

Development of Thermal Insulated Semi-Ceramic Hand Grips For Safe Gripping of Cooking Accessories

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ABSTRACT

There are three basic categories of materials on the basis of transmittance or conduction of heating and cooling temperatures through them such as conductors, semi conductors and Insulators. All the type of materials have different applications in different fields. In cooking work good quality conducting cookware are used for saving of fuel and time and comfort. At the time of cooking and heating of utensils our utensils and cooking accessories becomes too much hot due to which we normally feels uneasiness and discomfort because these accessories or cooking spoons are also made of stainless steel or steels of various grades. Different types of metallic utensils or graded steels have different-2 types of conductivity values due to factors like length of metallic conductor, skin depth, gauge of metal used in casting utensils and porosity. Along with these factors some other factors also work here like moisture content, aging of the cookware used, composition of alloys, availability of fresh air and air pressure, surface interaction of air, range of operating temperature, Time period in which heat is given to the container and make of the containers. The research project – “Development of thermal insulated semi-ceramic hand grips for safe gripping of cooking accessories and containers” includes the process of development of semi ceramic hand grips, their testing against temperature range from 100 to 190 ° C, observation at different stages and finally gone to the result or conclusion. Safety of our finger tips, fingers and palms is a very crucial issue when we are handling containers and cooking accessories during heating and after the heating of containers. Since long time a piece of white cotton cloth is used for holding hot containers which do not ensures heat safety as well as handling safety during our working. So, There is a need of inventing such thermal insulator devices or hand grippers which ensures both of these things. One more thing, in making of these hand grippers some waste products of other industries are used as a raw material.

Keywords- Conduction, Transmittance, hand grips, cooking accessories, metal content, Heat safety, hand grippers, finger tips.

INTRODUCTION

The type of energy which maintains the temperature of the system at higher values is called as thermal energy whereas the transfer of hot temperature from the thermal energy source to a medium or any object is known as heat. In other words we can see that the total kinetic energy of the molecules of a substance or an object with respect to time is the heat.

Types of heat transfer:- heat generally transfers by three different modes in three different physical states such as

1) Conduction:- Transfer of heat through a solid material or solid metallic conductor. This flow of heat occurs from its higher amount region to its lower amount region in the solid body.

2) Convection:- The type of heat transfer takes place in the liquid materials by the bulk motion of Molecules with in the liquids. Initially the process of convection starts by the conduction principle that occurs in the walls of the containers.

3) Radiation:- the type of flow of heat in which heat flows from one object to the other without the involvement of particles or molecules of the heating medium. In other words we can say that heat flows by the air or by the release of hot water vapours in to the surrounding air from one place to another is called as radiation.

Fourier's law of heat transfer:- It states that negative gradient of temperature & rate of heat transfer with respect to time is directly proportional to area at right angles of that gradient from where the heat is actually flow. The other name of Fourier's law is the Law of conduction of heat. We can express its statement in a simple algebraic expression:-

$$Q / \Delta t = - kA(\Delta T / \Delta x)$$

Where A = area of cross sectional surface, ΔT =Temperature difference between the endpoints,

Δx = distance between two ends.

Fins law of heat transfer to Atmosphere:-

According to Fin's law the rate of flow of heat or heat transfer from the surface of solid body to the atmosphere is directly proportional to the area of surface of that body. The extended surface is called as fin which enhances the rate of heat transfer to the atmosphere.

$$Q = h A \Delta T$$

Where Q = heat transferred ,

A= area of fin , ΔT = Change in the temperature .

Or $Q_{\text{conv.}} = h A_s (T_s - T_\infty)$

In other words we can define it as if we raise the length of the fin then the temperature gradient will automatically increase or by increasing object's surface area the transfer of heat from object to the surrounding environment also gets increased.

