MACROJOURNALS

The Journal of **Macro**Trends in Technology and Innovation

INSULATION EFFECT ON THE THERMAL BEHAVIOR OF THE HOUSING

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Abstract

The purpose of this work concerns the study of the insulation effect upon the thermal behavior of a house built with local materials according to Algerian building standard. In this regard, some simulations have been performed using the energy simulation software package 'TRNSYS 16' with the numerical model type 56. Our project involves the introduction of insulating materials in a building, so as to improve the thermal comfort and reduce the consumed energy. Different solutions and variants were proposed, in order to make a relevant choice, ensuring the best thermal comfort of a house while being as less energy-greedy as possible.

Keywords: *Solar energy, insulation, TRNSYS, heating of buildings*

1. Introduction

During recent decades, buildings energy consumption has significantly increased in Algeria. Nearly 42% of energy consumption of the country is allocated to this sector [1]. Most of this energy consumption is due to space heating and cooling. Due to rapid economic growth and growing desire for better indoor environment, energy demand for heating and cooling is expected to increase steadily. Thus, building sector has a significant potential for energy savings.

The influence and impact of the thermal inertia of the stone on the effectiveness of internal and external insulation was presented [2]. Such work and research allow us to draw some standards and criteria that are very interesting to act and acquire a perfect and wonderful insulation.

In summary, then we come to the conclusion that:

- Insulation acts as a thermal barrier.

- During a cold period, the heat losses are hampered by insulation, it effectively promotes the contributions of thermal comfort.

- In winter, despite the presence of the sun, the temperatures of the inner surfaces of the walls remain exposed colder. This implies undoubtedly the valuable role of the thermal inertia of the stone. We know that the length of the night during the winter is about 13 hours, it is more important with respect to the exposure time. These conditions are favorable to absorb the cold at night.

In practical terms, thermal insulation retains its commitments if it is made before the entrance to the hot or cold periods. This is to say that to access and complete a proper and consistent thermal insulation, you have to make before the entry of the summer or winter.

- An important inertia combines three characters:

- A high thermal capacity (heavy floors and walls in contact with the inside air).

- A high thermal conductivity (walls made of absorbent material).

- A large exchange surface

- Based on these results, it can also carry out important decisions at Ghardaia.

We cites as an example:

- Must carefully comply with the standards and principles of bioclimatic design in the construction of buildings at the site.

- It is important not to build houses with stone in Ghardaia. The strong reason is that the stone walls have a high capacity to absorb, store or heat storage. It proposes, for example hollow brick.

In a context of scarce energy resources and reduction targets by 4 emissions greenhouse gas emissions [3], the challenge facing the players in the construction industry is to develop concepts for buildings with high efficiency energy and dispose of engineering tools to evaluate them.
Many studies and feedback on building up annual heating requirements under 50 kWh.m^2. (including heating, cooling, hot water, lighting and ventilation) show that the reduction of energy consumption through design taking architectural account the compactness of the building and management of energy inputs liabilities on an envelope insulation, the establishment of free-cooling and a double flow ventilation with heat recovery. The performance of this latest technology are directly affected by the natural air exchange through the seal of the envelope defects. It therefore seems important to carry out a more detailed assessment of these phenomena [3]. A model of ventilation multizone simulation is developed.

It measures the airflow in the building and is part of a tool for the thermal design, COMFIE. This model is based on the assumptions of perfect mixing and mass conservation for each zone of the building. The air flows between two areas are expressed as a function of the pressure difference (due to the thermal and wind drawing) between these areas. Several kinds of ventilation connections are implemented with cracks, vents, large openings. The model uses the aeration temperature of the thermal model for which the air flows are given as an input. Both models are coupled, via a synchronous method, until a convergence criterion is reached. Two case studies are used to present the features of the models: a housing operation and a 'concept building' powerful urban building [4,5].

2. Description of the pilot dwelling

The pilot dwelling is a low-energy house with 65 m2 net floor area; 3 rooms, 1 kitchen, 1 bathroom, and lavatories. The prototype (Fig. 1) is designed as a typical single family home; it is built in accordance with Algerian building code [11,12]. The home is located at Souidania (20 km southwest of Algiers, latitude 36°7N, Longitude 03°2E). The location is characterized by a temperate Mediterranean climate with rainy and relatively mild winters and hot-humid summers.

Fig.1. The prototype dwelling.

