscopy was also measured and it was found that LLDPE blend film gave a translucent effect. The rodent test was also carried out and LLDPE film tends to repel them. Thus the LLDPE blends are made suitable for tertiary package.

CHAPTER 1 INTRODUCTION

Packaging is the science, art and technology of enclosing or protecting products for distribution, storage, sale, and use. Packaging also refers to the process of designing, evaluating, and producing packages.

Packaging can be described as a coordinated system of preparing goods for transport, warehousing, logistics, sale, and end use. Packaging contains, protects, preserves, transports, informs, and sells. In many countries it is fully integrated into government, business, and institutional, industrial, and personal use.

1.1 TYPES OF PACKAGING

Packaging may be of several different types. For example, a transport package or distribution package can be the shipping container used to ship, store, and handle the product or inner packages. Some identify a consumer package as one which is directed toward a consumer or household. It is sometimes convenient to categorize packages by layer or function: primary, secondary, etc.

Primary packaging is the material that first envelops the product and holds it. This usually is the smallest unit of distribution or use and is the package which is in direct contact with the contents.

Secondary packaging is outside the primary packaging, and may be used to prevent pilferage or to group primary packages together.

Tertiary packaging is a type of wrapping which protects the manufactured products. Tertiary packaging is used to smooth the progress of the transport and safe handling of goods or grouped packaging.

1.2 TERTIARY PACKAGING

Tertiary packaging is a type of wrapping which protects the manufactured products. Tertiary packaging is used to smooth the progress of the transport and safe

handling of goods or grouped packaging. Transportation and protection of goods are the main purposes of tertiary packaging.

Tertiary packaging prevents physical damage occurred during transport and faulty handling. Tertiary packaging of the goods changes with product type, mode of transportation and storage services.

It also known as Outer packaging includes slip sheets, pallets, stretch wrap and strapping labels used for the shipment and distribution of goods. Transit or transport packaging is the other names by which it is known. Tertiary packaging is very rarely seen by the final consumer as it is removed by retailers.

Distributors, warehouses and freight companies are the frequent users of tertiary packaging materials. Additionally, export companies are one of the major users of tertiary packaging. Some of the tertiary

packaging is disposable while some can be reused. Corrugated brown carton is one of the most widely used tertiary packaging.

Fig 1.1: Tertiary packaging at storage level(Open Source)

1.3 PROBLEMS IN TERTIARY PACKAGING

The biggest challenges are to give biological protection against micro-organism, insects, rodent, and other animals thereby protecting the products and enhancing thelife of it from biological hazard.

1.3.1 RODENTS

Rodents are mammals of the order Rodentia, which are characterized by a single pair of continuously growing incisors in each of the upper and lower jaws. About 40% of all mammal species are rodents (2,542 species); they are found in vast numbers on all continents except Antarctica. They are the most diversified mammalian order and live in a variety of terrestrial habitats, including human-made environments.

1.4 ABOUT THE PROJECT

Generally a project is done in order to study various existing systems or to improve or modify an existing systems or for any other useful applications. Our Project is mainly concerned with the synthesis of polymeric film in an efficient way in order to be used in packaging applications.

Unlike the older way of the synthetic polymeric film our film way different:

- The synthesis is carried out with peppermint oil and polyethylene in solventcasting process.
- To make the film suitable for packaging applications with required propertiesfor prevention of rodent attack.

CHAPTER 2 LITERATURE REVIEW

Concept is an important term in any research study. Review of concepts used in earlier studies provides a link with past approaches and helps one to adopt, modify andimprove the conceptual framework.

Synthetic polymers are widely used due to their excellent mechanical and thermal properties as well as their cost effectiveness. However, being non-biodegradable, these are a threat to environment. Hence, it is essential to develop packaging materials that is suitable for preventing rodent attack. The production of polymers film has received much attention due to the excellent biodegradability, biocompatibility and edibility of the films.

Alemayehu et al. (2004) carried out the work on the general rodents available and what are all the preventive measures available for it. The types of rodent attacks caused in packaging and how it is prevented are studied. There are many methods to prevent the rodent from damaging the resources such as rodent trapping, rat proofing, starving of rodents, anticoagulans are analyzed in this work

Brian et al. (2014) delt with the work of the properties and use of peppermintoil as pest and rodent repellent. The peppermint oil effects on how it is used to prevent the rodent attack are also studied.

The work about the non-chemical and non-lethal methods available under cost effective to control the rodent and pestwas carried out by **R.H. Smith et al. (2014).**

The work on what are methods available for controlling the rodent attack during the storage condition in rice cultivation and how the rodent attack is prevented by the using the methods was carried out by **P. R. Brown et al. (2017).**

V.R. Parshad et al (1998) has carried the work on the methods that are traditionally been used as repellent to rodent with cost efficacy. Analysis of the information available on the damage and economic losses caused by rodents in rice, wheat, sugarcane, maize, pearl millet, sorghum, oil seed, legume and vegetable crop

fields, horticulture and forestry, poultry farms, and rural and urban dwellings and storage facilities clearly shows that chronic damage ranging from 2%15% persists throughout the country and severe damage, sometimes even up to 100% loss of the field crop, is not rare. Environmental and cultural

techniques, such as clean cultivation, proper soil tillage and crop scheduling, barriers, repellents and proofing which may reduce rodent harbor age, food sources and immigration have long lasting effects but are seldom adopted.

