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Development of thermal insulated organic & Aluminum foil based hand grips for safely holding cookware & cooking spoons

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Abstract: Metals and their alloys have many unique properties including the property of conduction of heat and electric current. However conductivity of depends upon various factors. In our daily important tasks cooking in the kitchen is most basic & vital task. Since we uses cookwares and cooking accessories made of metals like aluminium and alloy steel and stainless steel which are very good conductors of heat and gives ease in fast cooking. Such thermal conductivity keeps cooking spoons and cooking utensils warm on high and low flame burners due to which we feels uneasiness and discomfort in holding them. Thermal conductivity of items made from alloys and pure metals depends on many factors like porosity,metal content, skin depth, length of metallic conductor, thickness of metallic conductor, permeability, moisture content, operating temperature, pressure, aging & surface velocity and metal composition of alloys.

The important fact to remember these things are unchangeable for us. The unique solution of this problem retains in the creation/ development of Thermal insulated organic hand grips and their use in our routine cooking work and practice.

Keywords: Conductivity, Thermal insulated, Organic, hand grips, cooking accessories, metal content.

1. INTRODUCTION:-

Metals and their alloys have some unique properties out of them conduction of heat is one of them.when the bulk density of atoms in a metallic sheet increases then conduction of heat decreases.

There are various factors on which conduction of heat depends. In my research work I have focused on in providing the product (thermal insulated organic hand grips) for holding cooking spoons and cookware. we know that most of kitchen utensils are made up of aluminium & stainless steel and aluminium is a very good conductor of heat and its thermal conductivity is in the range of 88 to 251 W/m-K whereas stainless steel have low thermal conductivity 25 W/m-K. But during cooking process it has been observed that cooking spoons are heated quickly due to conduction and we feels discomfort to hold them. Sometimes our fingers and hands gets burned/ injured due to it. So there is a need to develop such products which gives ease in griping cooking spoons by their insulation materials. Some of the insulating materials are organic in origin like wool. Saw dust of Acacia nilotica ,Polyurethane foam, sponge, expanded polystyrene whereas Aluminium foil is inorganic in its source.

Thermal conduction is the property of transfer of heat from the one end to other end of the body and the substances which have such property are called as conductors whereas those substances or materials which do not allow the passage of heat or electric current through them are insulator and property is called thermal resistance or R value. R value is the measure of resistance in the path of heat flow through the thickness of given insulator material. Good insulator are having higher R values.

Relation between R-value and thermal conductance (λ):- It has been found that R value is directly proportional to the thickness (l) or diameter of the body or insulating materials whereas it is inversely proportional to thermal conductance (λ).

$$R = l / \lambda$$

Where l = the thickness of the insulator material in metres, λ= thermal conductivity in W/mK
In watts per meter kelvin.

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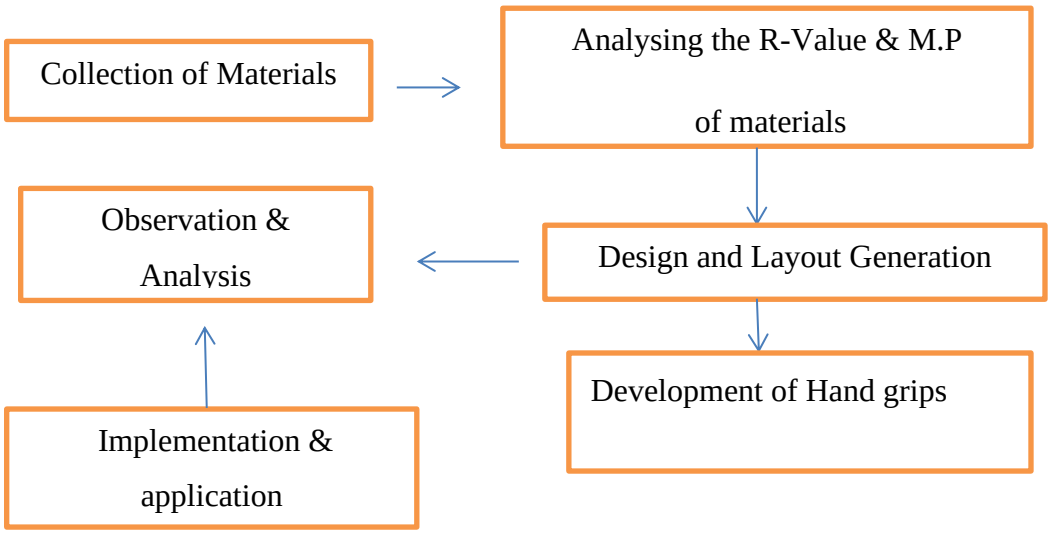
2. EXPERIMENTAL METHODS OR METHODOLOGY



Research methodology of my research work is a sequence of many steps which were carried out one by one These steps are as follows:-
Collection of Materials-Insulator materials used: Insulator material used are used Aluminium foil, waste pieces of polyurethane foams, spare wool, saw dust of Acacia nilotica ,Expanded polystyrenes, sponges, other materials includes gorilla adhesive, cello tape, scale ,spatula, petridish, glu.

