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Analysis of Thermal Conductivity of M-Sand Using Insulating Powder Apparatus

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***Abstract*—Heat is the transfer of kinetic energy from one medium or object to another, or from an energy source to a medium or object. Which we have extended this work by taking a new material like a M-sand, Fly ash, River sand.In which we conduct experiment on a insulating powder apparatus by varying the voltages that we analyze the thermal conductivity values of available materials . In which we are concluding the least thermal conductivity value of those materials and finally we will recommend the best available insulation material for reducing the heat transfer rate in various heat transfer applications.**

***Index Terms*— Fly ash, M-sand, River sand.**

I. Introduction

Heat is a form of energy in transit due to temperature difference. Heat transfer is transmission of energy from one region to another region as a result of temperature difference between them. Whenever there is temperature difference in mediums or within a media, heat transfer must occur. The amount of heat transferred per unit time is called heat transfer rate and is denoted by Q. The heat transfer rate has unit J/s which is equivalent to Watt.

A. Steady and Unsteady State Heat Transfer

For analysis of heat transfer problems, two types of heat transfer are considered-steady state and unsteady state. In case of steady state heat transfer, the temperature at any location on the system does not vary with time. The temperature is a function of space coordinates only, but it is independent of time mathematically, for rectangular coordinate system;

$$T = f\ (x, y, z) \qquad (1)$$

During steady state conditions, the heat transfer rate is constant and there is no change of internal energy of the system. For example, the heat transfer in coolers, heat exchangers, heat transfer from large furnaces etc.

B. Conduction Heat Transfer

Conduction is a process of heat transfer generated by molecular vibration within an object. The object has no motion of the material during the heat transfer process.

C. Conduction Rate Equation

In physics, everything must have an equation! It's kind of an unwritten rule. Conduction is no exception. How fast conduction happens depends on several factors: what material the objects are made from (the conductivity), the surface area of the two objects in contact, the difference in temperature between the two objects, and the thicknesses of the two objects. The rate of heat transfer to an object is equal to the thermal conductivity of the material the object is made from, multiplied by the surface area in contact, multiplied by the difference in temperature between the two objects, divided by the thickness of the material.

D. Thermal Conductivity

The amount of energy conducted through a body of unit area, and unit thickness in unit time when the difference in temperature between the faces causing heat flow is unit temperature difference. Metal in general have electrical conductivity, high thermal conductivity, and high density. Typically they are malleable and ductile deforming under stress without cleaving. In terms of optical properties, metals are shiny and lustrous. Although most metal have higher densities than most non-metals, there is wide variation in their densities, lithium being the least dense solid element and osmium the densest. The alkali and alkaline earth metals in group 1A and 2A are referred to as the light metals because they have low density, low hardness, and low melting point .The high density of most metals is due to the tightly packed crystal lattice of the metallic structure. The strength of metallic bound for different metals reaches a maximum around the canter of the transition metal series , a those element have large amount of delocalized electron in tight binding type metallic bonds.

II. Measurement Methods

The purpose of the present experiment is to test various types of powder insulation to find effective thermal conductivities. The testing apparatus was designed to create, as best as possible, a controlled volume which utilizes various devices to produce conditions suitable to measure thermal conductivity. Several past and current experiments were taken into consideration before attempting to design a new apparatus which would allow for a larger temperature range, a smaller temperature difference, and more accurate measurements, if possible. Current thermal conductivity measurement devices are discussed in this section.

A. Guarded Hot Plate

The guarded hot plate method of testing thermal conductivity was the first to become a nationwide standard (ASTM C177) [8]. This method employs an electrically heated plate sandwiched between a pair of specimens. Each specimen is then enclosed by a cooling plate. The earliest guarded hot plate mechanisms used water or ambient air as a heat sink for the cooling plate. The guarded hot plate method is an excellent method of testing the effective thermal conductivity of solids under certain conditions. The method attempts to create unidirectional heat transfer through the insulation specimens. The thickness and surface areas of the specimens can be measured precisely. Then, by adding a known heat flux to the hot plate while providing a heat sink at the cold plate a temperature gradient within the insulation specimen is formed. The subsequent temperatures at each side of the specimens are measured when the system reaches steady state. Using the heat flux, sample thickness and surface areas, and temperature measurements, Fourier's unidirectional heat conduction equation can then be applied to easily calculate an effective thermal conductivity for the samples. The guarded hot plate method, although very effective for many practical insulation tests, is difficult to apply to powder insulation. Containing the powder within the apparatus is much more difficult than installing a solid specimen. Any mechanical supports used would create a heat leak and make material thermal conductivity much harder to calculate. Therefore, other configurations which may be more conducive to powder insulation should be examined.