Sarinee et al (2010) has carried the work about the methods that deals with repellent to rodent by using card board and essential oil for packaging application

using Circular Open Field.

In large stores, particularly if situated in the city, it may be necessary to complement hygienic practices with chemical control. Because acute poisons invariably cause bait shyness, especially if applied over longer periods, it is strongly recommendedthat only anticoagulant rodenticides are used in buildings

Oluyemisi Elizabeth Adelakun (2011) has carried the work on repellent properties using citronella, lemon, and eucalyptus oils as insect repellent ingredients. natural products are being frequently used because they have been ascertained to have low toxicity, produce comparable efficacy in relation to other EOs and syntheticchemicals.

The study of how polyethylene film added with synthetic additives helps in rodent repellent. Polyethylene which is capable of protecting goods from attack and destruction by rodents, which comprises: polyethylene containing substantially uniformly distributed throughout from 1% to 2% by weight of tribute tin chloride. The study depicts that polyethylene is suitable for rodent repellentwas carried out by**Ellsworth E. Kimme et al (1964).**

Mr.V. Vishnuvardhan (2011) done work by relating polymer-rodent repellant chemical composition and its manner of manufacture, and also to rodent repellent fabric coated with such polymer- rodent repellent composition in the manner such as to favour repelling of the rodents away from regions required to be protected and maintained free of rodent attack such as for rodent free grain storage .Importantly, polymer-rodent repellant chemical composition and the treated fabric using the same neither kills rodent nor is harmful to humans and is thus found to be safe and widely applicable for diverse end uses /applications.

Low-density polyethylene (LDPE) film is widely used, especially in agriculture and for food packaging. Ethylene vinyl acetate was blended with LDPE to reduce volatilization of EOs. An EO from Japanese cypress (Chamaecyparisobtusa) was incorporated into the blend film to conduct field research on antimicrobial and insect repellent properties. Among the various concentrations of EO, the highest

concentration (2.5%) showed the highest efficiency in terms of pesticidal activitywas the work carried out by **Jin Gu KIM et al (2020).**

2.1 RESEARCH GAP

In today's scenario the synthetic polymer are used widely in many applications but even though it has good properties, it has a bad credit towards environment. The above researchers have carried out the work by considering the above problem to find an alternative material suitable for applications preventing the rodent attack in packaging sectors etc. and ended up with methods of successful prevention of it. The above researchers have carried out the work in improving the properties of material to gain effect of the materials so that it can be used in packaging applications to prevent rodent attack in an cost effective way.

2.2 AIM

To prevent rodent attack in bulk packaging in order to ensure safety of product and enhance life of product in storage level.

2.3 OBJECTIVES

- To prepare a film using peppermint oil and LDPE
- To ensure environment compatibility and cost effective of the film
- To analyze the mechanical Properties and prevention of rodent by the film

CHAPTER 3 MATERIALS AND METHODOLGY

3.1 MATERIALS

A material is a substance or mixture of substances that constitutes an object. Materials can be pure or impure, living or non-living matter. Raw materials can be processed in different ways to influence their properties, by purification, shaping or theintroduction of other materials. New materials can be produced from raw materials bysynthesis.

3.1.1 PEPPERMINT OIL

Peppermint extract is an herbal extract of peppermint (Mentha × piperita) made from the essential oils of peppermint leaves. Peppermint is a hybrid of water mint and spearmint and was indigenous to Europe and the Middle East before it became common in other regions, such as North America and Asia.

Fig 3.1: Peppermint Oil

Peppermint extract is commonly used in cooking, as a dietary supplement, as an herbal or alternative medicine, as a pest repellent, and a flavor or fragrance agent for cleaning products, cosmetics, mouthwash, chewing gum, and candies. Its active ingredient menthol activates the TRPM8 receptor in sensory neurons, resulting in a

cold sensation when peppermint extract is consumed or used topically. There is insufficient evidence to conclude it is effective in treating any medical condition.

Property:

- It has a high concentration of natural pesticides
- It has tendency to repel some pest insects, including mosquitos, rodents
- Ease of handle of oil
- It is very slightly soluble in water
- It has good anti-bacteria

3.1.2 POLYETHYLENE

Polyethylene or polythene is the most common plastic in use today. It is a linear, man-made, addition, homo-polymer, primarily used for packaging (plastic bags, plastic films, geo-membranes, containers including bottles, etc.). As of 2017, over 100 million tonnes of polyethylene resins are being produced annually, accounting for 34% of the total plastics market.

Fig 3.2: Polyethylene Pellets

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 using high pressure (1000-5000 atm) and high temperature (520 Kelvin), while high density polyethylene is extruded using low pressure (6-7 atm) and low temperature (333-343 Kelvin). Polyethylene is usually thermoplastic, however it can be modified to become thermosetting instead, for example in cross-linked polyethylene.

