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Simulation by Using ANSYS – FLUENT of Wall Room with Effect Air Gaps Between Walls

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Abstract. ANSYS -FLUENT using, Analysis of the temperature distribution through the room's walls takes into account the effect of using air gaps of various thicknesses for a number of gaps (8 cm, 5 cm, and 2.5 cm) between walls, with the goal of determining the ideal thickness. The analysis is done through simulation, with the results being compared to those from the experimental study. The current study's room dimensions were 1.56 x 1.5 and 1.5 cm, and it selected the winter weather conditions in Najaf Al-Shraf in January and February as the weather conditions that were impacted. While the primary chamber wall used for this research was thought to be constant, the air gap between it and the wall of the alucobond coating layer had different thicknesses (8, 5 & 2.5 cm) (14 cm).

Keywords: Ansys Fluent , Air Gap, Wall Room , CFD Analysis & Transient state.

Introduction

This study's main objective is to make use of the various air gaps between the room's primary wall and the used covering layer (alucobond) to establish a space where air can flow and be used for heating and cooling. The study, which was conducted in January and February of this year with the test wall facing south, made use of the ANSYS-FLUENT programme. The pattern of air flow and temperature distribution may be studied using the simulation's path lines and contour findings. The simulation was run following the instructions laid out for the present investigation. It provides an explanation for the differences and analyses of the simulation findings for different air gaps that act as thermal insulators.

Methodology (ANSYS 18 CFD)

Dynamic Computational Fluid Dynamics Fluid Simulation The effectiveness, capability, and applicability of the code to the application under consideration all play a role in choosing a reasonable commercial [1]. Computational fluid dynamics is the study of predicting fluid flow, heat and mass movement, chemical processes, and related phenomena using the numerical solution of the underlying mathematical equations. Computational fluid dynamics is used to numerically approximate the equations governing fluid motion [2]. Numerical and Computational Analysis Computational fluid dynamics has a wide application and powerful capabilities, especially for issues involving both flow and heat transfer [3].

2.1 Create Geometry Model

The design phase, which also involves making the model that will be put to the test and may involve using additional software, is the initial step in constructing the suggested case structure. One was erected in front of a layer of alucobond, with varying air gaps between the package and the main room wall, while the other had equal external dimensions and conditions in terms of temperatures and wind speed. The rooms' main wall is exposed to direct sunlight, but the remaining walls are thermally insulated, meaning they are composed of sandwich panels for both the isolated and non-isolated rooms' ceilings. Adiabatic process is described as a process in which no heat transmission happens.

2.3 Meshing Model

Improvements near walls enabled the fluid network (Fluent) meshing model to be completed. Using an ANSYS (fluent) fluid flow network with improvements near walls, the networking model was created. The practical and theoretical work was completed throughout the winter, a three-dimensional model was employed, and the wall under test faced south. It displays the creation of a mesh for a small, isolated room with dimensions of 1.5 m x 1.65 m x 1.5 m. The room's wall is made of bricks and two layers of cement (ficus), and in front of it, an insulating layer of alucobond is fixed with a number of air

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gaps due to the material's low thermal conductivity (0.15 w/m2.C) [4]. this project, The gaps function well as a thermal insulator. The non-insulated room has identical dimensions to the first, as well as identical temperature and wind speed conditions. However, because the cement wall in the non-insulated room is exposed to direct sunlight and absorbs a lot of solar energy, the temperature of the external walls is higher due to the high rate of heat acquisition. The model's work is based on the plane (YZ) axis, and heat flux is applied to room walls that are constructed with the axis (X) in mind. Convection heat transfer coefficients are projected within the rooms, and the temperature inside is kept constant.

Results and Discussion

<u>XY Plane</u>

<u>Case 1 Room (Without Air Gap)</u>

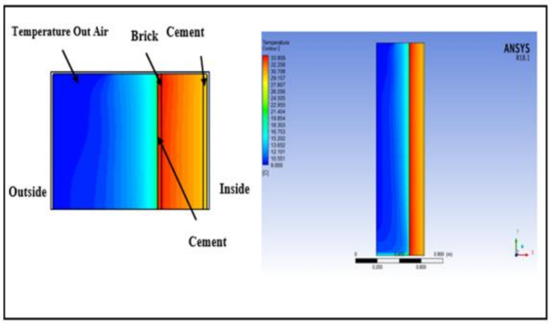

Figure .1. Show contour temperature distribution wall room without air gap.

