

# A Study to Improve the Efficiency of Buildings using Nanomaterials

Mahmoud Ahmed Zaki<sup>1</sup>, Ahmad Abd Elwahab Rizk<sup>2</sup>, Hosny Ahmed Dewer<sup>3</sup>, Ghada Samir Ali Ali<sup>4\*</sup>

<sup>1,2</sup>Professor, Department of Architecture, Tanta University, Tanta, Egypt
 <sup>3</sup>Lecturer, Department of Architecture, Tanta University, Tanta, Egypt
 <sup>3</sup>Master Student, Department of Architecture, Tanta University, Tanta, Egypt

Abstract: In light of the remarkable development in nanotechnology, and it is one of the most important applications that directly affect the building materials used in buildings in the internal and external environment in order, to achieve greater efficiency and access to environmentally friendly buildings to achieve sustainability.

Through some nanomaterial applications, and the selection of analytical examples applied to nanotechnology, as well as an application study on an administrative building for the application of nanotechnology in order, to reach the goal of study which is the role of nanotechnology to raise the efficiency of administrative buildings to achieve sustainability.

*Keywords*: Nanotechnology, Nano Architecture, Nano architecture application (Nano material).

## 1. Introduction

The most sought after in the current and future global challenges was the provision of new technologies and materials with qualifications that would lead to a leap in the world of architecture, and the largest share was nanotechnology, a technological means by which climate change can be addressed and help reduce future gas emissions. The building has a significant impact on the surrounding world, and in the way buildings are designed and nanotechnology is able to change the way it is built, and nanotechnology has a significant impact on building materials and their characteristics.

In past years the term 'nanotechnology' has been used in many fields (architecture, medicine, space, construction, etc.), and we will address the explanation of the definition of nanotechnology, Nano-architecture, Nano applications in architecture and a study case through which we apply nanomaterials, as nanotechnology has a profound impact on the architecture industry in all standards of interior design, and building design.

## 2. Methods

#### Definition of Nanotechnology

Nanotechnology is extremely diverse, ranging from new extensions to traditional device physics to a completely new approach based on molecular self-assembly, to developing new nanometer-scale materials, to predicting how to control matter on an atomic scale.

It has the potential to create a plethora of new materials and devices with wide-ranging applications, and nanotechnology raises many issues that any new technology introduces, such as nanomaterials and their environmental impact, And its potential economic impact. [1].

#### Nano architecture:

Nanotechnology + Architecture = Nano Architecture

Science at the molecular level is set to change the way we build.

Nanotechnology is responsible for the major changes that led to the development of architecture, as things on a one-to-ahundred-billion-meter scale make changes to materials and construction. However, the question is how willing we are to embrace these changes through which architecture can make a big difference.

Nano Architecture allows us to develop designs that better interact with the senses of man. Experience this architecture and look more 'natural' than the many designs which we face today. [2].

The grandest ambitions are actually very, very tiny for the future of our built environment. The nanotechnology industry has already begun transforming our buildings and using them on eight billion dollars a year; if their potential is realised, they can unbelievably transform our world. Nanotechnology has the potential to significantly alter our built environment and the way we live. It's potentially our most transformational technology, attracting more inquiry and discussion than nuclear weapons, space travel, computer systems or any other technology that has altered our lives.

What is the future of the building, for example, if we each have thermosafe skin that protects us from elements?

How can we interact, if walls and ceilings become thin and permeable or even invisible with our surroundings, and with each other? [3].

## Nano architecture application-Materials: [4]

- 1. Thermal insulation: Vacuum insulation panels (VIPs).
- 2. Thermal insulation: Aerogel

<sup>\*</sup>Corresponding author: ghadasamir566@gmail.com

# Thermal insulation: Vacuum insulation panels (VIPs)

The vacuum insulation Panels (VIPs) have a considerably thinner insulation thickness than usual for providing very good thermal insulating. Thermal conductivity is up to ten times lower in comparison to traditional insulation materials such as polystyrene. Max. thermal resistance with minimum isolation thinness can be achieved with this result. The thickness of these VIPs ranges from 2mm to 40mm [4]. Vacuum insulation panels can be used for both new building construction and conversion and renovation work, and they can be applied to both walls and floors.

It is generally estimated that the ages of modern paintings are 30-50 years old. It can also be used in electronic packages and to isolate pipelines. [4] (Fig. 1.).



Fig.1. Different sized vacuum insulation panels in storage [4]

## Thermal insulation: Aerogel:

Almira - 'Nanogel' is formerly the brand name of Cabot Corporation's. It is a unique material, lighter and best solid insulating material made of silica (silica), is a lattice network of glass filaments with very small pores, for Mira (Lumira) consisting of 5% of solids and 95% air, its structure creates Insulation, improves the spread of light and water repellent [5]. With a solid-touch environment and tremendous insulation capabilities [6].

Aerogel, which was developed in 1931, currently holds the record for the lightest known solid. It is a highly light-weight ventilation foam with about 100% air. The remaining foam material is silica, a glass-like material. The nano dimension in the pores of the foam is so important: air particles trapped inside the micro Nano theme - with each average size of only 20nm - are unable to move, lending.



Fig. 2. Aerogel in combination with glass [4].

It is used as an insulating filling material in cavities between glass parts, u-glass, or multi-walled acrylic glass panels, making it ideal for use in the construction of external envelopes.

Aerogels can significantly reduce heating and cooling costs. Aerogel conveys light well because it is transparent. The light spread evenly and comfortably. Aerogel also acts as an acoustic insulator, and contributes to energy efficiency in addition to its thermal insulating properties.



Fig. 3. Aerogel and its ability to withstand different forces and high insulation capacity with the small size of the sample section [7].

