Original Article

Role of the solar powered mechanical ventilation and the phase change materials on thermal comfort and electrical energy of buildings envelope

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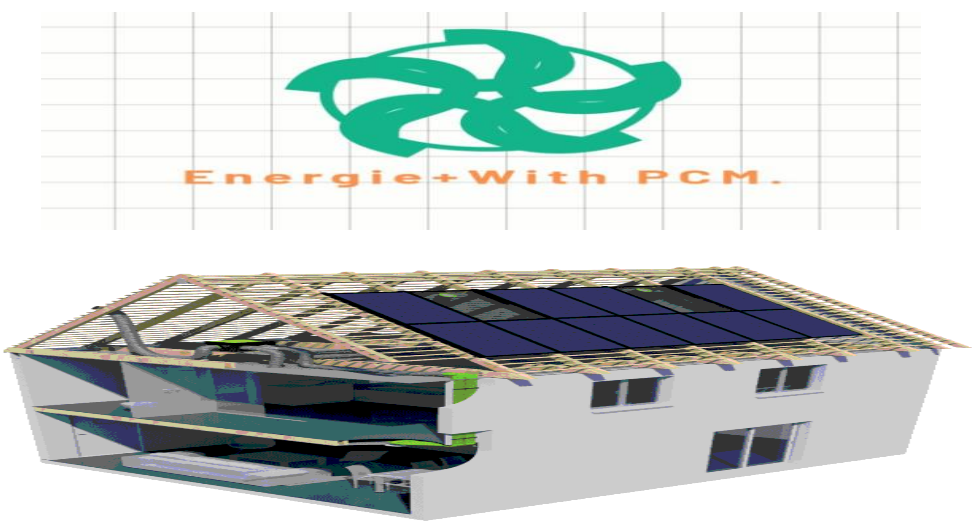
Abstract

The effects of carbon fuel consumption on the environment have stimulated development of a 'net-zero' energy measurement in buildings envelope for sustainable buildings a net-zero energy is key to reducing energy use and saving money .For several decades, low-income citizens in Moroccan cities have been suffering from thermal inequality, energy poverty and thermal comfort constraints. They resist indoor temperatures of less than 16°C and more than 32°C, , many software come to us from the world to simulate the building envelope . we are working only with software related to: calculation and simulationof electrical and thermal zones, which causes the phenomenon of thermal stress . Among the sources of energy consumption, Heating, Ventilation and air Conditioning (HVAC) systems represent about 50% of the total expenditure in buildings this considerable proportion can be explained in part by the great temperature variations recorded in Morocco, which make it essential to provide air conditioning or heating almost at all times. The development of green buildings thus inevitably requires an optimization of the use of powered mechanical ventilation can increase the airflow and improve heat transfer. Similarly, solar mechanical ventilation can be used to accelerate the heat flow and also using the local building materials p.c.m , with low environmental impact. In this perspective, a clear difference between the use of HVAC systems during the day and at night has been observed. This is because, during the day, the solar irradiation incident on the façade of a building coupled with the various internal gains (occupancy density, lighting, etc.) cause a high demand for air conditioning. This article presents a comparison between the Trnsys and energy plus . If the diversity of these programs is a boon in that it allows many different simulations to be compared, it also poses a problem in terms of comparison of results and even choice of program.

Keywords: Phase change material ; Solar ventilation ; ENERGY PLUS ; TRNSYS; Thermal performance; Energy efficiency.

INTRODUCTION



The building envelope studied in this project (unoccupied) in zone climate(NOUASSEUR CASABLANCA). Its total surface is 120 m2 .

The building sector, both residential and tertiary, is experiencing a major expansion in Morocco. At present, there is an extraordinary boom in construction activity. It is therefore expected that there will be a significant increase in the building stock, based on programs of the State in terms of construction in the short and medium term, as well as the projections of the Directorate of Statistics Directorate of the Haut-Commissariat au Plan.wih the big numbers of programs (tools).The majority of these tools were initially developed to calculate the electrical and thermal demand and needs of heating and air conditioning of a building, based on the characteristics of the envelope. In the case where this calculation is carried out on short time steps (generally one hour) and in a "dynamic" way, we commonly speak about DTS (Dynamic Thermal Simulation). The DTS, in its most common meaning, has two main limitations: The calculation is generally limited to the envelope (thermal needs) and does not integrate the thermal losses, nor the efficiency of the different Heating-Ventilation-Cooling (HVAC) systems at the level of emissions, regulation and generation. The calculation only includes the heating and air conditioning needs. In addition, the users of existing buildings suffer from serious problems due to the form and materiality of the material. This is because incoming shortwave solar radiation is mainly stored in building materials such as is radiated as long-wave heat into the urban environment atmosphere.This leads to the well-known "urban heat islands" and "heat stress". Urban heat causes many problems: deterioration or failure of infrastructure, thermal discomfort and waste productivity, (reduced physical and thermal performance) and health and safety problems (respiratory, cardiac and renal problems) [4.5.6] and additional deaths. In Morocco, it is expected that heat problems will also be exacerbated by rising temperatures induced by climate change[7.8]. Similarly, energy use has become a central issue in the operation and development of the building sector in Morocco. Similarly, energy use has become a central issue in the operation and development of the building sector in Morocco. The growth in energy consumption is associated with a significant increase in population and a rapid evolution of the housing stock. The major objectives of the new national energy strategy are to ensure the security of supply and availability of energy, the release of energy market, canceling subsidies, controlling demand and preserving the environment. These have multiple effects (e.g. energy poverty and heat stress) on the population in the short, medium and long term, and define the lines of force to be implemented. In addition, the population is more and more demanding in terms of quality but also in terms of comfort, both thermal and acoustic comfort in buildings. This requirement of comfort is closely accompanied by an augment in energy consumption, especially that related to heating especially that related to –ventilation-heating-air conditioning. In addition, it has been shown that appropriate levels of thermal insulation thermal insulation would allow to reduce 50% of the electrical and thermal energy consumption of the buildings. The difference in savings for insulated and non-insulated envelopes is significant. The objective of thermal insulation is to reduce the energy demand for heating and air conditioning in the building sector. The reduction of energy consumption in an energy-intensive sector such as buildings can be achieved by incorporating new materials or new materials or "intelligent pcm" systems contributing to a regulation of the energy flows and/or a stabilization of the temperature. Among the sources of energy consumption, Ventilation and air Conditioning .This considerable proportion can be explained in part by the great temperature variations recorded in Morocco, which make it essential to provide air conditioning or heating almost at all times. The development of green buildings thus inevitably requires an optimization. Indeed, dropping heat flow would have to be supplied and extracted would have to be supplied and extracted by the HVAC [3] system. This project will provide evidence of the value of integrating phase change materials into the building . This result will be provided in the form of thermal energy efficiency gains by decreasing energy consumption in heating and air conditioning systems, and in the form of thermal comfort gains, heating and cooling systems, and in the form of thermal comfort gains. The use of bio-based materials will bring a sustainable gain respectful of the environment. The economic benefits will be important for low and middle income citizens, and through the income citizens, and by the creation of jobs and companies associated with this sector. In terms of research, the project will evaluate the potential of phase change materials. A study was carried out by A. Brun et al (2009) [11] on the comparison of different simulation tools (PHPP, Pléiade, Clima win, CoDyBa,Trnsys, EnergyPlus and SimSpark) applied to the case of the building located at the INES . Two system analyst were tested, in the first case the convective exchange coefficients are constant and equal, imposed by Pléade and in a second time average annual values were used for the convective exchange coefficients in the case of three tools, EnergyPlus[12], Duforestel (2008) et al [13] give a broad overview of modeling assumptions that are no longer in line with the increasing performance of buildings.

METHODOLOGY

Fig. 1. 3D outlook.

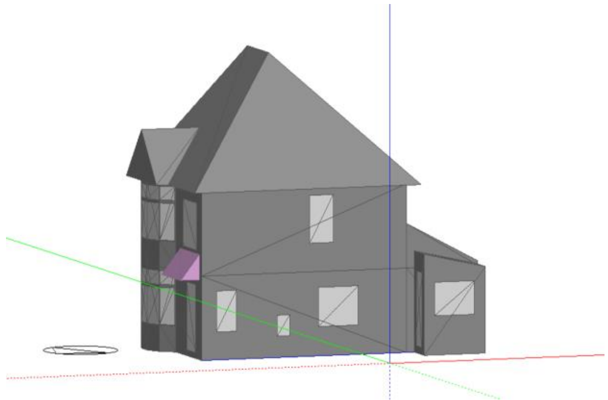


Fig. 2 . 3D view panorama of the zone.