Fins law of heat conduction:-

It states that

“More amount of heat conduction results in the more and more quantity of heat transfer.”

$$Q_{\text{conduction}} = kA(T_1 - T_2 / \Delta x)$$

$$Q_{\text{conduction}} = - k A (- \Delta T / \Delta x)$$

Now if $\Delta x=0$ the previous equation in differential form may be expressed as:-

$$Q_{\text{conduction}} = - k A (\Delta T / \Delta x)$$

$$Q = -k \cdot d T$$

Properties of a good insulator material:- we can judge any insulating material by their properties and parameters as good insulator or bad insulator. Some of the important properties of a good insulating material are as following:-

- 1) High thermal resistance value
- 2) Low thermal conductivity
- 3) Higher specific heat capacity
- 4) High surface emission
- 5) Porosity and light weight.
- 6) Heat safety
- 7) Eco-friendly
- 8) Cost effective or cheap.

Idea and Concept of the Research work:-Use of Flooring material & Ceramic thermal composites in the development of Thermal Insulated Hand Grips(as a wearable device) for the safety of hands during cooking in home kitchens.

Purpose of the Research work :- To develop a Thermal insulated semi ceramic hand grip for safe gripping of cooking spoons and some accessories.

Focus Areas of Research work:- It includes practical implementation of two methodologies of development of two different types of thermal insulators.

(1) Layering effect of insulation materials:- layering effect gives better results when we synthesize any new insulator by the combining the layers of 2 or more than two insulating materials which are having different thermal resistance values and may have different insulation properties. Insulation may be layered and 2 layered insulation is better as compared to single layered insulation practically because through it loss of heat gets half.

(2) Composite pads:- Secondly , the development of Semi Ceramic finger grips which are made by ceramic and porous sponge.

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Materials, Glassware and Equipment used in Research:

Materials:-

For Layering pad :-These heat resistant materials are used

Linoleum sheet, waste paper sheet, thin polyurethane waste sheet, cotton cloth as base material.

For composites :- high alumina cement, chalk powder, fine sand, silica aerogels sachets, fine pieces of waste bricks, water etc.

Glassware:-Measuring cylinder 50 ml glass, Petri-dishes, spatula , glass rods and flexible PVC-mould.

Equipment:- Electric weighing balance, Screw gauge, Iron ruler and for detection of heat transmission detection is IR-Laser Digital Thermometer, Thermo Couples connected with computer system.



Figure showing IR laser thermometer



Figure: showing thermocouple thermometer

Properties of Materials used:-

- 1) Linoleum:- the name of the material was originated from the Latin word Linum means flax & Oleum means oil completely we can say it as flax and oil.
Linoleum has many properties like
 - a) Robust
 - b) Resilient
 - c) Water resistant
 - d) Oil & grease resistant
 - e) Anti static and anti bacterial
 - f) Offers a soft comfortable and warm feeling.
 - g) Mostly used as a carpet or flooring.
 Advantages of using linoleum as a insulator material are :- it's a cheap cost material, versatile and eco-friendly, durable, repairing is easy, maintaining is easy, antibacterial and anti static and quiet.
- 2) Thin sponge sheet :- sponge sheets have very good thermal insulation properties like;-
 - a) Easy in cutting and pasting.
 - b) Comfortable and soft
 - c) Resistant to bacteria and mildew
 - d) Good thermal insulator having excellent thermal stability
 - e) Sealing capabilities are excellent
 - f) Light weight and porous
 - g) Versatile product.
- 3) Paper sheet having rich Cellulose :- It is a nice thermal insulation material having average thermal conductivity about 0.040 W/m-K equal to glass wool but it is safer in handling or use as compared to glass wool and glass.

Development process of Thermal Insulated Semi-Ceramic Hand Grips for safe Gripping of cooking Accessories:-

The development of thermal insulated semi ceramic hand grips for holding cooking accessories include are

development of thermal insulated semi ceramic finger grips, palm pads, finger covers etc.

Composition mixtures of three different types were prepared for filling up moulds of finger pads.

