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Development of Fly Ash and Light Weight Mineral Granules Based Thermal Insulated Ceramic Container Bases for Keeping Hot Pot & Hot Bowl

Sugeet Sethi[1], Dr.Vinay kumar Jain[2]

[1]Ph.D Research scholar - Chemistry, Madhyanchal Professional University, Bhopal, M.P
[2]Professor, Chemistry, Madhyanchal Professional University, Bhopal, M.P

Email Address of Corresponding Authors:-
[1]sugeetsethi2019@gmail.com, [2]vinay.jain@adityabirla.com

ABSTRACT
Thermal insulation based product development is the most important concern in the present age because we are using so many types of heating and cooking and baking devices and electronic equipment like microwave ovens, induction cook tops, Oven toaster Grillers, Electric tandoor, Roti makers, domestic furnace and electronic coffee & tea makers. When we take out our bowls and pots from the microwave ovens and such type of other kitchen devices then heat present in the walls of the containers like utensil, bowl & pot and heat present in the cooked food damages the top of the table and table covers. In order to prevent such things there is a burning need of development of thermal insulation bases and mats.

Keywords- heating, microwave ovens, table covers, devices, burning.

Introduction:
as we know that thermal energy is the most important form of energy for the food processing and cooking procedures but everything has its pros & cons similarly heat energy also has its pros & cons as it is beneficial in terms of cooking of food items but harmful in its burning and damaging effects on the contacting and touching surface and substrates. Some of the materials found in nature are very good thermal and electrical insulators like rocks, wool, some minerals like vermiculite and closed cell enclosed perlite. By using such type of raw materials in the composition mixture of ceramic products in a fixed and appropriate proportion we can develop thermal insulator ceramic products.

Light weight earthen mineral Effect:
our planet earth is the only planet which has so many minerals in its mantle and crust areas , some minerals are heavy weight and are of high density type and rest some of other minerals are light weight minerals like dolomite, muscovite, perlite, feldspar, calcite and quartz these minerals have lower gravity values in comparison to standard gravity(2.85). The effect of using closed cell expanded perlite upon its usage in the ceramic composite mixture is to reduce the over all weight of the ready ceramic product and

other benefits of using it are to lower down the thermal conductivity values of thermal insulated ceramic product and increase in compressive strength of the concrete mixture.

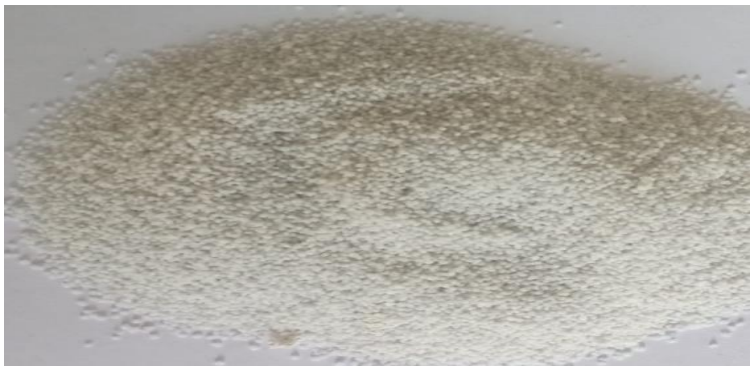

Figure -1 showing macro granulesof perlite mineral.

Basalt fibres usage Effect:- The type of fibres which are made from basaltic rocks are known as basalt fibres and naturally occurring basalt fibres are obtained from silica/ alumina oxides. They are the best replacement of asbestos fibres which is harmful for our health and caused respiratory disorders. There are many advantages of using basalt fibres in the concrete and ceramic composition mixture because basalt fibres are having strong tensile strength, high density and high elastic modulus. Its usage helps in increase in corrosion resistance and chemical stability in nature of composite even in alkaline mediums.

Figure -2 showing micro fibres (5-6 mm) of Basaltic rocks

Fine sand:- very fine sand helps in increasing the porosity of the composite and on the other hand it also increases the gripping power of the ceramic binder ie;- cements as it increases compressive strength of the material so it helps in the increase of durability of the ready ceramic products. It also helps in enhancement of resistance of penetration in side the ceramic composite so it helps in the increase in thermal resistance.

Figure -3 showing very fine sand particles

Literature review: I have reviewed many research papers for the development of my light weight thermal insulator ceramic table container Bases and out of them most helpful and important research paper was "An overview of Thermal insulation material for sustainable engineering building Applications" jointly written by Imhade P. okokpujie, Victor Essien, Omolayo M. Ikumapayi and Emeka S. Nnochiri, published in International Journal of Design & Nature and Ecodynamics 17(6):831-841 in December month of 2022 year. " High performance thermal insulation material based on waste Glass" published in the journal of IOP Conference series: Materials science and Engineering and written by Y T Panov et al in the year of 2020.