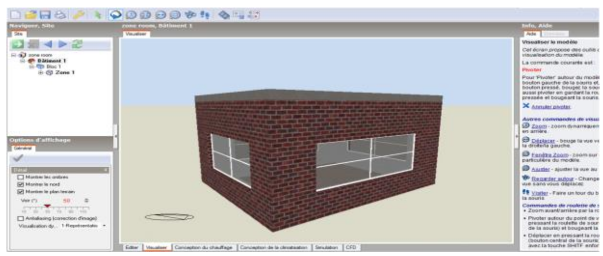


Fig. 3 . 3D outlook panorama of the zone.

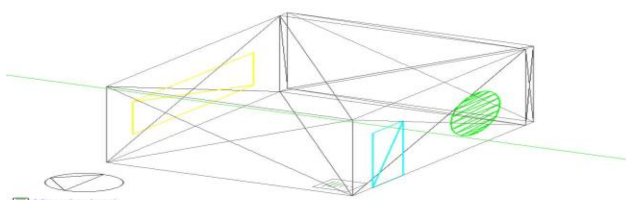
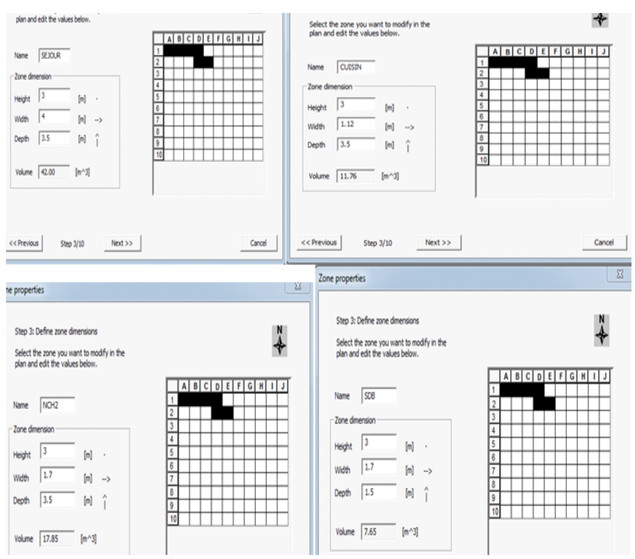


Fig. 4. Presentation of thermal characters surfaces of the zone.



DYNAMIC THERMAL SIMULATION APPLICATIONS:

The most common application consists in the analysis of the thermal comfort in summer in the absence of air conditioning. For this it is common that the programs indicate a certain number of hours of exceeding a threshold temperature, often 28°. Other methods can be used. Most of the tools on the market allow this type of analysis to be carried out, taking into account the operating temperature, which depends on the air temperature in the zone and the average temperature of the walls (Fig 4)Another application of the dynamic thermal simulation is the quantification of heating needs or even cooling in the presence of an active cooling system, in order to study the consequences of different technical solutions on the envelope (Fig1.2)Finally, among the common applications, we find less frequently the estimation of realistic consumption forecasts which requires to implement calculation engines taking into account in a refined

way the technical systems, the solar production ventilation systems, or the heating and air conditioning emission systems, even distribution storage and production the electrical and thermal energy . A first limitation of dynamic thermal simulation tools is the validation of input and output data. Another limit of the dynamic thermal simulation calculations lies in the basic assumptions of this type of calculation which is the zone model. (Fig 3)

Fig. 5. global software logics.

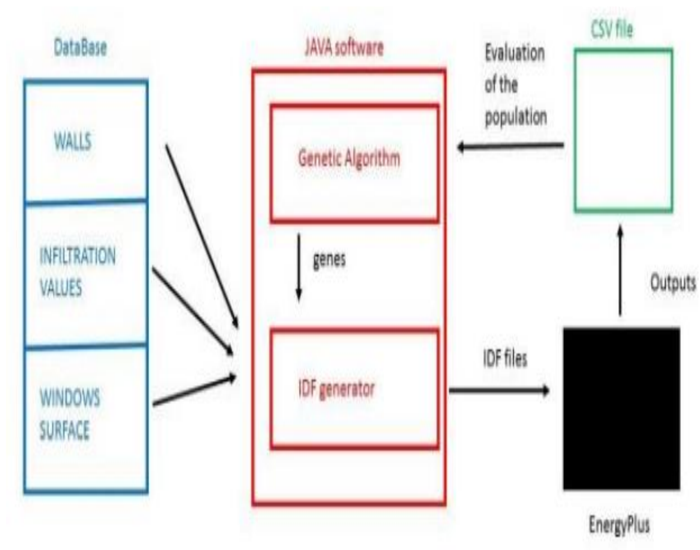


Fig. 6. Definition of thermal characters salon in the house.

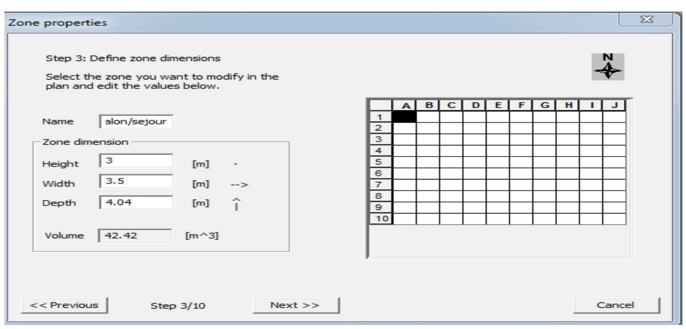
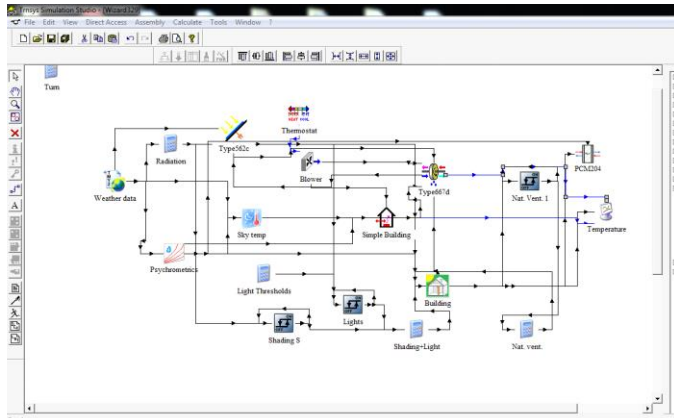


Fig. 7. Representation of the TRNSYS system interface.



Type 667 represents an air heating device that can be controlled either externally, or set to automatically try and attain a set point temperature. The furnace is bound by a heating capacity and an efficiency. Thermal losses from the furnace are based on the average air temperature. The outlet state of the air is determined by an enthalpy based energy balance that takes pressure effects into account. H in and H out refer to the enthalpy of air entering

and exiting the furnace, respectively. Thermal loss calculations are made based on the average temperature of air in the furnace and qη is the capacity of the furnace multiplied by its overall efficiency. In other words, qη is the amount of energy actually transferred from the fuel to the air in the mechanic solar ventilation furnace.

$$\mathbf{H\ air\ out= H\ air\ out+}\frac{\mathbf{q\eta}}{\mathbf{m}}+\frac{\mathbf{UA}}{\mathbf{m}}(\mathbf{T}-\mathbf{Tair})$$

Fig. 8.: Schematic And Cross-Sectional Views Of A ventilation.

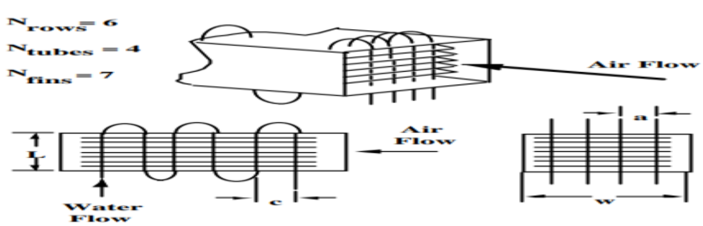


Fig. 9. Representation of the weather data extern subsystem in the TRNSYS system interface

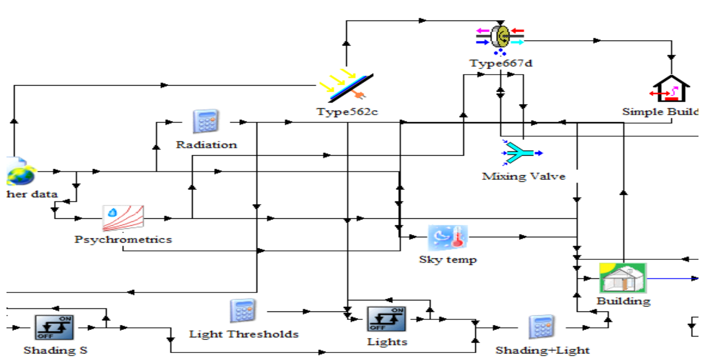


Fig. 10: Plan view of the building.

