



National Science Fair Synopsis

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Upcycling Seashell Waste and Coconut Shell Ash into Reflective Paint to Reduce Surface Temperature

1. ABSTRACT

This research explores the potential of using natural waste materials—specifically seashell powder and coconut shell ash—as additives in reflective paint formulations aimed at reducing surface temperature under sunlight. Urban environments often experience elevated temperatures due to heat absorption by rooftops and pavements, contributing to the urban heat island effect. At the same time, seafood and coconut industries generate large quantities of shell waste that are typically discarded.

The study involves preparing multiple paint samples with varying proportions of seashell powder and coconut shell ash, applying them to different surface materials, and exposing them to direct sunlight. Surface temperature readings are recorded at regular intervals using infrared thermometers, while reflectance is measured using a lux meter. Additional tests assess durability, adhesion, and water resistance.

By investigating the thermal and physical properties of these eco-friendly paint formulations, the project aims to evaluate their potential for reducing heat buildup on surfaces and promoting sustainable reuse of biodegradable waste. The findings may offer insights into low-cost, environmentally conscious solutions for urban cooling and material innovation.

2. INTRODUCTION

Urban areas often suffer from the "urban heat island" effect, where buildings and roads absorb sunlight and become much hotter than surrounding rural areas. This leads to increased energy use for cooling and makes cities uncomfortable, especially during summer.

One way to tackle this is by using reflective paints that bounce sunlight away instead of absorbing it. Interestingly, seashells—often discarded as waste—are made mostly of calcium carbonate, a naturally white and reflective material. Similarly, coconut shells, another common waste product, can be turned into ash or biochar that may improve paint texture and durability.

This project explores whether adding seashell powder and coconut shell ash to white paint can help reduce surface temperatures when exposed to sunlight. It's a creative way to recycle natural waste while addressing a real-world environmental challenge.

a. SELECTION OF PROBLEM AND BACKGROUND INFORMATION

The Problem: Urban surfaces like rooftops and pavements absorb heat, making cities hotter and increasing the need for air conditioning. At the same time, seafood and coconut industries generate large amounts of shell waste that often go unused.

Why This Matters: By repurposing seashells and coconut shells into paint additives, we can potentially create a more reflective, cooler surface coating while reducing waste. This dual benefit—environmental sustainability and urban cooling—makes the idea worth exploring.

Key Background Facts:

- **Seashells** are rich in calcium carbonate, a white compound known for its reflectivity.
- **Coconut shell ash** contains carbon and silica, which may enhance paint strength and texture.
- **Albedo** is a measure of how much sunlight a surface reflects. Higher albedo means cooler surfaces.

b. Objective

To test whether adding seashell powder and coconut shell ash to white acrylic paint reduces the painted surface temperature in direct sunlight compared to plain paint.

Key variables:

- Independent: Paint formulation (percentage of seashell powder, percentage of coconut shell ash).
- Dependent: Surface temperature (°C), visible reflectance (%), basic durability scores (adhesion, abrasion), gloss.
- Controlled: Board material and size, paint film thickness, sunlight exposure time and location, measurement times, mixing method.

c. HYPOTHESIS

Paints containing seashell powder will have higher visible reflectance and lower surface temperatures under sunlight than plain paint. A seashell-dominant mix with a small ash fraction will give the best balance of reflectivity and durability.

3. PROCEDURE

a. Study methodology

I. Raw Materials

- Cleaned, dried seashells (clam/oyster/mussel shells)
- Coconut shell ash
- Commercial white latex/acrylic paint (same batch)

II. Tools & Equipment

- Mortar & pestle/blender to make fine powders
- Sieve set (e.g., 250–500 μm and 75–125 μm)
- Scales (gram accuracy), measuring spoons/cups
- Stirrer (mechanical if available) or mixing sticks.
- Wooden/cement/metal boards (same size)
- Infrared thermometer (IR gun)
- Lux meter (android mobile app) for reflectance proxy
- Adhesion test kit (tape) and abrasion rub tools
- Camera, labels, notebook

III. Paint Formulation Plan

Sample	Composition
A	95% paint + 5% seashell powder
B	90% paint + 10% seashell powder
C	95% paint + 5% coconut shell ash
D	90% paint + 10% coconut shell ash
E	90% paint + 5% sea shell powder + 5% coconut shell ash
F	80% paint + 15% sea shell powder + 5% coconut shell ash
G (Control)	100% paint