Property:

- It has low strength, hardness and rigidity
- It is high ductility and has high impact strength
- It has low melting point
- It absorbs almost no water

- It has good biological problems repellent

3.1.3 HIGH DENSITY POLYETHELYNE

HDPE is a hydrocarbon polymer prepared from ethylene/petroleum by a catalytic process. It is a kind of thermoplastic which is famous for its tensile strength. Its unique properties can stand high temperatures.

Fig 3.3: High Density Polyethylene

The density of HDPE can range from 930 to 970 kg/m^3 HDPE has little branching, giving it stronger intermolecular forces and tensile strength. It is also harder and more opaque and can withstand somewhat higher temperature (120 °C/248
°F for short periods) HDPE is resistant to many different solvents. It is a food-grade plastic that is safe for storing perishable goods such as milk, but it is not designed for long-term food storage.

The HDPE process consists of:

1. **Polymerization:** Ethylene monomers are polymerized in solvent together with catalyst, hydrogen and co monomer. The polymerization heat is cooled through external circulation heat exchanger. The reacted slurry is transferred to the separation/drying process.
2. **Separation/Drying:** Slurry is transferred to a high-speed centrifuge from which it is separated into solvent and wet powders. The separated solvent is supplied to the reactor and some solvents are recycled in the process through refining. Wet powders are transferred to the powder dryer and dried.
3. **Transfer/Extrusion:** The wet powders are dried in the powder dryer by evaporating the solvent with high-temperature nitrogen and steam. The evaporated solvent is recovered by the scrubber. The dried powders are transferred to the extrusion process where they are melted and pelletized in the extruder. Then they are transferred to the storage silo.

4. **Storage & Packaging:** The products transferred to the pellet silo are cooled by air and homogenized.

Application:

1. HDPE filament for 3D printers
2. Strong packaging materials: bottle caps, plastic milk bottles, drums, bulk containers for industrial use
3. Fibres for ropes, nets, and industrial fabrics
4. Vehicle fuel tanks, boat parts
5. HDPE pipes and tubing

3.1.4 LOW DENSITY POLYETHYLENE

Low-density polyethylene is a thermoplastic made from the monomer ethylene. LDPE has a Society of Plastics resin code as 4. Low Density Polyethylene (LDPE) is a semi-rigid and translucent polymer.

Fig 3.4: Low Density Polyethylene

Properties:

- LDPE Melting point: 105 to 115°C
- Density of LDPE: 0.910–0.940 g/cm^3
- Chemical resistance of LDPE:
- Good resistance to alcohols, dilute alkalis and acids
- Limited resistance to aliphatic and aromatic hydrocarbons, mineral oils, oxidizing agents and halogenated hydrocarbons
- Temperature resistance up to 80°C continuously and 95°C for shorter times.
- Low cost polymer with good processability
- High impact strength at low temperature, good weatherability
- Excellent electrical insulating properties
- Very low water absorption
- FDA compliant
- Transparent in thin film form

Applications:

LDPE is widely used for manufacturing various containers, dispensing bottles, wash bottles, tubing, plastic parts for computer components, and various moulded laboratory equipment. Its most common use is in plastic bags. Other products made from it include:

- Trays and general purpose containers
- Corrosion-resistant work surfaces
- Parts that need to be weldable and machinable
- Parts that require flexibility, for which it serves very well

- Very soft and pliable parts such as snap-on lids, six pack rings

- Juice and milk cartons are made of liquid packaging board, a laminateof paperboard and LDPE (as the waterproof inner and outer layer), and often with of a layer of aluminum foil (thus becoming aseptic packaging)

- Packaging for computer hardware, such as hard disk drives, screen cards, and optical disc drives

- Playground slides

3.1.5 LINEAR LOW DENSITY POLYETHYLENE

Linear low-density polyethylene (LLDPE) is a substantially linear polymer (polyethylene), with significant numbers of short branches, commonly made by copolymerization of ethylene with longer-chain olefins.Linear low-density polyethylene (LLDPE) is a substantially linear polymer (polyethylene), with significant numbers of short branches, commonly made by copolymerization of ethylene with longer-chain olefins.

Linear low-density polyethylene differs structurally from conventional low- density polyethylene (LDPE) because of the absence of long chain branching. The linearity of LLDPE results from the different manufacturing processes of LLDPE and LDPE.

In general, LLDPE is produced at lower temperatures and pressures by copolymerization of ethylene and such higher alpha-olefins as butene, hexene, or octene. The copolymerization process produces an LLDPE polymer that has a narrower molecular weight distribution than conventional LDPE and in combination with the linear structure, significantly different rheological properties.