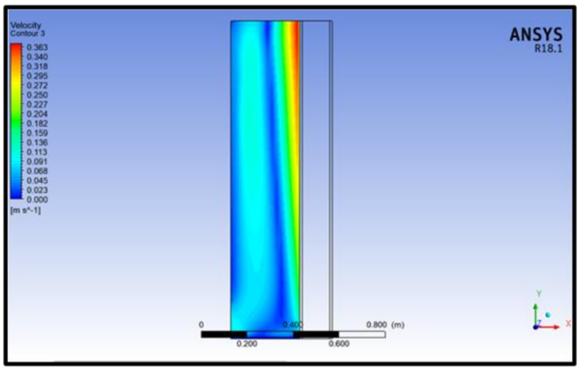

Figure .2. Show contour velocity distribution outer air periphery (without air gap).

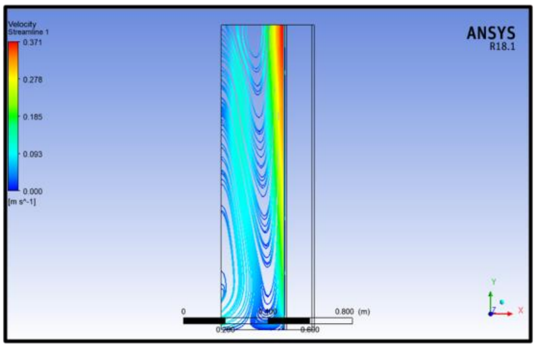

Figure .3. Show contour velocity streamline outer air periphery (without air gap).

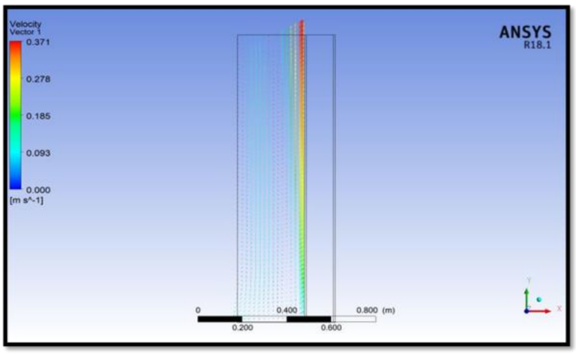

Figure .4. Show contour velocity vector outer air periphery (without air gap).

Case 2 Room With Air Gap (8cm)

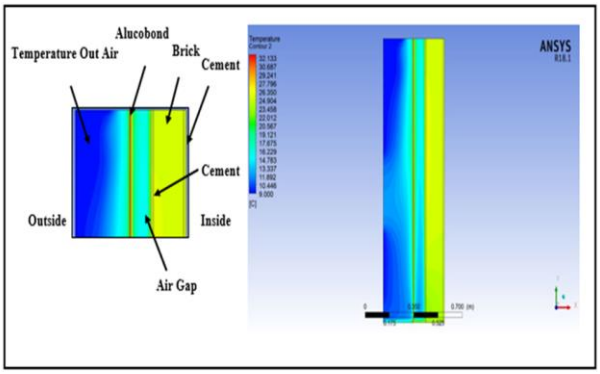

Figure.5. Show contour temperature distribution wall room with air gap .

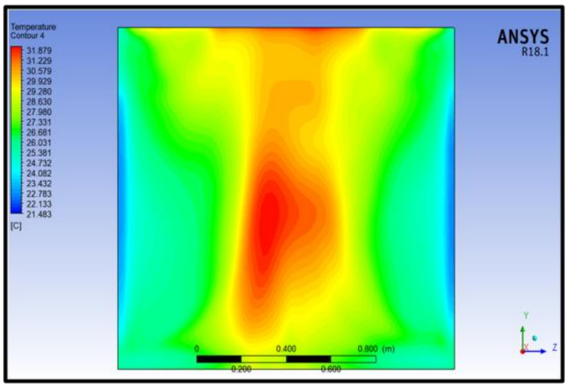

Figure.6. Show contour temperature distribution wall layer alucobond with air gap.

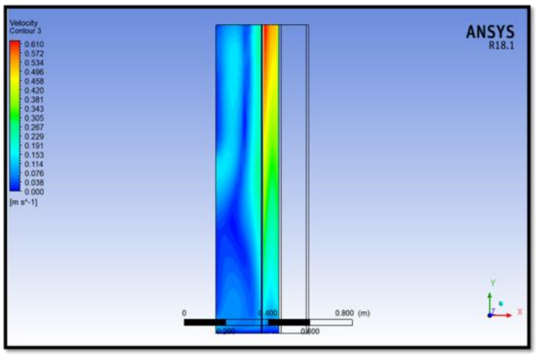

Figure.7. Show contour velocity distribution air inside air gap.