Delta T = zone air conditioning SetPointt emperature – hvac air conditioning setpoint Temp (difference in temperature between zone air and supply air).

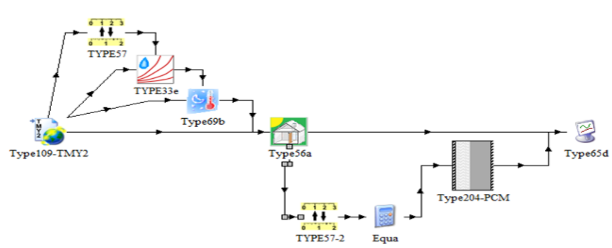
design Supply airflow = design max air conditioning Load / (Cp * deltaT *air density) .

when the temperature between zone air and supply air in the simulated system becomes very low and therefore very large airflow rates are required to meet cooling loads. So in order to account for this energy plus assumes a delta T of 1K in the above calculation when operative temperature control is in use.

Cooling ; Air conditioning : The air conditioning requirement (Fig6) of any wall of the zone subject to idealized to controlling the air conditioning requirement and also can be representing by specifying a cooling type. So when the air conditioning equipment is modeled in(MULTI BUILDING) the external TYPE 56 component;the air conditioning requirement type should not be used. Like that the ventilation , relative ratio humidity and temperature should be defined as INPUTS, fed by outputs from the conditioning equipment component(s) or negative transfers change radiative , convective and conductive GAINS should be defined.

The specification of a air conditioning control is optional and the default setting of the a air conditioning control is off.

Figure .11. Example the model inTRNSYS (TYPE 204pcm).



To get material input and output data for the simulation several steps are necessary:

max 100 values

#Material: PCM(SA) with Graphite Melttingpoint between 56 and 60 °C

#Measurement of q and rho from Andreas Heinz

#Temp[°C]	q[J/kg]	rho[kg/m^3]	lam[W/mK]	mu[N s/m^2]
0.00	0	1053.8	4.5	100000
2.60	5000	1053.8	4.5	100000
5.20	10000	1053.8	4.5	100000
7.80	15000	1053.8	4.5	100000
10.41	20000	1053.8	4.5	100000
13.01	25000	1053.8	4.5	100000
15.61	30000	1053.8	4.5	100000
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
115.00	436972	1053.8	4.5	100000

Solar photovoltaic panels

The photovoltaic solar are installed on the roof of the building envelope . There are 6 , inclined at 18° to the south view with the transfers the solar radiation and the three mode exchange transfers in south building. And also present the inclination to the sun or the weather variation because these are directly represent and informed from modules integrated into the library Trnsys program and plugging with the solar application , such as energy plus ; sketch up, AutoCAD, climate win, Autodesk ,meteonorm which simulates meteorological data (weather, temperature, humidity ,air flow ,inclination of the sun as the day progresses, air humidity, ...). An inverter is also integrated to alternate and series the direct current and tension , power that is recovered from the photovoltaic panels .After retrieving the data needed for the modeling, it is important to choose the right parameters and component from the libraries available in TRNSYS PROGRAM. As we can see in Figure 11, under TRNSYS this system is composed of 4 components: Meteonorm (type 15-6), photovoltaic panels (type 562e).

Figure. 11. Exterior wall parameters.

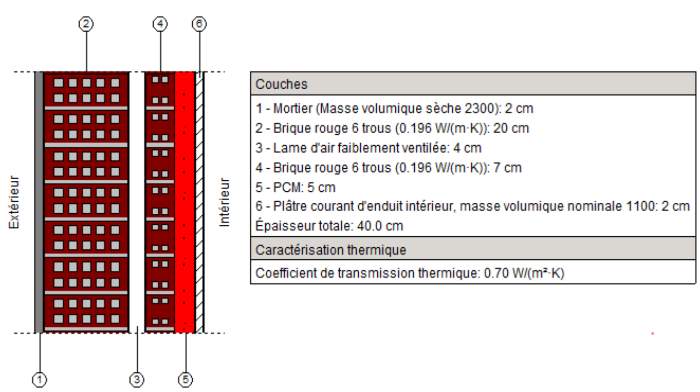
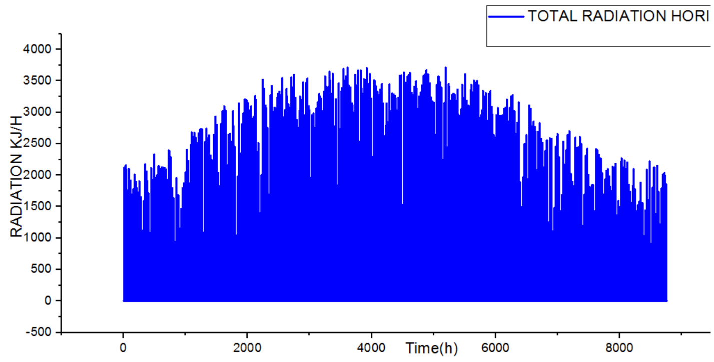


Figure. 12. Electrical Power produced by solar photovoltaic



The electrical power recovered by these solar photovoltaic panels is 1870 kJ/h (0.54 kW)(Fig 12), for the winter season and 3700 kJ/h (1.1 kW) for the summer season . From a simulation point of view, the resulting values are valid.

Air conditioning and heating set point: The set points for the building at 20°C and 26°C for heating and air conditioning respectively according to the Moroccan standard (NM ISO 7730 2010).

Mechanical Ventilation : The building is mechanically ventilated when the air temperature is similar in the air conditioning the set point (26°C) during the heating season (20°C) during the cold season. The amount of air flow was between 0.5 ACH and 1 ACH in summer and between 1.4 and 2.3 ACH in winter it is according with the natural infiltration and mechanical infiltration system an invariable infiltration rate of 0.5 ACH . This project is meant for demonstration purposes only and should not be considered to be representative of actual building performance. It is provided for the purposes of illustrating the functionality of the TRNSYS/CONTAM coupling implemented in version 3.1 of CONTAM.

$$\frac{dT}{dt} = \frac{UA}{cap}(Tam - T) + \frac{mven*cpair}{cap}(Tven - T) + \frac{minf*cpair}{cap}(Tinf - T) + \sum Q\ gains.$$

The moisture balance

$$\frac{d\omega}{dt} = \frac{minf}{\rho V}(\omega inf - \omega) + \frac{mven}{\rho V}(\omega ven - \omega) + \frac{\sum Q\ gains}{\rho V}.$$

Fig. 12. Presentation the plugging with the contam airflow model and building in Trnsys 17 system.

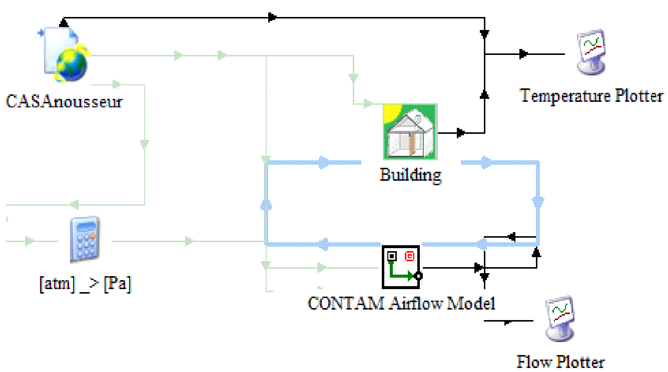
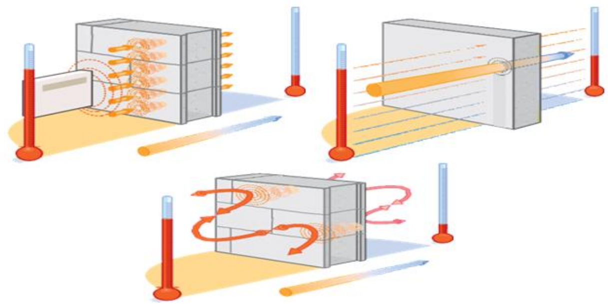


Fig .13. The 3 phenomena of heat transfer by conduction, convection and radiation.