# Aerogel's daily lighting capabilities:

Aerogel supports you in achieving energy code requirements in overcoming design issues, as it provides unprecedented thermal efficiency, high quality lighting and sound reduction, Aerogel has gained widespread acceptance throughout the United States and Europe for use in daylight systems as a result of the following [8]:

- 1. Transmission to light 91 % per cm2.
- 2. Reduce solar heat acquisition and noise.
- 3. Resistance to discoloration mold.
- 4. Reducing energy consumption and reducing carbon emissions.
- 5. Green Manufacturing Processes (Sustainable).



Fig. 4. Glass sample with black edging & aerogel-filled glazing cavity [4]

# Architectural destinations of the building:

The front façade (the main façade is the northern façade) of the university administration building is dominated by solid flats where it is 60%, and the open surfaces (void) are 40% of the building, while the side facades are also dominated by the flats on the southern façade the proportion of flat flats is about 70% of the entire facade.



Fig. 7. University Administration Building in Mansoura

# Analytical study:

		Tab	ole 1			
Indigo	Tower:	Bio	Purif	ication	Tow	er
D	01	3.6	1	1.01	1	1

Architect	10 Design Architects Team: Ted Givens Benny Chow, Mohamed Ghamlouch.
Site	Qingdao, China
Classification	Multi-use (residential- administrative- merchant)
Nanomaterials used	<ul> <li><i>Nano coating:</i> titanium dioxide, (TIO<sub>2</sub>)-Air purification</li> <li>Solar Nano cells.</li> </ul>
Sustainability standards	<ul> <li>Site: (No negative impact on the site- Carbon dioxide absorption).</li> <li>Water efficiency: (Use of rain water to feed the building- Wastewater recycling)</li> <li>Energy efficiency: (Wind power- Solar Energy).</li> <li>The internal environment: (Day lighting)</li> <li>Materials : (Use of Nano casing- Use of Nano coating)</li> </ul>
Project Description:	The Indigo Tower project is designed as an attempt to address urban air pollution by cleaning air by combining passive solar and nanotechnology technologies [9]. It works to combat air pollutants' through Nano coating where it performs photo stimulation as a result Of the interaction of titanium dioxide (TIO) with ultraviolet radiation (UV) and also works at night light on night lighting thanks to the negative solar energy through UV radiation collected during daylight [10].

Table 2 Bank of America Tower

	Bank of America Tower	
Architect	Cook + Fox Architects	
Site	New York, American	
Executing	Israel Berger & Associates; Permasteelisa Group	
Company		
Classification	Multi-use (Administrative-Service)	
Nanomaterials	Low emission glass.	
used		
Sustainability	• <i>Site:</i> (No negative impact on the site- Carbon dioxide absorption).	
standards	• Water efficiency: (The system of facades to collect rainwater and reuse it again)	
	• <i>Energy efficiency</i> : (Solar Energy).	
	Materials: (Use of Low emission glass).	
	The internal environment: (Day lighting).	
Project Description:	The building is the fourth tallest skyscraper in New York city, with a height of 366 m. Consisting of 55 floors and containing 2,100,000 square feet of office space, three escalators and 50 service desks. <i>Referred to as 'BOAT', a boat, which is an abbreviation for Bank of America</i> <i>Tower.</i> The project has been implemented with a 1 billion U.S. dollars to be one of the most efficient and friendly buildings in the world. Nano glass has been used as a low-emission glass with the aim of creating the highest quality in the workplace through daylight and fresh air, and essential urban-level outdoor contact, representing the tower in its local environment as well as downtown Manhattan [12].	Fig. 6. Bank of America Tower [12]

# 3. Methods

		Table 3
1	<b>University</b> A	dministration Building in Mansoura
	Architect	Prof. D.Eng. Adel Ahmed Deaf
	Site	Mansoura City Egypt
	area	6400m <sup>2</sup>
	Time	2000



Fig. 8. Analysis of the climate conditions surrounding the general site of the management building of The University of Al-Mansoura

## Steps to use DESIGN BUILDER in simulations:

All data for the building are entered in terms of (general location - climate conditions - and dimensions of the building) on the program and a model is formed mimicking the reality of the building so that it simulates everything related to energy consumption, internal thermal environment, openings and guidance. (Fig. 11.).

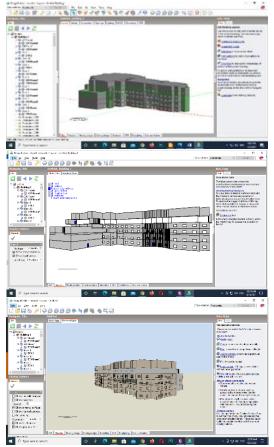


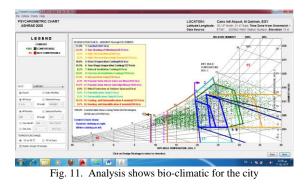
Fig. 9. The model that mimics the university administration building in Mansoura University

The materials built are identified in terms of materials used in roofs, floors, internal and external walls and external openings.

• Periods of use of the building and its division into working hours, official working days and weekly and annual vacation days.

