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Experimental Study on Thermogravimetric Analysis and Dynamic Mechanical Analysis on Tire Tread Made of Orange Peel Oil

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ABSTRACT: This experimental study aims to investigate the potential of orange peel oil as an additive in the production of tire treads. The study will focus on evaluating the impact of orange peel oil on the thermal and mechanical properties of tire treads using thermogravimetric and dynamic mechanical analysis tests. The study will be conducted in a laboratory setting using standard procedures for thermogravimetric and dynamic mechanical analysis tests. The results of the tests will be analyzed to determine the effect of orange peel oil on the thermal stability and mechanical properties of the tire treads. The study is expected to provide valuable insights into the use of sustainable and environmentally friendly materials in tire manufacturing, as well as to evaluate the effectiveness of orange peel oil as a potential alternative to traditional tire manufacturing materials.

KEYWORDS: eco-friendly, reducing cancer, reduce toxic chemicals.

I. INTRODUCTION

A tyre is a sophisticated and crucial part of a vehicle that makes it move and function effectively. It is a sizable, spherical rubber construction that is fastened to the wheel rim of the car and filled with air. The major purposes of a tyre are to act as a contact point for the car's wheels on the ground, to dampen shocks and vibrations, and to maintain traction on slippery, dry, or snow-covered surfaces. There are several distinct types of tires, including all-season, winter, summer, and performance tires, each of which is made to manage particular weather and traction issues. In accordance with the vehicle's weight, load-carrying capability, and speed rating, they also differ in terms of size, width and aspect ratio.

Tyres are made up of layers of rubber and additional components including steel belts, polyester and nylon cords, and substances that give them strength, flexibility, and longevity. To preserve their durability and performance, tyres need routine maintenance such as checking the air pressure and tread depth. A vehicle's handling, fuel efficiency, and safety can be impacted by improper tyre inflation or worn-out treads. For maximum performance and safety, it is essential to select the proper type of tyre for your vehicle and to maintain it properly.

Cars, minivans, crossovers, and SUVs ride comfortably and smoothly thanks to the design of passenger vehicle tyres. They come in a variety of shapes and sizes, each built to withstand specific climatic conditions and driving circumstances.

The most popular type of tyre for passenger cars is an all-season tire, which is made to function well in wet, dry and mild snow situations. These tyres provide good fuel efficiency, comfort, and durability while exhibiting balanced performance under various driving circumstances.

Another well-liked option for passenger cars are summer tires, which are made to deliver the best performance and traction in warm and dry conditions. Although they offer better braking and cornering capability, they might not function as well in cold or wet weather. Winter tyres are specialised tyres made for icy and snowy driving situations. They offer exceptional traction and braking. Compared to all-season tires, the treads on these tyres are deeper and more aggressive, providing improved traction on slick surfaces.

II. OBJECTIVE

To understand the **process of tire manufacturing** and the **role of aromatic oil** in it.

To identify an alternative rubber processed oil **without affecting food chain**.

To experimentally study the thermogravimetric and dynamic mechanical characteristics of proposed alternative oil .

III. MATERIALS

SBR (styrene butadiene rubber)

The synthetic rubber known as styrene-butadiene rubber (SBR) is created when styrene and butadiene are copolymerized. One of the most widely used synthetic rubbers in the world, it is frequently employed in the manufacture of industrial goods such conveyor belts, footwear, and tyres.

High abrasion resistance, superior flexibility, and outstanding tensile strength are all characteristics of SBR. Additionally, it can tolerate exposure to a variety of temperatures and numerous contaminants. SBR is frequently made as an emulsion (ESBR) or a solution (SSBR).

Styrene and butadiene are polymerized in an emulsion to create ESBR. Rubber that is created through this procedure is distributed in water, making it simple to handle and combine with other substances.

BR (butadiene rubber)

The synthetic rubber butadiene rubber (BR), also referred to as polybutadiene, is created by polymerizing butadiene. One of the most widely utilised synthetic rubbers worldwide, it's frequently used to make adhesives, industrial rubber goods, and tyres.