The heat exchange flux φ (phi) is the amount of electrical energy or heat passing through 1m2 of wall during one second when there is a temperature difference between its 2 zones**.**

$$\varphi = \frac{\lambda \, \Delta T}{e}$$ With λ the thermal conductivity; ΔT the temperature difference and e the thickness .

The amount of heat exchange from a wall decreases: when the thermal conductivity be negative , when the temperature difference between the 2 faces of the wall decreases and when the thickness of the wall increases.

Presentation the energy:

ENERGY_Surf= -dqwalldt - qcomi+ qcomo + qt_rgain_i +qt_rgain_o-qt_al [kJ/hr] .

ENERGY_Surf energy balance for a surface should be always 0. dqwalldt: change of internal energy of surface.

Fig. 14. Parameters of the p.c.m wall in building envelope.

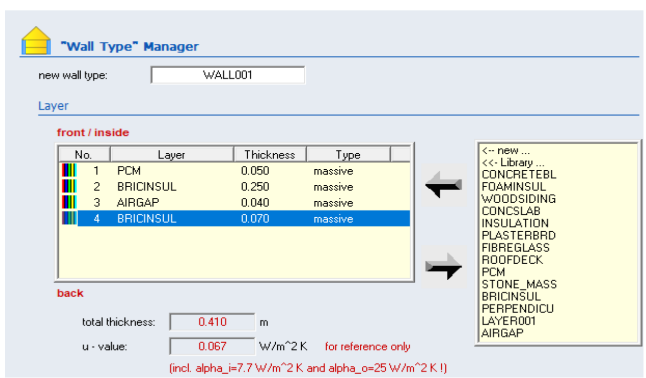


Fig. 15. special card section.

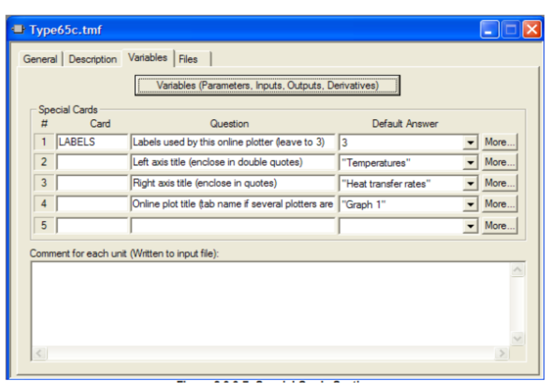
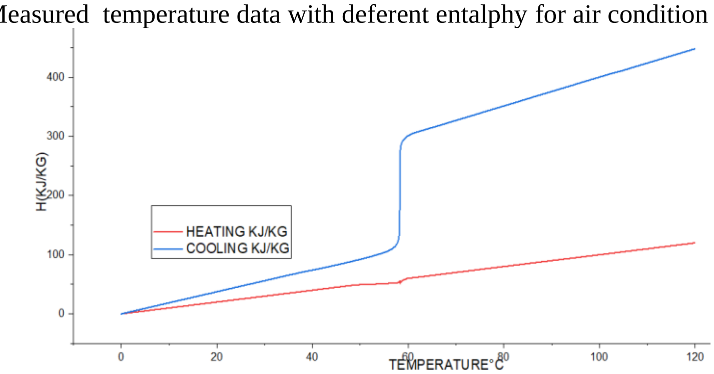


Fig. 16. AIRNODE OUTPUTS.

NTYPE#	Label	Description	Unit
NTYPE 90	THEAT	Set temperature heating	[°C]
NTYPE 91	PHMAX	Maximum power of heating	[kJ/hr]
NTYPE 92	HUMHEAT	Desired Humidity for heating	[%] or [kg/kg]
NTYPE 93	TCOOL	Set temperature cooling	[°C]
NTYPE 94	PCMAX	Maximum power of cooling	[kJ/hr]
NTYPE 95	HUMCOOL	Desired Humidity for cooling	[%] or [kg/kg]
NTYPE 96	ACHINF	Airchange rate infiltration	[1/h]
NTYPE 97	GABSHUM	humidity gain of defined gains	[kg/kg]
NTYPE 98	QDEHUM	latent energy demand of airnode by dehumidification (positive values)	[kJ/hr]
NTYPE 99	QHUM	latent energy demand of airnode by humidification (positive values)	[kJ/hr]

RESULTS AND DISCUSSION

Fig. 17. Measured temperature data with deferent entalphy for air condition and heating.



For a single heating-up data file would be necessary. But to simulate also air conditioning -down a cooling curve has to be generated.For this purpose the area of phase change in the heating curve is cut-out and a air conditioning curve with subcooling is inserted .For low temperatures and in the phase change region the data are identical. For the high temperature range a line of best fit between 60.6 and 74.2 °C is used to extrapolate up to 120 °C). The resulting material data are displayed in Fig. 17.

Fig. 18. Annual growth rate of the internal air temperature with solar powered mechanical ventilation and P.C.M.

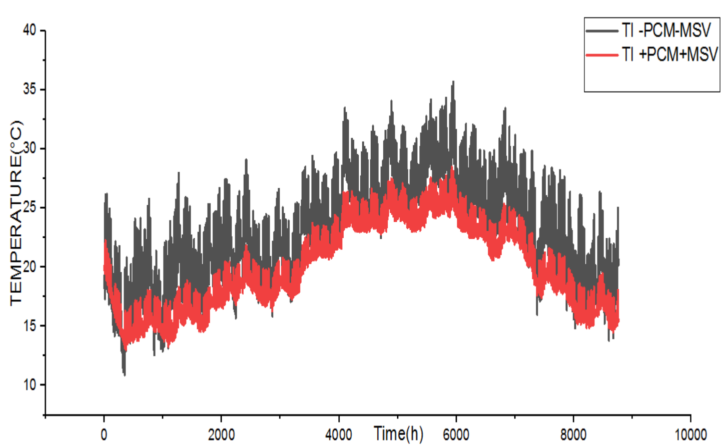


Fig. 19. Gowth rate of internal air temperature with and without solar powered mechanical ventilation in summer.

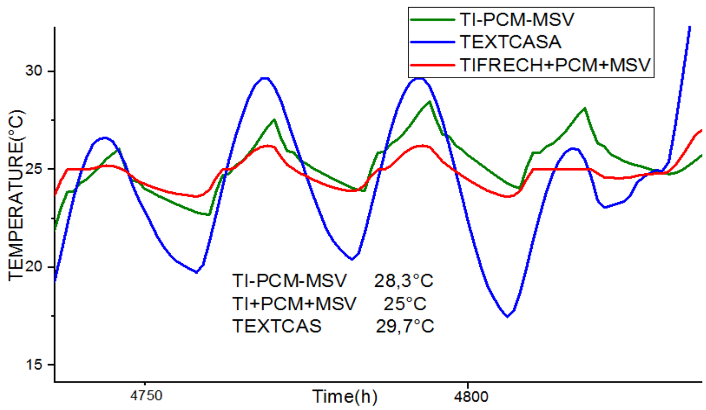


Fig18.19shows the growth rate of external temperature (nouasseur) and internal air temperature with and without solar powered mechanical ventilation and p.c.m in summer into the building envelope. The calcule show that the temperature of the outside air varies between 18 and 30 ° C. The internal air temperature without solar powered mechanical ventilation or mechanical solar ventilation and phase change maerials (msv+pcm) varies between 25 and 28 ° C, the temperature with (msv+pcm) has low values compared to that without(pcm+msv), the temperature with(pcm+msv) varies between 23°C and 25.7 ° C. It was found that the p in the presence of (msv+pcm)minimize the air temperature by 3.3° C. The We noticed that TRNSYS could be due to the variety of physical models used or uncertainties on the homogenization of parameters, and also TRNSYS, expert software for dynamic temperature and energy simulation.

Figure .20. Annual fresh outlet and exhaust inlet around the heat.

Figure .21. The cool outlet and exhaust inlet around the heat during the summer.