Schee	lules						
Gene	ral						
Gen	oral						
		ffice OpenOff Oc	<u>.</u>				
		fing: OFFICE Area: C		Occupancy acked	la		
		ing of fice Alea o	PERFORMENTED	. Occupancy schedu	UKINCM		
	urce						
	Category					rkshop businesses	
- 23	Region				General		
	hedule type				1-7/12 Sched	dule	
Desi	ign Days						
De	esign day definiti	on method			1-End use de	efaults	
Us	e end-use defau	ult			2-Occupancy	y	
Profi	les						
Month	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Jan	8.30 - 16.00	8.30 - 16.00	8.30 - 16.00	8:30 - 16:00	Off	Off	8.30 - 16.00
Feb	8:30 - 16:00	8:30 - 16:00	8:30 - 16:00	8:30 - 16:00	Ott	Off	8:30 - 16:00
Mer	8:30 - 16:00	8.30 - 16.00	8:30 - 16:00	8:30 - 16:00	Off	Off	8:30 - 16:00
Apr	8.30 - 16.00	8.30 - 16.00	8.30 - 16.00	8.30 - 16.00	Off	0#	8.30 - 16.00
May	8:30 - 16:00	8:30 - 16:00	8:30 - 16:00	8:30 - 16:00	Ott	Off	8:30 - 16:00
Jun	8:30 - 16:00	8:30 - 16:00	8:30 - 16:00	8:30 - 16:00	Off	Off	8:30 - 16:00
Jul	8.30 - 16.00	8.30 - 16.00	8.30 - 16.00	8.30 - 16.00	Off	Off	8.30 - 16.00
Aug	8.30 - 16.00	8.30 - 16.00	8.30 - 16.00	8:30 - 16:00	Off	Off	8:30 - 16:00
Sep	8:30 - 16:00	8:30 - 16:00	8:30 - 16:00	8:30 - 16:00	Ott	Off	8:30 - 16:00
Oct	8.30 - 16.00	8.30 - 16.00	8.30 - 16.00	8:30 - 16:00	Off	Off	8.30 - 16.00
Nov	8.30 - 16.00	8.30 - 16.00	8.30 - 16.00	8.30 - 16.00	0#	0#	8.30 - 16.00
Dec	8:30 - 16:00	8:30 - 16:00	8:30 - 16:00	8:30 - 16:00	Off	0#	8:30 - 16:00

Fig. 10. Sometimes the blanks that are known within the program are filled



# *First case: No insulation (Status quo) Output data:*

Cooling design: In-building energy consumption rate in the summer months (July-August-September).

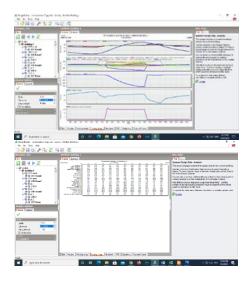


Fig. 13. In-building energy consumption rate in the summer months (July-August-September) in the program

*Cooling energy consumption rates in internal spaces:* The rate of energy consumption in the interior of all parts of the building in this case without adding any insulation materials: Total Cooling =2912.53 kW.

The total energy consumed in cooling operations in the summer months (July-August-September) is within the building's spaces as described in (Fig. 16), (Fig. 17).