B. Concentric Cylinders

Steady state thermal conductivity measurement methods involve the production of a temperature difference between the sides of an insulation specimen. The configuration of the specimen and apparatus varies for different methods. Two configurations which have proven to be suitable for powder insulation measurement are the concentric cylinder and concentric sphere. The concentric cylinder method has been used since as early as 1926 by Aberdeen and Laby [11]. In most cases the apparatus consists of a liquid cooled outer cylinder and an electrically heated inner cylinder. Between the cylinders powder can be filled and evacuated to the desired pressure. Ideally, the concentric cylinder apparatus should create a uniform heat flux in the radial direction. However, mechanical supports are required at the top and bottom of the inner cylinder. The supports act as heat leaks and create a temperature gradient in the inner cylinder. Therefore, the cylinder is designed to be very long with respect to its radius. This allows for a fairly uniform temperature along a sufficient length of the cylinder. However, axial heat leakage can still be problematic when using the concentric cylinder method.

C. Concentric Spheres

The concentric sphere method used by Nayak and Tien [12] is designed to eliminate end effects and guard plates associated with the concentric cylinder and guarded hot plate methods, respectively. A schematic of their concentric sphere apparatus is shown in Fig. 1. Thin nylon supports and electrical collections minimize the heat leak between cylinders, making it negligible. Small holes in the outer cylinder covered with filters allow for the insulation space to be evacuated. The temperature of the outer sphere is maintained by adjusting the cryogen level on the copper stem and the heating power of the stem heaters. The insulation space is evacuated, and the heater on the inner sphere is powered to create a temperature difference between the spheres. By this method any temperature range between the temperature of the cryogen and ambient temperature can be reached. A filler spout is placed atop the outer sphere to replace any powder lost from settling. The concentric sphere method is a novel approach to measuring effective thermal conductivity of powder. However, spheres are expensive to manufacture and difficult to work with. Therefore, other configurations would be more suitable for the standardization of a powder insulation thermal conductivity testing method.

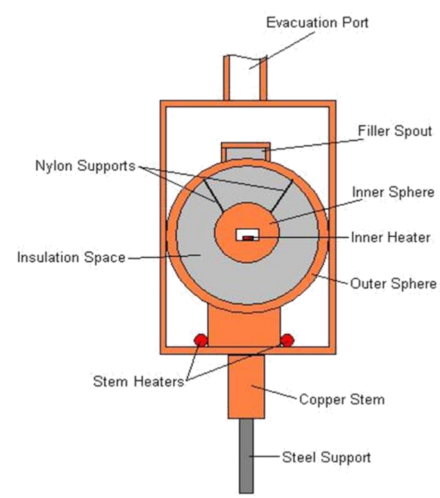

Fig. 1. Concentric spheres

D. Heat Flux Measurement

The determination of thermal conductivity under steady state conditions requires the precise measurement of boundary temperatures and heat flux. Temperature measurement can be achieved with any number of sensor types or with the use of a cryogen at its boiling point. However, more elaborate methods have been developed to accurately measure the heat flux through the insulating material. Measuring the power supplied to a heater is the simplest method of measuring heat flux. However, direct measurement of heating power is insufficient when large heat leaks may be present. The following sections discuss a few techniques which have been developed to negate the effects of heat leaks on heat flux measurement.

III. Insulating Powder Materials

A. Perlite

Perlite is a naturally occurring silicate glass. When crushed, perlite can then be expanded under intense heat to nearly 20 times its original volume. Perlite is one of the earliest used forms of powder insulation and is still used in many applications because of its affordability and wide range of uses. However, more advanced forms of powder insulation, such as those listed in the following sections, are steadily replacing perlite due to their superior insulating properties.

