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Anti-Rust Fluid Formulation from Waste Polymers for Auto Chassis Application

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Abstract
Conventional rust paints though effective are expensive and highly toxic. On the other hand packaged water sachets are dumped indiscriminately and served as a source of contaminant to the environment. This research was focused on the possibility of recycling low density waster materials as anti-rust fluid for auto-chassis. The waste 'pure water sachets' polyethylene bags were gathered, sorted, washed, ground into small chips and several chemical additives like: toluene, acetone, benzene, xylene, potassium persulphate ,turpentine, kerosene, petrol and hydrogen perioxide were added to the ground low density polymer chips at different stages of the anti-rust formulation. The formulated anti-rust paint was tested and compared with the conventional anti-rust paint. The actual results tested on a piece of metal. The conventional anti-rust had the kinematic viscosity of 0.78centi; drying time of 1.30 hours to 2 hours, specific gravity of 1.1, spreading time of 1.20-1.30 square, opacity –one coat finish, low flow rate and maximum gloss. Similarly the formulated anti-rust had the kinematic viscosity of 1.6centi ;drying time of 1.30 hours to 2 hours, specific gravity of 0.9, spreading time of 2.50-3.50 square, opacity –two coat finish, low flow rate and maximum gloss. The two anti-rust paints had similar rate of corrosion. However, the cost of four litres of conventional paint was ₦3000.00 (Three thousand naira) while that of anti-rust paint was ₦800.00 (Eight hundred) naira at Uyo metropolis in Akwa Ibom State, Nigeria. The results show that the formulated paint from waste 'pure water sachets' polymer bags can serve as an alternative to conventional anti-rust paint
Keywords: Anti-rust, auto-chassis, fluid , paint, polymers waste, formulation.

I. Introduction

Corrosion is the decay and loss of metal due to chemical reaction between the metal and it's environment. It is a transformation process in which the metal passes from elemental form to a combined or compound form. In corrosion, the metal will undergo a voluntary reaction with the surroundings [1]. Corrosion of materials has continued to receive interest in the technological world. In the field of corrosion inhibition, persistence work has been going on for efficient ways of combating the corrosion of metals.

Corrosion is the chemical disintegration of a substance into its component atoms due to the reaction with the environment. It is the degradation of metals commonly referred to as rust. Corrosion of metallic structures causes huge economic impacts. Corrosion is a serious concern in the oil and gas industry as in well tubings [2].Metallic corrosion destroys and damages engineering structures including pipelines, bridges, automobiles, storage tanks, ships and airplanes. Various methods devised to minimize the impact of corrosion include: anti corrosion-special metallic and organic coatings protect metals from corroding. They are particularly effective in protecting metals that are exposed to excessive levels of humidity and saline waters. Protective anti-corrosive coatings consist of several layers, including a pretreated layer. Galvanizing-It is an anti-corrosive method in which a metal, typically steel or fabricated iron is dipped into a molten zinc bath. The process also called hot-dip galvanizing and is used in all major industries and application that use steel and iron. Anti-corrosion inhibitors-They are substances when added to environment in small amounts effectively reduce the rate of corrosion of all exposed metals. They are used in the chemical, petroleum refining gas and oil production industries. Examples include sodium nitrite, chromates amines, phosphate, ascorbic acid, hexamine and cinnamaldelyde. Anti-corrosion polyethylene sheaths or jackets provide external corrosion protection to pipes and cables. They typically consist of a thick, high density sheath of polyethylene plastic extruded over an adhesive layer and finally fixed against corrosion and humidity in various conditions. The dual polyethylene sheath anti-corrosion method is commonly used for underground pipes and wiring system.

Generally, corrosion is a chemical or electrochemical attack on a metal by its surroundings such that the metal is converted into an oxide, salt or some other compound. It may be brought about by an almost unlimited number of bases and salts. It may also occur at elevated temperatures in media which are inert when or below room temperature. The metals may be corroded as a result of electrochemical reactions between a metal surface and the environment. Many corrosion phenomena are essentially electrochemical in nature and involve the presence of an electrolyte, usually aqueous solution of acid or alkali and referred to as wet corrosion. All other corrosion phenomenon involving chemical reaction between metal and gas or a liquid which is not an electrolyte is classified as dry corrosion. There is however no sharp dividing line between these two. Generally corrosion is divided into: chemical or dry corrosion and electrochemical corrosion,

Factors influencing corrosion are: Chemical nature of metal-composition, distribution of secondary phases, voids, inclusion, dissolve metallic particles; environment-concentration, temperature and movement of corrodents and presence of electrochemical couples, surface films and stresses internal structure and nature of engineering application.