Description in the program	Its thermal properties	Description in the program	Its thermal properties
External ceiling		External walls	
Constructions Layers Surface properties Image Calculated Cost Co	Constructions Layers Surface properties Image Calculated Cost Condensation analysis	Constructions Layers Surface properties Image Calculated Cost Conden	Constructions           Layers         Surface properties         Image         Calculated         Cost         Condensation analysis
Cross Section Outer surface 20.00mm - Concrete Tiles (rooting)(not to scale) 20.00mm - Cast Concrete (Lightweight (not to scale)	Convective heat transfer coefficient (W/m2-K) 4 460 Radiative heat transfer coefficient (W/m2-K) 5 540 Surface resistance (m2-K/W) 0.100 Duter surface	Cross Section Outer surface 40.00mm External Rendering	Inner surface Convective heat transfer coefficient (W/m2-K) Convective heat transfer coefficient (W/m2-K) Surface resistance (m2-K/M) U130 Unter surface resistance (m2-K/M) U130 U140 U140 U140 U140 U140 U140 U140 U14
40.00mm Sand and gravel 70.00mm Sand and gravel	Convective heat transfer coefficient (W/m2-K) 19.870 Radiative heat transfer coefficient (W/m2-K) 5.130 Surface resistance (m2-K/W) 0.040 No Bridging	20 Dimm Cart Concrete Lipitweight (not to scale)	Convective heat transfer coefficient (W/m2-K) 19.870 Radiative heat transfer coefficient (W/m2-K) 5.130 Surface resistance (m2-K/W) 0.040 No Bridging
	U-Value surface to surface (W/m2-K)         4.004           R-Value (m2-K/M)         0.390           U-Value (W/m2-K)         2.566           Wrin Bridging (ES EN ISO 6945)         2	290 Donn Britwood Inee	U-Value surface to surface (W/m24K)         1.496           R-Value (m2+K/W)         0.838           U-Value (W/m2+K)         1.193           With Bridging (BS EN ISIO 6946)         1197           Thickness (m)         0.3200
200.00mm Concrete, Reinforced (with 2% steel)	Thickness (m)         0.3700           Km - Internal heat capacity (KJ/m2-K)         212.1600           Upper resistance limit (m2-K/W)         0.390           Lower resistance limit (m2-K/W)         0.390	2000mm Datt Concrete [Lightweight]not to scale]	Km - Internal heat capacity (K-J/m2-K)         130.4000           Upper resistance limit (m2-K/W)         0.838           Lower resistance limit (m2-K/W)         0.838
20.00mm Floor/Root Soreedinatio scale) Inner surface	U-Value surface to surface (W/m2-K)         4.004           R-Value (m2-K)         0.390           U-Value (W/m2-K)         2.566	40.00mm External Rendering Inner surface	U-Value surface to surface (W/m2-K) 1.496 R-Value (m2-K/W) 0.838 U-Value (W/m2-K) 1.193
U-value =	2.566 (W/m <sup>2</sup> .K)	U-value =	1.193 (W/m <sup>2</sup> .K)
Ground floor		The interior floor	
Constructions Layers Surface properties mage Calculated Cost Cross Section Inner surface	Constructions           Lyse         Sufface properties         Image         Calculated         Cost         Condems           Inner-sufface         Convective heat transfer coefficient (W/m2+K)         0.342         Radiative heat transfer coefficient (W/m2+K)         0.540           Sufface resistance (m2+K/W)         0.170         Outer sufface         0.170	Constructions           Layers         Surface properties         Image         Calculated         Cost           Cross         Section         Inner surface         20.00m         Ceramic/porcelan         20.00m         20.00m         20.00m         20.00m         20.00m         20.00m         20.00m <td>Constructions           Lyser         Sufface properties         Image         Calculated         Cont         Condensation           Inner surface         Convective heat transfer coefficient (W/m2-K)         0.342         Radiditive heat transfer coefficient (W/m2-K)         5.540           Surface resistance (m2-K/W)         0.170         0.170</td>	Constructions           Lyser         Sufface properties         Image         Calculated         Cont         Condensation           Inner surface         Convective heat transfer coefficient (W/m2-K)         0.342         Radiditive heat transfer coefficient (W/m2-K)         5.540           Surface resistance (m2-K/W)         0.170         0.170
400.00mm Earth, common	Convective heat transfer coefficient (V/m2+K) 19.870 Radiative heat transfer coefficient (V/m2+K) 5.130 Surface resistance (m2+K/M) 0.040 No Bridging U-Value surface to surface (V/m2+K) 1.998	40.00mm : Clay or sit	Convective heat transfer coefficient (W/m2+C) 4.460 Radiative heat transfer coefficient (W/m2+K) 5.540 Surface resistance (m2+K/M) 0.100 No Bridging U-Yolue surface to surface (W/m2+K) 4.558
150.00mm Sand and gravel	U-Value (m2+K)         1.380           R-Value (m2+K)         0.711           U-Value (m2+K)         1.407           With Bridging (ISE IN ISO 6945)         1.407           Thickness (m)         0.5800	200.00mm Concrete, Reinforced (with 2% steel)	C Value (m24KM)         0.485           R-Value (m24KM)         0.485           U-Value (m24KM)         2.063           With Endging (BS EN ISO 5945)         1000           Thickness (m)         0.3000
50.00mm Sand and gravel 40.00mm Sand and gravel(not to scale) 20.00mm Cast Concrete (Lightweight)(not to scale) 20.00mm Ceramic/porcelam(not to scale) Outer surface	Km - Internal heat capacity (KJ/m2-K)         128.4800           Upper resistance limit (m2-K/W)         0.711           Lower resistance limit (m2-K/W)         0.711           U-Value surface to surface (W/m2-K)         1.998           R-Value (m2-K/W)         0.711	20.00mm External Rendering	Km: Internal heat capacity (KJ/m2+K)         235,7400           Upper resistance limit (m2-K/W)         0.485           Lower resistance limit (m2-K/W)         0.485           U-Value surface to surface (V/m2-K)         4.658           R-Value (m2-K/W)         0.485
	U-Value (W/m2-K) 1.407	Outer surface	U-Value (W/m2-K) 2.063
U-value =	1.407 (W/m <sup>2</sup> .K)	U-value =	2.063 (W/m <sup>2</sup> .K)
Inner walls		External openings	
Constructions           Layers         Surface properties         Image         Calculated         Cost         Condent	Constructions Layers Surface properties Image Calculated Cost Condensation analy Inner surface	Edit glazing Glazing Layen Calculated Cost	Edit glazing - Sgl Clr 3mm Glazing
Outer surface	Convective heat transfer coefficient (W/m2-K) 2.152 Radiative heat transfer coefficient (W/m2-K) 5.540	General Name Sgl Ctr 3mm Description	Layers Calculated Cost Calculated Values
40.00nm External Rendering 20.00nm Cast Concrete (Lightweight)	Surface resistance (m2-K/W)         0.130           Outer surface         Convective heat transfer coefficient (W/m2-K)         2.152           Radiative heat transfer coefficient (W/m2-K)         5.540	Source EnergyPlus dataset Cetegory Single Region General Colour	Total solar transmission (SHGC)     0.861       Direct solar transmission     0.837       Light transmission     0.898
1300mm-Proklaak kanet	Surface resistance (m2-K/W)         0.130           No Bridging	Definition method Definition method Leyurs Leyurs Number leyers 1	U-value (ISO 10292/ EN 673) (W/m2-K) 5.829 U-Value (W/m2-K) 5.89
20.00mm Cast Concrete (Lightweight)	U-Value (W/m2-K)         1.391           With Bridging (BS ENISO 8946)	Outermost pane Pane Spe Generic CLEAR 3MM Filip layer Radiance Daylighting	
40.00mm External Rendering	Upper resistance limit (m2-K/W)         0.719           Lower resistance limit (m2-K/W)         0.719           U-Value surface to surface (W/m2-K)         2.180		
	R-Value (m2-K/W) 0.719 U-Value (W/m2-K) 1.391		
U-value =	$1.391(W/m^2.K)$	U-value =	$5.894(W/m^2.K)$

Fig. 12. Characteristics of materials used and openings in construction elements within the program

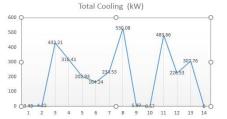


Fig. 14. Cooling energy consumption rates for the current situation without any insulation

