



A STUDY ON ECO-FRIENDLY PAINTS USED AGAINST CORROSION EFFECTS

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ABSTRACT

Corrosion damage, metals, and causes many problems in buildings, machines, and vehicles arise due to corrosion. Normal paints used to stop corrosion often have harmful chemicals that pollute the environment. This study explains the need for eco-friendly paints made from natural materials like plant oils and seed extracts. These paints are safe, biodegradable, and help protect metals from rust. Tests show that eco-friendly paints can reduce corrosion effectively and are better for the environment than regular paints.

KEYWORDS: *Eco-friendly paints, corrosion protection, natural materials, biodegradable coatings, seed extracts, plant oils, green inhibitors, metal protection, sustainable paints, rust prevention.*

INTRODUCTION

The increasing concern for environmental sustainability has shifted attention from conventional paints, which often have volatile organic compounds (VOCs), heavy metals, and synthetic chemicals, toward eco-friendly alternatives. Among these, paints derived from plant oils and seed extracts are appearing as a promising solution due to their renewable nature, biodegradability, and low toxicity. Plant oils such as linseed, soybean, castor, and tung oil, along with seed extracts rich in natural binders, resins, and pigments, serve as effective binders and colorants in paint formulations. These bio-based materials not only reduce dependence on petroleum-based chemicals but also improve paint properties such as adhesion, gloss, flexibility, and water resistance. Moreover,

paints prepared from such bio-based sources minimise environmental pollution and health hazards associated with traditional solvent-based coatings. Hence, eco-friendly paints offer a sustainable and effective approach to corrosion protection while supporting environmental and human health. The use of plant oils and seed extracts aligns with green chemistry principles and sustainable construction practices. Research shows that these natural components can replace or complement synthetic resins, leading to durable, non-toxic, and biodegradable paints suitable for both interior and exterior applications. However, challenges such as cost, stability, and large-scale production still need to be addressed to make plant-based paints commercially viable. This study focuses on the development and evaluation of eco-friendly paints derived from plant oils and seed extracts, exploring their physicochemical properties, performance characteristics, and environmental benefits. By investigating these natural alternatives, the study aims to contribute to sustainable product innovation in the paint industry and promote healthier, eco-conscious living environments.

MATERIALS AND METHODS

1. Materials

Plant-based oils and natural extracts

- Linseed oil: Used as a primary eco-friendly binder.
- Soybean oil: Secondary binder with good film-forming ability.
- Castor oil: Improves flexibility and adhesion.

Neem leaf extract (*Azadirachta indica*): Acts as a natural biocide and corrosion inhibitor

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- Turmeric extract (*Curcumatonga*) Natural pigment and antioxidant
- Green tea extract (polyphenols) Anti corrosive phytochemical

Natural pigments

- Iron oxide (red/yellow) nontoxic pigment
- Carbon black (from biomass) black pigment
- Calcium carbonate (chalk powder) – extender

2. Methods

Preparation of natural extracts

Drying and pulverisation: Plant leaves and seeds were shade-dried and ground into powder. 20 g of powdered sample was mixed with 200 ml ethanol and heated at 50°C for 2 hours. Extract was filtered and concentrated by evaporation.

ENGINEERING ADVANTAGES OF ECO-FRIENDLY PAINTS

Eco-friendly paints protect metal from rain, moisture, and air, so rust will not form easily. The paint sticks well to metal surfaces so it does not peel off easily. The paint film is flexible, so it does not crack when the metal expands or contracts. Eco-friendly paints were proved effective by salt spray test, saltwater test, adhesion test, and weather exposure test where the painted metal showed less rust, less damage and strong coating. Globally, in 2023 the environmentally friendly coatings / eco-friendly paint market valued at over USD 10.5 billion.

CORROSION RATE FORMULA (PRIMARY / ENGINEERING BASICS)

$$\text{Corrosion Rate (CR)} = K \times W / (\rho \times A \times t)$$

Where, W = weight loss of metal (mg)

ρ = density of metal (g/cm³)

A = exposed area (cm²)

t = exposure time (hours)

K = constant (for mm/year, K = 87.6)

Lower corrosion rate after applying eco-friendly paint indicates better corrosion protection.

PROTECTION EFFICIENCY OF ECO-FRIENDLY PAINT

$$\text{Protection efficiency (\%)} = (\text{CR}_{\text{bare}} - \text{CR}_{\text{coated}} / \text{CR}_{\text{bare}}) \times 100$$

Where, CR bare = corrosion rate without paint

CR coated = corrosion rate with eco-friendly paint

ENGINEERING MEANING

Higher efficiency (%) = stronger corrosion - resistance of the paint.