A Polymer is a group of many units [3]. A polymer is a large 'molecule' composed of repeating structural typically connected by chemical bonds like covalent bonds .Polymer is often used as a synonym for plastic but many biological and inorganic molecules are also polymeric. Plastics more commonly refers to the way a material behaves under applied forces or behave when it melts and flows. Commercial polymers are formed through chemical reactions in vessels under heat and pressure. Other ingredients are added to control how the polymer is formed and produced the proper molecular length and desired properties. The chemical process is called polymerization.

Polymers are characterized in many ways by chemical, physical structure: mechanical, thermal, optical or electrical properties. The mechanical properties include - strength, modulus (tensile and flexural), elongation, hardness, impact strength; thermal properties include-heat deflection temperature, glass transition temperature, heat capacity, thermal conductivity, thermal expansion coefficient; the optical properties include: light transmission, haze and refractive index. The electrical properties include: surface and volume expansion, dielectric constant, dielectric strength, dissipation factor and breakdown voltage. The environmental properties are: chemical resistance, flame resistance, oxygen index and water absorption.

The morphology of Polymers may be crystalline, orientation and composition. Polymers are classified into many groups namely: Thermoplastic, crystalline polymer, addition and condensation polymers, commodity polymers, engineering polymers and performance polymers. Thermoplastic are materials which can be reheated and formed repeatedly. The shape of the polymer molecules is generally linear or slightly branched, allowing them to flow under pressure, when heated above effective melting point. Crystalline polymers are polymers with structure which have simple backbones and tend to be flexible and can be folded up to form very dry tightly packed and ordered ''crystalline areas. The level of crystalline varies from 0 to 100%. Addition and condensation polymers include nylons, acetals and polyesters and are made by condensation or step reaction polymerization of monomers of different chemicals combining to form chains of alternating chemical group.

Commodity polymers have relatively low physical properties. They are used for inexpensive or disposable consumer or industrial products or packaging, they have limited stress and low temperature resistance, but are well suited to high volume production. Polystyrene and polypropylene are good examples. Engineering polymers have higher strength and normal resistance. Their price may range from two to ten times as much as commodity polymer. They are used in enclosure, structural frame resistance and have the ability to endure cyclic stress loading. Examples are polyesters, polycarbonate and ABS. Performance polymers are at the highest end of the spectrum, with very high strength and thermal resistance. They are used in high temperature, high stress application, in hash environments and in generally low medium volume production. Examples include PEEK and polyetherindes.

There are many processing methods for polymers. Commercial processing equipment from per thousand naira to many millions of naira. In addition to the equipment itself, tools are generally required to make a particular shape to force a monomer or pre-polymer mixture into right shape. Such methods include moulding, blow moulding, extension, casting, forming, calendaring, coating and spinning.

Solid waste constitutes an immense environmental challenge in Nigeria [4]. Utilization of non-biodegradable polymeric waste for energy recovery stands as a better option to solve the staggering environmental problem and as well as compensates the prevalent high energy demand [5]**.**Waste polymers are also obtained from multilayer packaging materials[6] [7] Pollution caused by plastics and rubber has become an issue of global concern.

Paints are classified based on the industry [8]. [9] outlined the procedures for production of paints. Clays, depending on the quantity are also used in the production of paints [10].

Anti-rust fluid is a surface prevention of ferrous structures or equipment to mitigate the formation of iron oxide on the surface of a metal. Anti-rust is a term used to describe number of substances use for protecting metal surface against chemical attack by water or other contaminants.

The barrier might be due purely to the properties of polymer to the inclusion of inert pigment that act to increase the length of the diffusion path through the coating. Anti-rust is a fluid with viscosity, dry time and flowing properties dictated by formation. It normally consist of solvent, binder, pigments and additives, waste polymer which may be applied in relatively thin layer and which changes to a thin opaque continuous film. It may or may not be reversible and may occur by evaporation of solvent or by chemical reaction or by a combination of the two.

The surface of many objects corrodes and deteriorates when exposed to air as a result of hazardous effect of weather. They also wear when subjected to chemical oxidation and mechanical abrasion if not well protected. Anti-rust are used to protect and decorate such surfaces and objects for durability purposes. This is achieved by speeding, spraying, dipping, flow coating, use of brush.