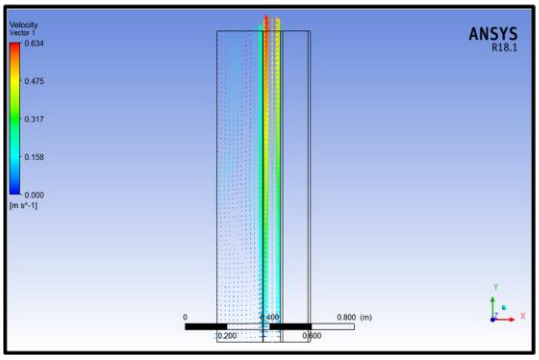

Figure.8. Show contour velocity vector air inside air gap.

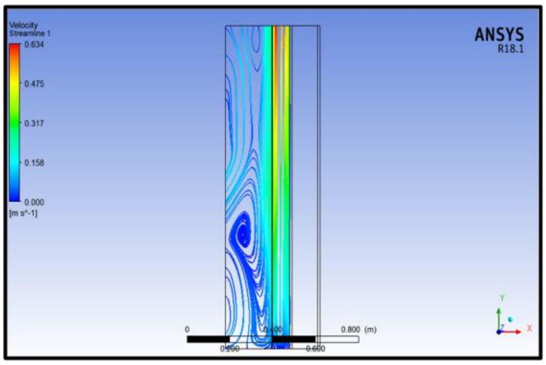

Figure.9. Show contour velocity streamline air inside air gap.

Case 3 Room With Air Gap (5cm)

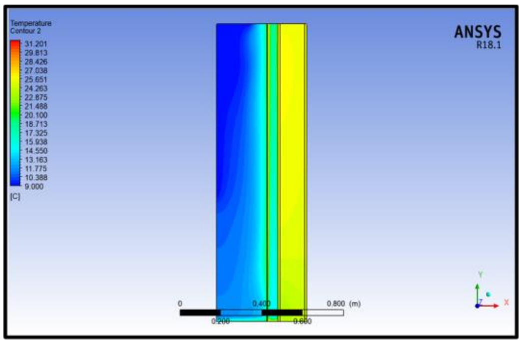

Figure .10. Show contour temperature distribution wall room with air gap.

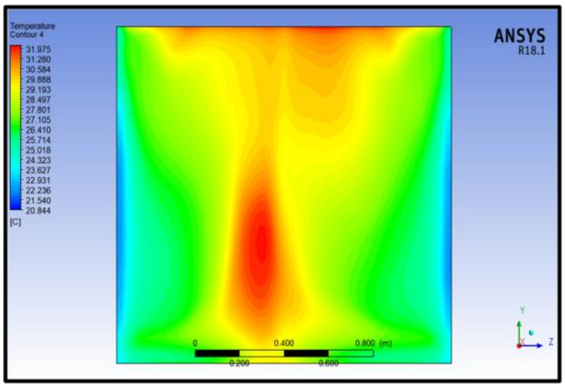

Figure .11. Show contour temperature distribution wall layer alucobond with air gap.

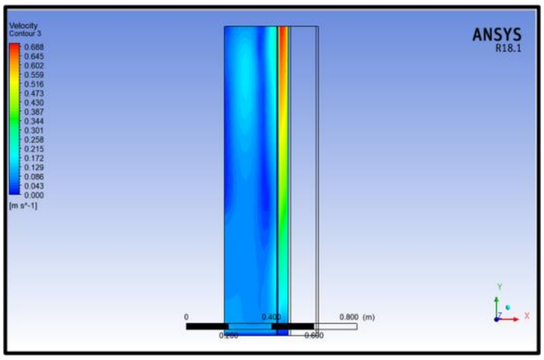

Figure 12. Show contour velocity distribution air inside air gap.

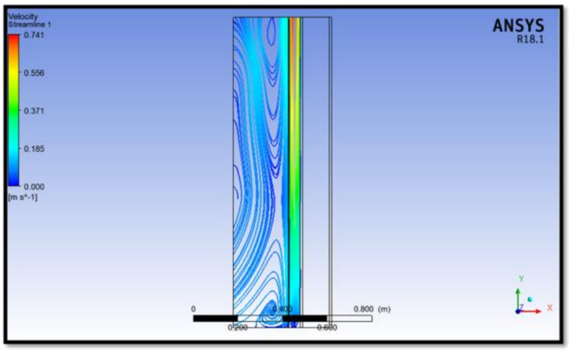

Figure .13. Show contour velocity streamline air inside air gap.