- 1) Composition mixture of waste chalk powder, Portland cement, Alumina dust, silica aerogel, water.
- 2) Composition mixture of fine sand, Portland cement, silica aerogel and water
- 3) Composition mixture of fine pieces of bricks, Portland cement, Alumina dust, silica aerogel, water.

Procedure:-1. Ceramic finger pads

1. Preparation of Handles of finger Grips:- Thin elastic pieces of 3.2 inches length were cut from its roll and folded each piece once but in unequal parts.
2. Preparation of 3 different composition mixtures for making the hand grips.
 - a) Chalk powder composition:-
 Chalk powder + port land cement + Alumina dust + silica aerogel
 18 gm + 18 gm + 2gms + 2 gm
 - b) Fine sand composition :-
 Fine sand + port land cement + silica aerogel
 15 gm + 24 gm + 1gm
 - c) Brick powder composition :-
 Fine brick powder + Port land cement + silica aerogel
 18 gm + 19 gm + 1 gm
3. Filled all the composition mixtures in the flexible PVC- moulds.
4. Kept all the composition mixture for their setting for approximately 12 hours.
5. After their setting & drying de-molded all the type of finger pads from their mold.
6. Kept all ceramic finger pads dip in the water for 15 hours for increasing their comprehensive strength .



Fig:-shows single use PVC spoons as ceramic finger pad mould.



Fig :- showing brick powder



Fig- showing ceramic finger pads of fine sand.



Fig: showing elastic handles of finger pads



Fig: Ceramic finger pads of chalk powder

Procedure:- 2. Preparation of Layering pads.

Collected all the required Things like Glassware , detection equipment and other important equipment before development process.

On the cotton base of cotton hand gloves Linoleum sheet material was join by the help Of thread stitching method which generally have no harmful and side effects.

A palm pad was design and then prepared by the combination of two materials first is wastepaper sheets or paper napkins and second is poly-urathane foam sheet.

$$\begin{aligned} \text{Total area of the pad} &= \text{Length} \times \text{Breadth} \\ &= 10 \text{ cm} \times 8.5 \text{ cm} \\ &= 185 \text{ cm} \end{aligned}$$

thickness of polyurethane sheet =3 mm
 folded paper napkin taken in four layers.

$$\begin{aligned} \text{Cellulose pad} &= \text{Length} \times \text{Breadth} \\ &= 10 \text{ cm} \times 8.5 \text{ cm} \\ &= 185 \text{ cm} \end{aligned}$$



Fig: showing two layered Palm pad

Attached both the layers of polyurethane and paper sheets stich together.

Preparation of Optional Thumb Pad :-

Special feature ; - Layering effect of highly porous materials, soft material with Linoleum.

first layer – linoleum layer.

second layer- polyurethane foam layer 5 mm.

third layer - sponge of 1 inch thickness.

fourth layer- waste paper napkin 4 layered.

outer covering of the thumb pad by waste cloth of green cloth bags from its all six phases .



Fig shows layering effect in thumb pad



Fig: shows Covered thumb pad.

Development of Palm pad covering:-

- a. Trace hand shapes on the linoleum sheet twice first time from dorsal side and then second time from front side of the palm excluding the thumb.
- b. Cut these designs by scissors and then stitch on both the surfaces of cotton made gloves.
- c. Trace the thumb designs & then cut each one piece on both the surfaces of thumb side.
- d. Kept the palm pad inside the front side of palm.



Fig:-shows Linoleum hand Grip.

Design consideration of the Hand Grip insulator :- In the design of insulator hand grip a consideration of creation of aeration area has been kept. when ever user uses it area of aeration always created on the opposite side to the exposure which helps in quick cooling of the thermal insulator hand grips.



Fig shows Aeration area for quick easy entry of air into hand grip.



Fig:- shows ceramic and Layered finger pads with insulator hand grip

Holding of any kitchen accessory may be possible by the involvement of two fingers like fore finger and middle finger and thumb. By using such thermal insulated hand grip we can grip any kitchen accessory or spoon by the involvement of only 1-finger (fore finger) and thumb. so there is an advantage of freedom of middle finger during doing such task.