Zone	Design Capacity	Design Flow Rate (m3	Total Cooling Load (kW/)	Sensible (kW)	Latent (kW)
Building 1					
Block1:2192	3.95	0.2709	3.43	3.38	0.06
Block2:2202	4.86	0.3329	4.22	4.15	0.07
Block3:227Room	497.04	33.9740	432.21	423.51	8.70
Block4:230Room2	233.37	15.9821	202.93	199.23	3.70
Block4:229Room3	363.87	24.9241	316.41	310.70	5.71
Block5:231Room4	188.87	12.8932	164.24	160.72	3.51
Block6:232Room5	269.71	18.4208	234.53	229.63	4.90
Block7:233Room8	609.59	41.7809	530.08	520.83	9.25
Block 8:236 Room	6.86	0.4714	5.97	5.88	0.09
Block9:235Room	0.65	0.0449	0.57	0.56	0.01
Block10:239Room9	556.21	38.0527	483.66	474.35	9.30
237Room6:237Room6	260.51	17.6910	226.53	220.53	6.00
238Room7:238Room7	353.92	24.0433	307.76	299.72	8.04
Totala	2249 41	220.002	2012 52	2052 19	50.25

Fig. 15. Cooling energy consumption rates for the current situation without any insulation

External thermal energy rates for internal vacuums:

Rates of thermal energy consumption in force to internal spaces through architectural building elements (ceilings, exterior walls, windows and floors). During the summer months, it's clear:

- Glazing Gains and Solar Gains = 186.269 kW.
- Wall Gains = 62.975kW.
- Floor Gains = 117.244 kW.
- Roof and Ceiling Gains =129.942 kW.

# The second case: By adding nanotechnology-modified insulation materials.

By adding Nano-mineral fibers, adding insulation materials to the ceilings, exterior walls and floors, and adding aerogel as an insulation material on window glass.

Description in the program	Its thermal properties	Description in the program	Its thermal properties
External ceiling		External walls	
Constructions Lyren Sufface properties Image Calculated Cost Condensatio Cross Section Outer sufface 2000m Concrete Ties (poting(rof to scale) 2000m Section 2000m Section 2000m Section 2000m 2000m Section 2000m Section 2000m Section 2000m 20000m Concrete, Reinforced (with 2% steel) 20000mm Flooring, Reinforced (with 2% steel) 20000mm	n . Laves States properties Image Calculater Cold. Cold Condensation analysis Treate States and the transfer coefficient (W) 4 460 Redictive heat transfer coefficient (W) 5540 Surface resistence (m24/W) 0.100 Convective heat transfer coefficient (W) 19870 Redictive heat transfer coefficient (W) 5130 Surface resistence (m24/W) 0.040 W6 Enging U-Value surface to surface (W/m24) 0.219 U-Value surface to surface (W/m24) 0.219 U-Value (W/m24) 0.212 W6 Bedging (03 ET (KO 0540) Thickness (m) 0.5524 Km - Intent heat capacity (K/m24) 0.212 U-por resistance Imit (m24/W) 4.710 Lover resistance Init (m24/W) 0.213 H-Value (W/m24) 0.212	Constructions Layer Surface properties mage Calculated Cost Condensation a Crose Section Dude section User Section User Concerns (Lotwend Floot to scale) Condensation Cost Concerns (Lotwend Floot to scale) Concerns Cost Concerns (Lotwend Floot to scale) Condensation Cost Concerns (Lotwend Floot to scale) Concerns Cost Conc	Constructions           Uncernations           Inner statute           Convective heat transfer coefficient (W/m2-4)         2.152           Redshow heat transfer coefficient (W/m2-4)         2.152           Redshow heat transfer coefficient (W/m2-4)         0.130           Outcome transfer coefficient (W/m2-4)         0.130           Convective heat transfer coefficient (W/m2-4)         0.130           Convective heat transfer coefficient (W/m2-4)         0.800           Probatic methods transfer coefficient (W/m2-4)         0.800           V-Value surface to surface (W/m2-4)         0.800           Probatic methods (W/m2-4)         0.800           Probatic methods (W/m2-4)         0.800           Probatic methods and copecity (%/m2-4)         0.439           Thichness (m)         0.4200           Monthmethod and copecity (%/m2-4)         0.200           Monthmethod and copecity (%/m2-4)         0.800           U-Value surface to surface (W/m2-4)         0.805           U-Value surface to surface (W/m2-4)         0
U-value =	.212 (W/m <sup>2</sup> .K)	U-value =	0.449 (W/m <sup>2</sup> .K)
Ground floor		The interior floor	
Constructions Layer Suffice reporting Image Calculated Cost Condensation Cost Section Index suffice 400 00vm Early common 500 00vm Early common 200 00vm Cost Cost Early 200 00vm Cost Early 200	Interestudio-2     S       Convective heat transfer coefficient (. 0.342; Radidive heat transfer coefficient (. 540; Suitcer ereistance (in:ext-VM)     0.170       Outer suitce:     S       Convective heat transfer coefficient (. 19.870; Radidive heat transfer coefficient (. 5130; Suitcer ereistance (in:ext-VM)     0.140; Heat transfer coefficient (. 5130; Suitcer ereistance (in:ext-VM)       U-Value (in:ext-VM)     0.140; Heat transfer coefficient (. 5130; Rivelaue (in:ext-VM)     0.140; Heat transfer coefficient (. 5130; Rivelaue (in:ext-VM)       U-Value (in:ext-VM)     0.120; Rivelaue (in:ext-VM)     0.120; Rivelaue (in:ext-VM)       U-Value (in:ext-VM)     0.700; Rivelaue (in:ext-VM)       U-Value (in:ext-VM)     0.730; Rivelaue (in:ext-VM)       U-Value (in:ext-VM)     0.737; U-Value (in:ext-VM)       U-Value (in:ext-VM)     0.737; U-Value (in:ext-VM)	Constructions Layers Extrace properties Image Calculated Cost Condensation Cross Section Inter surface Calcolonic Concerlen Calcolonic	Constructions           Layer         Sufface properties         Image         Calculated         Cost         Condensation analysis           Image sufface         Convective heat transfer coefficient (W/m.         5.540           Sufface resistence (m2+K/M)         0.170           Outrea cutive heat transfer coefficient (W/m.         5.540           Suiface resistence (m2+K/M)         0.170           Outrea cutive heat transfer coefficient (W/m.         5.540           Redictive heat transfer coefficient (W/m.         5.540           Suiface resistence (m2+K/M)         0.100           U-Value suiface to suiface (W/m2+Y)         4.558           R-Value (m2+K/M)         0.455           U-Value suiface to suiface (W/m2+Y)         2.35.7400           Upoper resistence limit (m2+K/M)         0.465           Lower seistence limit (m2+K/M)         0.465           U-Value suiface to suiface (W/m2+K)         4.558           R-Value (W/m2+K)         4.558           Lower resistence limit (m2+K/M)         0.465           U-Value suiface to suiface (W/m2+K)         4.558           R-Value (W/m2+K)         2.163
U-value =	1.254 (W/m <sup>2</sup> .K)	U-value =	2.063 (W/m <sup>2</sup> .K)
Inner walls Constructions Layers Surface ropentes mage Calculated Cost Condensator Cross Section Under surface 40.00mm External Rendering 20.00mm Call Constrets Lightweight 20.00mm Call Constrets Lightweight 40.000mm External Rendering 20.00mm Call Constrets Lightweight 40.000mm External Rendering Inner surface	Units surface           Convector head transfer coefficient (W/m2-K)         2.152           Radiative heat sansfer coefficient (W/m2-K)         5.540           Surface resistance (m²-K/W)         0.139           Outrie surface         2.152           Radiative heat sansfer coefficient (W/m2-K)         2.152           Notice sansfer coefficient (W/m2-K)         2.152           Radiative heat sansfer coefficient (W/m2-K)         2.180           LV-Value (w/m2-K)         1.391           U-Value (w/m2-K)         1.391           U-Value (w/m2-K)         1.394           U-Value (w/m2-K)         1.134           U-Value (w/m2-K)         2.180           U-Value (w/m2-K)         2.181           U-Value (w/m2-K)         2.181           U-Value (w/m2-K)         1.1341           U-Value (w/m2-K)         1.391	External openings	Clazing Layen: Calculated Cost Total solar transmission (SHGC) 0.45 Direct solar transmission 0.338 Light transmission 0.624 U-value (NJ/m2-K) N/A U-Value (WJ/m2-K) 0.891
U-value =	$1.391(W/m^2.K)$	U-value =	$0.891(W/m^2.K)$

