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UTILIZATION OF CORNFLOUR PARTICLES AS A MODEL FOR THERMAL INSULATOR FOR SUPPORTING TEACHING AND LEARNING PROCESS FOR STUDENTS WITH HEARING IMPAIRMENTS

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Abstract

This study's goal was to ascertain whether or not cornflour particles could be used as a thermal insulator for instructional materials for students who have hearing loss. Cornflour particles were placed on the wall as test subjects for experiments. The wall was heated with different bulb lamp intensities (i.e., 8, 10, and 12 W). The findings demonstrated that cornflour particles are effective heat insulators. The thermocouple test demonstrated a drop in the temperature of the insulator testing toolbox. The cornflour fragments prevented the heat from the bulb inside the box from dissipating fully. It was discussed how the idea of heat radiation and the transformation of heat absorbed by cornflour particles may be further explored for learning materials for students. The findings of this study should make it easier for teachers to explain the use of heat insulators to their students, especially those who have hearing difficulties.

Keywords: Education, Heat transfer, Performance, Students with hearing impairment, Thermal insulator.

1. Introduction

A substance that prevents the transfer of heat is known as a thermal or heat insulator. Typically, heat insulators are employed in culinary appliances as heat separators. A substance with a low thermal conductivity value makes an excellent heat transfer insulator. The material itself when it is used must have a specific performance, such as a low thermal conductivity value, be light in weight, and have a low compressive strength value to meet the requirements for the usage of lightweight brick and a heat insulator [1]. It is crucial to educate yourself on heat-insulating materials. This is because heat insulators are frequently found and used in daily life.

Numerous heat-insulating materials can be employed to lessen temperature dissipation and heat leakage [2]. Polyester and glass wool are two examples of materials that insulate heat. Polyester heat-insulating fiber production is not an environmentally favourable method. This is because polyester is made from petroleum. Due to the comparatively high energy required to heat glass fiber to temperatures between 1500 and 1700°C, the production of glass wool is also seen as being less environmentally friendly.

In addition, obtaining heat-insulating materials will be challenging for the instructor if they are employed as teaching tools. This is particularly problematic if the teaching and learning process is carried out in an area with poor transportation and access. Indeed, Indonesia, an island nation in development, is where you will find this. It is critical to comprehend scientific concepts, particularly for vocational schools that require experiments and relate to practicum [3, 4].

In general, students might have no trouble comprehending what a heat insulator is. They require concrete medium and straightforward explanations, in contrast to kids with special needs [5]. Students with exceptional needs experience difficulties in both their academic and developmental areas. As a result, they affect learning process issues [6]. They require specific care and education. To facilitate the process for teaching and learning for children with special needs, methods and media must be modified. Particularly for students with hearing impairments, items or things that pupils frequently come into contact with in daily life might be employed as learning resources.

This experimental study utilizes cornflour particles as one of the alternative teaching and learning media based on our earlier research on experimental demonstration for teaching and learning science to students [7-14]. Although there have been numerous studies on heat insulators, none have yet examined the use of cornflour particles as heat insulators for learning media in children with hearing impairments. One of the components that can be obtained in daily life is cornflour particles, which have a wide range of uses [15-17]. Its non-toxic qualities enable the creation of kid-friendly learning media. To conduct the studies, insulating cornflour particles were placed on the wall and exposed to several lamp intensities (by varying lamp energy of 8, 10, and 12 W). To ascertain the temperature variations that take place over a specific period, we used a thermocouple analysis as a supporting tool. This was done to regulate how much heat is absorbed by the insulating cornflour particles.

2.Methods

The utilization of cornflour particles as a heat insulator for instructional material in children with hearing impairments was the study's main focus. The stages of the research process are shown in Fig. 1. They are the planning stage, which involves gathering various tools and materials, the implementation stage, which involves carrying out experiments using cornflour particles as a heat insulator, and the analysis stage, which involves observing and evaluating the data gathered.

Fig. 1. Research procedure.