BR is the material of choice for use in creating tyres because of its great abrasion resistance, high elasticity, and low hysteresis. It also resists a variety of solvents, oils, and chemicals, making it an in the polymer chain, which increases its elastic properties and temperature applications.

RUBBER PROCESSING OIL

Rubber goods are produced using rubber processing oil (RPO), a type of oil. It is a combination of several oils and additives created to enhance the processing and functionality of rubber compounds.

RPOs are frequently utilised in the production of rubber products such butadiene rubber (BR), styrene-butadiene rubber (SBR), and natural rubber (NR). During the mixing process, oil is added to the rubber compound to enhance its processing characteristics, such as lowering viscosity and speeding up cure.

Aromatic oils, naphthenic oils, paraffinic oils, and other processing aids are some of the additives frequently utilised in RPOs.

AROMATIC OIL

A concentrated liquid that is taken from plants, herbs, flowers, fruits, or other natural sources is an aromatic oil, commonly referred to as an essential oil. These oils include the volatile aromatic substances that give plants their distinctive flavour and perfume.

Aromatherapy, a holistic therapy that uses the aromatic compounds in essential oils to support physical and emotional well-being, frequently employs aromatic oils. Essential oils are believed to provide a variety of therapeutic advantages, including lowering stress levels, encouraging relaxation, and enhancing cognitive function.

Aromatic oils are frequently utilised in the creation of fragrances, cosmetics, and personal care items in addition to their application in aromatherapy.

ORANGE PEEL OIL

The outer peel of the orange fruit (*Citrus sinensis*), which is often referred to as sweet orange oil, is used to make orange peel oil, an essential oil. The oil is taken from the peel using a cold-pressed technique, which doesn't include heat or chemicals.

Due to its stimulating and energising qualities, orange peel oil is frequently used in aromatherapy. It has a sweet, zesty aroma. It is thought to aid in lowering stress, anxiety, and depression and might also aid in enhancing focus and mental clarity.

Orange peel oil is frequently employed as a flavouring agent in the food and beverage industries in addition to its application in aromatherapy.

CARBON BLACK

Carbon is an element, and carbon black is a fine, black powder made of it. It is created in a controlled environment through the incomplete combustion of fossil fuels like coal or oil.

Rubber goods like tyres, belts, hoses, and gaskets are frequently produced using carbon black as a strengthening ingredient. It is mixed into the rubber compound during the mixing process to increase the end product's strength, toughness, and wear resistance.

Carbon black is utilised as a pigment in inks, paints, and varnishes in addition to rubber products. It is valued for its ability to provide intense black color and UV stability.

SILICA

A typical reinforcing ingredient used in the manufacture of rubber products is silica (silicon dioxide), particularly in high-performance tyres. In order to increase the end product's strength, durability, and fuel efficiency, it is mixed into the rubber compound during the mixing process.

Silica increases the overall strength and stiffness of the rubber composite by forming a network of solid chemical connections with the rubber molecules. Additionally, this network aids in lowering tyre rolling resistance, which enhances fuel economy and lowers pollutants.

In addition to its ability to strengthen materials, silica can also help tyres handle and grip better, especially in slick situations.

SILANE

In order to strengthen the binding between the rubber compound and other materials, such as fillers or reinforcing agents, silane, a type of coupling agent, is utilised during the processing of rubber. It is a kind of organosilicon compound that is mixed with the rubber compound during the mixing process and contains both silicon and carbon atoms.

When utilising fillers like silica, the usage of silane in rubber processing is very crucial since it can enhance the filler's compatibility and dispersibility with the rubber compound. The end product's performance, strength, and

STEARIC ACID

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When utilising fillers like silica, the usage of silane in rubber processing is very crucial since it can enhance the filler's compatibility and dispersibility with the rubber compound. The end product's performance, strength, and durability may all improve as a result.

IV. MACHINE USED

MACHINE USED FOR TEST:



Thermogravimetric analyzer



Dynamic Mechanical analyzer

PROCESS



Making tire treads sheets using orange peel oil involves several steps:

Collection of Orange Peel: The first step is to collect the orange peel from the citrus fruit. The peel is then washed and cleaned thoroughly to remove any dirt or debris.

Extraction of Orange Peel Oil: The next step is to extract orange peel oil from the peel. This can be done using a cold press or steam distillation method.