Equipments:- Infra red Thermometer with Laser sensor, stop watch.
Analysing the R-Value of materials:- First of all I have analyse the individual R values of each material used in the development of thermal insulated organic hand grips then I have sort them in ascending order of their R values.
Designing of Thermal insulated hand grips :-In my Research work ,i have given designs of two different models of thermal insulator hand grips for holding pans and cookware accessories like cooking spoons by drawing their designs.
Development of composite thermal insulated Hand Grips- I developed my products by the using sandwich model of insulated materials, application of waste organic matter like saw dust of Acacia nilotica(Babul)
Implementation part:- Implementation of these two models have been done by fixing of such models into our cookware handles and cooking spoons.
Observation & Analysis:--After fixing these insulator composite organic hand grip models in the cookwares I have taken readings of temperature at inner surface of container and outside surface of hand grips.

3.RESULTS AND DISCUSSION:-

Since all the materials used in making Thermal insulated organic hand grips are good insulators and most of them are organic in their source hence the hand grips were found to be very efficient in resisting the high temperature or heat generated during the cooking task and do not have any adverse effect on the environment.

Chart: R values and melting points of Insulator materials

S.no	Insulator materials used	Melting point	R value
1	Expanded polystyrene	270 ^{0}C	5 Kelvin / inch
2	Polyurethane	Above 93 ^{0}C	0.022 -0.035W/m-K
3	Sponge(HPRI-Aromatic polyimide Foam)	240 ^{0}C	3.7 Kelvin/ inch
4	Aluminium foil	660 ^{0}C	235 W/m-K

Designing of thermal insulated hand grips:- Layering Sequence of insulating materials
a) polystyrene model b) polyurethane model

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Aluminium foil As Outermost layer
Wrapping layer of saw dust coated sheep wool
Sponge layer 3mm
Polystyrene layer1.5 cm
Sponge layer 3mm
Wrapping layer of saw dust coated sheep wool
Aluminium foil & inner most covering

Polystyrene Model:-- In this model insulators are made by the sequence of layers of aluminium foil twice, sponge layers twice and one layer of Polystyrene foam of 1.5 cm.
Area dimension;- length x breadth = 2 inch x 1.5 inch
Total area = 3 inches.
Thermal resistance of polystyrene is 5.0 K / inch and its Melting point is 270 ^{0}C, so it is considered to be a very good insulating material for cooking and cooking assistance tasks.
Temperature tolerance range of polystyrene expanded boards is 75 ^{0}C for long term temperature exposure whereas aluminium foil has melting point value of 660 ^{0}C and its R value is 235 W/m-K which shows that it is better insulating material as compared to other used in the development of this product that's why I used it at the innermost and outermost places of the model.

Preparation of Acacia saw dust paste :-chemical composition of paste
Gorilla Adhesive(Glu) – quantity taken 50 ml
Acacia sawdust- 20 gms.

Sponge layer- 3mm Outermost
Aluminium foil - single Layer
Polyurethane Layer 1.5 cm (PUR-Layer)
Sponge layer- 3mm
DOUBLE LAYER OF Aluminium Foil

I have mixed both of these ingredients well in the big sized petridish by spatula.
Then I have dipped the sheep wool fibres in the petridish containing Acacia sawdust paste and applied such paste on the woollen fibres by the help of spatula.By the action of adhesive present in the paste acacia saw dust got easily stuck on woollen fibres keep these fibres for 12 hours for complete drying and setting of paste on it. Acacia nilotica wood and its sawdust have high thermal resistance & is very good natural insulator that's why I used it for heat resistance.After 12 hours I separated out these woollen fibres and wrapped on the 3-layered sponge-xpx-sponge insulator well then tied its both ends.After that I have pasted Aluminium foil on innermost and Outermost surfaces of the insulator.
Synthetic sponge used in the model contains 3 basic chemical components which are wood pulp,
Sodium sulphate and hemp fibers.