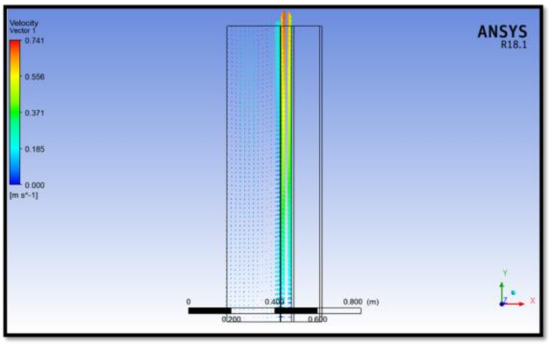

Figure .14. Show contour velocity vector air inside air gap.

Case 4 Room With Air Gap (2.5cm)

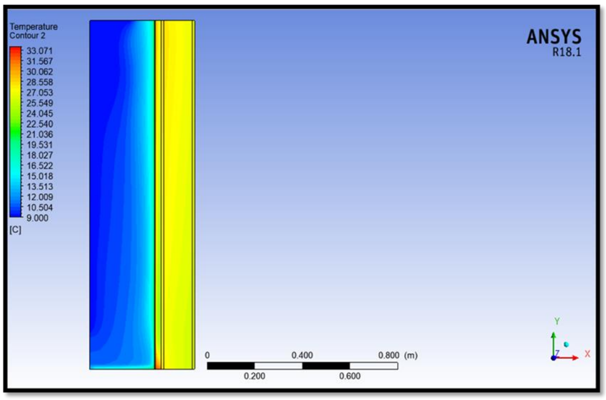

Figure.15. Show contour temperature distribution wall room with air gap.

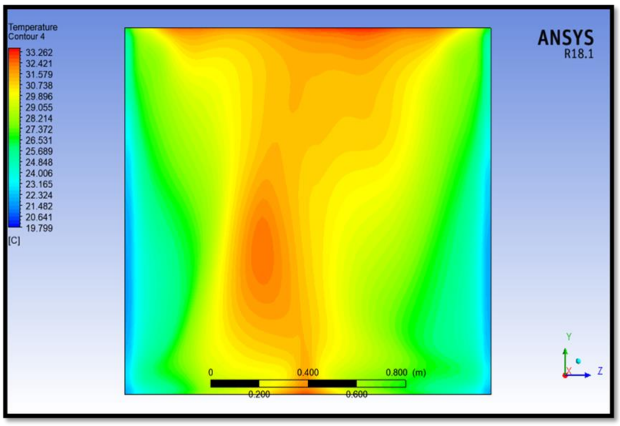

Figure .16. Show contour temperature distribution wall layer alucobond with air gap.

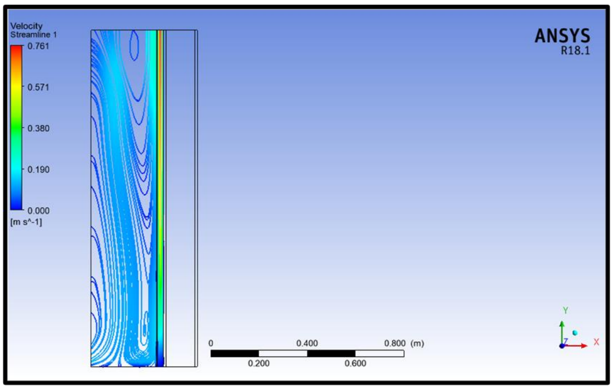

Figure .17.Show contour velocity streamline air inside air gap.

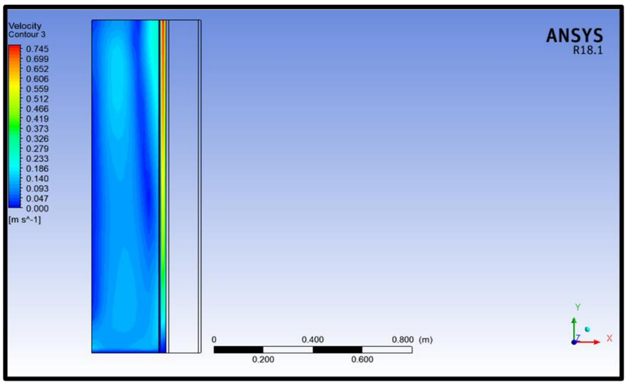

Figure.18.Show contour velocity distribution air inside air gap.