U-value =

Fig. 17. Characteristics of materials used and openings in construction elements within the program

Zone	Glazing Gains (kW)	Wall Gains (kW)	Floor Gains (kW)	Roof and Ceiling Gain
Building 1				
Block1:2192	0.000	0.639	0.419	0.483
Block2:2202	0.000	0.576	0.364	0.513
Block3:227Room	4.505	13.610	-30.663	10.639
Block4:229Room3	4.002	7.957	24.653	12.818
Block4:230Room2	2.495	4.281	17.988	4.737
Block5:231Room4	2.134	3.261	19.234	3.335
Block6:232Room5	1.949	4.207	22.996	6.451
Block7:233Room8	0.000	10.404	38.854	57.808
Block8:236Room	0.044	1.096	0.484	0.526
Block9:235Room	0.000	0.221	0.035	0.036
Block10:239Room9	4.719	13.236	-0.672	23.101
237Room6:237Room6	21.967	-0.002	-3.517	0.452
238Room7:238Room7	23.916	0.001	17.393	0.383
Analysis Summary	65.730	59.486	107.567	121.281
ntitled, Building 1 Analysis Summary Zone	_	59.486	People Gains (kW)	Solar Gains (kW)
ntitled, Building 1 Analysis Summary Zone Building 1	Electric Equipment Ga	ns Lighting Gains (kW)	People Gains (KW)	Solar Gains (KW)
ntitled, Building 1 Analysis Summary Zone Building 1 Block1:2192	Electric Equipment Gai	ns Lighting Gains (KW)	People Gains (KW)	Solar Gains (kW) 0.000
ntitled, Building 1 Analysis Summary Zone Building 1 Block1:2192 Block2:2202	Electric Equipment Ga 0.138 0.194	ns Lighting Gains (KW) 0.235 0.329	People Gains (KW) 0.089 0.125	Solar Gains (KW) 0.000 0.000
ntitled, Building 1 Analysis Summary Zone Building 1 Block1:2192 Block2:2202 Block3:227Room	Electric Equipment Ga 0.138 0.194 24.553	ns Lighting Gains (kW) 0.235 0.329 31.826	People Gains (KW) 0.089 0.125 15.953	Solar Gains (KW) 0.000 0.000 10.227
ntitled, Building 1 Analysis Summary Zone Building 1 Block1:2132 Block2:2202 Block2:2207 Block4:229Room3	Electric Equipment Ga 0.138 0.194 24.553 15.161	ns Lighting Gains (KW) 0.235 0.329 31.826 13.910	People Gains (KW) 0.089 0.125 15.853 9.789	Solar Gains (KW) 0.000 0.000 10.227 11.151
ntitled, Building 1 Zone Blouking 1 Block1:2132 Block2:2202 Block2:220Room Block4:230Room2	Electric Equipment Gal 0.138 0.194 24.553 15.161 9.889	ns Lighting Gains (KW) 0.235 0.329 31.826 13.910 11.632	People Gains (kW) 0.089 0.125 15.853 9.789 6.385	Solar Gains (kW) 0.000 0.000 10.227 11.151 4.052
ntitled, Building 1 Analysis Summary Zone Building 1 Block 12192 Block 2202 Block 2207Room Block 4229Room2 Block 4229Room2 Block 5231Room4	Electric Equipment Gat 0.138 0.194 24.553 15.161 9.889 10.048	0.235 0.329 31.826 13.910 11.632 12.651	People Gains (kW) 0.089 0.125 15.853 9.789 6.385 6.488	Solar Gains (kW) 0.000 0.000 10.227 11.151 4.052 3.879
Analysis Summary Zone Building 1 Block 1:2192 Block 2:2202 Block 2:22Room Block 4:228Room2 Block 4:23Room4 Block 5:23Room4 Block 5:23Room5	Electric Equipment Ga 0.138 0.134 24.553 15.161 9.689 10.048 13.957	ns Lighting Gains (KW/) 0.235 0.239 31.826 13.910 11.632 12.651 15.263	People Gains (KW) 0.099 0.125 15.853 9.799 6.385 6.488 9.012	Solar Gains (KW) 0.000 0.000 10.227 11.151 4.052 3.879 8.215
Artitled, Building 1 Analysis Summary Zone Building 1 Block1:2182 Block2:2202 Block3:227Rom Block4:230Rom3 Block4:230Rom4 Block5:231Rom4 Block5:233Rom5 Block7:233Rom8	Electric Equipment Ga 0.138 0.194 24.553 15.161 3.669 10.048 13.957 23.957 23.952	ns Lighting Gains (kW/) 0.235 0.329 31.826 13.910 11.632 12.651 15.263 40.717	People Gains (KW) 0.099 0.125 15.653 9.789 6.385 6.488 9.012 15.472	Solar Garis (k.V/) 0.000 0.000 10.227 11.151 4.052 3.879 8.215 0.000
Tritted, Building 1 Analysis Summary Zone Jaulding 1 Block1.2192 Block2.2202 Block3.227Room Block3.227Room Block3.237Room Block5.237Room Block5.237Room Block5.237Room Block5.237Room	Electric Equipment Gar 0.138 0.194 24.553 15.161 9.869 10.048 13.957 23.962 0.224	ns Lighting Gains (KW) 0.235 0.329 31.836 13.910 11.632 12.651 15.263 15.263 40.717 0.162	People Gains (kw) 0.089 0.125 15.853 9.789 6.385 6.488 9.012 15.472 0.145	Selar Gains (KW) 0.000 10.227 11.151 4.052 3.879 8.215 0.000 0.070
