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Developing the Insulation Sheet of Luffa Cylindrica for Mitticool Fridge

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ABSTRACT

Sustainability and eco-friendly requirement of engineering materials is sort for in recent times, in this study use of "Luffa Cylindrica" natural fibers can be processed into industrial products such as Insulation. This insulated sheet attach from outer side of Mitticool for the purpose of insulation the sheet will help to us to maintain the constant temperature or ideal temperature by using the principle of the pot-in-pot refrigerator culture. 'Mitticool' refrigerator, a possible 'upgrade' that also uses evaporative cooling through the use of clay, but which looks a little more like the refrigerator you're more familiar with. The Mitticool uses no electricity. So this luffa Cylindrica insulation sheet will decrease the evaporation percentage and increase the effectiveness of evaporative cooling varies with the temperature, humidity and airflow. Given a constant flow of cool dry air the inner pot can achieve temperatures as low as (17 °C), which is the temperature below which mesophilic ("middle temperature") bacteria such as food spoilage bacteria have significantly slowed growth

CHAPTER NO-1

INTRODUCTION

Luffa sponge products are readily available in the cosmetic and bath section of department stores, discount stores, pharmacies, and specialty shops.

Luffa is from the family of commonly called as sponge gourd luffa is a member of cucurbitaceous family. Luffa sponge is a lignocelluloses material composed mainly of Cellulose, hemicelluloses and lignin the fibers are composed of 60% cellulose, 30%hemicellulose and 10% lignin. The stem is green and pentagonal and grows climbing other physical solid. The luffa sponge is cultivated, unlike the sponge produced with cellulose that is extracted from trees. The plant is cultivated in many countries, including India and Brazil, where its cultivation has an increasing economic importance. The fruits of Luffa cylindrica are smooth and cylindrical shaped. Mature Luffa sponge will produce at least 30seeds.

The popularity of luffa for personal hygiene products is due to the gentle exfoliating effect the fibers have on the skin. Plant is bitter tonic, emetic, diuretic and purgative and useful in asthma, skin diseases and splenic enlargement. It is used internally for rheumatism, backache, internal hemorrhage, chest pains as well as hemorrhoids. Young fruit can be eaten raw like cucumber or cooked like squash, while the young leaves; shoots, flower buds, as well as the flowers can be eaten after being lightly steamed. Many environmentally conscious Consumers appreciate that luffa products are biodegradable, natural, and a renewable resource.

In Many other countries luffa is also used to make household cleaning products for scrubbing pots, pans, Barbecue grills, tires, and many other surfaces that are not harmed by the abrasive fibers. The tough fibers can also be processed into industrial products such as filters, insulation, and packing materials. Craft shows often exhibit dolls, hats, toys, and other decorative items made from luffa sponges. The fruits which grow to about 60 cm in length are oblong or cylindrical, smooth and contain many seeds. The fruit is brown when mature and dries on the vine to develop an inedible sponge-like structure. The fiber has also been used for its shock and sound absorbing properties, for instance in helmets and armored vehicles, and as a filter in engines. In Ghana the dry fiber is used to filter water and palm wine. The young fruit is eaten fresh or cooked as a vegetable, but it has to be picked before the fibrous vascular bundles harden and before the purging compounds develop.

In Guinea and Côte d'Ivoire edible cultivars are grown. Edible forms have also been developed in India and the Philippines where the plant is commonly cultivated. In India and China a type of curry is prepared with the fruit which is peeled, sliced and fried. In Japan the fruits are eaten fresh or sliced and dried to be eaten later. The leaves are also eaten as a vegetable.

Luffa sponges are the fibrous interiors of the fruits of the luffa sponge gourd plant (Luffa Cylindrica Mill.). A tropical member of the Cucurbitaceous, the luffa sponge gourd plant is an annual vine with Tendrils and large, cylindrical fruit that is edible when young. The fruit section of L. aegyptiaca may be allowed to mature and used as a bath or kitchen sponge after being processed to remove everything but the network of xylem fibers. If the luffa is allowed to fully ripen and then dry out on the vine, the flesh disappears leaving only the fibrous skeleton and seeds, which can be easily shaken out. Marketed as luffa or luffa, the sponge is used as a body scrub.

In Paraguay, panels are made out of luffa combined with other vegetable matter and recycled plastic. These can be used to create furniture and construct houses. Most luffa cultigens are flowers develop in a cluster, whereas female flowers develop singly or in association with male Flowers.