Water and cornflour particles from Mama Suka, PT Mama Suka in Indonesia were the experimental materials used in this investigation (AQUA, P.T. Tirta Investama, Indonesia). The equipment used includes 8, 10, and 12-W light bulbs (purchased from Philips, P.T. Philips Indonesia, Indonesia; an insulator testing kit), a 250-mL measuring glass cup (to measure volume scales from Nankai, P.T. Rohartindo Nusantara Luas, Indonesia) and a stopwatch (see Fig. 2)

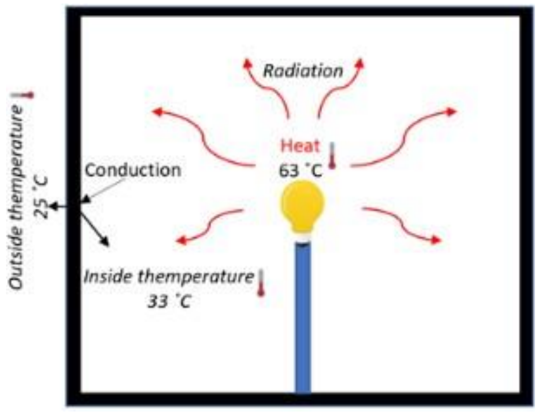

Fig. 2. Illustration of the concept of the equipment used for heat radiation.

We followed the protocol for the experiments. In general, 200 g of cornflour particles (about 500 um) were weighed. Then, 250 mL of water was poured into a measuring cup. The cornflour particles were added to the measuring cup, and the mixture was stirred to form a dough. The dough was then pasted on the wall of the insulator testing toolbox (with a thickness of 5 mm, as measured by a ruler). Finally, it was kept there until it dried. We installed 4 thermocouples inside and 8 outside the box of the insulator testing apparatus (each side contains 3 thermocouples). We checked and measured each thermocouple temperature change in the duration range every 5 minutes. Specifically, it is at 0, 5, 10, 15, 20, 25, 30, 35, 40, and 45 minutes. To check the time, we used a stopwatch and recorded the results. We tested cornflour particles as an insulator and the heat used a light bulb (i.e., 8, 10, or 12 W) installed in the box of the test apparatus (in the center). The phenomenon during the experiment is shown in Fig. 2.

To put it briefly, the experiment's demonstration involved watching the heating phenomena caused by the radiation from a bulb lamp within a cube and the walls (that were patched by cornflour particles). The experimental box's measurements were 30 cm in length, 30 cm in breadth, and 30 cm in height. The walls of this cube can be replaced by ones made of other materials and insulators of the same thickness and surface area.

A single-switch button was installed to create it simple in turning on/off the light, and a bulb lamp with a specific power was used to generate heat radiation inside the cube's center. Many thermometers were placed in various positions, and the temperatures were recorded every 5 minutes to test the heat transmission phenomenon in the cube. Four thermometers were installed within the cube (one of them was affixed to the inner wall), and two thermometers were placed outside the cube to measure heat loss.

The temperature readings from the installed thermometers were utilized to calculate both conduction and radiation heat transfer. By comparing the thermometers on the cubes outside wall and inside, we were able to understand conduction and heat loss. Every thermometer has certain requirements: Thermometer specifications include the following: temperature range of -50 to 110°C; temperature resolution of 0.1°C; operating voltage of 1.5 V; battery of LR44 button batteries; dimensions of the thermometer of 48×28.6×15.2 mm; and LCD temperature display of 46×27 mm.

The thermometers were positioned with a gap of 5 cm between each one to ensure the investigation of heat radiated by the bulb lamp. To stop air exchanges with the heating system, cloth tape was also applied between the linked walls.

3. Results and Discussion

The experimental setting up for this work is depicted in Fig. 3. In essence, the studies were carried out by tracking the temperature's variation over time as a result of heat transfer by radiation [17-20]. In this instance, we made use of bulb light radiation, which is efficient in transferring information gleaned from temperature changes based on thermometers. The experiment's central idea is the observation of heat transmission processes utilizing an iron insulator testing box (30×30×30 cm) with four sides coated with dough formed of cornmeal particles. There was an input for a light bulb on the upper side. For heat emission, the light bulb was positioned in the box's middle. The thermocouple as a sensor for temperature was employed to gauge the temperature inside the box's four sides. To check the outside temperature at a distance of between 5 and 10 cm, there are two thermocouples on each side of the enclosure.