B. Aerogel Beads

Aerogel is a low density granular solid produced by a solution-and-gelatin (sol-gel) process. In this process a silicon solution is hydrolyzed to form a SiO_2 gelatin structure. The gelatin is then dried to form a nano-porous solid with roughly the same structure. A continuous spray process is employed to produce the aerogel beads. The beads used in the present experiment are Nanogel® aerogel beads produced by the Cabot Corporation. Some advantages to aerogel beads are affordability, ease of installation, non-settling, no preconditioning required, and a highly porous structure. The nano pores tend to trap gas molecules, thereby significantly reducing convection and gaseous conduction.

C. Glass Microspheres

Glass microspheres, or bubbles, are similar to aerogel beads in many respects. The microspheres consist of borosilicate glass and amorphous silica. The production process for microspheres is also fairly similar to that of the aerogel beads. However, as the name suggests, microspheres are at least an order of magnitude smaller than aerogel beads. Recent experimental data from Fesmire et al [2] has shown that under certain conditions glass bubbles have a lower thermal conductivity than aerogel beads and thus may be the most effective insulating powder available. However, thermal conductivity data is needed for glass bubbles over a larger temperature range to confirm the powder's superior insulating properties.

TABLE I
POWDER INSULATION PROPERTIES

Name	Diameter	Density	Main Component
Nanogel (R) Aerogel Beads	1-4 mm	1900-2200 kg/m^3	Silica Gel >97%
3M (TM) Glass Bubbles	10-120 microns	100-600 kg/m^3	Soda Lime Borosilicate Glass >97%
Ryolex (R) Perlite	50-1000 microns	2350 kg/m^3	Expanded Perlite 100%

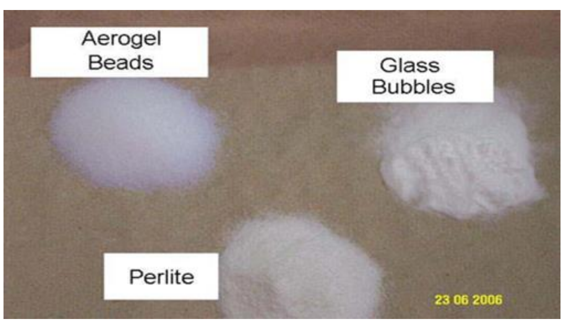

Fig. 2. Powder insulation

D. Sulphur

Sulphur is a naturally occurring element that supports more efficient use of the Earth's resources. It is a critical plant nutrient in agriculture, a key ingredient in sustainable urban development, and an essential input in efforts to slow the loss of productive farm land due to soil degradation. Insoluble sulfur is amorphous form of sulfur made from the heat-polymerizing of sulfur, also can be obtained by reacting sulphureted hydrogen with sulfur dioxide. Insoluble sulfur is macromolecule polymer, and there are several thousand of sulfur atoms in its molecular chains. Since it doesn't dissolve in carbon disulfide, it is called insoluble sulfur or polymeric sulfur. Insoluble sulfur is an important rubber additive agent. It improves product quality, wearability and resistance to both fatigue and ageing. In addition to being universally recognized as the best vulcanizing agent, it is widely used in the manufacture of tire, rubber pipe, shoes, cable and wire insulating materials, latex, and automobile rubber parts and is also a necessary component of belt tires.


Fig. 3. Sulphur

IV. INSULATING MATERIALS

A. M-Sand

Manufactured sand (M-Sand) is a substitute of river sand for concrete construction . Manufactured sand is produced from hard granite stone by crushing. Manufactured sand is an alternative for river sand. Due to fast growing construction industry, the demand for sand has increased tremendously, causing deficiency of suitable river sand in most part of the word.Due to the depletion of good quality river sand for the use of construction, the use of manufactured sand has been increased. Another reason for use of M-Sand is its availability and transportation cost.Since manufactured sand can be crushed from hard granite rocks, it can be readily available at the nearby place, reducing the cost of transportation from far-off river sand bed.Thus, the cost of construction can be controlled by the use of manufactured sand as an alternative material for construction. The other advantage of using M-Sand is, it can be dust free, the sizes of m-sand can be controlled easily so that it meets the required grading for the given construction.