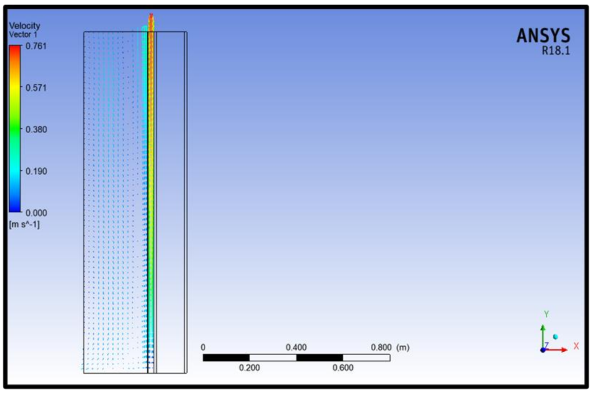

Figure.19.Show contour velocity vector air inside air gap.

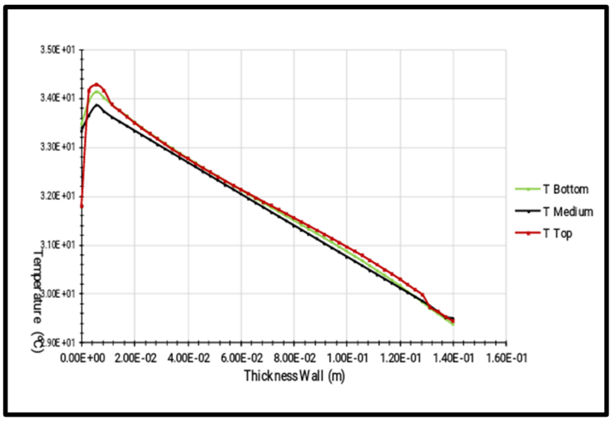

Figure .20. Show distribution temperature wall room and thickness wall without air gap.

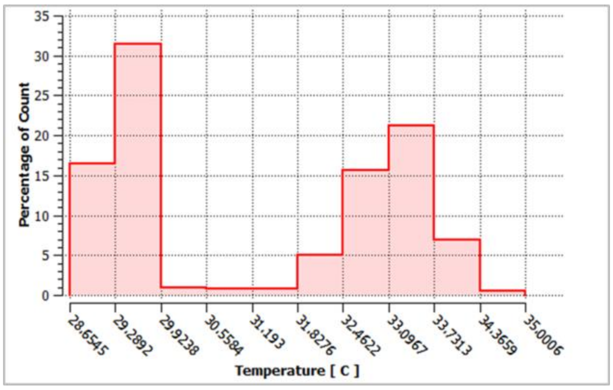

Figure.21. Histogram Graph of distribution temperature in wall room without air gap.

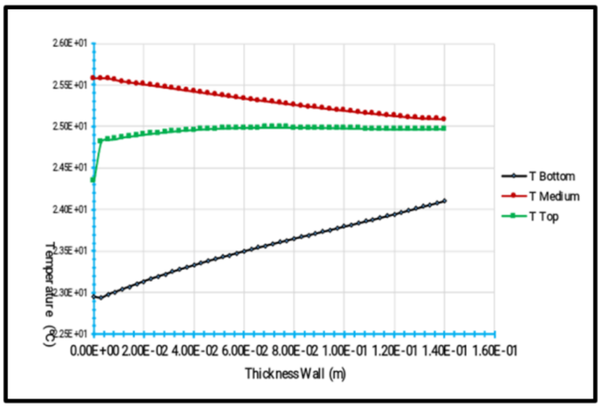

Figure.22. Show distribution temperature wall room and thickness wall with air gap (8cm).

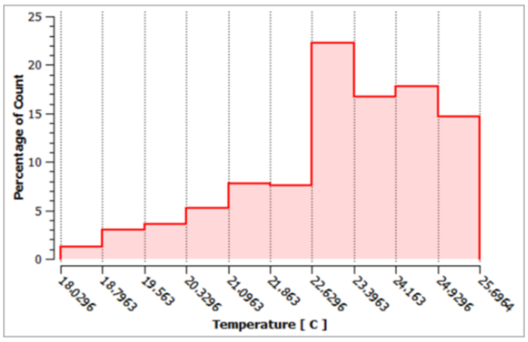

Figure.23. Histogram Graph of distribution temperature in wall room with air gap (8cm).