The lower nodes of luffa usually bear only male flowers, followed by nodes having both male and female flowers, which are followed by solitary female flowers at the uppermost nodes. The mature, dry fruit consists of a hard shell surrounding a stiff, dense network of cellulose fibers, adapted for support and dispersal of hundreds of flat, smooth black seeds. Luffa is closely related to cucumber and modified cultural practices for trellised cucumber production can be used. One must keep in mind; however, that luffa is a tropical plant which requires a long growing season and warm temperatures.

When the fruit is fully ripened, it is very fibrous. The fully developed fruit is the source of the luffa scrubbing sponge which is used in bathrooms and kitchens. Luffa is not frost-hardy, and requires 150 to 200 warm days to mature.

1.2) Luffa cylindrica as a natural fiber

There are many potential natural resources, which India has in large quantity. Most of it comes from the agriculture and forest. Luffa species are used as food plants by the larvae of some Lepidoptera species, including Hypercom albicornis

Figure 1: Natural Luffa Cylindrica

Figure 2: Luffa Cylindrica Matured

1.3) Mitticool Fridge

Mitticool, a clay refrigerator that works without electricity Mitticool Fridge is an eco-friendly product, which has no maintenance costs. It also retains the original taste of vegetables", says Mansukhbhai who has sold 1500 units so far. The fridge is made of clay and it takes ten people to make the fridge in a day. It can store water, fruits and vegetables for 8 days and milk for a day. Mitticool Refrigerator is a low cost refrigerator made of clay that can run without electricity. The innovative fridge cools water naturally while keeping food such as vegetables, fruits, and liquids fresh for several days. Mansukhbhai Raghavbhai Prajapati, a Gujarat-based potter, makes this fridge that uses no electricity. The refrigerator works on the principle of evaporation. The temperature used to make the Mitticool fridge is 1200°C in the oven. The length of Mitticool fridge is 15 ft and the breath

It has two large tanks, one at the top and the other at the bottom with a capacity to store approximately 20 L of water. The fridge also has a cabinet to store food items. The water tanks cool the sides of the fridge in the same manner as clay pots used to cool water during summers. "The refrigerator is a natural cooler. Unlike the fridges used normally in homes, the water that is stored in the clay tanks is cooled naturally. This has several health benefits as well. This also helps preserve food items like fruits and vegetables, which can be stored up to six days, and liquids like milk up to three days." The fridge gives a higher cooling effect in a dry climate compared to a humid one. It is low on maintenance. Says the innovator, "For the poor, the cost of the fridge is not the only consideration, additional maintenance costs such as electricity is also a big concern. My fridge takes care of these problems as well." It helps save a considerable amount of energy. Moreover, with electricity still being a luxury in many Indian villages, this fridge can be used in rural areas as well.

In fact," says Mansukhbhai jokingly, "my fridge is attracting more customers from urban areas than rural areas." On being asked about the durability and strength of the fridge, he says, "I have sold many fridges in the market, but haven't received any complaints so far. But if you ask me I would say that the fridge will last for five years, because over the years, the cooling decreases." Baking the clay used for manufacturing the fridge at 1200 ºC makes it very strong. Hence, no special care needs to be taken. However, he adds, the fridge gives better cooling if placed near a fan.

Figure 3: First Sample Mitticool Fridge at Exhibition

In the fateful earthquake of January 2001, Mansukhbhai suffered huge loss, as most of his stock got broken. He distributed the stock that escaped the quake to the quake affected people of Kutch. In February 2001, Sandesh Gujarati Daily had a photo feature on the earthquake where at one place it showed a broken water filter of Mansukhbhai with the caption 'the broken fridge of poor'. This caption ignited a thought in him to work on a rural fridge that did not need electricity and could be used by masses. Though he started thinking about it after the Gujarat earthquake of 2001, it was 2002 when he actually started his work. Almost the same time, Mansukhbhai came into the contact of Gujarat Grassroots Innovation Augmentation Network (GIAN), Ahmedabad. After a painstaking journey of three years during which he tested all sorts of soils and fridge designs, he finally came out with Mitticool fridge in 2005. A civil engineer saw the fridge and looking at its applications gave him the order of 100 pieces and an advance of Rs. 2 lakh

This news was also covered by local dailies. Most of you will be familiar with the pot-in-pot refrigerator by now. Well, today we'll revisit this concept by taking a look at the 'Mitticool' refrigerator, a possible 'upgrade' that also uses evaporative cooling through the use of clay, but which looks a little more like the refrigerator you're more familiar with. And, just like the pot-in-pot refrigerator, the Mitticool uses no electricity.