Observation:-By using ruler measured the lengths of cooking accessories. and by the use of screw gauge measured gauge of the accessories.

Type of utensil	Length (in Cm.)
Cooking spoon	26.5
Mesh Skimmer (poni)	39.5
Rice cooking spoon	23.5
Pour Ladle (Dosa spoon)	35

Thickness of utensils (in gauge):-

Type of utensil or accessory	gauge
Cooking spoon	20
Mesh Skimmer (poni)	10
Rice cooking spoon	25
Pour Ladle (Dosa spoon)	20

Temperature recorded during performance testing of Chalk powder-Alumina pad:-

At both surfaces utensil's last end and at ceramic made grips.

First reading:- for 5 minutes.

Type of utensil / part of utensil	temperature at utensil surface (in ° C)T ₁	Temperature at Chalk powder,opc ,Alumina pad(in ° C)T ₂
Mesh Skimmer (poni) handle	39	39
Rice cooking spoon	54.5	51
cauldron (kadhai)	119	69.9
Handle of cauldron	86	54

Second reading:- for 5 minutes

utensil / part of utensil	Temp. at utensil surface (in ° C)T ₁	Temp. at Chalk powder,opc ,Alumina) pad (in ° C)T ₂
Mesh Skimmer (poni) handle	38	38
Rice cooking spoon	101.6	94
cauldron (kadhai)	81	71.6
Handle of cauldron	88.5	72

Temperature recorded during performance testing of Fine sand- OPC pad:-

First reading:- for 5 minutes.

Type of utensil	Temperature at utensil surface) (in ° C)T ₁	Temperature at Fine sand ,opc) pad (in ° C)T ₂
Mesh Skimmer (poni) handle	40	38
Rice cooking spoon	62.7	51
cauldron (kadhai)	106.8	68
Handle of cauldron	103	70.1

Second time for 5 minutes:-

Type of utensil	Temperature at utensil surface) (in ° C)T ₁	Temperature at Fine sand ,opc) pad (in ° C)T ₂
Mesh Skimmer (poni) handle	45	38
Rice cooking spoon	65	54
cauldron (kadhai)	155	113
Handle of cauldron	111	78

RESULT AND CONCLUSION

Result :- After doing the data analysis and calculating the change in temperatures from T₁ to T₂ results showed that the ceramic finger pads composed of chalk powder + OPC + Alumina dust + silica (very less quantity) have very good thermal resistance capacity as compared to other to ceramic pad of other chemical composition viz – fine brick powder model and Fine sand + OPC + silica (very less quantity).

Highest ΔT values found in case of Chalk + OPC + Alumina + Silica ceramic finger pads are 49.5 > 32 > 16

Highest ΔT values found in case of fine sand + OPC + Silica ceramic finger pads are 42 > 38.8 > 33 .

Conclusion:- After comparing the highest ΔT values in both the models it has been found that chalk powder + OPC + Alumina + Silica ceramic finger pads have better re-radiate capacity of heat as compared to fine sand + OPC + silica ceramic finger pads.

However, Performance of both the ceramic grips found to be good and efficient.

Achievements and findings:-

1. Some flooring materials which have very high thermal resistance (R) value may be used in heat safety devices.
2. Layered finger pads made of some insulator, soft and porous materials in the research work showed very high heat loss in to the surrounding that helped in maintaining the lower temperature value in hand grip.
3. Ceramic finger pads found to be very efficient in thermal resistance capacity due to the presence of OPC, alumina dust, silica.
4. Waste material like double folded paper napkins (unused) and single use Green cloth bags may also be used in the development of thermal insulated hand grips.
5. Waste material like sponge pieces of thickness 1 inch or more may also be used in layering effect based insulators.

6. Blend or mixed type of insulators may be develop by the combination of different insulators after their development process.
7. The cost of such blended type of hand grip very cheap. It can be sell in the market at 100 Rs per pair.

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