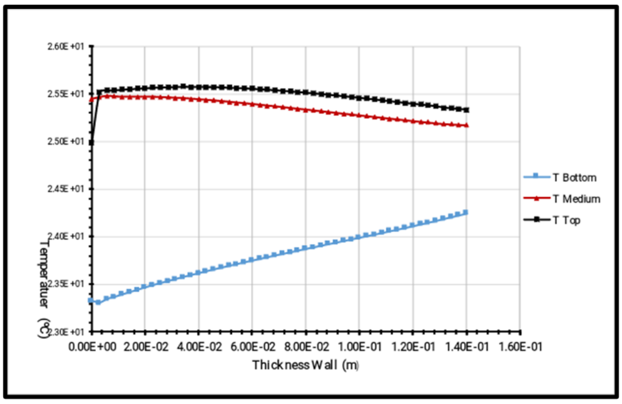

Figure .24. Show distribution temperature wall room and thickness wall with air gap (5cm).

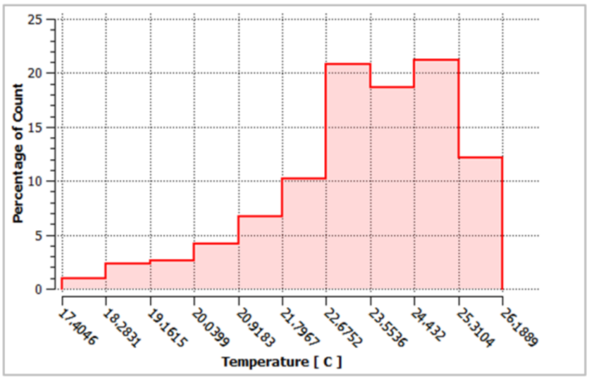

Figure .25. Histogram Graph of temperature distribution in wall room with air gap (5cm).

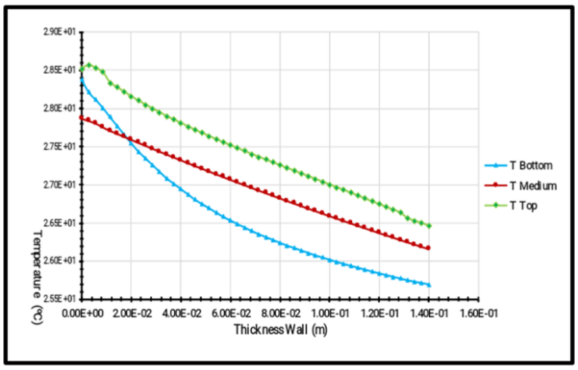

Figure .26. Show distribution temperature wall room and thickness wall with air gap (2.5cm).

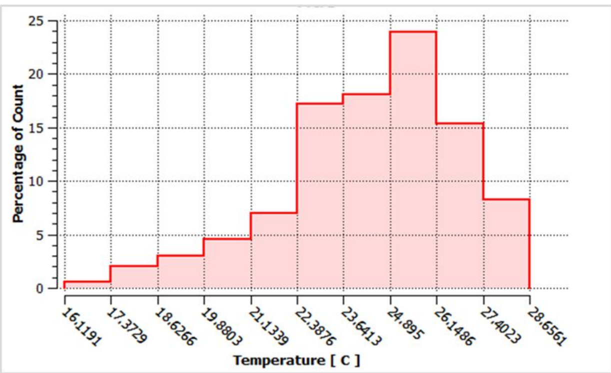

Figure .27. Histogram Graph of distribution temperature in wall room with air gap (2.5cm).

Case First . A Figure 1 depicts the contour temperature distribution through the main room wall, which is made of bricks (12 cm thick) and two layers of cement (1 cm thick). The other walls are adiabatic, and the main room wall faces south. The wall is symmetrical and has two directions (X, Y). the sun's rays hitting a wall perpendicular to the centre of the wall and in the direction of the (X) axis. Because the sun shines directly on the room's wall and it takes a long time to acquire that warmth, there is no thermal insulator to lessen the sun's rays as they descend. This is why the wall is represented in red on the right side of the figure.