3. Analytical study

The prototype dwelling is reproduced as virtual model using TRNSYS Version 16 (a transient thermal energy modeling software developed at the University of Wisconsin Madison).

The dwelling is modeled in TRNYSY [8,9] with Type 56 using 8 zones: 3 rooms, kitchen, bathroom, lavatories, hall, and attic[10].

The thermal behavior of the prototype house was simulated by varying the type of insulation used in the composition of the exterior walls. TRNbuild is used to define the studied habitat.

4. Results

4.1. Trend of temperatures during the year

We plotted the results obtained from the temperature inside the house in the case of three insulators; 1.Polystyrene, 2 Air gap, 3 Rockwool. And it during the whole year[13].

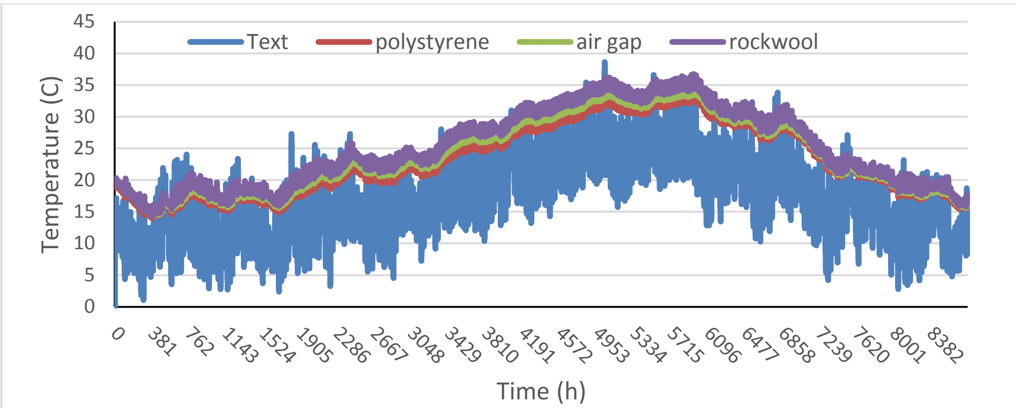

Fig.2. Evolution of the temperature inside the house during the year

The internal temperature of the house evolve in the same way as the outside temperature varies from 15 ° C to 25 ° C in winter and 27 ° C to 36 ° C in summer, and for all three cases. The outside temperature ranged from 1.05 ° C at 23 ° C in winter and reaches 37 ° C in summer. External values are average values given by the software METEONORM.

4.2. Weather season

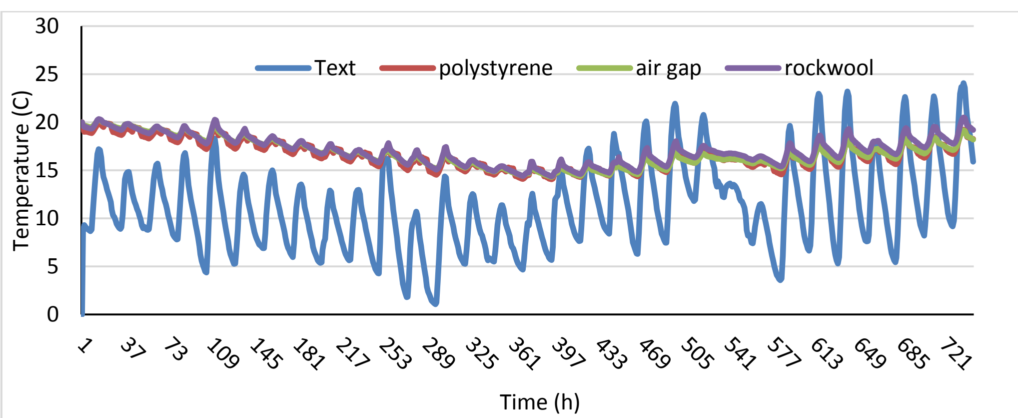

Fig.3. Evolution of the temperature inside the house during the month of January

For the winter season we plotted the temperatures for the month of January. We note that the temperature inside the house is between 15 ° C and 20 ° C and that for the three insulators.