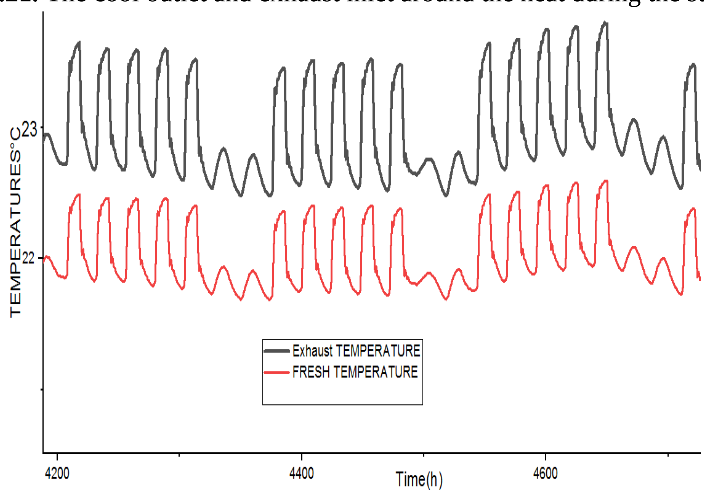


Figure21shows a graph representing the cool output of the heat wheel and the exhaust input during the summer period (air conditioning). Figure 22 represents the cool output of the heat wheel and the exhaust input during the winter period (heating).

Figure .22. The cool outlet and exhaust inlet around the heat during winter.

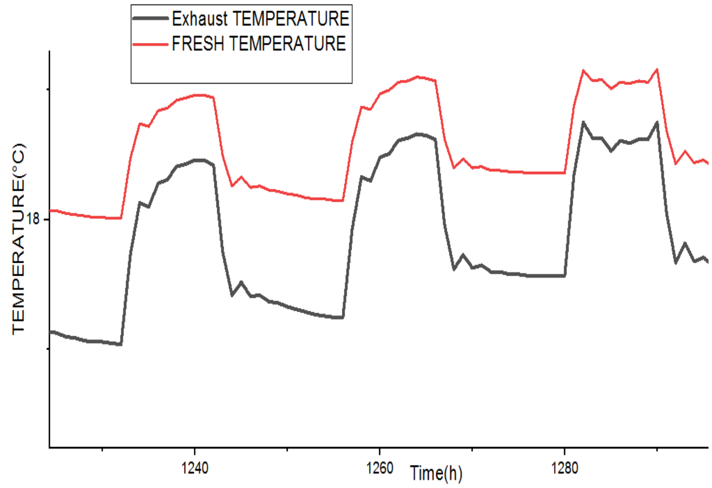


Figure 21 shows a graph representing the cool output of the heat wheel and the exhaust input during the summer period (cooling). Figure 22 represents the cool output of the heat wheel and the exhaust input during the winter period (heating).

Fig. 23. Annual heating consumption with and without solar powered mechanical ventilation (msv+p.c.m) .

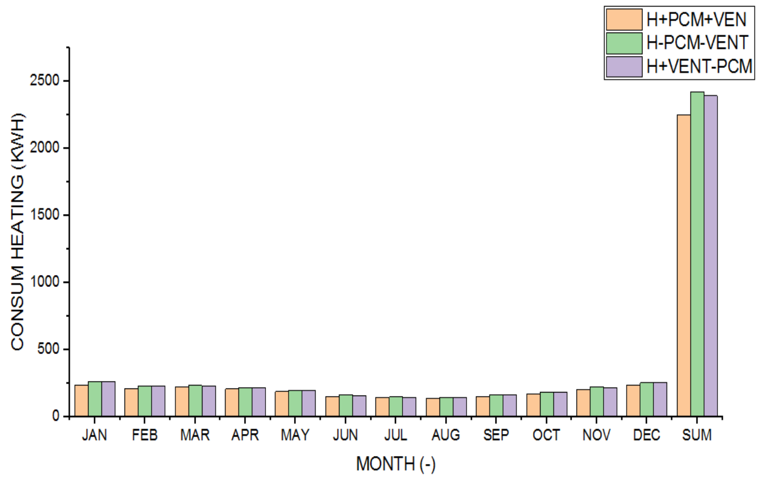


Fig. 24. Annual grozth rate of the internal ambient air temperature without solar powered mechanical ventilation (msv+p.c.m).

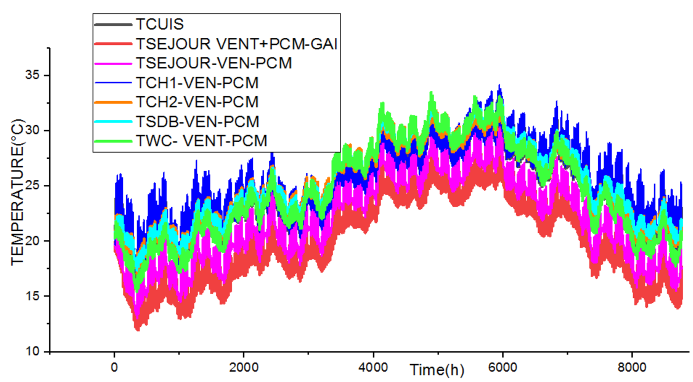


Fig. 25. Annual growth rate of the intern air temperature with and without solar powered mechanical ventilation (msv+p.c.m) and extern air temperature.

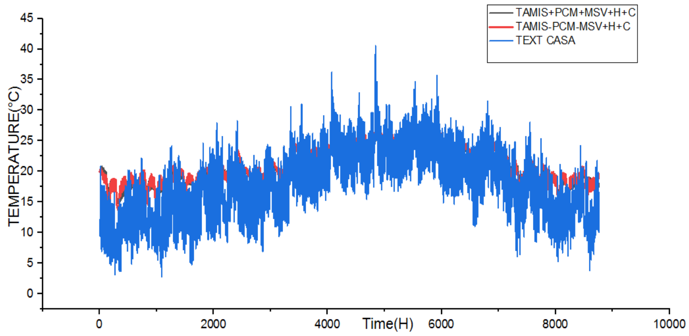


Fig. 26. Evolution of the internal ambient temperature with and without solar powered mechanical ventilation(msv+p.c.m) in summer

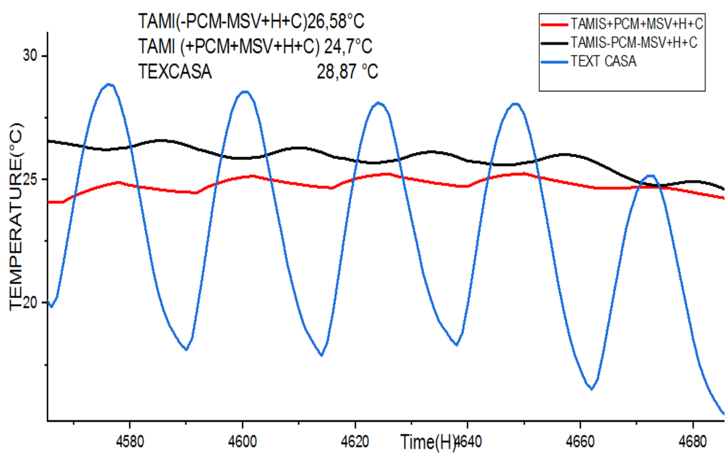


Fig. 26 present the growth rate of the internal air temperature with and without phase change materials and solar powered mechanical ventilation and external air temperature in summer with Trnsys application in zone climate in morocoo. The external air temperature is 28.87°C by meteonorm application and the internal air temperature with phase change materials solar powered mechanical ventilation is25.4°C fluctuation of 3.2°C. and without phase change materials and solar powered mechanical ventilation is26.8°C difference of 1.4°C.

Fig. 27. Monthly consumption of air conditioning with and without solar powered mechanical ventilation and phase change materials (msv+p.c.m).

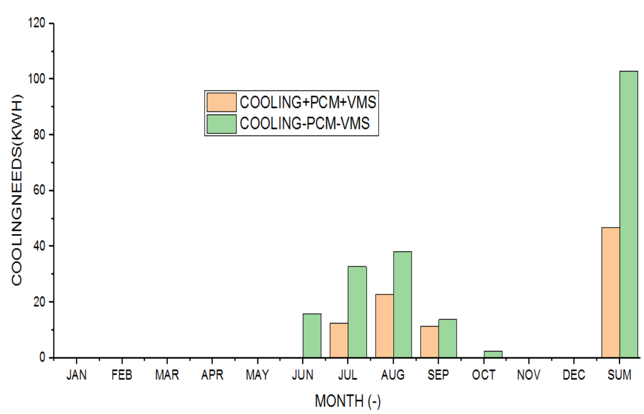
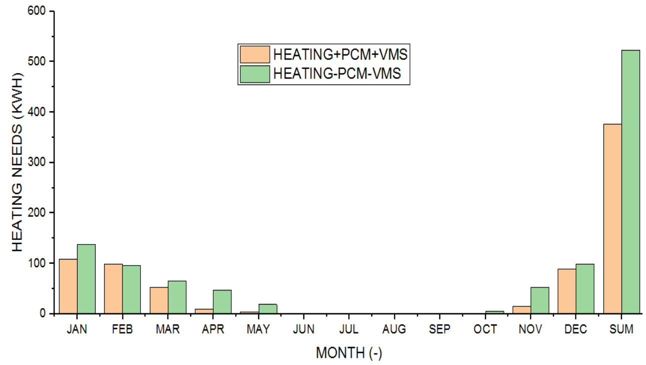


Fig. 28. Annual heating consumption with and without solar powered mechanical ventilation (p.c.m+msv)



The comparison of the thermal energy and electrical charge about the air conditioning and heating requirements for the two SCENARIOS , shows that the building envelope with solar powered mechanical ventilation and phase change materials storage and requires less electrical and thermal energy for heating and air conditioning than the building envelope without solar powered mechanical ventilation and phase change maerials (msv+p.c.m) . During the winter period, JANUARY has the highest energy consumption. During the summer season , AUGUST has the highest energy consumption .(FIG28.27).Table1.