B. Advantages of Manufactured Sand (M-sand)

- It is well graded in the required proportion.

- It does not contain organic and soluble compound that affects the setting time and properties of cement, thus the required strength of concrete can be maintained.
- It does not have the presence of impurities such as clay, dust and silt coatings, increase water requirement as in the case of river sand which impair bond between cement paste and aggregate. Thus, increased quality and durability of concrete.
- M-Sand is obtained from specific hard rock (granite) using the state-of-the-art International technology, thus the required property of sand is obtained.
- M-Sand is cubical in shape and is manufactured using technology like High Carbon steel hit rock and then ROCK ON ROCK process which is synonymous to that of natural process undergoing in river sand information.
- Modern and imported machines are used to produce M-Sand to ensure required grading zone for the sand

C. Properties of Manufactured Sand for Concrete Construction

1) Higher strength of concrete

The manufactured sand has required gradation of fines, physical properties such as shape, smooth surface textures and consistency which makes it the best sand suitable for construction. These physical properties of sand provides greater strength to the concrete by reducing segregation, bleeding, honeycombing, voids and capillary.

Thus required grade of sand for the given purpose helps the concrete fill voids between coarse aggregates and makes concrete more compact and dense, thus increasing the strength of concrete.

2) Durability of concrete

Since manufactured sand (M-Sand) is processed from selected quality of granite, it has the balanced physical and chemical properties for construction of concrete structures.

This property of M-Sand helps the concrete structures withstand extreme environmental conditions and prevents the corrosion of reinforcement steel by reducing permeability, moisture ingress, and freeze-thaw effect increasing the durability of concrete structures.

3) Workability of concrete

Size, shape, texture play an important role in workability of concrete. With more surface area of sand, the demand for cement and water increases to bond the sand with coarse aggregates. The control over these physical properties of manufacturing sand make the concrete require less amount of water and provide higher workable concrete. The less use of water also helps in increasing the strength of concrete, less effort for mixing and placement of concrete, and thus increases productivity of construction activities at site.

4) Less construction defects

Construction defects during placement and post-concreting such as segregation, bleeding, honeycombing, voids and capillarity in concrete gets reduced by the use of M-Sand as it has optimum initial and final setting time as well as excellent fineness.

TABLE II
PARAMETERS OF M-SAND & P-SAND

Parameters	**M Sand**	**River Sand**
Process	Manufactured in factory.	Naturally available on river banks.
Shape	Angular and has rougher texture. Angular aggregates demands more water. Water demand can be compensated with cement content.	Smoother texture with better shape. Demands less water.
Moisture Content	Moisture is available only in water washed M Sand.	Moisture is trapped in between the particles which is good for concrete purposes.
Concrete Strength	Higher concrete strength compared to river sand used for concreting.	Lesser concrete concrete compared to M Sand
Silt Content	Zero silt	Minimum permissible silt content is 3%. Anything more than 3% is harmful to the concrete durability. We can expect 5 - 20% slit content in medium quality river sand.
Over Sized Materials	0%. Since it is artificially manufactured.	1 - 6% of minimum over sized materials can be expected. Like pebble stones.
Marine Products	0%	1 - 2% like sea shells, tree barks etc
Eco Friendly	Though M Sand uses natural coarse aggregates to form, it causes less damage to environment as compared to river sand.	Harmful to environment. Eco imbalances, reduce ground water level and rivers water gets dried up.
Price	M Sand price ranges from Rs.35 - Rs.45 per cubic feet in Bangalore.	River sand price ranges from Rs 60 - 80 per cubic feet in Bangalore.

5) Economy

As discussed above, since usage of M-Sand has increased durability, higher strength, and reduction in segregation, permeability, increased workability, decreased post-concrete defects, it proves to be economical as a construction material replacing river sand. It can also save transportation cost of river sand in many cases.

6) Eco-Friendly

Usage of manufactured sand prevents dredging of river beds to get river sand which may lead to environmental disaster like ground water depletion, water scarcity, threat to the safety of bridges, dams etc. to make M-Sands more eco-friendly than river sand.