IV. Powder preparation Seashell Powder:

- Wash shells, sun-dry
- Crush and grind to fine powder
- Sieve to <125 μm and 125–250 μm fractions

Coconut Shell Ash/Biochar:

- Controlled charring or pyrolysis
- Grind and sieve

V. Paint mixing procedure (Standardized)

1. Use percentage equivalent volume of base paint (eg - 90gms for 90%)
2. Weigh additive powder for desired %, in grams.
3. Stir powder into paint for 5–10 minutes
4. Apply single coat on boards, same thickness and drying time

VI. Experimental Setup and measurements

A. Surface Temperature Test:

- Place boards outdoors in Sun (11:00–14:00)
- Measure temperature at 0, 10, 20, 30, 40, 50, 60 minutes
- Record ambient temperature and solar conditions

B. Surface Illuminance \ Reflectance

- Measure surface illuminance to determine albedo using a lux meter

C. Thermal cycling \ durability

- Expose the panels to the Sun daily for a week, sprinkle water and check for color washout or surface change.
- Use rating scale of 1 to 5. 1 - showing the highest level of washout \ disintegration. 5 - showing the lowest level of washout \ disintegration.

b. Measurement of temperature

For measuring temperature, commercially available infrared non-contact thermometer will be used.



Infrared thermometers measure temperature by detecting infrared radiation emitted by objects.

c. Sample Preparation - Setup



d. Sample Preparation - Painting



e. Recording temperatures



4. RESULTS

a. Observations of temperature trend

All measurements are weighted average of 3 recordings.

1.1 Observation for Sample A (95% Paint, 5% Seashell)

Duration of exposure to Sun	Temperature in Fahrenheit			
	Wood	Cement	Steel	Average
10 Minutes	91.5	92.0	93.5	92.3
20 Minutes	93.0	93.5	95.0	93.8
30 Minutes	94.0	94.5	96.0	94.8
40 Minutes	95.0	95.5	97.0	95.8
50 Minutes	96.0	96.5	98.0	96.8
60 Minutes	96.5	97.0	98.5	97.3

1.2 Observation for Sample B (90% Paint, 10% Seashell)

Duration of exposure to Sun	Temperature in Fahrenheit			
	Wood	Cement	Steel	Average
10 Minutes	90.5	91.0	92.5	91.3
20 Minutes	91.5	92.0	93.5	92.3
30 Minutes	92.5	93.0	94.5	93.3
40 Minutes	93.5	94.0	95.5	94.3
50 Minutes	94.5	95.0	96.5	95.3
60 Minutes	95.0	95.5	97.0	95.8

1.3 Observation for Sample C (95% Paint, 5% coconut shell ash)

Duration of exposure to Sun	Temperature in Fahrenheit			
	Wood	Cement	Steel	Average
10 Minutes	93.0	93.5	95.0	93.8
20 Minutes	94.5	95.0	96.5	95.3
30 Minutes	96.0	96.5	98.0	96.8
40 Minutes	97.0	97.5	99.0	97.8
50 Minutes	98.0	98.5	100.0	98.8
60 Minutes	98.5	99.0	101.0	99.5

1.4 Observation for Sample D (90% Paint, 10% coconut shell ash)

Duration of exposure to Sun	Temperature in Fahrenheit			
	Wood	Cement	Steel	Average
10 Minutes	93.5	94.0	95.5	94.3
20 Minutes	95.0	95.5	97.0	95.8
30 Minutes	96.5	97.0	98.5	97.3
40 Minutes	97.5	98.0	99.5	98.3
50 Minutes	98.5	99.0	100.5	99.3
60 Minutes	99.0	99.5	101.0	99.8

1.5 Observation for Sample E
(90% Paint, 5% coconut shell ash, 5% seashell)

Duration of exposure to Sun	Temperature in Fahrenheit			
	Wood	Cement	Steel	Average
10 Minutes	92.5	93.0	94.5	93.3
20 Minutes	94.0	94.5	96.0	94.8
30 Minutes	95.5	96.0	97.5	96.3
40 Minutes	96.5	97.0	98.5	97.3
50 Minutes	97.5	98.0	99.5	98.3
60 Minutes	98.0	98.5	100.0	98.8