Table. 1. Energy consumption with and without solar powered mechanical ventilation (msv+p.c.m).

CONSUM KWH	CONSUM (MSV+PCM) KWH	CONSUMATION (-MSV-PCM) KWH	GAINS KWH	GAINS %.
sum(H+C)	423,5kwh	625.67kwh	202.17 kwh	32.35%
Sum(H+C+ Inf+GAINS)	1314 kwh	1766,9kwh	452.72 kwh	25.62%

Fig. 29. Growth rate the internal ambient air temperature with(msv+p.c.m) in energy plus and TRNSYS .

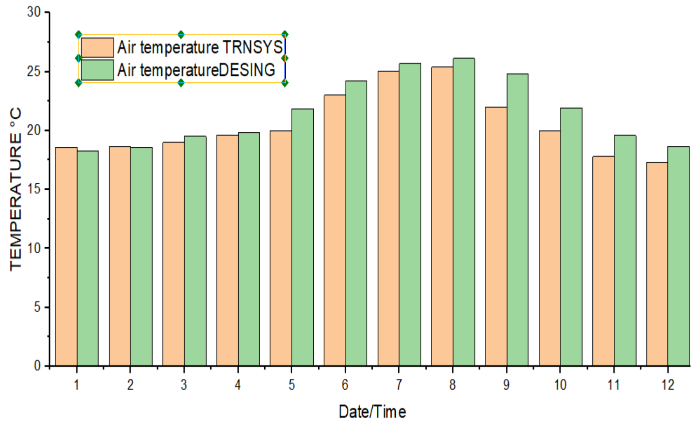


Fig. 30. Growth rate of the relative ratio humidity in TRNSYS and Energy plus.

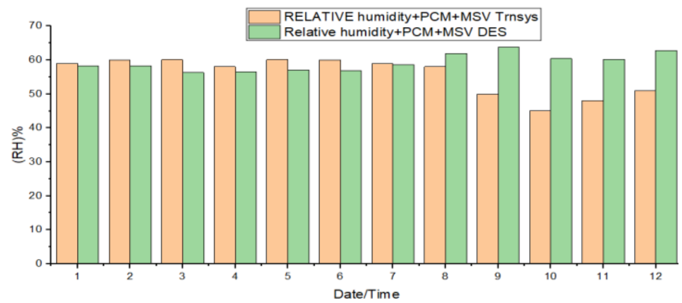
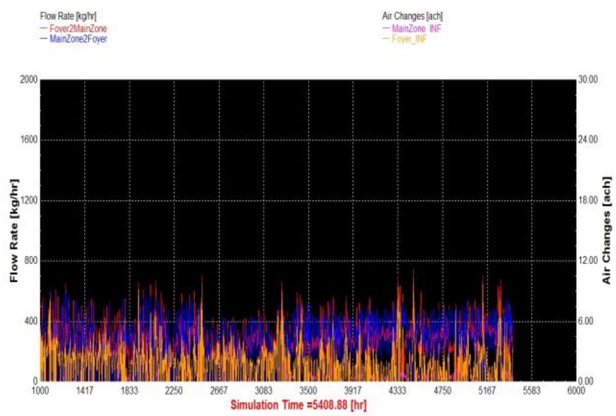


Figure 29 and Figure30 present the growth rate of the ambient temperature and relative ratio humidity of the two software TRNSYS and Energy plus. The results of the simulation similar in the regalement RTCM ;so it is according to a comfort interval (19°C to 26°C) .The difference of the ambient internal air temperature is 2.6°C and 17 % the difference about relative ratio humidity.So the difference between TRNSYS and Energy plus conclude that TRNSYS is it , expert software for dynamic temperature and thermal ans electrical energy simulation.

Fig. 31. Evolution of air flow and air changes (ach) under Trnsys.



Fresh and Comfort zone : The analytical comfort and fresh air flow heat indexes of Fanger (PMV/PPD) KANSAS UNI TSV and Pierce PMV (Fig32.33) requires as input value of thermal insulation (clo), the level of activity and outdoor work (met) of the occupants and the value of indoor air speed (m/s).

Fig. 32. The annual Pierce "PMV" index.

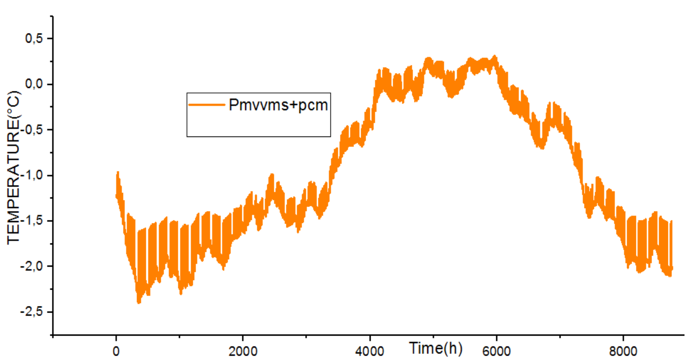


Fig. 33. The "PMV" Kansas and pierce index simulated during one year

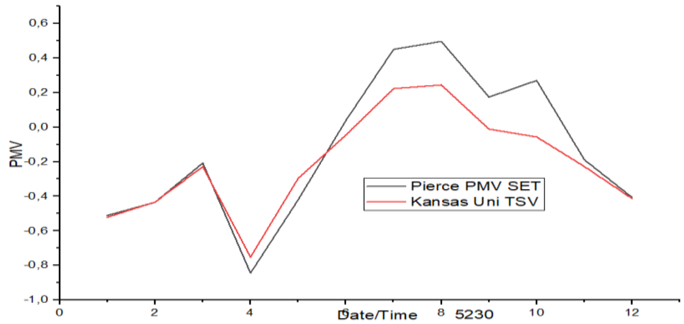


Fig. 34. Annual growth rate of the internal air temperature with and without cooling and heating requirements and solar powered mechanical ventilation .(h+c+msv+pcm).

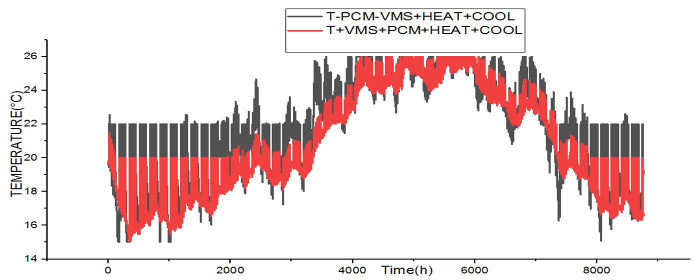


Fig. 35 .Annual percentage of discomfort hours with and without solar powered mechanical ventilation.

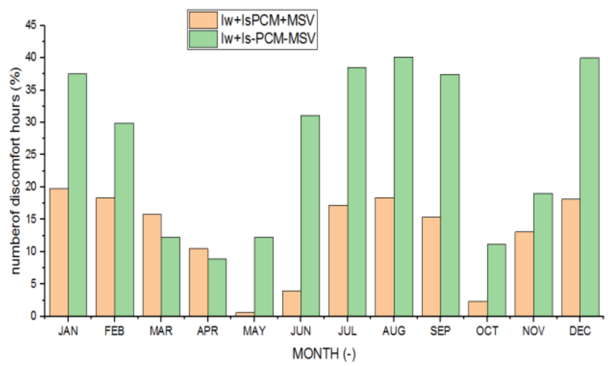


Fig. 35. Present annual percentage of the number thermal of discomfort hours with and without solar powered mechanical ventilation and phase change materials.