Figure 4: Mitticool Fridge

1.4) How does it work

The topmost section holds water, which very slowly drips down the sides. As perm culturists will know, one of many 'constants' we can count on and use to advantage is that evaporation cools. As the water evaporates from the porous clay surface, it cools the interior, enabling you to store fruit, vegetables, milk, etc.


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Figure 5: Raw Mitticool Fridge before sending to Oven

There is even a tap on the front of the unit, so it doubles as a water cooler as well. In the following videos you'll meet the maker of Mitticool, and learn how it is made from a specific combination of four different types of clay he has found in his local area.

The inside temperature of the Mitticool can be up to 8°C lower than the outside temperature. This refrigerator will not function everywhere, of course. Evaporative cooling only works well in dry climates. But for those people living in the right conditions, this looks to be a very sensible, low-cost and planet-friendly way to extend the shelf life of your produce

CHAPTER NO-2

MATERIALS AND METHODS

2.1) Properties of rigid Luffa Cylindrica

In the selection of a suitable Thermal insulation material, the required thermal properties are of prime importance, other important criteria in the choice of insulation are mechanical strength, resistance to ageing, sound insulation properties, and resistance to moisture and fire. Insulation materials display excellent insulation characteristics.

The properties of the insulation materials depend on their structure, the raw Materials used and the manufacturing process. They have low thermal conductivity values and can achieve optimal energy savings. The excellent mechanical strength values and exceptional durability of rigid Luffa cylindrica fulfill all the requirements made of insulation materials used in the study.

Table 1: Physical Properties of Luffa cylindrica.

Chemical constituents (%)		Physical properties of luffa fiber	
Lignin %	11.69±1.2	Diameter(μm)	270±20
Hemicelluloses %	20.88±1.4	Aspect ratio	340±5
Ash %	0.4±0.10	Density (gm/cc)	0.92±0.10
Cellulose %	63.0±2.5	Microfibrillar	12±2

Table 2: Typical properties of Epoxy Resin

Properties	Evaluation
Viscosity at 25°C (centipoises)	548
Gel point in minutes	26
Specific gravity at 25°C (gm/cc)	1.11
Tensile strength (Mpa)	6.9
Appearance	A milky white liquid
Solid contents (%)	84
Tensile modulus (Mpa)	166
Impact strength (kJ/m²)	1.1
Gel point in minutes	26

2.2) Luffa Cylindrica Materials

The Luffa cylindrica collected from Bhavan Chander Products Limited, Tiruvallur, TN. The Luffa Cylindrica was shaken out for the dried seed and the dried fibrous cut into smaller sizes, luffa fiber was cut carefully to separate the inner fiber core from the outer mat core was used in this study. A property of luffa cylindrica was given in the table.

Figure 6: Chopped pieces of Matured Luffa Cylindrica

2.3) Luffa Cylindrica Fiber Polymer Materials

In this study we use the grinded particles of the luffa cylindrica for making the insulation sheet which is going to applicable as a sheet on “Mitticool Fridge”. Luffa cylindrical posses desired mechanical properties and a very light. As we know in the earlier study and the research this material extensively used in aeronautical applications. The luffa cylindrica having good strength of filtering properties too.

Now in this study we use the sheet for the purpose of the insulation in “Mitticool”.

2.4) Preparation LC Insulation Sheet

The Luffa Cylindrica was shaken out for the dried seed and the dried fibrous cut into smaller sizes, luffa fiber was cut carefully to separate the inner fiber core from the outer mat core was used in this study. A property of luffa cylindrica was given in the table. Grounded the luffa fibers are grinder into small particles and washed with water and 2 % NAOH.

The fiber is washed several times with water. And again the sheet is washed with 1 % sulfuric acid to make the sheet neutralized; the particle is washed with the distilled water. The chemical used for the surface modification of fiber. The fiber is preserved in polythene bags, later then sieved with 1.0 mm to get the fine fiber particles.