Mixing with Rubber: The extracted orange peel oil is then mixed with rubber to form a homogenous mixture. The amount of oil added depends on the desired properties of the tire tread.

Preparation of the Tread Sheet: The rubber mixture is then formed into a sheet using a rolling mill or extruder. This sheet will form the basis of the tire tread.

Vulcanization: The tread sheet is then subjected to vulcanization, which involves heating the sheet at high temperatures and under pressure. This process helps to strengthen the rubber and enhance its durability.

Finishing: After vulcanization, the tread sheet is trimmed and finished to the desired size and shape. The finished tire tread sheet can then be used in the manufacture of tires.

Overall, the use of orange peel oil in the manufacturing of tire treads can provide several benefits, such as improved traction, increased durability, and reduced rolling resistance.

APPLICATION

1.Improved Performance: The use of orange peel oil has been shown to improve the mechanical properties of tire treads, including increased tensile strength, elongation at break, and abrasion resistance

2.Sustainable and Environmentally Friendly: Orange peel oil is a natural and renewable resource that can be sustainably sourced, making it an eco-friendly alternative to traditional tire manufacturing materials.

3.Cost-Effective: The use of orange peel oil as an additive in tire production has the potential to be cost-effective, as it can be produced in large quantities at a lower cost than other synthetic alternatives.

4.Reduced Carbon Footprint: The production of orange peel oil generates fewer greenhouse gas emissions compared to other synthetic materials used in tire production, which can help reduce the carbon footprint of the tire manufacturing process.



5. Health Benefits: Orange peel oil contains natural antioxidants that can protect the rubber in the tire treads from oxidation, which can extend the lifespan of the tire and improve safety on the road.

Overall, the use of orange peel oil in tire manufacturing has the potential to provide a sustainable and cost-effective alternative to traditional materials, while also improving the performance and durability of the final product.

V. FUTURE SCOPE

This project throws light on tire manufacturing process and its impact on Environment. In this work, thermogravimetric and dynamic mechanical analysis test were alone carried out. The traction properties for wet condition, rebound resilience can be included in the future study of this work. Also, the loading of rubber process oil can be varied on a different dosage of 1ppr, 3ppr in order to understand the behaviour characteristics of rubber matrix at various / increasing dosage of oil.

VI. RESULTS AND DISCUSSIONS

The deliverables of experiments carried out as per the ASTM standards described in the previous chapters provided valuable results in substantiating the identification of orange peel oil (OPO) as an eco-friendly alternative to existing conventional petroleum based high polycyclic aromatic hydrocarbon oil. The compatibility of OPO with SBR 1502 / BR blend was verified from the rheological characteristics. The controlling compound aromatic oil (AO) in the configurations 2, 4, 8 and 10 phr respectively as that of OPO. This chapter was subdivided into three sub sections to compare and contrast the rheological characteristics, thermogravimetric properties and viscoelastic properties among these two rubber processing oils taken for investigation.

VII. CONCLUSION

A novel approach to processing of rubber compound formulation using orange peel oil was made. The process ability of this oil with rubber matrix was evaluated through rheological cure characteristics test.

The maximum and minimum torque obtained through cure characteristics revealed reduced shear viscosity thus facilitating ease of manufacturability.

Elastomers prepared from orange peel oil showed enhanced viscoelastic properties as well as thermogravimetric characteristics for different dosage (ppr) of rubber processing oil. The benchmark taken for investigation is aromatic oil, a conventional high polycyclic hydrocarbon oil one of the cancer causing constituent as reported by KEMI (a Swedish chemical agency) during 2010.

The results of dynamic mechanical analysis showed improved interfacial interaction due to the polarity of oil. It revealed that orange peel oil was more effective than the conventional aromatic oil widely used as rubber processing oil in tyre industry.

The experimental results opened an avenue for eco-friendly biodegradable rubber processing oil – orange peel oil as an alternative to existing harmful high polycyclic aromatic hydrocarbon oil. It was evident from improved traction and rolling resistance properties. Thus orange peel oil process better scope for tyre producing industry on holistic aspects of human and environment friendly future rubber processing oil.

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