Fig. 36. Annual Number discomfort indexes with and without solar powered mechanical ventilation (p.c.m+msv).

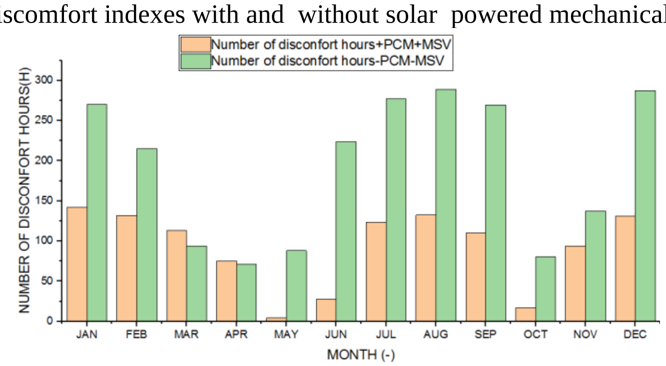


Fig.36. show the number thermal of discomfort hours with and without solar powered mechanical ventilation and phase change materials.The comparison showed that the phase change materials with the solar powered mechanical ventilation can created the fresh air temperature and comfort zone and maintain the heating in the summer season and also decrease the overflow rate and relative ratio humidity and diminish the number of discomfort hours.

Fig. 37. Annual growth rate the mechanical solar ventilation.

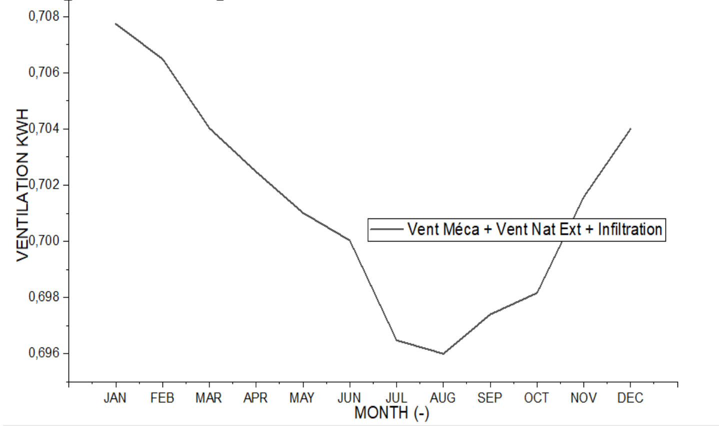


Fig. 38. Annual sensible heating production in TRNSYS.

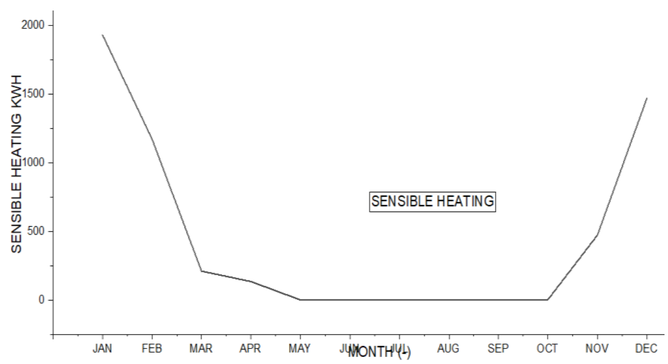


Fig. 38. Present the annual sensible heating production with solar powered mechanical ventilation in TRNSYS program . The comparisons result allow an increase thermal and electrical production energy and growth storage capacity the solar radiation in phase change materials . January the biggest sensible heating production month of the year is 1940 kwh .

Fig. 39. The grater evolution of the energy convective for the air heat flow without and with phase change materials in summer.

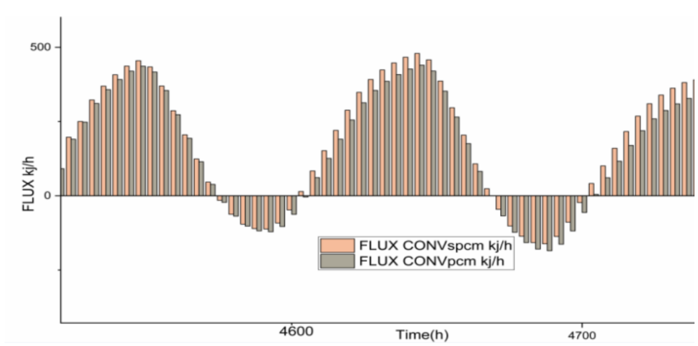


Fig.40. Energy needs for different amounts of solar powered mechanical ventilation .

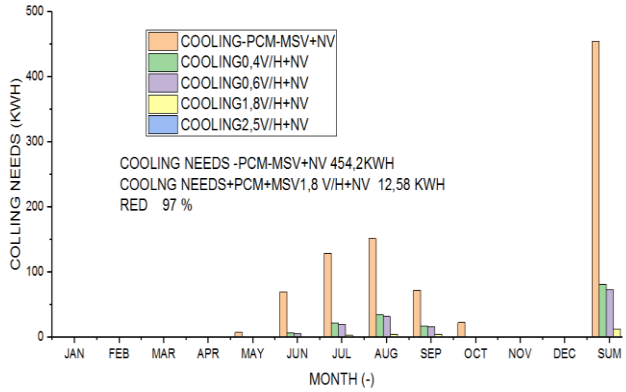


Figure.40. present the influence of the different amount of solar powered mechanical ventilation on the air conditioning thermal and electrical energy needs consumption. The air conditioning needs energy consumption diminish with increasing the air flow amount of solar powered mechanical ventilation . In general, the growth rate air flow amount of solar ventilation provided, the big up effect of the solar powered mechanical ventilation and phase change materials (msv+pcm) on energy savings in the all walls with phase change materials. Figure 39 show of the grater storage for the convective solar energy in the wall incorporate the phase change materials and also the heat flow asserts into the wall with phase change materials has a effect influence on the reduction of the thermal and electrical energy and the heat gains transmitted in the interior of the building envelope. However, the influence of the amount of ventilation on needs energy consumption became insignificant when the ventilation was greater than 1.5 ac/h. The air conditioning energy consumption, ventilation energy consumption and total energy spent for different ventilation amounts in (98% reduction), and when decreasing the solar ventilation amount between 0.5ac/h and 1.4 ac/h the needs energy consumption decreased in winter (54% reduction). So we take between 0.5 and 1.4ac/h in the heating season and between 1.5 and 2.4 ac/h in the air conditioning season.

Fig .41. The heating zone.

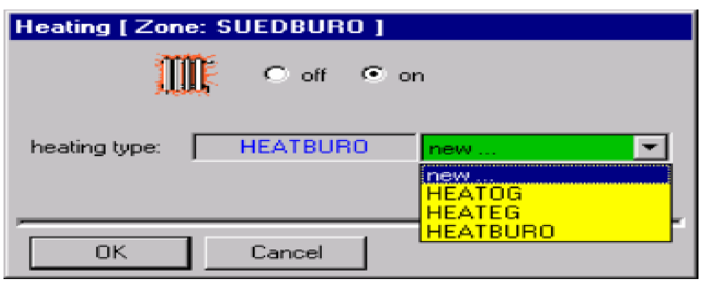
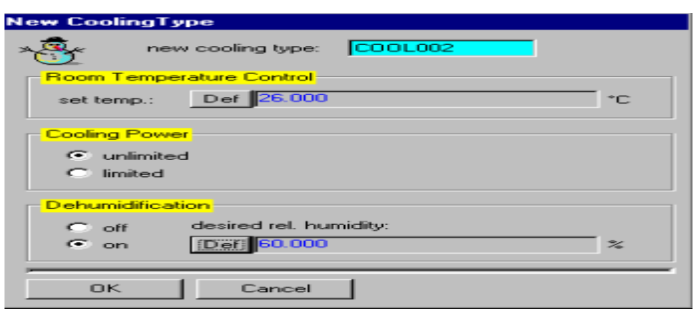


Fig .42. The air conditioning zone.



Son son period. Which means that the amount of ventilation also played an important role in reducing energy consumption.