Focus of Research:- My focus of research in the present research paper is on searching of naturally occurring thermal insulating materials, study of their properties including chemical, physical and thermal and mechanical properties upon their usage in any composite product. However, I focused equally on the development of Thermal Insulated Ceramic Bases (TICB's) for the applications of keeping and holding of hot containers, hot pots and hot bowl upon them.

Methodology:-

1. **Collection of Chemicals, equipment & Materials-**.
   Equipment:- Temperature indicator and controller with thermocouple sensors, Infra red Thermometer with Laser sensors, Eagle Electric weighing balance etc.
   Glassware- scale, Cement mixer, beaker- 250 ml, Measuring cylinder-100 ml , Cylindrical shaped PVC moulds.
   Chemicals and Materials :-Pozzolona cement, Portland cement, water, basalt ceramic fibres, fly ash, closed cell enclosed perlite (light weight mineral), very fine sand, white Portland cement.
2. **Determination of Mould mass:-**
   First taken the weight of empty flexible p.v.c mould by pouring mixture of fine aggregate and cement in 55 :45 ratio , I got the weight as 151.5 gms.
3. **Designing of Thermal insulated ceramic bases :-**In my Research work ,i have made designs of two types of ceramic bases for keeping hot pots and hot bowls on the wooden and sun mica surface of Dinner tables.
   1. Grey pozzolona cement made ceramic bases
   2. White Portland cement made ceramic bases.
4. **Development of composite thermal insulated ceramic bases:-**

1) Determination of shape :- determination of shape and size of the thermal insulation ceramic made products is the most important and primary step in the development process. So, I have decided for the selection of cylindrical shape with diameter of the pvc mould of 4 inch.
2) Determination of the raw material weight in the mould- after filling the macro granules of perlite and finely powdered white Portland cement in empty mould I got its weight to be 151.5 gm.
3) Preparation of ceramic Mixture Pastes for both Model -1 and Model-2:- Addition of various raw materials was done in this chemical composition by their mass percentage. Chemical composition taken by the mass percentage of total mass of ceramic composites
   Mixtures.

Model -1 Thermal insulated ceramic Base (Grey pozzolona cement made ceramic bases)

S.no	Name of the raw materials	Quantity taken (in gm)
1.	Grey cement (J.K cement)	71 gm
2.	Fly ash	1.5 gm
3.	Very fine sand aggregates	65 gm
4.	Perlite (light weight Aggregate)	10 gm
5.	Ceramic fibres	4 gm
6.	Water	80 ml

Table -1 showing contents of Grey Pozzolona cement made insulation container Bases

Model -2 Thermal insulated ceramic Bases (White Portland cement made ceramic bases)

S.no	Name of the raw materials	Quantity taken (in gm)
1.	White Portland cement (ultra tech brand)	71 g
2.	Fly ash	1.5 gm
3.	Very fine sand aggregates	65 gm
4.	Perlite (light weight Aggregate)	10 gm
5.	Ceramic fibres	4 gm
6.	Water	80 ml

Table -2 showing contents of Portland cement made insulation container Bases

Figure -4 showing mixture of ingredients

Figure -5 showing dry mixed ingredients

4) After the stirring both the ceramic pastes individually in separate containers or ceramic mixers I added these into two separate p.v.c moulds.
5) Kept the material with mould for normal drying at room temperature range 27 to 39 ºC in the summer season for three days for its setting and hardening.
6) De moulding of the material.
7) Water absorption capacity test- model-1 absorbed 5 ml of water in 24 hours of time duration and model-2 absorbed 3.5 ml of water in 24 hours of time duration.

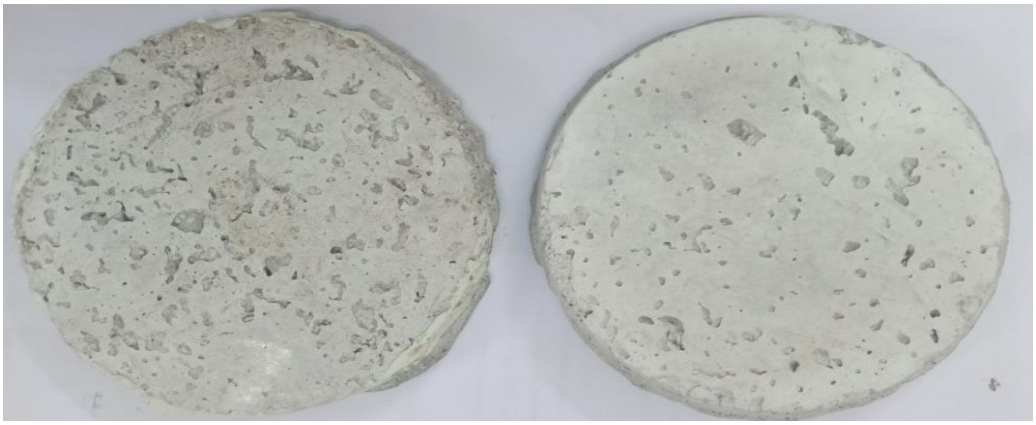

Figure -6 showing the images of porous thermal insulation ceramic Bases

8) Coating of top surface of porous thermal insulation ceramic Bases by the mixture paste of white Portland cement and fly ash on model -2 (Portland cement model) for top finish.