The outside temperature is shown on the same graph, it varies sinusoidally between 1.05 ° C and 24 ° C during the month of January. So without further contributions heating, indoor temperature remains comfortable. The air gap is the smallest, since its conductivity is 0,06W / mK with a thickness of 5 cm, it has a resistance of $R = e / \lambda = 0.833\ m^2\ K / W$. The rock wool with a conductivity of 0.036W / m · K and a thickness of 5 cm, so $R = 1.388 m^2 K / W$. According to the curve, the change is the same as that obtained with the air gap. The curves are almost indistinguishable. Polystyrene with a conductivity of 0.04W / mK and a thickness of 9 cm which gives $R= 2.25 m^2 K / W$. $\lambda_{air} < \lambda_{polys} < \lambda_{rockwool}$ which means that the wool is the best insulator. We have a week to better interpret the evolution of temperatures in the three cases of insulation.

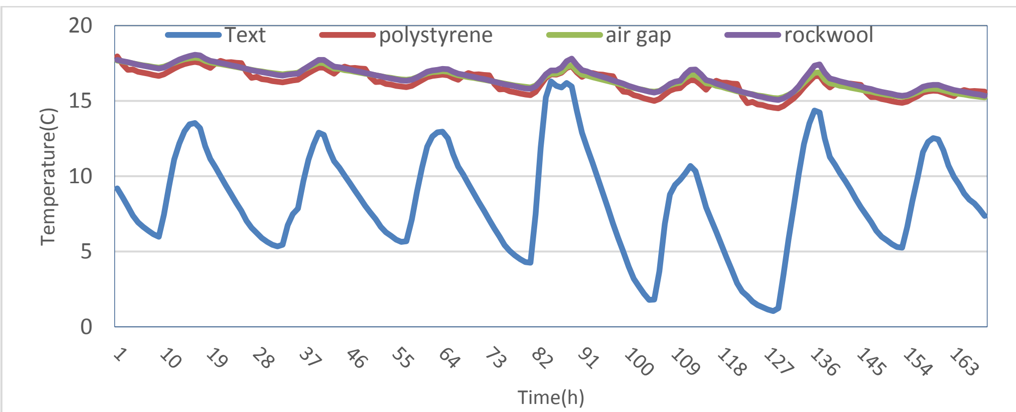

Fig.4. Evolution of the temperature inside the house during one week of January

This curve shows the trend in the previous more accurately, the temperature inside the house ranges from 15 ° C to 18 ° C in all three cases of insulation. In the case of polystyrene, the temperature curve is lower than 1 ° C, against the Rockwool better insulates the outer walls, since the temperature is higher. Meanwhile, the outside temperature is between 1.05 ° C and 16 ° C.

4.3. Summer season

During the summer, we traced the evolution of the temperature during the month of August inside the house in the case of three chosen insulators and this without use of air conditioning.

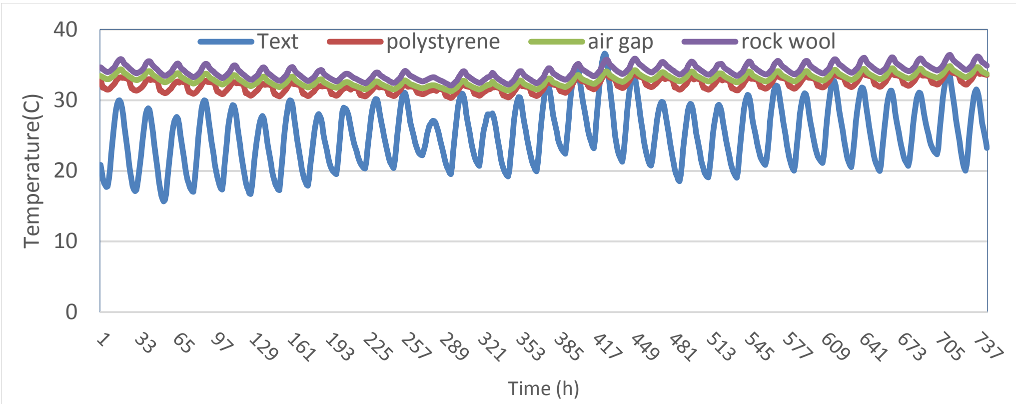

Fig .5. Evolution of the temperature inside the house during the month of august

On this curve are shown the temperatures inside the house during the hottest months. They evolve in the same way and are between 30 ° C and 36 ° C, while the outside temperature varies from 16 ° C to 36.5 ° C. It is clear that the outside temperature is below indoor temperatures habitat, which shows that the insulation in this case night at home comfort. As regards the choice of the insulator, there is the same temperature changes with a slight difference in favor of polystyrene. In this case, rock wool, the thermal conductivity is lower (higher resistance) makes the indoor environment of your home uncomfortable.