Figure 4 depicts the conceptual display of the experimental equipment for testing insulators from above. The lamp's bulb sent off heat radiation. As a result, on each side, temperature gauges (i.e., TA1, TB1, TC1, and TD1) are fitted. As an insulator, cornflour particles were applied to each of the four sides (i.e., A, B, C, and D). Two temperature gauges are fitted on each exterior side at a distance of 5 cm (i.e., TA2, TB2, TC2, and TD2) and 10 cm (i.e., TA3, TB3, TC3, and TD3).

Three different lamp power levels and insulating cornflour particles were used in our experimental tests (8, 10, and 12 W). To gauge the temperature, we used thermocouples. The test results of cornflour particles as an insulator employing an 8 W light power are shown in Table 1.

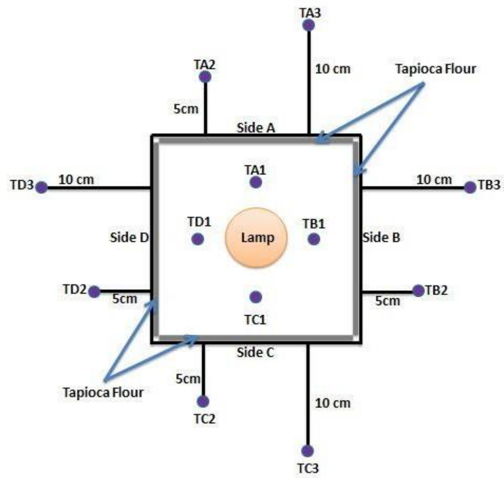

Fig. 3. The 2D layout of the heat transfer toolbox (taken from the top of the box).

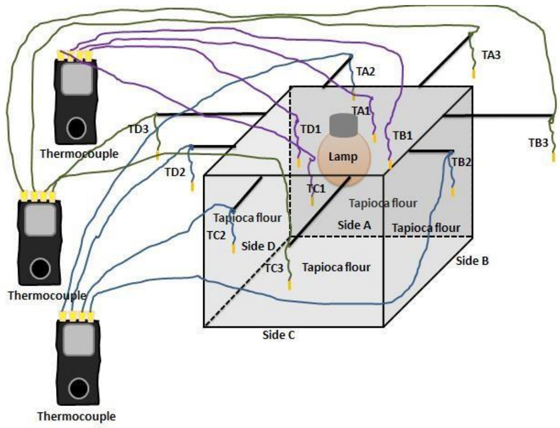

Fig. 4. The 3D layout of the heat transfer toolbox.

We used 12 temperature test points, including 4 inside the insulator testing toolbox (i.e., TA1, TB1, TC1, and TD1) and 8 outside (i.e., TA2, TB2, TC2, and TD2) at various distances of 5 and 10 cm (TA3, TB3, TC3, and TD3). Data can be explained in the following:

(i) The data from the analysis revealed that the four points in the toolbox for testing insulators (i.e., TA1, TB1, TC1, and TD1) had identical temperature values at the start of the test at 27.70°C (0 min) and the completion of the test at 27.20°C (45 min). Throughout the 45-minute test, the temperature in the toolbox remained constant with an average of 27.97°C.

(ii) The result analysis of four places outside the insulator testing tool's box at a distance of 5 cm for each thermocouples (i.e., TA2, TB2, TC2, and TD2) revealed that their temperatures at the start of the test (0 min) and the end of the test (25.50°C) were the same (45 min). With a mean temperature of 25.28°C during 45 minutes of experimental testing, the temperature outside the test equipment box appears stable.

(iii) The study of four places outside the insulator testing tool's box at a distance of 10 cm for each thermocouples (i.e., TA3, TB3, TC3, and TD3) revealed that the temperature at the start of the test and the end of the test were both 22.20°C (45 min). With a mean temperature of 22.76°C throughout the 45-minute experimental test, the temperature outside the testing toolbox seemed constant.

Table 1. Experiments utilizing cornflour particles using a lamp with 8 W. *Tave* is the mean temperature.