Fig 3.5: Linear low density polyethylene

Properties:

- It has higher tensile strength
- It have higher impact
- It has puncture resistance more than Linear Density Polyethylene
- It is very flexible and elongates under stress
- It has good resistance to chemicals
- Density 0.917 – 0.930 g/cm^3
- It has good electrical properties
- Tensile strength 0.20 – 0.40 N/mm^2 and impact strength no break
- Thermal Coefficient of expansion – 6

The LDPE process consists in five operations:

1. **The compression of gas:** Gaseous ethylene is supplied and melted with a partof unreacted gas from the process in order to be compress in the first reactor. This new compressed gas is melted again with unreacted gas and compress inthe second compressor.
2. **The polymerization:** An initiator (organic peroxide) is added to the second compressed gas into the reactor and the materials are mixed inside the reactor through stirrer. Polymerization is obtained in the reactor at a certain pressureand temperature.
3. **The separation of gas:** The unreacted gas is then separated by 3 levels of separators. Those unreacted gas will be injected before the compressor, notice than a part will be exclude from the process.
4. **The extrusion:** Once the unreacted gas is removed, the polymers can be extruded and pelletized.
5. **The storage and packaging:** The pellets are dried through dryer and classified pellets by pellet size. The degassing is done by hot air injection.

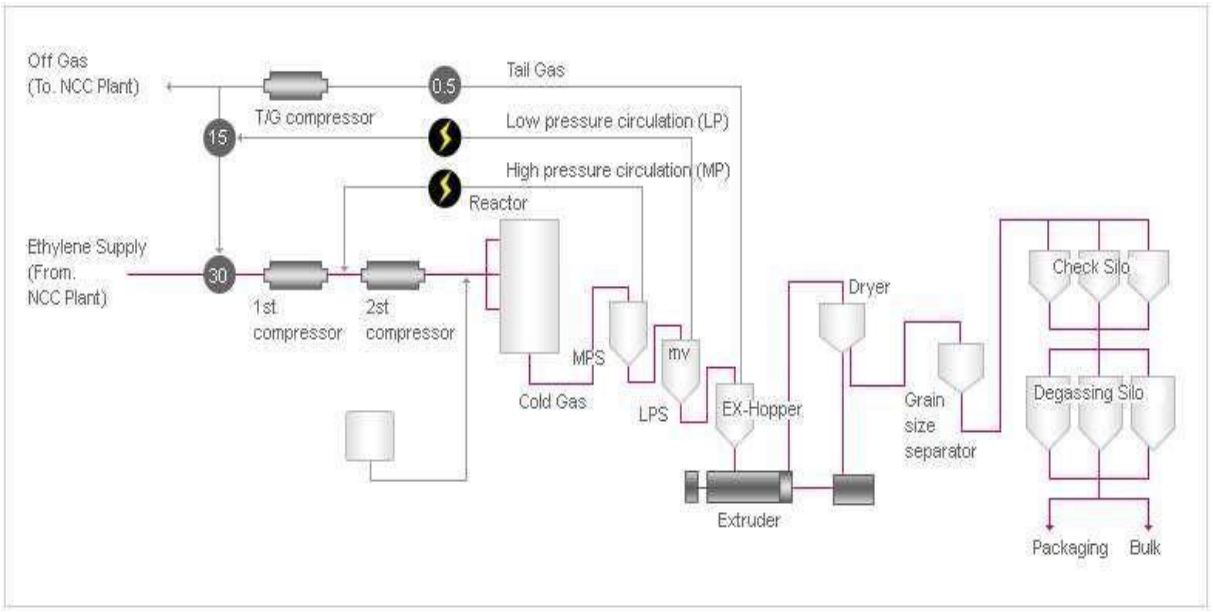


Fig 3.6: Production Process of LDPE(Open source)

Applications:

Some of the applications of LDPE are as follows:

- It is used for plastic bags and sheets (where it allows using lower thickness than comparable LDPE)
- It is used as plastic wrap and stretch wrap
- It is used pouches, toys, covers, lids, pipes
- It can be used for buckets and containers
- It can be used for covering of cables

3.1.6 TOLUENE

Toluene is an aromatic hydrocarbon composed of a benzene ring linked to one methyl group. Toluene is used a solvent or as a chemical intermediate in various industrial applications. Rapid inhalation of high concentrations of toluene can cause severe neurological complications. Toluene appears as a clear colorless liquid with a

characteristic aromatic odor. Less dense than water (7.2 lb/gal) and insoluble in water. Hence floats on water. Vapors heavier than air. May be toxic by inhalation, ingestionor skin contact. Used in aviation and automotive fuels, as a solvent, and to make other chemicals. It's chemical formulae is C_7H_8.

Fig 3.7: Toluene

Properties:

- It has density of 0.865 g/ml at 25°C
- It has a flash point 40°F
- It is colourless liquid
- It has vapour pressure of 2.8 kPa

Applications:

- It is a solvent in paints, lacquers, thinners, glues, correction fluid, and nail polishremover
- Toluene can be used as an octane booster in gasoline fuels used in internalcombustion engine

3.2 METHODOLOGY

Methodology is a contextual framework for research, a coherent and logical scheme based on views, beliefs, and values that guides the choices researchers make.