Polyethylene is an essential thermoplastic material use for anti-rust fluid production. It is produced by polymerizing ethylene gas with a catalyst in a reactor. Polyethylene are characterized by their low cost, light weight, excellent low temperature properties. T exhibits excellent resistance to gamma rays in atomic radiation and is non toxic, tough, near-zero moisture absorption, excellent chemical resistance, excellent electrical insulating properties, low coefficient of friction and ease of processing. Polyethylene is divided into two main categories: low density polyethylene (LDPE) and high density polyethylene (HDPE).LDPE is flexible and has impact strength but relatively low heat resistance. Dielectric properties at room temperature are considered excellent. HDPE has greater stiffness, rigidity, heat resistance and increased resistance to permeability than HDPE. HDPE are classified as either homopoymer which are stiffer or copolymer which are more stress-crack resistance. HDPE is used for structural application as it almost four times in tensile strength and three times in compressive strength than LDPE. HDPE has working temperature of $100^oC - 140^oC$ under low local condition and it may be autoclaved at sterilization temperatures. The properties of anti-rust fluid include: Gloss, flow, adhesion and, drying time.

Gloss is one of the most important properties of good quality of anti-rust. It is the measure of the degree of specula reflection. The different characteristics that are considered are: intensity of specula reflection or brightness at or close to the specula angle; the distinction images- the details that can be resolved in a pattern of reflection surface grazing, that is preferential reflection near the specula angle for light at near grazing incidenties shows a gross value of 100%[]. Flow is the measure of visco-elastic behavior of the anti-rust fluid. For the anti-rust fluid to adequate flow time, it is important that the rheological behaviour of the anti-rust should not be interfere with the flow. It must exhibit considerable degree of Newtonian behavior, with shear force effect on the viscosities. Adhesion is the measure of the adherence of the anti-rust to the substance or object. The adhesion properties show the extent of the positive and decorative capacity of the anti-rust. Adhesion determines the quality of the binder used in the manufacture of the ant-rust paint. The drying time is the time taken for the anti-rust film to dry completely to a thin continuous opaque. A high quality anti-rust show a short time because of the type of film used. The process that converts the material into solid opaque film is complex. More coating undergoes one or a combination of the following three processes: Evaporation, polymerization and coalescence. Evaporation occurs soon after the coating is applied and is the changing of the turpentine (thinner) and vapourized into the atmosphere. In polymerization, certain elements in the film former are combined to produce a solid state. This is a reasonably fast process when applied to spirit borne coating which contains no drying oil. It is very slow after initial oxidation has occurred in the anti-rust fluid. A thinner may have a secondary function, that keeps apart particles of resin which come into contact with the solid film. In the drying process the coalescing or coming together occur as the thinner has evaporated.

The main functions of the anti-rust fluid include: Aesthetic purpose-It beatifies the material by enhancing appearance in terms of colour, gloss and texture; protective – It protects the surface against corrosion, moisture, solar radiation, chemical and mechanical damages; and functional purpose- this include road material ,football, table tennis boards, etc.

of protecting a substrate from the detrimental effects of the environment is to coat it with polymer barrier of anti-rust to isolate it from the surrounding. It can be done by coating, surface treatment, chemicals, electroplating, cathodic and anodic arrangement or other means. Rust preventives are one of the groups of products, often mixed with petroleum thinners. The main objective of this research is to produce anti-rust fluid from waste polymers for auto chassis applications and also to determine its economic production compared to conventional anti-rust paint.

II. Materials and Methods

The materials used in this research were: Waste polyethylene (sachet water), crushing machine, recycling machine, heat exchanger or cooling medium, cutting machine, receiver or collector, solvents- toluene, acetone, benzene, xylene, potassium persulphate, turpentine, kerosene, petrol and hydrogen peroxide; measuring cylinder, fume boards, weighing balance, thermometer, stop watch, test tube and test tube holder. Electrically

operated oven, electrically operated grinder, spacula and string rod, electrically operated heating mantle, safety eye goggle, viscometer and a beaker.

2.1 Procedure for recycling waste polyethylene

The waste polyethylene were gathered and sorted. They were later washed, rinsed and dried. The polyethylene was weighed using the automatic digital weighing machine. They were subsequently inserted into the crushing machine. The crushed waste polyethylene was made to pass through recycling machine then to the hot heater, where melting process occurred. From the heater, the melted polyethylene was allowed to pass through water for cooling and solidification. The solidified waste polyethylene '' long needle-like shape' were made to pass through the cutting machine to cut the solidified waste polyethylene into tiny chips and collected at the receiver.