	Temperature (°C) at the testing time (min)										
Sample	**0**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	***Tave***
TA1	27.70	28.40	28.80	30.10	30.10	26.20	27.20	26.80	27.20	27.20	27.97
TA2	25.50	25.70	25.20	25.10	24.70	25.30	25.30	25.10	25.40	25.50	25.28
TA3	22.20	22.30	25.30	23.10	23.50	22.20	22.30	22.10	22.30	22.30	22.76
TB1	27.70	28.40	28.80	30.10	30.10	26.20	27.20	26.80	27.20	27.20	27.97
TB2	25.50	25.70	25.20	25.10	24.70	25.30	25.30	25.10	25.40	25.50	25.28
TB3	22.20	22.30	25.30	23.10	23.50	22.20	22.30	22.10	22.30	22.30	22.76
TC1	27.70	28.40	28.80	30.10	30.10	26.20	27.20	26.80	27.20	27.20	27.97
TC2	25.50	25.70	25.20	25.10	24.70	25.30	25.30	25.10	25.40	25.50	25.28
TC3	22.20	22.30	25.30	23.10	23.50	22.20	22.30	22.10	22.30	22.30	22.76
TD1	27.70	28.40	28.80	30.10	30.10	26.20	27.20	26.80	27.20	27.20	27.97
TD2	25.50	25.70	25.20	25.10	24.70	25.30	25.30	25.10	25.40	25.50	25.28
TD3	22.20	22.30	25.30	23.10	23.50	22.20	22.30	22.10	22.30	22.30	22.76

The findings from the temperature observations agreed well with what was on the opposite side of the box. Tables 2 and 3 display specific temperature information in great detail. Table 4 then displays the comparison information for the mean temperature as a correlation of light power.

The temperature differential between the insulator testing tool's box and the exterior was shown in the results. The temperature rose on average across five test sites from the start of the test until 45 minutes into it. This provided proof that the lamp's power affected heat radiation. A higher temperature was produced using a stronger bulb. Additionally, we discovered that as the lamp's power weakened over time, the temperature dropped. The battery power required to activate the lights starts to run out. The average temperature of each test, however, tends to produce steady findings.

When the materials themselves can obstruct the transfer of heat, their effectiveness as heat insulators can be observed [21-24]. We discovered the potential for cornflour particles as a heat insulator. This is because there is less of a temperature difference between the outside and inside of the box. During testing, an 8-W light was used. The temperature difference between the positioned points inside and outside the box is 5.21 ℃. During tests with a 10-W lamp. The points inside and outside the box are 4.88 ℃ apart in temperature. Utilizing a 12-W lamp for testing.

The points within and outside of the box are 6.44 °C apart in temperature. Because the distance has an impact on the amount of heat radiation that takes place, the temperature that positioned at outside the box, which is positioned at 10 cm away, is lower than the 5 cm.

Table 2. Experiments utilizing cornflour particles using a lamp with 10 W. T_{ave} is the mean temperature.

	Temperature (°C) at the testing time (min)										
Sample	**0**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	***Tave***
TA1'	28.20	29.00	26.90	27.40	27.70	28.00	28.00	28.00	27.80	27.90	27.89
TA2'	25.40	25.50	24.70	25.80	25.70	25.70	25.70	26.00	25.70	25.60	25.58
TA3'	24.80	22.30	24.20	22.70	22.60	22.80	22.90	22.60	22.70	22.50	23.01
TB1'	28.20	29.00	26.90	27.40	27.70	28.00	28.00	28.00	27.80	27.90	27.89
TB2'	25.40	25.50	24.70	25.80	25.70	25.70	25.70	26.00	25.70	25.60	25.58
TB3'	24.80	22.30	24.20	22.70	22.60	22.80	22.90	22.60	22.70	22.50	23.01
TC1'	28.20	29.00	26.90	27.40	27.70	28.00	28.00	28.00	27.80	27.90	27.89
TC2'	25.40	25.50	24.70	25.80	25.70	25.70	25.70	26.00	25.70	25.60	25.58
TC3'	24.80	22.30	24.20	22.70	22.60	22.80	22.90	22.60	22.70	22.50	23.01
TD1'	28.20	29.00	26.90	27.40	27.70	28.00	28.00	28.00	27.80	27.90	27.89
TD2'	25.40	25.50	24.70	25.80	25.70	25.70	25.70	26.00	25.70	25.60	25.58
TD3'	24.80	22.30	24.20	22.70	22.60	22.80	22.90	22.60	22.70	22.50	23.01

Table 3. Experiments utilizing cornflour particles using a lamp with 12 W. Tave is the mean temperature.