1.6 Observation for Sample F
(80% Paint, 15% coconut shell ash, 5% seashell)

Duration of exposure to Sun	Temperature in Fahrenheit			
	Wood	Cement	Steel	Average
10 Minutes	91.0	91.5	93.0	91.8
20 Minutes	92.5	93.0	94.5	93.3
30 Minutes	93.5	94.0	95.5	94.3
40 Minutes	94.5	95.0	96.5	95.3
50 Minutes	95.5	96.0	97.5	96.3
60 Minutes	96.0	96.5	98.0	96.8

1.7 Observation for Sample G (100% paint)

Duration of exposure to Sun	Temperature in Fahrenheit			
	Wood	Cement	Steel	Average
10 Minutes	91.5	92.0	93.5	92.3
20 Minutes	93.0	93.5	95.0	93.8
30 Minutes	94.5	95.0	96.5	95.3
40 Minutes	95.5	96.0	97.5	96.3
50 Minutes	96.5	97.0	98.5	97.3
60 Minutes	97.0	97.5	99.0	97.8

b. Observations of durability checks

Sample	Composition	Cement (lx)	Wood (lx)	Iron (lx)	Avg (lx)
A	95% paint + 5% seashell powder	5	4	4	4.33
B	90% paint + 10% seashell powder	4	4	4	4
C	95% paint + 5% coconut shell ash	5	5	5	5
D	90% paint + 10% coconut shell ash	5	5	5	5
E	90% paint + 5% seashell + 5% ash	5	5	4	4.67
F	80% paint + 15% seashell + 5% ash	5	5	5	5
G	100% plain white paint (control)	4	4	4	4

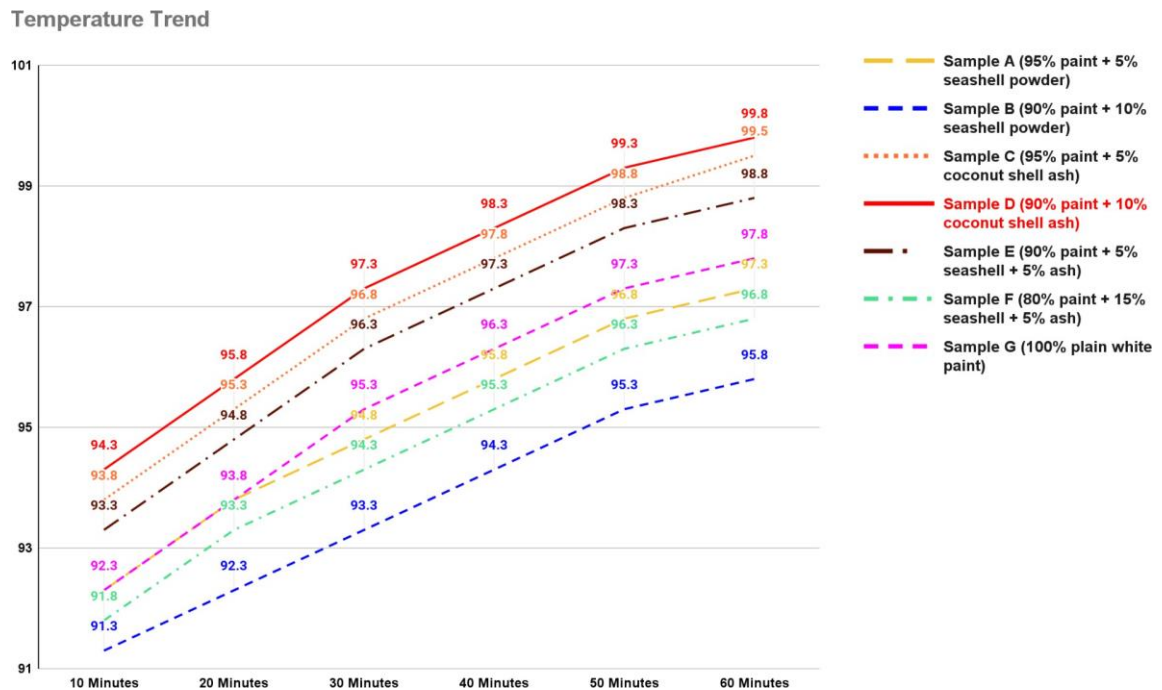
c. Observations of reflection trends using lux meter