Initiang         Initiang         Initiang           Zone         Zone         Zone           Buding         Block 200         Statistics           Block 2202         Block 3227Room         Stock 4298 Room 3           Block 2320Room 2         Block 2320Room 4         Stock 6238Room 5           Block 2320Room 5         Block 2320Room 5         Block 2280Room 5           Block 2280Room 5         Block 2280Room 5         Block 2280Room 5	Electric Equipment Ga 0.138 0.134 24 553 15.161 3.989 10.046 13.957 23.952 0.224 0.016	Lighting Geins (kW) 0.225 0.329 31.826 13.910 11.632 12.651 15.263 40.717 0.162 0.025	People Gains (kW) 0.089 0.125 15.853 3.789 6.385 6.488 9.012 15.472 0.145 0.000	Solar Gant (kw)           0.000           0.000           10.227           11.151           4.052           3.879           8.215           0.000           0.070           0.000
Tritted, Building 1 Analysis Summary Zone Jaulding 1 Block1.2192 Block2.2202 Block3.227Room Block3.227Room Block3.237Room Block5.237Room Block5.237Room Block5.237Room Block5.237Room	Electric Equipment Ga 0 138 0 134 24 553 15 161 9 683 10 048 13 357 23 952 2 3952 0 224 0 016 2 25 434	ns Lighting Gains (KW) 0.235 0.329 31.836 13.910 11.632 12.651 15.263 15.263 40.717 0.162	People Gains (kw) 0.089 0.125 15.853 9.789 6.385 6.488 9.012 15.472 0.145	Selar Gains (KW) 0.000 10.227 11.151 4.052 3.879 8.215 0.000 0.070
Initiang         Initiang         Initiang           Zone         Zone         Zone           Buding         Block 200         Statistics           Block 2202         Block 3227Room         Stock 4298 Room 3           Block 2320Room 4         Block 2320Room 5         Block 2280Room 5           Block 2320Room 5         Block 2280Room 5         Block 2280Room 5           Block 2280Room 5         Block 2280Room 5         Block 2280Room 5	Electric Equipment Ga 0.138 0.134 24 553 15.161 3.989 10.046 13.957 23.952 0.224 0.016	Lighting Geins (kW) 0.225 0.329 31.826 13.910 11.632 12.651 15.263 40.717 0.162 0.025	People Gains (kW) 0.089 0.125 15.853 3.789 6.385 6.488 9.012 15.472 0.145 0.000	Solar Gant (kw)           0.000           0.000           10.227           11.151           4.052           3.879           8.215           0.000           0.070           0.000
Initian         Building 1           Analysi         Summary           Zone         Bioch 2           Bioch 2202         Bioch 2278 com           Bioch 2278 com         Bioch 4228 com           Bioch 2278 com         Bioch 2278 com           Bioch 2287 com         Bioch 2287 com           Bioch 2287 com         Bioch 2287 com           Bioch 2287 com         Bioch 2287 com           Bioch 102287 com         Bioch 10287 com	Electric Equipment Ga 0 138 0 134 24 553 15 161 9 683 10 048 13 357 23 952 2 3952 0 224 0 016 2 25 434	Lighting Gane (KW)           0.235           0.329           31.826           13.910           11.632           12.651           15.633           40.717           0.162           0.026           25.425	People Gains (AW) 0.093 0.125 15.653 9.798 6.488 9.012 15.472 0.145 0.010 16.423	Solar Game (IAW)           0.000           0.000           10.227           11.151           4.052           3.873           8.215           0.000           0.000           0.000           11.752

Fig. 16. The thermal energy gained in this case without insulation of internal spaces through windows, ceilings, walls and floors

#### Output data:

*Cooling design:* In-building energy consumption rate in the summer months (July-August-September).