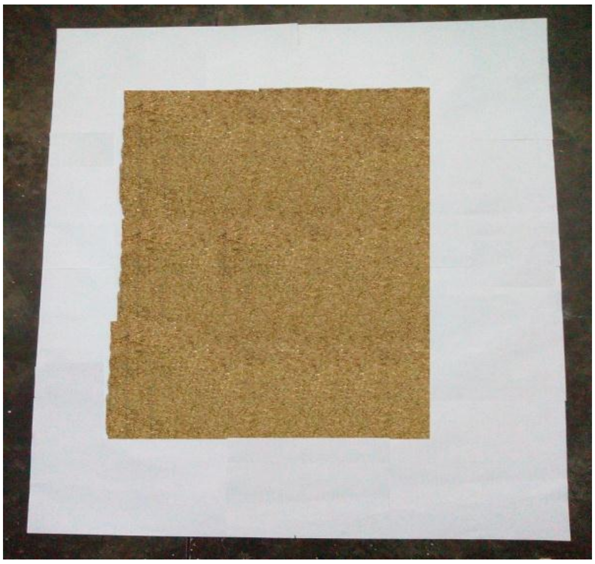


Figure 7: Insulation sheet of Luffa Cylindrica

Now the grounded particles mixed epoxy (LY 556) hardener (HY 951) commonly called as Araldite was used as the matrix material in the fabrication of composites. The mixture is flattened at 7 mm thickness on iron mat to get the slim sheet left for 3 days to get to dry the sheet.

Three sheets has been prepared for the three side of Mitticool fridge, the size of 13 Inch Sheet pasted back side of Mitticool fridge. Both right and left side of Mitticool 10 Inch has been pasted.

2.5) Specific Heat Capacity Cp Of Few Common Materials

The specific heat capacity cp states how much heat energy is required to increase the temperature of 1 kg mass of a material by 1 K. Specific heat capacity cp is measured in J/(kg·K).More heat energy is required to raise the temperature by 1 K of a material with a greater heat capacity. And inversely, less energy is required to produce a 1 K increase in temperature in materials with lower heat capacities. The specific heat (also called specific heat capacity) is the amount of heat required to change a unit mass (or unit quantity, such as mole) of a substance by one degree in temperature. Therefore, unlike the extensive variable heat capacity, which depends on the quantity of material, specific heat is an intensive variable and has units of energy per mass per degree (or energy per number of moles per degree). The heat capacity of a substance can differ depending on what extensive variables are held constant, with the quantity being held constant usually being denoted with a subscript. For example, the specific heat at constant pressure is commonly denoted c_P, while the specific heat at constant volume is commonly denoted c_V. The specific heat of water at constant atmospheric pressure is

i.e., 1 calorie is needed per degree Kelvin (or Celsius) of temperature change for 1 gram of liquid water. In fact, the definition of (one of the several types of) the calorie is the amount of heat needed to change the temperature of 1 g of water by 1 °C at its temperature of maximum density (roughly 3.98° C).The heat capacity ratio is defined as the ratio of specific heats of a substance at constant pressure and constant volume,

Table 3: Specific Heat capacity of different materials

Material Specific heat capacity	Cp = J/(kg·K)
Rigid Polyurethane foam (PUR/PIR)	1400-1500
Wood-fiber insulation Boards	1400
Mineral Wool	1030
Wood and wood-based materials	1600
Luffa Cylindrica	950
Plasterboard	1000
Aluminum	880
Air (ρ=1.25 kg/m³)	1000

In accordance with EN 12524, these calculated values are to be used in special Calculations of heat conduction in building components with unsteady boundary conditions.

This table show the specific value of Luffa Cylindrica, it's good for the use as the conduction materials of insulation process value of the Luffa cylindrica=950.

CHAPTER NO-3

INSULATION

It's a material or substance that is used to stop heat, electricity, or sound from going into or out of something. How insulation works it helps to understand heat flow, which involves three basic mechanisms conduction, convection, and radiation. Conduction is the way heat moves through materials, such as when a spoon placed in a hot cup of coffee conducts heat through its handle to your hand. Convection is the way heat circulates through liquids and gases, and is why lighter, warmer air rises, and cooler, denser air sinks in your home. Radiant heat travels in a straight line and heats anything solid in its path that absorbs its energy.

Most common insulation materials work by slowing conductive heat flow and -- to a lesser extent -- convective heat flow. Radiant barriers and reflective insulation systems work by reducing radiant heat gain. To be effective, the reflective surface must face an air space. Regardless of the mechanism, heat flows from warmer to cooler until there is no longer a temperature difference. In your home, this means that in winter, heat flows directly from all heated living spaces to adjacent unheated attics, garages, basements, and even to the outdoors. Heat flow can also move indirectly through interior ceilings, walls, and floors -- wherever there is a difference in temperature. During the cooling season, heat flows from the outdoors to the interior of a house.