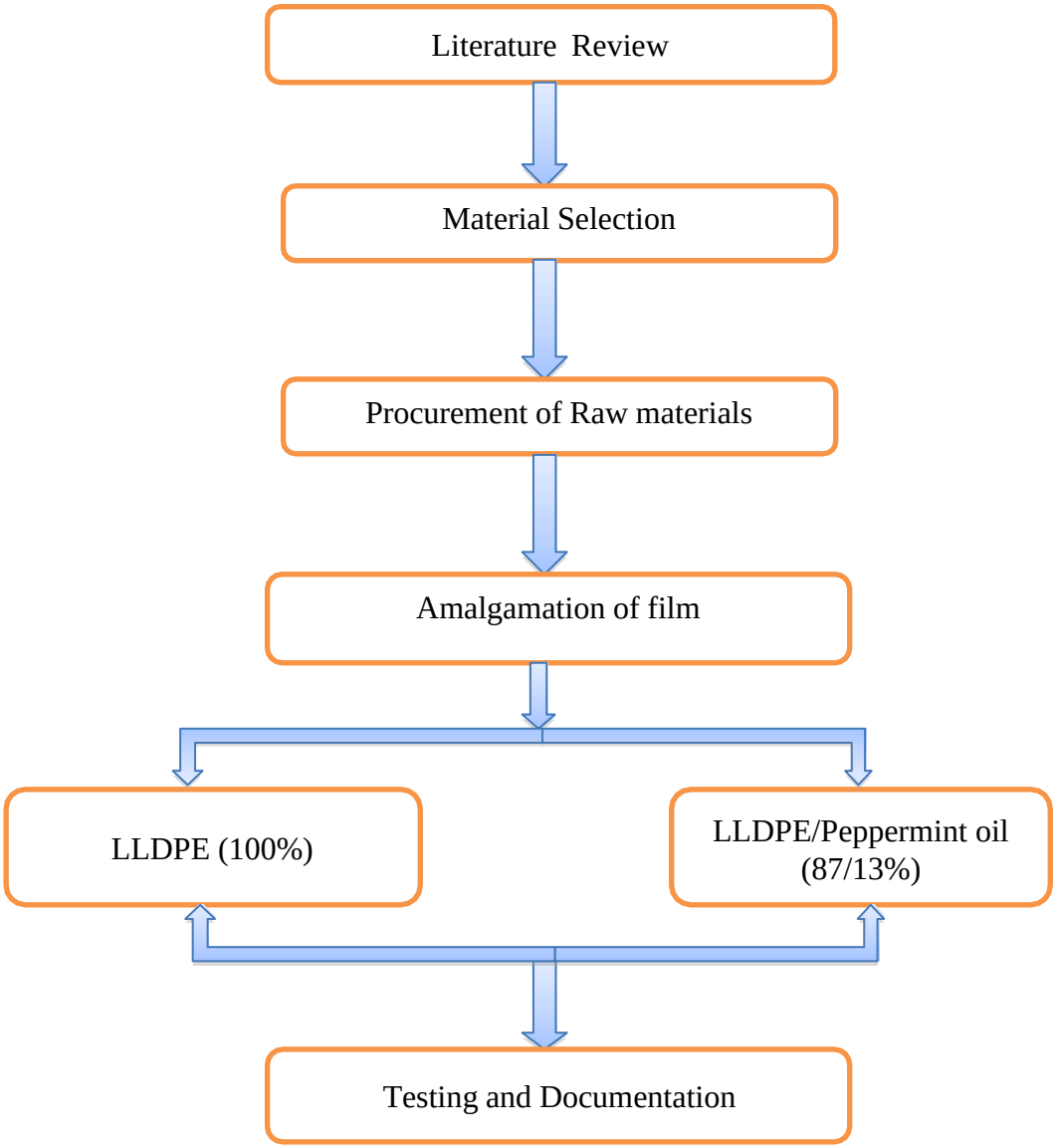


Fig 3.8: Methodology

CHAPTER 4 SYNTHESIS OF FILM

4.1 SYNTHESIS

The process of making raw material into polymer film is called as synthesis and there are many methods of producing the polymer film they are:

1. Melt forming

These are mostly used when the polymer raw materials are in melt form at elevated temperature. Mostly

all the synthetic polymer films are made by these methods.

- Film casting
- Extrusion
- Solid state forming

2. Result processing

These are mostly used when the polymer are soluble in solvents like distilled water, chloroform, glycerol, etc.,. This method is best suited because it is convenient way and easy of producing the film.

- Solvent cast method

4.1.1 SOLVENT CASTING METHOD

In solvent casting, a polymer is dissolved in an organic solvent. Particles, mainly salts, with specific dimensions are then added to the solution. The mixture is shaped into its final geometry. For example, it can be cast in a glass plate to producea membrane or in a three-dimensional mould to produce a scaffold. When the solvent evaporates, it creates a structure of composite material consisting of the particles together with the polymer. The composite material is then placed in a bath which dissolves the particles, leaving behind a porous structure.

Solution Casting Method is one of the simplest methods of producing film. The solvent must be able to dissolve both the polymers and dopants efficiently. One of the advantages with this method is that drying can be done in simple hot air ovens. The method involves the following steps:

1. Preparation of polymer and salt solutions in a common solvent
2. Mixing of solutions in required ratios
3. Uniform stirring of the mixture employing a stirrer or ultrasonic equipment
4. Homogeneous casting of the mixture on the required substrate

5. Drying in an inert atmosphere under vacuum or open atmosphere

Polymer solution casting is a technique that can replace film extrusion to deliver high-quality films with superior optical, mechanical and physical film properties. In polymer solution casting, polymer is dissolved or dispersed in solution, coated onto a carrier substrate, and then the water or solvent is removed by drying to create a solid layer on the carrier. The resulting cast layer can be stripped from the carrier substrate to produce a standalone film. It is a process for forming thermoplastic polymer samples by dipping a mould into a solution of the polymer and drawing off the solvent to leave a polymer film adhering to the mould.

