Usage of hemp and vetiver blended with lime as natural additives to reduce greenhouse gas emissions

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Abstract:
This research demonstrates the neutrality of greenhouse gases with the application of hemp blessed as a simple natural filler for fabric materials, which absorbs greenhouse gaseous like CO₂, CO and NOx. Notably in our research hempcrete drafted as heat-insulating dressing material throughout the load-bearing core of panel structures, Hemp, chrysopogen zizanoides used in homes with the extension of bonding bicomponent (hydraulic lime). Our research focusses on Lime-hemp, a lime-vetiver matter, an innovative idea and heat-insulating substance that enhanced greenhouse gas sequestration and enhance heat insulation like artificial materials. It gives super fragrance along its lifetime, Hempcrete is a mixture of hemp, lime hydrate, and water. This is recyclable stuff that contributes tremendous warmth and sound insulation. The most significant fact in the improvement is that it accelerates the setting of lime. Specifically, Hempcrete develops rather swiftly to absorb greenhouse gases, enhance heat insulation. Our main objective was achieved in this novel research by natural additives when blended with lime with around 96% greenhouse gas sequestration from panels made by natural additives. The emissions are checked with AVL 5 gas analyser and the temperature of the materials during the operation by IR temperature gun. It is also observed that by using these panels, we can enhance the heat insulation also which is an additional advantage of using the natural additives.

Keywords: greenhouse gas, emissions, hempcrete, natural additives, gas analyzer

1. Introduction

The UK parliament to launch in law world diverse aggressive environment conversion objective, diminishing greenhouse gas discharges by seventy-eight percent within 2035 correlated to 1990 greenhouse gas emissions[1]. Concerning the initial era, the UK’s 6th Carbon Budget combines the UK’s percentage of worldwide aeronautics, and sailing discharges here begin the UK with longer than three decades of the plan to greenhouse gas emissions neutral by mid-21st century. Besides, the UK is the primary G7 nation to accept a milestone North Sea Transition Deal to boost the fuel and propellant company’s transformation to purify fresh service while sustaining forty thousand businesses.[2] Within the agreement, this division has pledged to slash discharges by fifty percent within 2030. The administration division and enterprise laborers will struggle mutually till the next 20 years and exceed to achieve the abilities, reform, and additional support needed to curb the greenhouse gases. Since the
requirements toward the sustainability of the construction manufacturing and specifications for refinement of dynamic necessities of fabricating structures, the demand for substances, including conventional heat-insulating substances resources, rises [3]. The extract can perform nebbish through profitable heat-insulating characteristics; furthermore, their mean volume density would improve the restoration of structures. Different procedures concerning the utilization of natural additive reusable substances as building elements, which has both commercial and eco-friendly advantages.[4] The article is concentrated on applying hemp blessing as a wild eco-friendly stuffing for building components, indistinct hempcrete for Thermo insulating fill encompassing a bearing edifice of wooden structures, and absorb greenhouse gaseous.[5-10]

2. NATURAL ADDITIVES AND CHARACTERSTICS:

2.1 Lime:
The pneumatic characteristics of the lime obtained through saturated element research and modern methods. This procedure for the inspection according to IS 6932 (Part VII) - 1973 as per detail referenced in IS 712 - 1984. we made 5cm cubes and cured for 28 days. These hydraulic properties and lime index (LI) are determined according to Eqs. (1) and (2) individually.

\[ \text{Pneumatic or hydraulic index (HI)} = \frac{\text{SiO}_2 + \text{Al}_2\text{O}_3 + \text{Fe}_2\text{O}_3}{\text{Mgo} + \text{Cao}} \] (1)

\[ \text{Cementation index (CI)} = \frac{2.8 \text{SiO}_2 + 1.1\text{Al}_2\text{O}_3 + 0.7 \text{Fe}_2\text{O}_3}{\text{Mgo} + \text{Cao}} \] (2)

The differentiating evidence of lime dependent on water-driven file ranges developed by Taylor is:

- If 0.32 < HI < 0.52 − feebly water powered
- 0.52 < HI < 0.72 − decently water powered
- 0.72 < HI < 1.12 − higher the list, more water-powered

Each series of lime reliant on the cementation index created by Eckel is:

- If CI < 0.156 − air lime
- 0.156 < CI < 0.301 − sub water driven lime
- 0.301 < CI < 0.501 − feebly water powered.