To maintain comfort, the heat lost in the winter must be replaced by your heating system and the heat gained in the summer must be removed by your cooling system. Properly insulating your home will decrease this heat flow by providing an effective resistance to the flow of heat

3.2) Insulated Panels

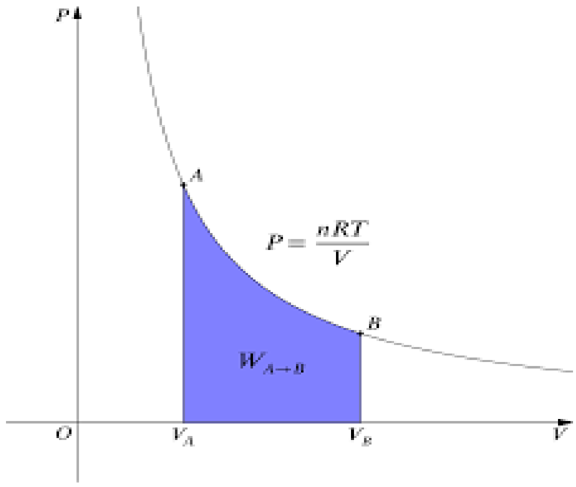
Insulated panels provide solution to the numerous insulation problems occurring in light weight prefabrication. For this application, insulated panels find wide use around the world due to its characteristics to provide maximum.

Insulation panels or sheet have monolithic sandwich construction which is formed as result of good efficiency, this days many big companies trying to build the biggest panels which involves of polyurethane foam at high pressure between the cladding using a high pressure mixer. The insulation panels are supplied as per the requirement or custom design made to order sizes.

The different kinds of the insulation panels are used in the construction of a cold room are the wall, ceiling and the floor panels. The ceiling and floor panels for partitioning in applications where multiple compartments need to be built.

3.3) Isothermals

An isothermal process is a change of a system, in which the temperature remains constant: $\Delta T = 0$. This typically occurs when a system is in contact with an outside thermal reservoir (heat bath), and the change occurs slowly enough to allow the system to continually adjust to the temperature of the reservoir through heat exchange. In contrast, an adiabatic process is where a system exchanges no heat with its surroundings (Q = 0). In other words, in an isothermal process, the value $\Delta T = 0$ and therefore $\Delta U = 0$ (only for an ideal gas) but $Q \neq 0$, while in an adiabatic process, $\Delta T \neq 0$ but $Q = 0$.



$$P = \frac{nRT}{V}$$

Figure 8: Isothermal Formula with Graph

3.4) R-Value Insulation

The R-value is a measure of thermal resistance used in the building and construction industry. Under uniform conditions it is the ratio of the temperature difference across an insulator and the heat flux (heat transfer per unit area per unit time,) through it or . Thermal resistance varies with temperature but it is common practice in construction to treat it as a constant value.

An R-value is a unit of thermal resistance for a particular material or assembly of materials (such as an insulation panel). The R-value depends on a solid material's resistance to conductive heat transfer. For loose or porous material, the R-value accounts for convective and radiative heat transfer through the material. However it does not account for the radiative or convective properties of the material's surface, which may be an important factor for some applications.

R is expressed as the thickness of the material normalized to the thermal conductivity. The unit thermal conductance of a material is the reciprocal of the unit thermal resistance. This can also be called the unit surface conductance. The higher the value of R, the better the insulation's theoretical effectiveness.

3.5*) Multiple temperature measurement*s

This approach is based on three or more temperature measurements inside and outside of a building element. By synchronizing these measurements and making some basic assumptions, it is possible to calculate the heat flux indirectly, and thus deriving the U-value of a building element. The following requirements have to be fulfilled for reliable results:

Difference between inside and outside temperature, ideal > 15 K

Constant conditions

No solar radiation

No radiation heat nearby measurements

3.6) Typical R-values (per inch of material)

R-values per inch given in SI and imperial units in practice, the values for the materials will have been obtained using different methods. Typical values are approximations based on the average of available figures. Clicking on the RSI column sorts by median value of the range. Clicking on the R-value column sorts by lowest value.