7) P Sand

Plastering M Sand (PSand) is used for Wall plastering and brick work purposes. The granule thickness is 150 microns to

2.38 mm is ideal for block masonry and plastering purposes. Plastering M Sand to be mixed in the cement ratio 1:4(Internal Works) and 1:6(External Works)We adhere to best standards of quality control and offer the highest quality products at reasonable prices and deliver them within the agreed timelines.

8) River sand

Natural sand is one of the most important construction materials for a long time. It is found in various sizes depending on the amount of disintegration that has taken place. Due to large scale urbanization there has been a huge demand in the consumption of natural river sand. As such there has been a large scale quarrying of river sand at various locations of a river. However, the sand collected may not be of suitable quality and might not be apt for construction. Hence, an attempt is made to study the engineering properties of the sand of river Pagladia and to evaluate their suitability as construction material. The present study concentrates on the engineering properties of the river sand and also its suitability as a road construction material.

V. Experimental Design

Fig. 4. Experimental setup

A. Heat Coils

Heat coils, also known as protectors, bugs or carbons serve as a surge protector between the telephone exchange and outside plant. They are commonly the last point of appearance for a telephone circuit before it leaves the office, for example on the outside plant side of the main distribution frame. On some competitive local exchange carrier circuits there are two heat coils, the extra one being at the point of interface between their circuit and where the incumbent local exchange carrier or Regional Bell Operating Company receives it. Their primary purpose is to protect central office equipment from surges of high voltage. If a surge comes down the line it will melt the connection between the central office and outside plant sides, as in a fuse, thereby protecting the equipment. Some heat coils have springs in them, so that when a surge breaks the circuit their tension is released and the plastic cover pops off as a visual indicator that the line is somehow defective.

B. Sphere

A sphere (from Greek σφαῖρα — sphaira, "globe, ball"[1]) is a perfectly round geometrical object in three-dimensional space that is the surface of a completely round ball, (viz., analogous to a circular object in two dimensions).

Like a circle, which geometrically is an object in two-dimensional space, a sphere is defined mathematically as the set of points that are all at the same distance r from a given point, but in three-dimensional space [2]. This distance r is the radius of the ball, and the given point is the center of the mathematical ball. These are also referred to as the radius and center of the sphere, respectively. The longest straight line through the ball, connecting two points of the sphere, passes through the center and its length is thus twice the radius; it is a diameter of the (sphere) ball. While outside mathematics the terms "sphere" and "ball" are sometimes used interchangeably, in mathematics a distinction is made between the sphere (a two-dimensional closed surface embedded in three-dimensional Euclidean space) and the ball (a three-dimensional shape that includes the sphere as well as everything inside the sphere). This distinction has not always been maintained and there are mathematical references, especially older ones that talk about a sphere as a solid. This is analogous to the situation in the plane, where the terms "circle" and "disk" are confounded.

Fig. 5. Sphere

C. Copper

Copper is a chemical element with symbol Cu (from Latin: cuprum) and atomic number 29. It is a soft, malleable, and ductile metal with very high thermal and electrical conductivity. A freshly exposed surface of pure copper has a reddish-orange color. Copper is used as a conductor of heat and electricity, as a building material, and as a constituent of various metal alloys, such as sterling silver used in jewelry, cupronickel used to make marine hardware and coins, and constantan used in strain gauges and thermocouples for temperature measurement. Copper is one of the few metals that occur in nature in directly usable metallic form (native metals) as opposed to needing extraction from an ore. This led to very early human use, from c. 8000 BC. It was the first metal to be smelted from its ore, c. 5000 BC, the first metal to be cast into a shape in a mold, c. 4000 BC and the first metal to be purposefully alloyed with another metal, tin, to create bronze, c. 3500 BC. In the Roman era, copper was principally mined on Cyprus, the origin of the name of the metal, from aes cyprium (metal of Cyprus), later corrupted to cuprum, from which thewords copper (English), cuivre (French), cobre (Spanish), Koper (Dutch) and Kupfer (German) are all derived. The commonly encountered compounds are copper (II) salts, which often impart blue or green colors to such minerals as azurite, malachite, and turquoise, and have been used widely and historically as pigments. Copper used in buildings, usually for roofing, oxidizes to form a green verdigris (or patina). Copper is sometimes used in decorative art, both in its elemental metal form and in compounds as pigments. Copper compounds are used as bacteriostatic agents, fungicides, and wood preservatives.Copper is essential to all living organisms as a trace dietary mineral because it is a key constituent of the respiratory enzyme complex cytochrome c oxidase. In molluscs and crustaceans, copper is a constituent of the blood pigment hemocyanin, replaced by the iron-complexed hemoglobin in fish and other vertebrates. In humans, copper is found mainly in the liver, muscle, and bone. The adult body contains between 1.4 and 2.1 mg of copper per kilogram of body weight.