Sample	Composition	Cement (lx)	Wood (lx)	Iron (lx)	Avg (lx)
A	95% paint + 5% seashell powder	25,027	24,613	24,482	24,707
B	90% paint + 10% seashell powder	25,456	25,041	24,912	25,136
C	95% paint + 5% coconut shell ash	24,204	23,789	23,658	23,884
D	90% paint + 10% coconut shell ash	23,834	23,421	23,287	23,514
E	90% paint + 5% seashell + 5% ash	24,572	24,157	24,028	24,252
F	80% paint + 15% seashell + 5% ash	25,238	24,823	24,694	24,918
G	100% plain white paint (control)	24,804	24,389	24,258	24,484

5. DISCUSSION

a. Analysis of temperature on exposure to sun

The temperature trend for each of the samples have been plotted in this graph (Chennai recorded 90°F at the start of the experiment),



The following observations could be made based on this graph,

- Sample B (90% paint + 10% seashell powder) shows the lowest average increase in temperature
- Sample D (90% paint + 10% coconut shell ash) shows the highest average increase in the temperature.
- Sample F (80% paint + 15% seashell + 5% ash) shows 2nd lowest raise in temperature.
- Sample G (100% plain white paint) shows average increase, higher than the samples that contain seashell.

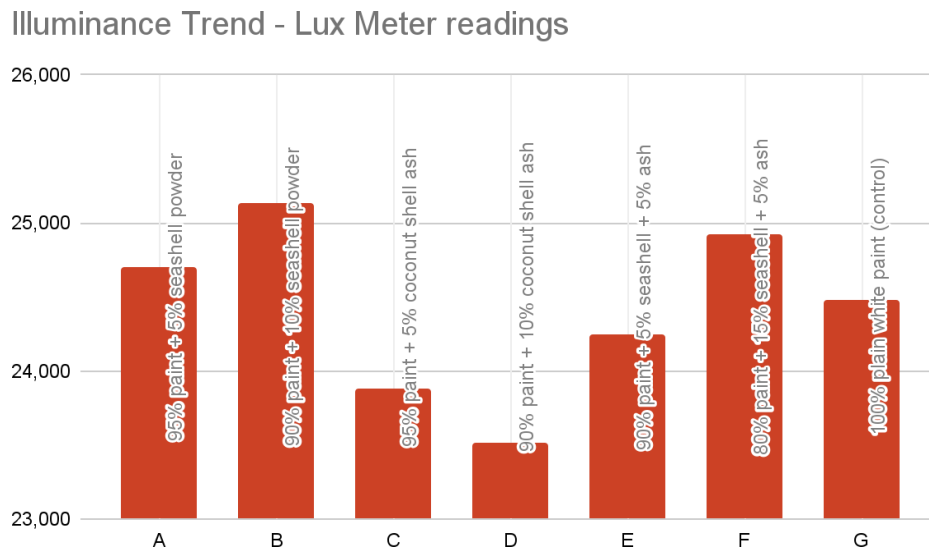
b. Analysis of durability checks

The following samples show the best results for texture and durability,

- Sample D (90% paint + 10% coconut shell ash)
- Sample C (95% paint + 5% coconut shell ash)
- Sample F (80% paint + 15% seashell + 5% ash)

c. Analysis of reflectance (lux meter readings)

The average reflectance proxy has been plotted here for each of the samples.



The following observations could be made based on this bar chart -

- Sample B (90% paint + 10% seashell powder) shows high reflectance due to sea shell powder.
- Sample D (90% paint + 10% coconut shell ash) shows the least reflectance due to high ash content.

6. CONCLUSION

Based on the observations made as part of this experiment, we can conclude the following,

- Adding seashell powder to paint can considerably reduce the indoor temperatures of our homes and offices.
- Adding coconut shell improves the durability and texture of the paint finish.
- Adding 15% seashell powder and 5% ash produces an optimal result for temperature and durability.
- If durability is not needed, we can add seashell powder for best temperature reduction.

7. FINAL RESULT

Based on this experiment and its results, our hypotheses that paints containing seashell powder will have higher visible reflectance and lower surface temperatures under sunlight than plain paint. A seashell-dominant mix with a small ash fraction will give the best balance of reflectivity and durability.

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9. BIBLIOGRAPHY

Li et al. (2020): BaSO₄ nanoparticle paints with high solar reflectance

Santamouris (2015): Review of reflective materials and urban heat island mitigation

Anuar et al. (2020): Optical properties of coconut husk ash

Mhaya et al. (2022): Coconut shell reduces thermal conductivity in concrete

Ihfansyah (2020): Coconut shell ash improves paving block durability

Kushwah et al. (2024): Biochar as green additive for CO₂ sequestration