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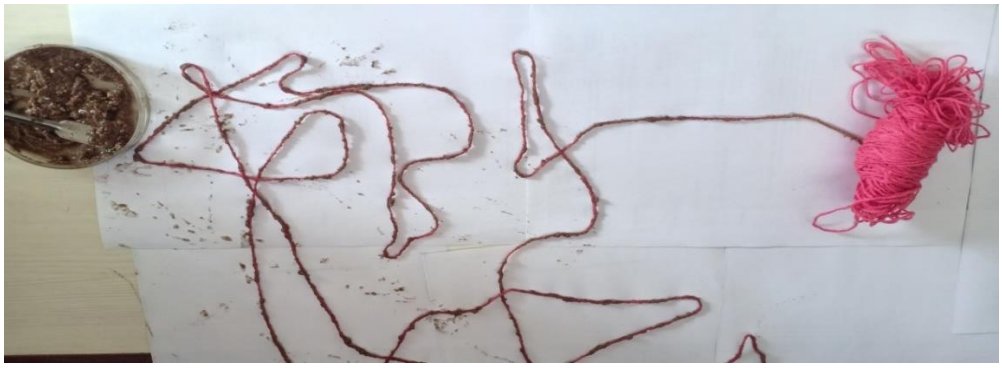

Photo –showing the coating process of Acacia nilotica saw dust paste on wool.

Sandwich Model of Insulators (S.M.I):- In this sandwich model of insulators, insulators are arranged according to decreasing values of melting points of materials used, i.e:- the insulating
Material with highest melting point is kept at the inner most place in hand grip insulator.
Polystyrene Sandwich model:- Al foil > synthetic sponge > polystyrene
660 ^{0}C > 290 ^{0}C > 270 ^{0}C

Photo showing coating of sawdust paste on wool wrapped on synthetic sponge.

Photo- showing –XPS- Polystyrene – sawdust- wool model

Polyurethane sandwich model:- In this model insulating material with highest melting point ie – Aluminium foil is placed in innermost location in its double layer at each pane of hand grip insulators.
Area dimension – length x breadth=> 3 inch x 2 inch.= total area = 6 inches.

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Photo showing – Polyurethane Foam-Aluminium foil thermal insulator.

Aluminium foil > sponge > polyurethane foam

660 ^{0}C > 230 ^{0}C > 93 ^{0}C

Double layer of Aluminium foil is installed in the hand grip insulator inner most side in both the panes to resist heat entry in it because the temperature of the steel pan reached to 220 ^{0}C after 30 minutes from starting of burner which can easily resist such huge amount of heat whenever we keep handles of cookware/ steel pan.

Observation & Analysis :- After the development of thermal insulator Hand Grip model I have used them for holding / griping cooking spoon (polystyrene sawdust sheep wool Model) and steel cookware pans (Polyurethane- Aluminium foil model) I have observed such readings and results.I have used two devices for the detection of thermal resistance and performance of hand grip insulators which were Infra red Laser Digital thermometer and stop watch for time measurement till 30 minutes. Three Readings were taken after an interval of ten minutes.

Laser detection of temperature during use of Polystyrene model:-

S.No	Temperature of container	Temperature of spoon handle	Temperature at thermal insulator hand grips
1	88.8 ^{0}C	52.9 ^{0}C	36.3 ^{0}C
2	91.5 ^{0}C	53.2 ^{0}C	36.3 ^{0}C
3	96.7 ^{0}C	53.6 ^{0}C	37.1 ^{0}C

Laser detection of temperature during use of Polyurethane foam and Aluminium foil -model:-

S.No	Temperature of container	Temperature at handle of cookware pane	Temperature at thermal insulator hand grips
1	89.5 ^{0}C	54.0 ^{0}C	37.2 ^{0}C
2	93.5 ^{0}C	60.1 ^{0}C	38.0 ^{0}C
3	96.7 ^{0}C	64.3 ^{0}C	38.5 ^{0}C

CONCLUSION

After the implementation and analysis part I found these thermal insulator Hand Grip models very effective, safe and handy and some unused materials were also used in their development. Thermal insulator hand grips are the alternate of Cotton cloth piece & napkins. which may spread Bacterial/ viral infections in food and may cause risk of fire incidences. Mean value for polystyrene model was found to be 36.3 ^{0}C whereas Mean value for Aluminium Foil - polyurethane model was calculated by the average(mean) formula :-

Average = first reading + second reading + third reading / 3

Average => 37.2 ^{0}C + 38.0 ^{0}C + 38.5 ^{0}C /3 = 113.7 ^{0}C /3

Average value = 37.9 ^{0}C

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