D. Microcontroller

A microcontroller (or MCU for microcontroller unit) is a small computer on a single integrated circuit. In modern terminology, it is similar to, but less sophisticated than, a system on a chip or SoC; an SoC may include a microcontroller as one of its components. A microcontroller contains one or more CPUs (processor cores) along with memory and programmable input/output peripherals. Program memory in the form of ferroelectric RAM, NOR flash or OTP ROM is also often included on chip, as well as a small amount of RAM. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general purpose applications consisting of various discrete chips. Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, toys and other embedded systems. By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes. Mixed signal microcontrollers are common, integrating analog components needed to control non-digital electronic systems. Some microcontrollers may use four-bit words and operate at frequencies as low as 4 kHz, for low power consumption (single-digit milliwatts or microwatts). They will generally have the ability to retain functionality while waiting for an event such as a button press or other interrupt; power consumption while sleeping (CPU clock and most peripherals off) may be just nanowatts, making many of them well suited for long lasting battery applications. Other microcontrollers may serve performance-critical roles, where they may need to act more like a digital signal processor (DSP), with higher clock speeds and power consumption.

E. Integrated circuit

An integrated circuit or monolithic integrated circuit (also referred to as an IC, a chip, or a microchip) is a set of electronic circuits on one small flat piece (or "chip") of semiconductor material, normally silicon. The integration of large numbers of tiny transistors into a small chip results in circuits that are orders of magnitude smaller, cheaper, and faster than those constructed of discrete electronic components. The IC's mass production capability, reliability and building-block approach to circuit designhas ensured the rapid adoption of standardized ICs in place of designs using discrete transistors. ICs are now used in virtually all electronic equipment and have revolutionized the world of electronics. Computers, mobile phones, and other digital home appliances are now inextricable parts of the structure of modern societies, made possible by the small size and low cost of ICs.ICs were made possible by experimental discoveries showing that semiconductor devices could perform the functions of vacuum tubes, and by mid-20th-century technology advancements in semiconductor device fabrication. Since their origins in the 1960s, the size, speed, and capacity of chips have progressed enormously, driven by technical advances that fit more and more transistors on chips of the same size - a modern chip may have several billion transistors in an area the size of a human fingernail. These advances, roughly following Moore's law, make a computer chip of today possess millions of times the capacity and thousands of times the speed of the computer chips of the early 1970s.ICs have two main advantages over discrete circuits: cost and performance. Cost is low because the chips, with all their components, are printed as a unit by photolithography rather than being constructed one transistor at a time. Furthermore, packaged ICs use much less material than discrete circuits. Performance is high because the IC's components switch quickly and consume comparatively little power because of their small size and close proximity. The main disadvantage of ICs is the high cost to design them and fabricate the required photomasks. This high initial cost means ICs are only practical when high production volumes are anticipated.

F. Thermocouple (Temperature Sensor)

A thermocouple is an electrical device consisting of two dissimilar electrical conductors forming electrical junctions at differing temperatures.