This formula shows how effectively eco-friendly paint prevents corrosion. When the corrosion rate of the coated metal is much lower than the bare metal, the efficiency value becomes high. Most economically preferred paints: water based and zinc phosphate paints are the most economically beneficial eco-friendly paints because they give corrosion protection, long service life, minimal maintenance cost, and environmental safety.

PLANT SEED POWDERS USED IN ECOFRIENDLY PAINTS

In eco-friendly paints, plant seed powders are used as natural binders, fillers and corrosion inhibitors. They replace toxic chemicals and improve sustainability.

1. Linseed (flax seed) powder
2. Soybean seed powder
3. Neem seed powder
4. Castor seed powder
5. Mustard seed powder
6. Sunflower seed powder

Why plant seed powders are important (Engineering point):

- Reduce toxic chemicals
- Act as natural corrosion inhibitors
- Lower paint cost & improve adhesion and durability
- Support sustainable and green energy

NEED FOR ECOFRIENDLY PAINTS

Eco-friendly paints are developed to reduce harmful effects on human health and the environment. Unlike conventional paints, they contain low or zero volatile organic compounds (VOCs), which help in improving indoor air quality. These paints are made from natural, water based or renewable materials, making them safer and sustainable. Eco-friendly paints also provide good durability, corrosion resistance, and cost benefits over long term use. Plant seed powders used in eco-friendly paints. Plant seed powders are used as natural binders, fillers, corrosion inhibitors, and antimicrobial agents in eco-friendly paints.

KEY NEEDS:

1. **Health safety**-Conventional paints release toxic chemicals (VOCs) that cause headaches, allergies, and breathing problems. Eco-friendly paints have **low or zero VOCs**, making them safer for homes, schools, and hospitals.
2. **Environmental protection**- They reduce **air, water, and soil pollution** during manufacturing and application.
3. **Better indoor air quality**- They do not release harmful fumes, so indoor air remains clean and healthy.
4. **Sustainable materials**- Made from natural or biodegradable materials, reducing dependence on petroleum-based chemicals.
5. **Energy and climate benefits**- Some eco-paints reflect heat, reducing indoor temperature and saving energy.
6. **Safe for children and elderly**- Non-toxic and odor-free, suitable for sensitive people.

Table of plant seed powders

| Plant seed powders | Main function in paints | Advantages | Limitations |
|--------------------------------------|--------------------------------|---|-------------------------|
| 1) Tamarind seed powder | Powder thickener | Excellent adhesion, good film formation, low cost | Needs proper processing |
| 2) Neem seed powder | Antimicrobial, anti corrosive | Prevents fungal growth, corrosion resistant | Slight odour |
| 3) Moringa seed powder | Natural coagulant / binder | Improves durability & gloss | Limited availability |
| 4) Castor seed powder | Plasticizer& binder | Enhances flexibility, water resistance | Higher cost |
| 5) Linseed (flax) seed powder | Binder / drying agent | Good surface finish, strong adhesion | Slow drying |
| 6) Mustard seed powder | Antibacterial additive | Controls microbial growth | Less binding strength |
| 7) Sesame seed powder | Binder & moisture resistance | Smooth finish, eco safe | Moderate durability |
| 8) Groundnut seed powder | Filler material | Improves thickness | Low water resistance |

Tamarind seed powder considered the best overall for eco-friendly paints because of its natural binding property, excellent adhesion to surfaces, low cost and easily available in India. It is biodegradable and nontoxic. Neem seed powder is the best for antimicrobial and corrosion protection.

CONCLUSION:

Eco-friendly paints are effective in protecting metals from corrosion while being safe for the environment. These paints have low or no toxic chemicals and reduce air pollution. They form a protective layer on the metal surface and prevent moisture, oxygen, and chemicals from causing rust. Eco-friendly paints also increase the life of structures and reduce maintenance costs. Hence, they are a suitable alternative to conventional anticorrosive paints and support sustainable development. Eco-friendly paints are essential for a **healthy, safe, and sustainable future**. They minimise toxic emissions, improve indoor air quality, and reduce environmental pollution while providing effective and durable performance. By choosing eco-friendly paints, we protect **human health**, conserve **natural resources**, and support **environmental sustainability**, making them a responsible alternative to conventional paints.

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