CONCLUSION

It is concluded that the efficiency of the solar powered mechanical ventilation and phase change mateials can be improved if the building can be properly ventilated to release some of the heat flow and heat gains. In particular when the internal air temperature is close in the phase change materials to the melting temperature of the 21-22°C . A global building envelope modeled and simulated in TRNSYS and EnergyPlus and the modeled exchanger fan system with solar air/PCM is simulated under climate (Nousseur casablanca) .The construction of minim thermal and electrical energy buildings reducing the consumption charge and the annual demands of heating and air conditioning and control the indoor ambient temperature and heat flow and create a more comfortable area. In this article, the mechanical ventilation with solar energy is proposed according to different ventilation rates between 0.5 and 1.4 ACH in winter and 1.4 and 2.5 ACH in summer. In addition, the mechanical ventilation unit is powered by a solar photovoltaic system; if solar power is not available, the ventilation unit is connected to the national power grid. solar mechanical ventilation can also increase the airflow locally and improve heat transfer. Similarly, solar mechanical ventilation can be used to accelerate the heat release from the p.c.m at night and the thermal energy storage efficiency of the p.c.m can be significantly improved. It is believed that the application of pcm and solar ventilation on the building envelope with air conditioning and environmentally friendly natural and solar ventilation can be one of the most effective measures to minimize indoor temperature fluctuations and mold and reduce building energy consumption and CO2 concentration. The results show that the Mechanic solar ventilation(p.c.m+msv) reduces the ambient temperature and thermal and electrical energy demands and needs of the building. Indeed, the ventilation has the beneficial effect on the energy saving and maintain the cost demand equipment about HVAC , optimum thermal performance energetic , control the exchange air flow with external and internal surface and also created the fresh and comfort space .

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COMPLIANCE WITH ETHICAL STANDARDS:

This article does not contain any studies involving human or animal subjects.

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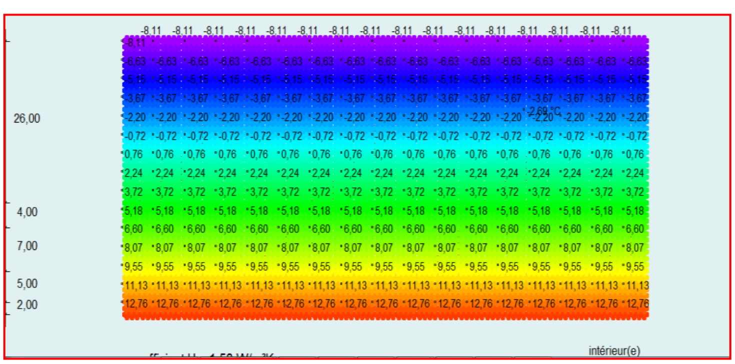
2008.

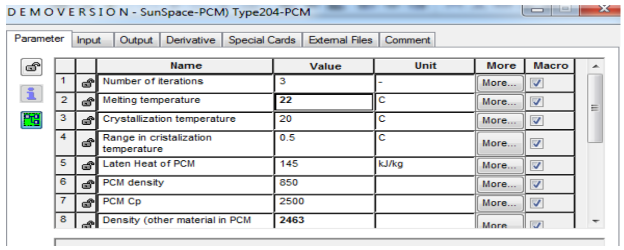
ABREVIATIONS

DTS :Dynamic thermal simulation (DTS).
AIE (IEA) :Agence Internationale de l'Énergie (International Energy Agency)
ASHRAE :American Society of Heating, Refrigerating and Air-Conditioning Engineers
p.c.m :phase change materials
msv : mechanical solar ventilaion
PMV :Predicted Mean Vote
PPD :Predicted Percentage Dissatisfied
RDC : Rez de chaussée
RT :Réglementation Thermique (France)
RTCM : Règlement Thermique des Constructions au MAROC .
TPF :TRNSYS Project File
TRNSYS : TRansient SYstem Simulation
Tam : AMBIENT TEMPERATURE
TA : Air temperature.

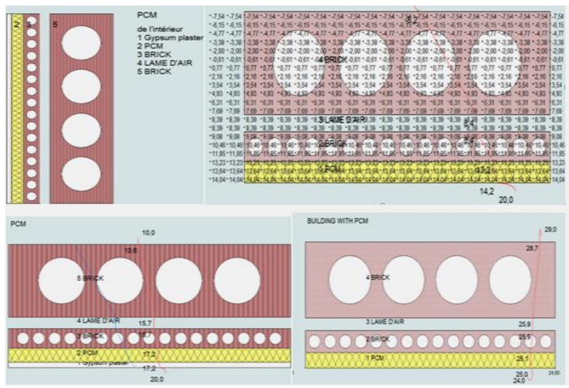
NOMENCLATURE

A : thermal diffusivity (m2/s)
Cp :specific heat capacity (J/kg.K)
Cel : cost of electricity E : layer thickness (m)
H : heat transfer coefficient specific enthalpy(J/kg)
i :inflation rate (%)kwh
K :thermal conductivity (W/m.K)
T : temperature (°C) Ta :ambient air temperature (°C).
Tc : cooling set-point temperature (°C)
Tsky : sky temperature (K)
X : coordinate direction normal to the wall
(msv+p.c.m) : mechanic solar ventilation and phase change materials .
C max : maximum capacity rate .
Cmin : minimum capacity rate .
Cpc : Specific heat of cold side fluid .
Cph : Specific heat of hot side fluid .
ε :heat exchanger effectiveness.
mc :fluid mass flow rate on cold side.
mh :fluid mass flow rate on hot side.
qt : total heat transfer rate across heat exchanger.
qmax :the maximum heat transfer rate across exchanger .
Tc : cold side inlet temperature Tco cold side outlet temperature .
Thi :hot side inlet temperature .
RH : Relative air humidity
C :Convective
i :inside, node number
j :layer number o: outside
r :radiative
S :surface, solar

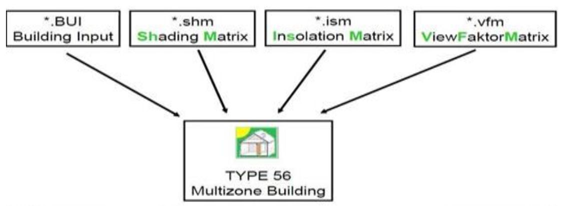




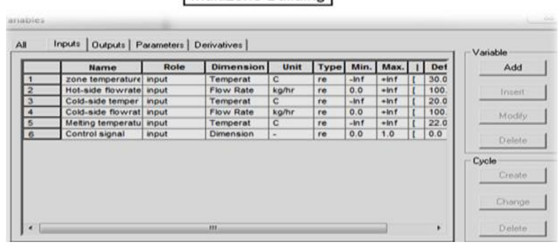
D E M O V E R S I O N - SunSpace-PCM) Type204-PCM
Parameter
Input
Output
Derivative
Special Cards
External Files
Comment
Name
Value
Unit
More
Macro
Number of iterations
3
Melting temperature
22
C
Crystallization temperature
20
C
Range in cristalization temperature
0.5
C
Laten Heat of PCM
145
kJ/kg
PCM density
850
PCM Cp
2500
Density (other material in PCM
2463



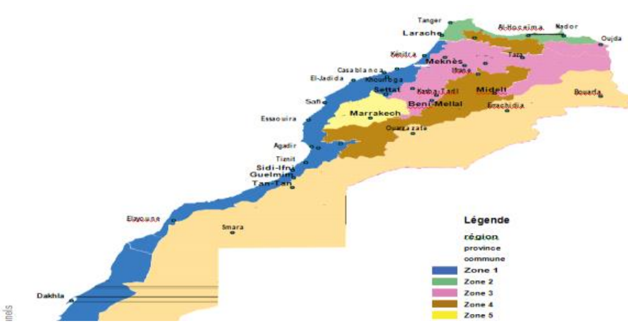
PCM
de l'intérieur
1 Gypsum plaster
2 PCM
3 BRICK
4 LAME D'AIR
5 BRICK
BUILDING WITH PCM



*.BUI
Building Input
*.shm
Shading Matrix
*.ism
Insolation Matrix
*.vfm
ViewFaktorMatrix
TYPE 56
Multizone Building



All
Inputs
Outputs
Parameters
Derivatives
Name
Role
Dimension
Unit
Type
Min.
Max.
Def
zone temperature
Hot-side flowrate
Cold-side temper
Cold-side flowrat
Melting temperatu
Control signal
Variable
Add
Insert
Modify
Delete
Cycle
Create
Change
Delete



Tanger
Larache
Oujda
Meknès
Casablanca
Settat
Midelt
Marrakech
Beni Mellal
Essaouira
Agadir
Sidi-Ifni
Guelmim
Tan-Tan
Smara
Dakhla
Légende
région
province
commune
Zone 1
Zone 2
Zone 3
Zone 4
Zone 5