	Temperature (°C) at the testing time (min)										
Sample	**0**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	***Tave***
TA1"	28.10	28.40	29.40	29.50	29.50	29.80	29.30	29.70	29.60	29.70	29.30
TA2"	25.40	25.20	25.60	25.30	25.20	25.20	25.20	25.10	25.20	25.10	25.25
TA3"	24.30	22.90	23.00	22.70	23.00	22.60	22.70	22.50	22.20	22.70	22.86
TB1"	28.10	28.40	29.40	29.50	29.50	29.80	29.30	29.70	29.60	29.70	29.30
TB2"	25.40	25.20	25.60	25.30	25.20	25.20	25.20	25.10	25.20	25.10	25.25
TB3"	24.30	22.90	23.00	22.70	23.00	22.60	22.70	22.50	22.20	22.70	22.86
TC1"	28.10	28.40	29.40	29.50	29.50	29.80	29.30	29.70	29.60	29.70	29.30
TC2"	25.40	25.20	25.60	25.30	25.20	25.20	25.20	25.10	25.20	25.10	25.25
TC3"	24.30	22.90	23.00	22.70	23.00	22.60	22.70	22.50	22.20	22.70	22.86
TD1"	28.10	28.40	29.40	29.50	29.50	29.80	29.30	29.70	29.60	29.70	29.30
TD2"	25.40	25.20	25.60	25.30	25.20	25.20	25.20	25.10	25.20	25.10	25.25
TD3"	24.30	22.90	23.00	22.70	23.00	22.60	22.70	22.50	22.20	22.70	22.86

Table 4. Effect of lamp power (watt) on mean temperature (T_{ave}).

Lamp power	Temperature (°C) at the testing time (min)											
	Position	**0**	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	***Tave***
8 W	Inside box	27.70	28.40	28.80	30.10	30.10	26.20	27.20	26.80	27.20	27.20	27.97
	Outside box: 5 cm	25.50	25.70	25.20	25.10	24.70	25.30	25.30	25.10	25.40	25.50	25.28
	Outside box: 10 cm	22.20	22.30	25.30	23.10	23.50	22.20	22.30	22.10	22.30	22.30	22.76
10 W	Inside box	28.20	29.00	26.90	27.40	27.70	28.00	28.00	28.00	27.80	27.90	27.89
	Outside box: 5 cm	25.40	25.50	24.70	25.80	25.70	25.70	25.70	26.00	25.70	25.60	25.58
	Outside box: 10 cm	24.80	22.30	24.20	22.70	22.60	22.80	22.90	22.60	22.70	22.50	23.01
12 W	Inside box	28.10	28.40	29.40	29.50	29.50	29.80	29.30	29.70	29.60	29.70	29.30
	Outside box: 5 cm	25.40	25.20	25.60	25.30	25.20	25.20	25.20	25.10	25.20	25.10	25.25
	Outside box: 10 cm	24.30	22.90	23.00	22.70	23.00	22.60	22.70	22.50	22.20	22.70	22.86

4. Conclusions

The utilization of cornflour particles as a model of heat insulator for instructional materials for supporting teaching and learning for students with special needs condition (i.e., hearing impairments) has been successfully explored in this study. Cornflour particles were placed on the wall as test subjects for experiments, and heat from different bulb lamp intensities was used. The powers of lamp that were tested were 8, 10, and 12 Watts. The findings demonstrated that cornflour particles are effective heat insulators. It described how heat radiation works and how heat absorbed by cornmeal particles changes, which can be improved for use in educational media for students who have hearing loss. The cornflour fragments prevented the heat from the bulb inside the experimental testing box from dissipating fully. It described how heat radiation works and how heat absorbed by cornmeal particles changes. This can be improved for use in educational media for students who have problems in the hearing loss. The findings of this experiments should make it easier for teachers to explain the function of heat insulators to their students, particularly for pupils who have hearing issues.

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