2.2 Polyethylene Waste Formulation

20g of polyethylene waste was made to dissolve in 400ml of toluene, 100ml of benzene, 1ooML of acetone, 50ml of xylene, 10ml of hydrogen peroxide, 3.0g of potassium persulphate at an elevated temperature of $79^{\circ}C$,After the dissolution process at elevated temperature, 0.68ml of petrol was added and the solution allowed to cool to $55^{\circ}C$. At $55^{\circ}C$, 0.2ml of petrol was added. The dissolved waste polyethylene become a paste. Time lap for dissolution was 33 minutes 0.6 seconds. The treated polyethylene was ground into fine paste.

2.3 Procedure for Anti-Rust Base Formulation

A clean dry beaker (reactor) was placed on the weighing machine and about 0.11l of solvent (kerosene and petrol) in the ratio of 1:4 was added About 0.75ml of alkyid-resin (linseed oil) was added to the mixture and thoroughly mixed.3.5g of calcium drier was added to facilitate the dispersion of the pigment and about 0.8g of universal dispersant added as a wetting agent. This was followed by the addition of 0.4g of easy gel as suspending agent and the mixture mixed thoroughly at every point of material addition. 12.3g of red oxide was added. Again, 2.5g to 3.5g of cobalt-drier (cobalt linoleate siccative) for surface drying and mixture was thoroughly mixed. About 2.6g of lea drier was then added and mixed and finally 0.05ml of petrol was added and thoroughly mixed.

50g of formulated polyethylene paste was measured and combined with 100g of anti-rust base fluid in a beater and thoroughly blended and ground to produce the anti-rust fluid from waste polymer for automobile chassis application

2.4 Tests of the properties of the anti-rust fluids

Various tests were conducted to determine the properties of the anti-rust fluid, such as the absolute viscosity, kinematic viscosity, drying time, specific gravity, spreading time opacity, flow and gloss. In addition anti-corrosion test was done to determine its resistance to corrosion.

III. Results and Discussion

3.1 Results

The materials used in the formulation of the anti-rust fluid from waste polymer are presented in Table 1.

Table 1:Materials Used in the formulation of anti-rust paint along with waste polymer

Serial number	Material Description
1	Benzene
2	Acetone
3	Xylene
4	Toluone
5	Akyld resin
6	Easy gel
7	Calcium drier
8	Universal dispersant
9	Pigment
10	Lead
11	Cobalt
13	Kerosene and Petrol

The physical properties of the conventional anti-rust fluid and anti rust fluid from waste polymer are presented in Table 2**.**

Table 1: Physical properties of conventional and formulated anti-rust paint

Property	Conventional anti-rust fluid	Formulated anti-rust fluid
Absolute Viscosity	86 centipois $32^{\circ}C$	148.5 centipois $33^{\circ}C$
Kinematic Viscosity	0.78 centi-stoke	1.6 centi-stoke

Drying time	1 hour 30 minutes-2 hours	1 hour 30 minutes-2 hours
Specific gravity	1.1	0.9
Spreading time	1.20-1.3-square	2.50-3.50 square
Opacity	One coat finish	Two coat finish
flow	Low flow rate	Low flow rate
Gloss	Maximum	Maximum

Table 3 shows the procedure used in conducting corrosion test of the conventional anti-rust fluid and anti rust fluid from waste polymer. Figure 1.0 shows the comparison of some properties of the two anti-rust paints.

Table 3: Rate of Corrosion on pieces of Metals

Procedure	Sample A[1] (For (Formulated anti-rust paint)	Sample B[1] (For conventional paint)
Initial mass	37.7333g	37.401g
Two Metal Samples soaked in brine water(20g of Nacl into 200ml of deionized water), then after 5 days, masses were measured.	37.695g	37.275g
Samples now coated with anti -rust fluids and left for 5 days in brine water and mass measured again	37.694g	37.275g