Table 4: R-values of different material per inch material

Material	RSI per inch (m^2·**K**/(**W**·in))	R-value per inch (ft^2·°F·**h**/(**BTU**·in))
Rice hulls	0.50	R-3.0
Polyurethane rigid panel	1.23–1.41	R-7–R-8

(CFC/HCFC expanded) initial		
High-density fiberglass batts	0.63–0.88	R-3.6–R-5
Cardboard	0.52–0.7	R-3–R-4
Fiberglass rigid panel	0.44	R-2.5
Wood chips and other loose-fill wood products	0.18	R-1
Softwood (most)	0.25	R-1.41
Wood panels, such as sheathing	0.44	R-2.5
Luffa Cylindrica	0.40	R-2.7-R-3.0
Fiberglass loose fill	0.44-0.65	R-2.5-R-3.7

In this table which there is different material is provided of the values as per the inch base. For the Luffa Cylindrica is 0.40 is the value per inch (m^2·K/(W·in). This value proved that Luffa Cylindrica fiber is the good enough to make the insulation sheet for the Mitticool fridge and many uses. The R-value is taken from the ASTM Insulation chart *ASTM* D3418, ASTM E384, and ASTM D 3039 method which states the fiber strength and tensile properties.

CHAPTER NO-4

IMPLEMENTATION

The Flattened sheet is pasted three side of the Mitticool fridge as a insulated materials it is the regular temperature of the Mitticool fridge is 20-21° C. After apply insulation sheet on Mitticool is 17°C or below.

Figure 9: Luffa Cylindrica Insulation sheet attached to Mitticool Fridge

Benefit of the Luffa Cylindrica Insulation sheet.

Eco friendly Material.
Low cost compare to Polyurethane foam sheet.
Easy available in market.
Insulating material for cold temperature as well as hot temperature.
Stagnant cool dry

4.2) Discussion

Now the "Mitticool" temperature comparatively lower as much earlier, the normal temperature is 17°C which is maintained after pasted the luffa cylindrica insulation sheet. Luffa cylindrica sponge has a moderate capacity for the Mitticool Fridge due to its good insulation strength. It was that the media performance efficiency was improved by washing the luffa cylindrica with the NAOH and Sodium oxide and after adding the epoxy resin or araldite to the LC particles for hardness. And which is flatten and dried into direct sun light. This absorbed energy is a measure of a given material's toughness and acts as a tool to study temperature dependent ductile-brittle transition. It is widely applied in industry, since it is easy to prepare and conduct and results can be obtained quickly and cheaply.

4.3) Results

A new type of luffa cylindrica-glass fiber hybrid composite laminates has been fabricated successfully. The flexural strength is also found to be 108.36Mpa for stacking sequence which is about 177% higher than the only luffa cylindrica reinforced fibers. Comparing the properties of the designed laminates, it is found that the optimum properties R-Values and Flexural strength, Specific Capacity are achieved more enough from luffa cylindrica fiber sheets on the Mitticool Fridge. Now this insulation helps to keep the moisture of the Mitticool fridge as same for many days and the minimum temperature is 17°C maintained.

CHAPTER NO-5

CONCLUSION

In this study that the luffa cylindrica sponge posses a great potential for insulation purpose while using and working with cold temperature or hot temperature. This investigation dealt with a potential opportunity for the development of luffa fibers particles with the epoxy and the fiber is undergo in treat with few chemical treatment to significantly which is important for mechanical, and low temperature resistance properties of the luffa cylindrica fibers. Earlier research said the Thermal, Tensile and flexural and mechanical many properties of Luffa cylindrica sponge in research study. Over all conclusions to establish insulation sheet material for the Mitticool fridge and for many applications for like aircraft, automotive and home appliances industries and it can replace the polyurethane foam and make the earth as eco friendly.

5.2) Future Work

In this study i used the chopped pieces of the Luffa Cylindrica, and which is treated NAOH and Sulfuric acid and again washed in distilled water. The Luffa Cylindrica composites particles are mixed with epoxy and the hardener (Araldite) and made the sheet to dry for three days then it becomes the insulation sheet for the Mitticool Fridge.

In future work if we grind the Luffa Cylindrica fiber in very small particles then if we mix with the epoxy material then strength will be high and it can be equalize with properties of polyurethane foam, which can be used as Aerospace, Automobile and the Sound engineering industries. The temperature is now achieved 17°C it can be more like 14°C and this sheet can replace the polyurethane foam in future.

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