A thermocouple produces a temperature-dependent voltage as a result of the thermoelectric effect, and this voltage can be interpreted to measure temperature. Thermocouples are a widely used type of temperature sensor. Commercial thermocouples are inexpensive, interchangeable, are supplied with standard connectors, and can measure a wide range of temperatures. In contrast to most other methods of temperature measurement, thermocouples are self-powered and require no external form of excitation. The main limitation with thermocouples is accuracy; system errors of less than one degree Celsius (°C) can be difficult to achieve. Thermocouples are widely used in science and industry. Applications include temperature measurement for kilns, gas turbine exhaust, diesel engines, and other industrial processes. Thermocouples are also used in homes, offices and businesses as the temperature sensors in thermostats, and also as flame sensors in safety devices for gas-powered major appliances.

G. Ammeter

An ammeter (from Ampere Meter) is a measuring instrument used to measure the current in a circuit. Electric currents are measured in amperes (A), hence the name. Instruments used to measure smaller currents, in the milliampere or microampere range, are designated as milliammeters or microammeters. Early ammeters were laboratory instruments which relied on the Earth's magnetic field for operation. By the late 19th century, improved instruments were designed which could be mounted in any position and allowed accurate measurements in electric power systems. It is generally represented by letter 'A' in a circle.

H. Voltmeter

A voltmeter is an instrument used for measuring electrical potential difference between two points in an electric circuit. Analog voltmeters move a pointer across a scale in proportion to the voltage of the circuit; digital voltmeters give a numerical display of voltage by use of an analog to digital converter. A voltmeter in a circuit diagram is represented by the letter V in a circle. Voltmeters are made in a wide range of styles. Instruments permanently mounted in a panel are used to monitor generators or other fixed apparatus. Portable instruments, usually equipped to also measure current and resistance in the form of a multimeter, are standard test instruments used in electrical and electronics work. Any measurement that can be converted to a voltage can be displayed on a meter that is suitably calibrated; for example, pressure, temperature, flow or level in a chemical process plant. General purpose analog voltmeters may have an accuracy of a few percent of full scale, and are used with voltages from a fraction of a volt to several thousand volts. Digital meters can be made with high accuracy, typically better than 1%. Specially calibrated test instruments have higher accuracies, with laboratory instruments capable of measuring to accuracies of a few parts per million. Meters using amplifiers can measure tiny voltages of microvolts or less. Part of the problem of making an accurate voltmeter is that of calibration to check its accuracy. In laboratories, the Celli's used as a standard voltage for precision work. Precision voltage references are available based on electronic circuits.

VI. Specification of Equipment

- Material of inner & Outer sphere: Copper
- Radius of the inner sphere (ri): 160mm
- Radius of the outer sphere (ro): 240mm
- Voltmeter: 0 to 220 V
- Ammeter: 0 to 20 amp
- No. of thermocouple: 06 Nos.
- Insulating Powder: Sulphur
- Temperature indicator: 0 to 100°c, digital
- Heater coil Strip heating element: 200 watts Sandwiched

VII. Experimental Procedure

A. First Experiment

We are going to analysis the thermal conductivity of M Sand using insulating powder apparatus.

TABLE III
ANALYSIS ON M-SAND

S.No.	Voltage (V)	Current (A)	$T1$°C	$T2$°C	$T3$°C	$T4$°C	$T5$°C	$T6$°C
1	110	0.25	59.0	55.0	59.0	43.0	41.0	40.0
2	130	0.30	65.0	61.0	65.0	45.0	43.0	41.0
3	150	0.35	70.0	68.0	70.0	47.0	45.0	42.0

TABLE IV
ANALYSIS ON P-SAND

S.No.	Voltage (V)	Current (A)	$T1$°C	$T2$°C	$T3$°C	$T4$°C	$T5$°C	$T6$°C
1	110	0.25	65.0	63.0	65.0	57.0	55.0	50.0
2	130	0.30	70.0	68.0	68.0	62.0	60.0	53.0
3	150	0.35	74.0	73.0	72.0	63.0	61.0	58.0

TABLE V
ANALYSIS OF RIVER SAND

S.No.	Voltage (V)	Current (A)	$T1$°C	$T2$°C	$T3$°C	$T4$°C	$T5$°C	$T6$°C
1	110	0.25	77.0	75.0	72.0	71.0	69.0	70.0
2	130	0.30	78.0	77.0	73.0	71.0	70.0	70.0
3	150	0.35	82.0	80.0	75.0	72.0	72.0	71.0

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B. *Second Experiment*

Instead of analysis the thermal conductivity of P-Sand using insulating powder apparatus.