In addition, cement absorbs a great deal of solar radiation, and the blue colour on the image's left side indicates the outside air environment, which is near to the room's wall and controlled by the outside air's temperature (9 oC) and wind speed on January 23, at 10 a.m. With a convective heat transfer coefficient, a room's temperature remains constant (25 oC). By conduction and convection, heat is conveyed through room walls and throughout the room, respectively. Figures 2 and 3 illustrate the contour distribution of air velocity in the outer periphery, which is hot as a result of a heated wall. When air touches a hot surface, its temperature rises and its density decreases, causing it to ascend to the top. In addition to figure 4, which depicts the vector of the air's contour velocity, the air rises to the summit because hot air floats due to buoyant force (buoyancy effect).

Case Second . As for the , Figure 5 shows the contour temperature distribution through the main room's wall, which is made of bricks (12 cm thick), two layers of cement (1 centimetre thick), wall packing (4 mm thick), and an 8 cm thick air gap between two walls, at a temperature of 9 degrees Celsius. The remaining walls are south-facing adiabatic walls. The wall has an XY axis length and is balanced about the Y axis. The sun's rays enter chamber through the centre of the wall, parallel to the (X) axis. Because the alucobond heat insulating package blocks the sun's rays and lowers the temperature of the cement wall, the main wall of the room has low temperatures. As the distribution of heat with different thicknesses effects heat transmission, choosing the ideal thickness of the air gap is one of the difficult aspects of wall room design for the current study. The purpose of this numerical research is to ascertain the impact of the air gap thickness between the room wall and packaging layer on the thermal characteristics of a wall in Najaf during winter. The room's walls can also be used to study air circulation and thermal dispersion. Alucobond's heat conductivity is incredibly low (0.15 w/m2.k) [5]. Typically because metallic materials conduct heat faster than masonry. The air gap and contour temperature spread on the alucobond wall layer are shown in Figure 6. The cement wall is heated by hot alucobond layer because this layer's high temperature works as solar radiation on the cement wall from face to face, raising the cement wall's temperature, which is with the packaging layer. Tables 7 and 9 Figures 7 and 9 show how the air velocity within the air gap is distributed along contours, and the hot environment is result of the heated alucobond wall. When air comes into contact with a hot surface, its temperature increases and its density reduces, which causes it to ascend. The air inside the air gap is also represented by Figure 8's velocity distribution contour vector. When air reaches a void, its velocity rises and it rises because of its temperature.

Case Three . As for the, Figure 10 depicts the contour temperature distribution through the main room's walls, which are made of bricks (12 cm thick) and two layers of cement (1 cm thick), with a wall packing (4 mm) and an air gap (5 cm) between them, and an ambient temperature of (9 C). The remaining walls are adiabatic and face south. The wall is symmetrical about the (Y) axis and faces in the (XY) direction. Sunlight strikes the room's wall perpendicular to the centre of the wall and in the direction of the (X) axis. Because the alucobond heat insulating package works to block the sun's rays and consequently lower temperatures of cement wall, we notice the low temperatures of the room's main wall. The optimal thickness of the air gap must be chosen when designing the room's walls for the current study because various air gap thicknesses have an impact on how much heat is distributed. The purpose of the numerical research is to determine how the thickness of the air gap between the room wall and the packaging layer affects a wall's thermal properties in Najaf during the winter. Investigations into air flow and heat transfer through a room's partition are also possible. Alucobond's thermal conductivity is extremely low (0.15 w/m2.k), typically because aluminium conducts heat and cools down more quickly than brick. Figure 11 displays the contour temperature distribution on the alucobond wall layer with an air space. As can be seen, this layer is hot and helps to heat the cement wall by acting as a solar radiation collector for the packaging layer, which is a layer of cement.

Figures 12 and 13 show the contour distribution of air velocity inside the air gap. The alucobond wall has heated the atmosphere, which causes it to rise upward because air temperature rises and density diminishes when it comes into contact with a hot surface. The contour vector of velocity distribution depicts the air inside the air gap in addition to Figure 14. Due to its increased velocity and heat, air rises when it reaches a gap. Due to the buoyant energy, it floats and emerges from the top (the effect of buoyancy).