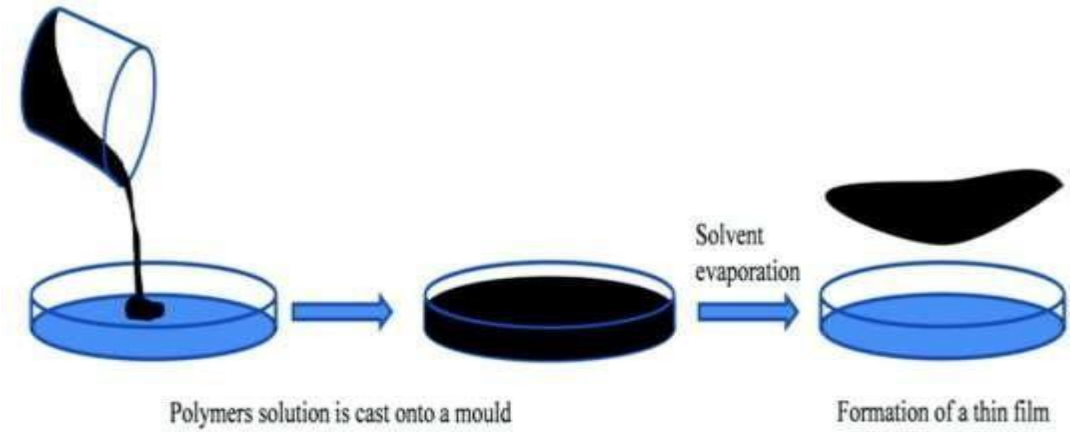


Fig 4.1: Synthesis of Film(Open source)

Manufacturing process advantages of polymer solution casting over traditional film extrusion methods include:

1. Processing at low temperatures, which is valuable for thermally activated films or applications incorporating temperature-sensitive active ingredients.
2. Ability to produce high-temperature resistant films from non-thermoplastic but soluble raw materials.
3. Simplified incorporation of additives and fillers.
4. Quicker changeovers for platforms with many part numbers that are differentiated based on formula.
5. Single pass manufacturing of multi-layer films (the ability to cast a free film, then coat an adhesive and laminate release liner on one side, and coat a top coat on the other side).
6. Wider range of material choices with casting from either aqueous or solvent- based solutions.

4.2 FORMULATION OF FILM

LLDPE (4.0g) was completely dissolved in Toluene (100ml) by vigorous mixing for 4 hours on a magnetic stirrer at 7 ˚C temperature. The peppermint oil (0.5ml) was added to the LLDPE solution and stirred for varying time duration to determine the complete blending of oil in the polymer solution. The resultant solution was poured evenly onto the petri dish plates. Then the solvent was allowed to evaporate at room temperature. After 12 hours of drying, the films were stripped off from the trays.

4.2.1 Defects of film:

The synthesis of film was carried out by mixing LLDPE (4.0gm) with toluene (100ml) under four hour stirring (1000rpm) at 70^{o}C temperature. During synthesis of film, the defects are caused due to improper chemical reaction such as poor miscibility, bond formation, and bubble formation and environmental condition. The below figure represent the defects of LLDPE caused.

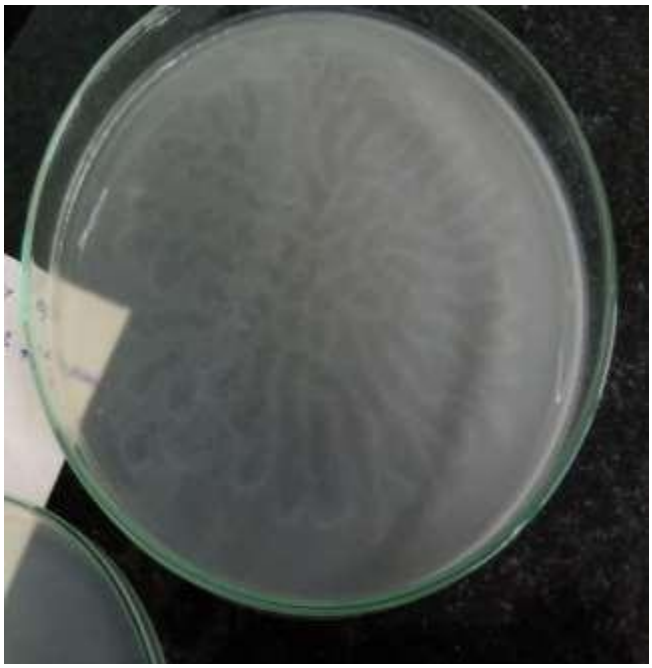


Fig 4.2: LLDPE pure form

Fig 4.3: LLDPE and essential oil

4.2.2 Optimized film:

The synthesis of film was carried out by mixing LLDPE (4.0gm) with toluene (100ml) and LLDPE (4.0gm) with toluene (100ml) with peppermint oil (0.5ml) under four hour stirring (1000rpm) at 70^{o}C temperature. During synthesis of film, the defects such as improper chemical reaction such as poor miscibility, bond formation, and bubble formation were rectified and optimized film was produced. The below figure represent the casted film.