C. *Third Experiment*

Instead of analysis the thermal conductivity of river sand using insulating powder apparatus.

VIII. Formula Used

Rate of heat supply Q = V x I W (2)

Thermal conductivity of insulating powder apparatus:

$$K = \frac{Q \times (r_o - r_i)}{4 \times \pi \times r_i \times r_o \times (T_i - T_o)} \quad (3)$$

Where

K - Thermal conductivity of an insulating powder in W / mK.

Q - Rate of heat supply in W.

r_o - Radius of outer sphere in m.

r_i - Radius of inner sphere in m.

T_o - Outside surface temperature in ℃

T_i - inside surface temperature in ℃

$$T_i = \frac{T_1 + T_2 + T_3}{3} \quad (4)$$

$$T_o = \frac{T_4 + T_5 + T_6}{3} \quad (5)$$

IX. Results

TABLE VI

Available Materials and Thermal Conductivity

S.No.	Available Material	Thermal Conductivity(w/mk)
1	M-Sand	0.3743
2	P-Sand	0.555
3	River Sand	1.114

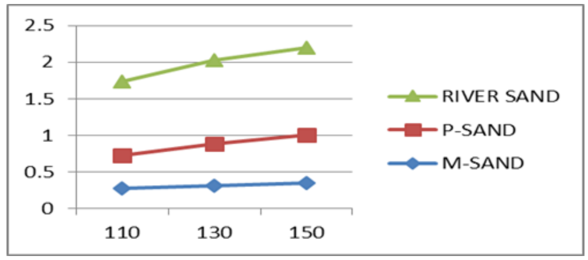

Fig. 6. Graph: Thermal conductivity vs. Voltage applied

X. Conclusion

According to analysis the experimental researches gives the result that M-Sand thermal conductivity of 0.3743 w/mk. So we can use as insulation materials. M-Sand ecofriendly product which is harmful to not environment and surrounding. This is no chemical components. Material is easy to collect the product .Cost of the materials is very low .Compare to other insulation like P-sand, River Sand. Thermal conductivity very low. Also used as summer in to decrease the heat in the concrete walls. Human comfort is increase used for M-Sand. So this can be used as an insulation materials whenever heat transfer must be reduced.

References

[1] T. Rettelbach, J. Säuberlich, S. Korder, J. Fricke, “Thermal conductivity of silica aerogel powders at temperatures from 10 to 275 K”, Journal of Non-Crystalline Solids 186, pp. 278-284, 1995.

[2] J.E. Fesmire, S.D. Augustynowicz, “Thermal Performance Testing of Glass Microspheres Under Cryogenic Vacuum Conditions”, Advances in Cryogenic Engineering, Vol. 710, Issue 1, June 2004.

[3] R.R. Zarr, “A History of Testing Heat Insulators at the National Institute of Standards and Technology”, ASHRAE Transactions, V.107, Pt. 2, June 2001.

[4] J.E. Fesmire, S.D. Augustynowicz, K.W. Heckle, B.E. Scholtens, “Equipment and Methods for Cryogenic Thermal Insulation Testing”, Advances in Cryogenic Engineering, Vol. 710, Issue 1, June 2004.

[5] J.E. Fesmire, S.D. Augustynowicz, S. Rouanet, “Aerogel Beads as Cryogenic Thermal Insulation System”, Advances in Cryogenic Engineering: Proceedings of the CEC, Vol. 47, 2002.

[6] A.L. Nayak, C.L. Tien, “Thermal Conductivity of Microsphere Cryogenic Insulation”, Advances in Cryogenic Engineering 22, pp. 251-262, 1977.

[7] Y.S. Choi, M.N. Barrios, H.M. Chang, S.W. Van Sciver, “Thermal Conductivity of Powder Insulations for Cryogenic Storage Vessels”, Advances in Cryogenic Engineering, Vol. 823, Issue 1, April 2006.

[8] B.K. Hodge, R.P. Taylor, Analysis and Design of Energy Systems Third Edition, Prentice-Hall, New Jersey, 1999.