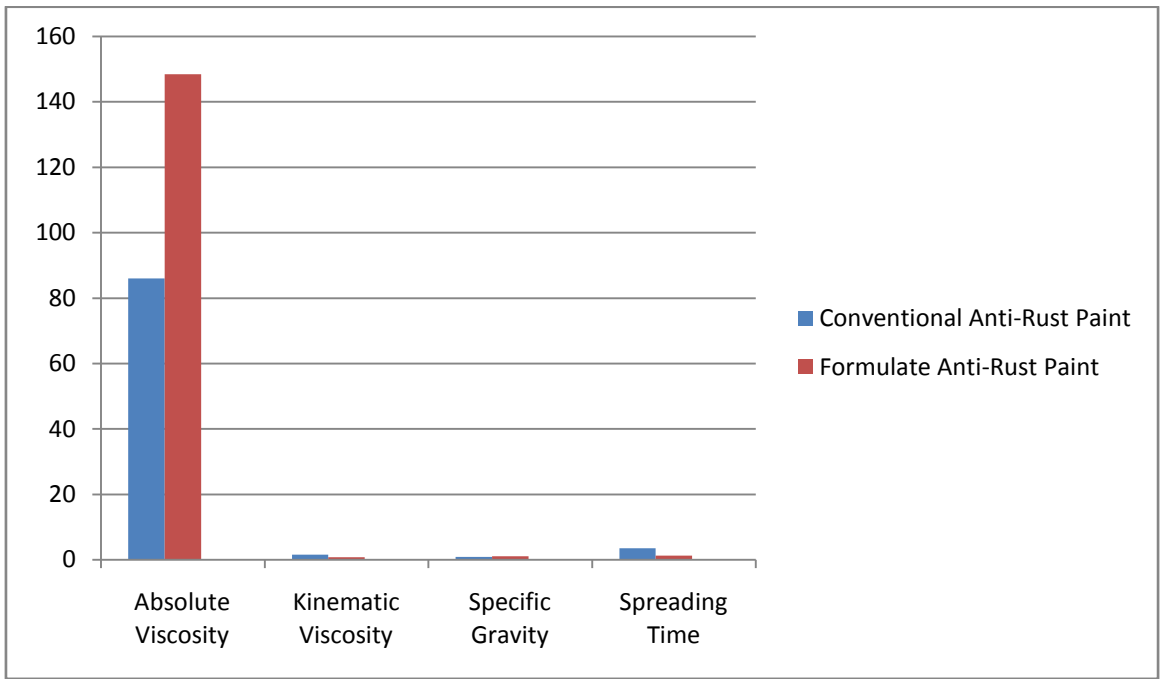

Figure 1.0 : Comparison of Some Properties of Conventional and Formulated Anti-Rust Paint

3.2 Discussion of Results

The cost of materials used in the formulation of anti-rust paint from waste polymer is presented in Table 1. The total cost stood at ₦28,100.00 twenty eight thousand one hundred naira. Table 2presents the properties of both conventional and formulated anti-rust paints. The absolute viscosity of the conventional paint is 86 centipoise, while that of the anti-rust paint is 148.5 centipoise. The viscosity of the formulated anti-rust paint can be improved by the addition of more waste polyethylene paste. The two paints have the same drying time of 1.30 hours to 2 hours. The specific gravity of the conventional paint is more than that of the formulated anti-rust paint by 0.2. This shows that the conventional paint is heavier than the formulated anti-rust paint. This can be seen on the opacity. The conventional anti-rust paint required one coating, while the formulated anti-rust paint needed two coatings. In terms of flow characteristics, the two paints exhibit low flow rate, they also have maximum gloss.

The solvent-petrol and kerosene were the major component of the anti-rust base formulation and has the major advantage of thinning the anti-rust base formulation fluid to a suitable handling consistency or viscosity. After the anti-rust had been applied the solvent evaporates and leave the dry anti-rust paste film on the substrate

The pigments gave the anti-rust maximum coverage capacity colour and durability and good specula reflection.

The binder assisted to produce the desired surface texture. They also contributed to opacity if used above critical volume concentration.

From Table 3, it can be seen that the loss of weight due to the application of the formulated anti-rust paint is negligible and may be due to experimental error. It can thus be implied that, they have the same rate of corrosion when applied on metals**.**[11] reported that waste plastic sachet contributes to the corrosion resistance of coating.

Most importantly, its production will reduce the amount of polymer waste dumped in our environment and converts waste to wealth and at the same time contribute to the economy by production, creation of employment and contribution of income to the Country.

IV. Conclusion

The research has shown that anti-rust paint can be produced from waste polymer for auto-chassis application. It cost ₦800.00 (Eight hundred naira) to produce 4 litres of anti-rust paint while the conventional anti-rust paint cost ₦3,000.00 (three thousand naira). The formulated anti-rust fluid is cheaper than the conventional anti-rust paint and at the same time served the purpose converting waste polymer sachets water bags into wealth and thereby eliminates environmental pollution to the environment.

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