LLDPE (100%)

4.2.2.1 LLDPE/Peppermint oil(87/13%) Fig 4.4: LLDPE films

CHAPTER 5 CHARACTERIZATION OF FILM

Characterization is an analytical branch of polymer which has a goal to improve the performance of the material. These techniques are typically used to determine molecular mass, molecular

structure, morphology, thermal properties, and mechanical properties.

5.1 TENSILE STRENGTH

Tensile strength is a measurement of the force required to pull something such as rope, wire, or a structural beam to the point where it breaks. It is the maximum amount of tensile stress that a material can take before failure, for example breaking. ASTM D882 is a common testing standard that is used to determine the tensile properties of thin plastic films and is commonly used for in-line quality control purposes.

During ASTM D882 testing, specimens are pulled in tension until failure. The crosshead speed is dependent on the length of the specimen and can be calculated by multiplying the initial grip separation (length of the specimen) by the initial strain rate in mm/mm x min. The initial strain rate is conditional on the maximum elongation of the specimen at break. Because plastic films and sheeting tend to be highly elastic, higher crosshead speeds are commonly required.

Fig 5.1 Tensile testing machine

One critical factor in testing to ASTM D882 is using an appropriate preload. Thin film specimens are usually relaxed and not taut when loaded into grips for testing. A preload, which can be easily configured in Bluehill Universal testing software, helps to remove any slack in the specimen prior to recording data during testing, ensuring that results are accurate and repeatable.

5.2 CONTACT ANGLE

The contact angle is the angle, conventionally measured through the liquid, where a liquid–vapor interface meets a solid surface. Polymer films are often used to create decorative and informative graphics for applications such as automobile instrument panels and consumer electronics. The packaging application is also being considered by blending oil in the polymer and making it suitable. In some cases a secondary operation, such as corona treatment, is necessary to promote surface adhesion.

Fig 5.2 Contact angle measurement

The contact angle of a water drop on the polymer surface is an indirect measurement of the surface's ability to accept and hold a coating or resistance given by the blend. According to ASTM D5946 it is measured by taking a unit of water drop on to the samples. 2 mL of pre-calibrated water drop was released on to the surface of LLDPE and its blends. Contact angle apparatus, which is equipped with a CCDcamera, was operated at an acquisition speed of 50 frames per second.

5.3 UV SPECTROSCOPY

The Principle of UV-Visible Spectroscopy is based on the absorption of ultraviolet light or visible light by chemical compounds, which results in the production of distinct spectra. Spectroscopy is based on the interaction between light and matter.

According to ASTM D4329 the UV spectroscopy was measured by transmittance method where the

UV rays are passed from 800nm to 200nm range and the film was tested at the wavelength for the passage light.

Fig 5.3 UV spectroscopy

5.4 RODENT TEST

Packaging is the science, art and technology of enclosing or protecting products for distribution, storage, sale, and use. Packaging also refers to the process of designing, evaluating, and producing packages.

Tertiary packaging is a type of wrapping which protects the manufactured products. Tertiary packaging is used to smooth the progress of the transport and safe handling of goods or grouped packaging.

At tertiary package level the problems arises in storage or warehouse were the rats or so called rodent play their major role in damaging the package. In order to reduce the rodent attack the test of the film need to carried out and in a warehouse environment.

CHAPTER 6 RESULTS AND DISCUSSION

The testing film was carried out and the results are obtained for them respectively and discussed below.

6.1 TENSILE STRENGTH

The LLDPE blends were found to have less tensile strength than LLDPE. It was measured by the tensile testing machine under test speed of 500 mm/min and the values obtained are 2.80MPa of tensile strength for LLDPE and 1.60MPa tensile strength for LLDPE blends. The elongation test was carried on same machine at a speed of 500 mm/min. The values obtained are 66.6% for LLDPE blends and 22.9% for LLDPE which tells that LLDPE blends tend to induce flexibility by addition of plasticizer by a percentage increase of 65.6% than LLDPE.