2.2 Hemp:
The architecture industry practices hempcrete. hemp is a thermo insulating plant with extraordinary demands of rainwater, clay, nourishment, and horticultural technology. This is a rather adored duo specious or mono specious plant adopted for spinning, stretching up to 2 – 6 meters giant. It crushes the germination of grass, it has reclamation and anti-erosion capabilities, it consumes contaminations, poisons, and weighty elements from clay. Its growing does not demand pesticides or herbicides, which enhance the capacity of the atmosphere. It includes about 24 percent of fiber,79 percent of lignin – the so-call blessing. The cultivation period catches within 100 – 120 days; the quantity of lignin that originates throughout this season on 1 ha of the field is about twice as much as on 1 ha of a forest, which raises for numerous dozen ages.it absorbs all greenhouse gases[16-20]

2.3 Vetiver:
vetiver scientific title is Chrysopogon zizanioides which raises throughout the regions of Kerala, TamilNadu, Andhra Pradesh it consumes more bounteous co2 as hemp, used for phase change element at 600 degree Celsius as feldspar in mohrs scale diamond value =10, vetiver value= 8.1, subsequent extorting origins from the grass it gives good fragrance and consumes more co2, NOx as well as greenhouse gaseous.it also absorbs greenhouse gases[21-25] and give soft fragrance in rooms.

2.4 Gokshura :
Gokshura is a seaweed available near the seacoast, green areas which ought prickly configuration holds more calcium oxalate crystals for reducing the primary stage and decisive stage setting of lime and also enhances the compressive strength of lime when it is blended with lime-(like kadukkai and jaggery [6]periodically increases its compressive strength) since it includes more calcium oxalate crystals.

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2.5 Indian kudz:
Indian kudz have woody shape roots it will takes 3 to 4 months for growth in soil, this powder form is used by body builders to get good strength and stamina, it also contains more calcium oxalate crystals like kadukkai and gokshura [7], when blended with lime initial and final stage of lime decreases and compressive strength increases periodically [10].

2.6 Corn powder:
Corn produce in all Asian countries which need more water for growth it takes nearly 50 to 70 days for cultivation of corn. If we blended 50 grams of corn powder to 200 gms of lime within 30 days its compressive strength increases to 5 to 6 MPa but lime can bear 0.9-1.2 Mpa when blended with hemp, vetiver or other natural additives.

![Images of different plants and seeds]

**Figure 1.** a) Hemp cultivation in Visakhapatnam district of Andhra Pradesh state. b) Vetiver cultivation in Kozhikode district of Kerala. c) Indian kudz cultivation in Kancheepuram district of Tamil Nadu. d) Corn cultivation in Kancheepuram district of Tamil Nadu. e) Gokshura seeds near Appikonda beach and Visakhapatnam beach of Andhra Pradesh

3. Experimental Setup

The green house gaseous absorption was done by (GREEN HOUSE GASES PROTOCOL STANDARDS P2, P59, P60, and P63). AVL 5 gas analyzer with computerized single cylinder four stroke diesel engine with eddy current dynamometer their absorption percentage with lime, combination of lime and hemp, combination of lime, hemp and vetiver and finally the combination of lime, hemp, vetiver and gokshura.
4. Results and Discussion

The emissions from the internal combustion engine are analyzed and % emissions are recorded with the help of exhaust gas analyzer. The values are tabulated for several loads and various combinations of the natural additives.

Table 1. Emissions with lime+blended natural additives introduced in the exhaust outlet of the engine

| Time (sec) | Load(kN) | CO (%vol) | HC(PPM) | CO₂(%) | O₂(%) | NOₓ(PPM) | Opacity smoke |
|------------|----------|-----------|---------|--------|-------|----------|----------------|
| 70.55      | 0        | 0.02      | 7       | 1.00   | 19.52 | 49       | 4.39           |
| 40.13      | 4        | 0.02      | 8       | 1.59   | 18.62 | 156      | 39.1           |
| 31.41      | 8        | 0.02      | 10      | 2.05   | 18.01 | 252      | 59             |
| 23.95      | 12       | 0.01      | 14      | 3.29   | 16.06 | 439      | 70.4           |
| 20.70      | 16       | 0.05      | 21      | 4.19   | 14.80 | 477      | 82.3           |

Table 2. Emissions with Lime + hemp fragments introduced into the outlet

| Time (sec) | Load(kN) | CO (%vol) | HC(PPM) | CO₂(%) | O₂(%) | NOₓ(PPM) | Opacity smoke |
|------------|----------|-----------|---------|--------|-------|----------|----------------|
| 73.89      | 0        | 0.01      | 0       | 0.39   | 20.35 | 18       | 4.1            |
| 44.12      | 4        | 0.01      | 1       | 0.59   | 20.02 | 60       | 15.01          |
| 32.48      | 8        | 0.01      | 4       | 0.79   | 19.81 | 95       | 15.8           |
| 25.95      | 12       | 0.01      | 4       | 0.59   | 19.42 | 106      | 28.7           |
| 20.68      | 16       | 0.02      | 5       | 1.08   | 19.05 | 129      | 39.8           |
Table 3. Emissions with Lime + hemp + vetiver fragments:

| Time (sec) | Load(kN) | CO (%vol) | HC(PPM) | CO₂(%vol) | O₂(%vol) | NOₓ(PPM) | Opacity smoke |
|------------|----------|-----------|---------|-----------|----------|----------|---------------|
| 62.38      | 0        | 0.25      | 0       | 0.33      | 18.91    | 13       | 29.01         |
| 41.38      | 4        | 0.28      | 1       | 0.30      | 17.48    | 23       | 30.29         |
| 31.43      | 8        | 0.02      | 3       | 0.39      | 17.56    | 96       | 24.41         |
| 24.00      | 12       | 0.02      | 3       | 0.44      | 16.76    | 133      | 37.41         |
| 20.17      | 16       | 0.01      | 2       | 0.48      | 12.58    | 139      | 23.43         |

Table 4. Emissions with Lime + hemp + vetiver + gokshura fragments:

| Time (sec) | Load(kN) | CO (%vol) | HC(PPM) | CO₂(%vol) | O₂(%vol) | NOₓ(PPM) | Opacity smoke |
|------------|----------|-----------|---------|-----------|----------|----------|---------------|
| 64.53      | 0        | 0.03      | 10      | 0.333     | 20.01    | 20       | 30.24         |
| 42.84      | 4        | 0.02      | 3       | 0.32      | 20.54    | 64       | 30.28         |
| 35.64      | 8        | 0.02      | 3       | 0.28      | 20.59    | 95       | 25.43         |
| 26.93      | 12       | 0.02      | 2       | 0.27      | 16.54    | 108      | 35.54         |
| 24.31      | 16       | 0.01      | 3       | 0.26      | 15.34    | 136      | 34.53         |

Figure 3. Greenhouse gas emissions measured using AVL gas analyzer at 0 KN load
**Figure 4.** Greenhouse gas emissions measured using AVL gas analyzer at 4KN load

|                | NO NATURAL ADDITIVES | LIME+HEMP | LIME+HEMP+VETIVER | LIME+HEMP+VETIVER+GOKSHURA |
|----------------|----------------------|-----------|-------------------|-----------------------------|
| CO2            | 0.02                 | 0.01      | 0.28              | 0.02                        |
| HC             | 10                   | 4         | 3                 | 2                           |
| CO2            | 2.05                 | 0.79      | 0.39              | 0.27                        |
| O2             | 18.01                | 19.81     | 17.56             | 16.54                       |
| NOx            | 252                  | 95        | 96                | 108                         |
| Smoke          | 59                   | 15.8      | 24.41             | 35.54                       |

**Figure 5.** Greenhouse gas emissions measured using AVL gas analyzer at 8kN load

|                | NO NATURAL ADDITIVES | LIME+HEMP | LIME+HEMP+VETIVER | LIME+HEMP+VETIVER+GOKSHURA |
|----------------|----------------------|-----------|-------------------|-----------------------------|
| CO2            | 0.02                 | 0.01      | 0.02              | 0.02                        |
| HC             | 10                   | 4         | 3                 | 2                           |
| CO2            | 2.05                 | 0.79      | 0.39              | 0.27                        |
| O2             | 18.01                | 19.81     | 17.56             | 16.54                       |
| NOx            | 252                  | 95        | 96                | 108                         |
| Smoke          | 59                   | 15.8      | 24.41             | 35.54                       |
Figure 6. Greenhouse gas emissions measured using AVL gas analyzer at 12 kN load

Figure 7: Greenhouse gas emissions measured using AVL gas analyzer at 16 kN load

The temperature of the panel is measured for all the cases with the help of an infrared temperature gun (Mextech made) which is according to IS 14164:2008, IS 3346:1980. The variation of temperature is shown in Figure 9.
5. Conclusion

Based on the study, the following points are concluded:

- From the experimental study with different combinations of additives, it is realized that among the combinations like i) hemp with lime, ii) hemp with lime and vetiver, iii) hemp with lime, vetiver and gokshura, the hemp with lime, vetiver and gokshura absorbed more greenhouse gases with more effectiveness. Hence this combination is recommended for use to reduce greenhouse gas emission.
- The hemp with lime, vetiver and gokshura enhances the insulation property of the thermal insulation of panel. The panel temperature showed a value of 26.5\(^\circ\)C when the room temperature was 36\(^\circ\)C and the outside temperature was 44\(^\circ\)C. Hence we can conclude that when lime was blended with hemp, vetiver and gokshura, the panel have more greenhouse gases absorption and it enhances heat insulation property also.

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Figure 8. a - c Temperature measurement by IR Thermometer

Figure 9. Ambient and Panel Temperatures
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