Case Four . As for the , Figure 15 depicts the distribution of the air gap thickness between the two walls of the main chamber, which is made of bricks (12 cm thick) and two layers of cement (1 centimetre thick), with a wall packing (4 mm thick), and an ambient temperature of 9 C. The other walls are adiabatic and face south. The wall is symmetrical about the (Y) plane and runs in the (XY) direction. Sunlight strikes the room's wall perpendicular to the centre of the wall and in the direction of the (X) axis. Because the alucobond heat insulating package works to block the sun's rays and consequently lower the temperatures of the cement wall, we notice the low temperatures of the room's main wall. Choosing the best air gap thickness is a challenging aspect of the current study's wall design because various air gap thicknesses have an impact on the distribution of heat. The numerical study's goal is to determine the impact of the width of the air gap between a room's wall and its packaging layer on a wall's thermal properties during Najaf's winter months. Investigations into air flow and heat transfer through a room's partition are also possible. Alucobond's thermal conductivity is extremely low (0.15 w/m2.k), typically because aluminium conducts heat and cools down more quickly than brick. Figure 16 displays the contour temperature distribution on the alucobond wall layer with an air gap. As can be seen, the alucobond layer is hot and helps to heat the cement wall because it acts as a solar radiation on the cement wall from face to face. The cement wall is also covered by a packaging layer. The atmosphere is hot as a result of heating an aluminum-coated wall, as shown in Figures 17 and 18. This is because when air contacts a hot surface, its temperature rises and its density falls, causing it to rise upwards. The contour vector of velocity distribution depicts the air inside the air gap in addition to Figure 19. Due to its increased velocity and heat, air rises when it reaches a gap. Due to buoyant energy, it rises to the top and floats (the effect of buoyancy).

As for Figures 20 and 21 show the temperature change in the wall in a horizontal direction along the (X) line, which corresponds to the thickness of the room's main wall without the air gap. The temperature change is depicted by each of these lines connecting the top of the wall, the centre of the wall, and the bottom of the wall. The temperature distribution with wall thickness varies with height as seen through a brick wall with two layers of cement and no alucobond packaging, and the highest value of the temperature at (T top.) is a wall at the top because it is hot and floats and then rises to the top. Figures 22 and 23 show the same primary wall made of bricks and two layers of cement with a covering of air-filled alucobond in front of the wall. At the air gap (8 centimetres), we can see a distribution of degrees. We observe a rise in the line as a result of heat passing through the primary wall of the room, which is located on the (X) axis. The middle of the wall, where the average temperature is situated, floats. The increase in gap causes more constrained air to be present, which raises temperatures in the centre of the wall where the heat and buoyancy forces become dominant. which lessens the heat absorbed in the gap. As for Figures 24 and 25, they show the same primary wall made of bricks and two layers of cement with a cover made of an air-filled layer of Alucobond in front of the wall. When using the air gap (5 centimetres), we observe how the room's main wall's temperature varies depending on the wall's thickness. The line (T top) on the (X) axis increases as the temperature of the highest wall rises as a result of hot air rising in the atmosphere. The centre of the wall, where heat and buoyancy force are predominant, is the cause of the higher temperatures. Due to increased air restriction in the gap over time, which lowers heat absorption, increasing the air gap thickness decreased the rate of air heating. As for Figures 26 and 27, they depict the temperature distribution along the room's main wall and the thickness of the air gap (2.5 centimetres), which is in the direction of the (X) axis.

This thickness is very thin, and because of how readily it will be heated by solar radiation, the building's heating system will have to work harder. In addition, concrete walls cache solar radiation as usable energy for use at night and vice versa. By holding thermal energy in walls, you can warm the air. As a consequence, both the amount of air in the gap and the amount of heat energy stored in the wall will rise over time. The primary stagnant region, symbolised by the centre of the room's wall, is shown in the figure. Here, losses are very high, and heat and buoyant forces predominate and grow with decreasing speed.

Conclusion

This study's use of computational fluid dynamics, this study's main room wall system, which is composed of bricks and two layers of cement, was able to predict thermal load and normal conductivity. The simulation programme ANSYS-FLUENT was used, and the room measured 1.56m x 1.5m x 1.5m. In a recent research, the ideal air gap thickness for an alucobond-packaged room wall system was assessed. Three different thicknesses of the air gap were investigated (8 cm, 5 cm, and 2.5 cm). Recent research used meteorological information for a sunny day in the winter month of January 2022/1/23. Please remember that preparing for this exam on any other day will not affect the results. The findings indicate that the thickness of the air gap (8 cm) has a clear advantage over other researched gaps in terms of how heat is distributed in the room wall and how air moves through it. The amount of air trapped inside the area increases as the air gap widens, reducing heat gain. Narrowing the air gap increases air speed while also increasing the dispersal of heat through a room's wall. Because it floats, heats up, and rises to the top, the air encircling the aluminum-alloy layer is heated, as shown in Figures 5, 10, and 15. The heated air then leaves the top, acting as a sun chimney.

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