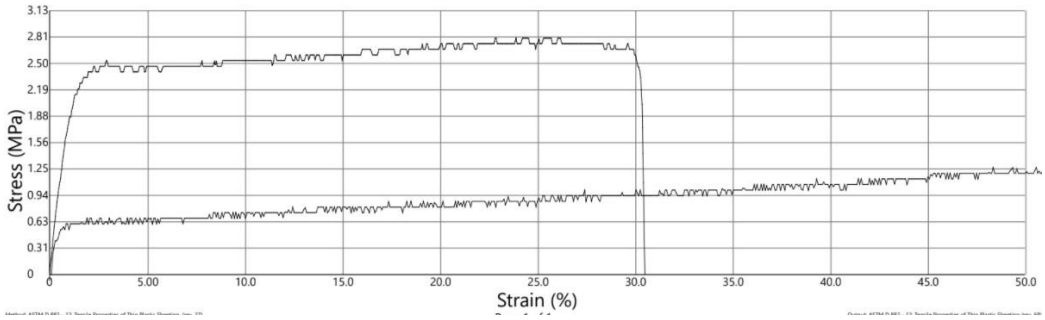
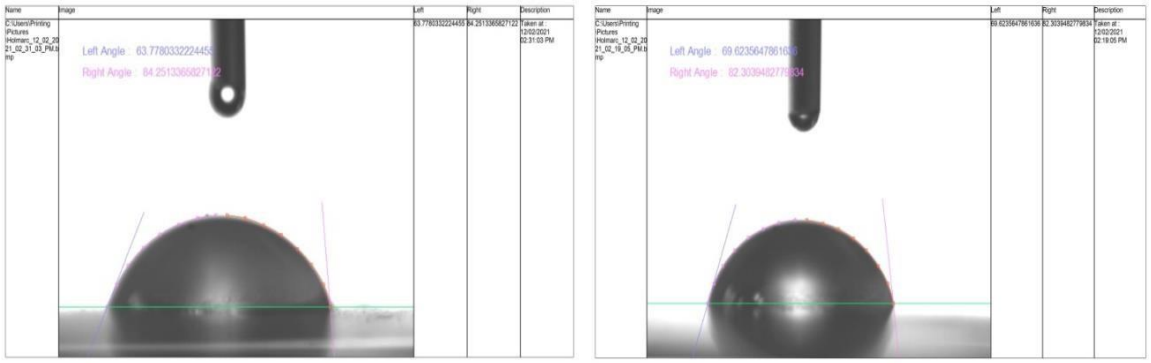


Fig 6.1 Tensile strength

6.2 CONTACT ANGLE

The contact angle is the angle, conventionally measured through the liquid, where a liquid – vapor interface meets a solid surface. In LLDPE the contact angle found was 67^{o} left and 85^{o} right which depicts that it is hydrophobic in nature.



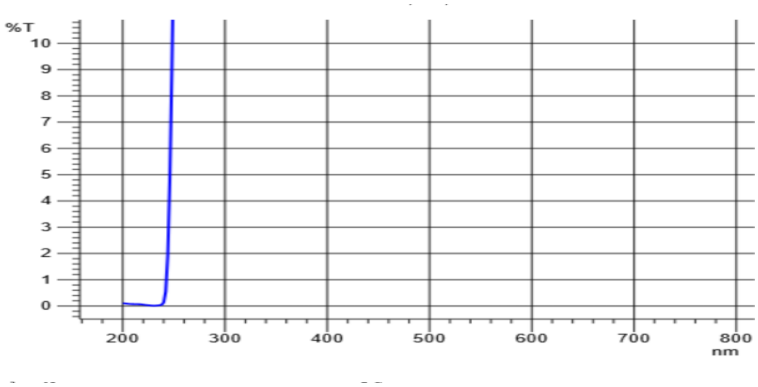
(a) LLDPE (b) LLDPE blend Fig 6.2 Contact angle (a) LLDPE , (b) LLDPE blend

Also the values were taken for LLDPE blends and were found that it has 69^{o} left and 89^{o} right which depicts that it is hydrophobicity has increased than LLDPE by 3%.Hence the produce film will be water repellent also and so it can be used in tertiary packaging.

6.3 UV SPECTROSCOPY

The film produced was tested under UV spectroscopy to check whether it can transmit the light. It was found that the UV light passed through the film but did pass completely and it produced a translucent effect. The LLDPE blend gave that effect than LLDPE and this made the film suitable for tertiary package level.

Fig 6.3 UV spectroscopy value



6.4 RODENT TEST

The rodent test was carried out under warehouse condition, the rat was made to damage the package stored in warehouse and it is found that the LLDPE did get the repellency as the rodent damaged the pack but the LLDPE blend with peppermint oil gave a breakthrough in repelling the rodent and protecting the pack at the warehouse. Thus the LLDPE blends tend to repel rodent than LLDPE.

Fig 6.4 Rodent test

CHAPTER 7 CONCLUSION

In packaging sector the tertiary package level has major level threats like rodents, insects and pests. However the present work dealt with the synthesis of the polymeric film by using linear low density polyethylene and peppermint oil which is derived naturally and used as to improve the characteristics of the film and make the film rodent repellent which is carried out from literature survey. The experimental formulation has been carried out to produce film that would make it suitable fortertiary level packaging. The film was casted by solvent casting method.

Thereafter the optimized film was obtained and was taken for testing purpose. The tensile strength was 1.60MPa for LLDPE blend as compared to LLDPE which is 2.80MPa. The elongation was improved with value of 66.3% for LLDPE blend than LLDPE which is 22.9%. The contact angle was measured for the produced film andthe values of left and right angles are 67ºC and 89ºC respectively. The UV spectroscopy was measured and the peak transmittance value of the film showed that the LLDPE blends produce translucent effect than LLDPE.

The rodent test was carried out and the film was tested against rodent through which it repelled the rodent by the influence of peppermint oil. Thus, the material with LLDPE blends can be a great turn to be used in tertiary packaging level.

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