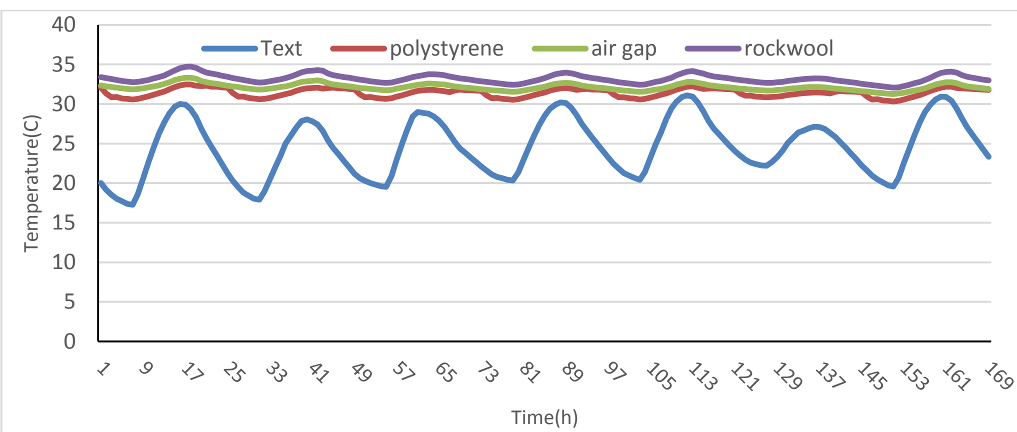

Fig.6. Evolution of the temperature inside the house during one week of august

Our observations in the case of the month of August are confirmed in this graph which represents the results of a week. The house is insulated so that it remains at a very high temperature and reaches 35 ° C in the case of rock wool. In this case, we should think of natural ventilation to refresh the indoor environment.

4.4. Comparison with measured values

We plotted the values obtained by simulation and compared with measured on site for a week in August (2013) values.

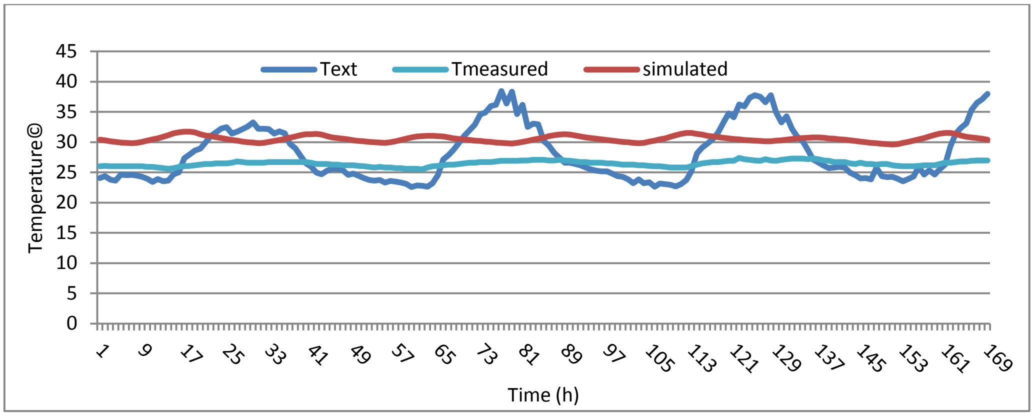

Fig.7. Evolution of the temperature inside the house during one week of august (2013)

This curve shows clearly that the measured values are much lower than those obtained by simulation with TRNSYS (a difference of 4 to 5 ° C). We can say that the house is poorly insulated, so that air infiltration is important, since a rate of 1 we approach the actual values. The indoor temperature is around 26 ° C, while the outside temperature ranges from 20 ° C to 33 ° C, so the interior ambience is comfortable.

5. Conclusion

According to the results obtained by simulation in TRNSYS, during winter, insulation maintains the house at a certain level of comfort. Also, we find that the rock wool best insulation for housing, as the temperature values obtained are more interesting. By cons during the summer, natural ventilation is needed to refresh interior environment of the habitat. The three insulating studied are interesting because their habitat in thermal conductivities are lower than 0.04 W / mK. So the choice of insulation depends on the availability and cost. In the case of air exchange rate used in the residential sector is around 0.6 (*DTU 68.2).*

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