Figure -7 showing coated surface of model -2 on the right side.

Implementation:- I have used both the Thermal insulation container Bases(T.I.C.B's) near microwave oven slab for keeping hot bowl and hot bone china pots on them. Also kept some of the hot dish containers on both the Thermal insulation container Bases(T.I.C.B's) and recorded the temperature difference values on the hot container and at the same time on the dinner table by using infra red –Laser sensor enabled digital thermometer.

Observation & Analysis:-After the development of Thermal insulation container Bases(T.I.C.B's), a type of insulator composite ,I have keep them on dinner Table area and nearby microwave oven areas for keeping the hot pots and hot bowls on them for the prevention of surface of tables and dinner tables from damaging effects of heat and hot vapours.

Date of recording	Temp. at the hot container	Temp. at the dinner table
22 /11/2023	72.5 ºC	28.2ºC
25/11 /2023	84.8 ºC	26.6 ºC
28/11/2023	87.5 ºC	27.1 ºC
01/12/2023	73.1ºC	26.4 ºC
04/12/2023	68.1 ºC	31.5 ºC
07/12/2023	73.5 ºC	30.8 ºC
10//12/2023	82.5 ºC	32..5 ºC
13/12/2023	72.7 ºC	31.1 ºC
16/12/2023	82.6 ºC	31.5ºC

Table:-3 showing temperature recorded inside at container & at the dinner table(in case of model -1) Pozzolona cement made thermal insulated ceramic base.

19/12/2023	75.4 ºC	30.1ºC
22/12/2023	80.0 ºC	31.2ºC
25/12/2023	78.1 ºC	30.1 ºC
28/12/2023	74.0 ºC	31.0ºC
31/12/2023	79.0 ºC	32.0ºC
01/01/2024	81.5 ºC	34.0 ºC
04/01/2024	83.4 ºC	37.0ºC
07/01/2024	64.2 ºC	37.2 ºC
10/01/2024	83.2 ºC	31.4ºC

Table:-4 showing temperature recorded inside at container & at the dinner table(in case of model -1) Pozzolona cement made thermal insulated ceramic base.

Date of recording	Temp. at the hot container	Temp. at the dinner table
22 /11/2023	72.5 ºC	27.2ºC
25/11 /2023	82.2 ºC	26.0 ºC
28/11/2023	81.5 ºC	28.3 ºC
01/12/2023	73.1ºC	27.5 ºC
04/12/2023	70.1 ºC	31.5 ºC
07/12/2023	73.0 ºC	30.0 ºC
10//12/2023	72.5 ºC	32.7 ºC
13/12/2023	77.4 ºC	31.0 ºC
16/12/2023	80.6 ºC	31.2ºC
19/12/2023	75.4 ºC	30.1ºC
22/12/2023	80.7 ºC	31.3ºC
25/12/2023	78.5 ºC	30.5 ºC
28/12/2023	74.2 ºC	31.0ºC
31/12/2023	81.0 ºC	32.4ºC
01/01/2024	80.5 ºC	34.0 ºC
04/01/2024	89.4 ºC	37.0ºC

07/01/2024	91.2 ºC	37.2 ºC
10/01/2024	85.2 ºC	31.1ºC

Table:-5 showing temperature recorded inside at container & at the dinner table(in case of model -2) Portland cement made thermal insulated ceramic base.

Observations of their thermal and mechanical properties after testing:-

S.no	Name of thermal property	Values of Model -1	Values of Model -2
1.	Heat capacity	0.92 KJ/kg-K	0.98 KJ/kg-K
2.	Thermal conductivities	-1.46 $W.m^{-1}k^{-1}$	-1.24$W.m^{-1}k^{-1}$
3.	Thermal Expansion coefficient	8 microstrains/ºC	10 microstrains/ºC
4.	Compressive strength	8.7 MPa	21 MPa

Table:-6 showing Thermal & mechanical properties of T.I.C.B's -1 and 2

Results and Discussion:- Thermal insulated ceramic Bases of model-1 which were composed of grey pozzolona cement (JK cement) are made up of pozzolona grey cement whose compressive strength is less and thermal conductivity is more -1.46 $W.m^{-1}k^{-1}$ whereas model-2 TISB's were more efficient in many properties as compared to model -1 specially in their high thermal expansion coefficient values and high thermal resistance.

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