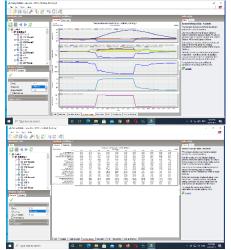


Fig. 18. In-building energy consumption rate in the summer months (July-August-September) in the program

## Cooling energy consumption rates in internal spaces:

The rate of energy consumption in the interior of all parts of the building in this case without adding any insulation materials:

• Total Cooling = 1257.51kW.

The total energy consumed in cooling operations in the summer months (July-August-September) is within the building's spaces as described in (Fig. 19), (Fig. 20).

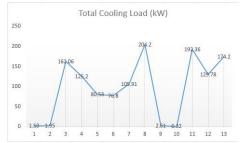


Fig. 19. Details cooling energy consumption rates of the condition with the insulation layer used nanotechnology (aerogel and Nano Mineral Fibers) within the interior spaces

Zone	Design Capacity (kW)	Design Flow Rate (m3/s)	Total Cooling Load (kW)	Sensible (kW)
Building 1				
Block1:2192	1.83	0.1227	1.59	1.53
Block:2:2202	2.24	0.1511	1.95	1.88
Block3:227Room	186.37	12.5037	162.06	155.87
Block4:229Room3	143.98	9.6823	125.20	120.70
Block4:230Room2	92.61	6.2264	80.53	77.62
Block5:231Room4	88.32	5.9246	76.80	73.86
Block6:232Room5	121.80	8.1728	105.91	101.88
Block7:233Room8	234.82	15.7990	204.20	196.95
Block8:236Room	3.01	0.2010	2.61	2.51
Block9:235Room	0.37	0.0252	0.32	0.31
Block10.239Room9	221.21	14.8592	192.36	185.23
237Room6:237Room6	149.25	9.9921	129.78	124.56
238Room7:238Room7	200.33	13.4095	174.20	167.16
Totals	1446.14	97.0696	1257.51	1210.05

Fig. 20. Cooling the state's energy consumption rates with the isolation layer used by nanotechnology (aerogel and Nano Mineral Fibers) within internal spaces.

Zone	Glazing Gains (kW/)	Wall Gains (kW)	Floor Gains (kW)	Roof and Ceiling Ga
Building 1				
Block1:2192	0.000	0.604	0.139	0.110
Block2:2202	0.000	0.359	0.129	0.114
Block3:227Room	2.907	6.754	-28.045	5.231
Block4:229Room3	2.806	4.397	6.750	3.457
Block 4:230Room2	1.563	2.433	4.518	1.678
Block5:231Room4	1.450	1.808	4.892	2.515
Block6:232Room5	1.650	2.275	5.578	1.905
Block7:233Room8	0.000	6.700	11.759	9.998
Block8.236Room	0.017	1.062	0.150	0.108
Block9.235Room	0.000	0.210	0.011	0.007
Block10:239Room9	3.279	6.657	-1.830	4.688
237Room6:237Room6	16.389	0.004	4.983	-0.212
238Room7:238Room7	16.765	0.004	-1.510	-0.102
Totals ntitled, Building 1 Analysis Summary	46.825	33.269	-2.443	29.497
ntitled, Building 1 Analysis Summary				
ntitled, Building 1 Analysis Summary Zone		33.269	People Gains (KW)	29.497 Solar Gains (kW)
ntitled, Building 1 Analysis Summary Zone Building 1	Electric Equipment Gair	ns Lighting Gains (kW)	People Gains (Kw)	Solar Gains (kW)
ntitled, Building 1 Analysis Summary Zone Building 1 Block1:2192	Electric Equipment Gair 0.130	ns Lighting Gains (KW/) 0.221	People Gains (kW)	Solar Gaine (I/W/) 0.000
ntitled, Building 1 Analysis Summary Zone Building 1 Block1:2192 Block22202	Electric Equipment Gair 0.130 0.194	ns Lighting Gains (KW/) 0.221 0.329	People Gains (KW) 0.084 0.125	Solar Gains (KW) 0.000 0.000
ntitled, Building 1 Analysis Summary Building 1 Block1:2192 Block2:2202 Block3:227Room	Electric Equipment Gair 0.130 0.194 24.381	ns Lighting Gains (kW) 0.221 0.329 35.839	People Gains (k\v/) 0.084 0.125 15.743	Solar Gaine (I.W) 0.000 0.000 3.346
ntitled, Building 1 Analysis Summary Zone Building 1 Block1:2192 Block2:2202 Block2:227Room Block4:229Room3	Electric Equipment Gain 0.130 0.194 24.381 15.161	ns, Lighting Gains (kW/) 0.221 0.329 35.839 19.467	People Gaine (kw/) 0.084 0.125 15.743 9.789	Solar Gaine (kW) 0.000 0.000 3.346 3.243
ntitled, Building 1 Analysis Surmary Zone JBuilding 1 Block1:2192 Block2:2202 Block2:2207 nom Block4:220R com2 Block4:230R com2	Electric Equipment Gair 0.130 0.194 24.301 15.161 3.809	<ul> <li>Lighting Gains (KW)</li> <li>0.221</li> <li>0.329</li> <li>35.639</li> <li>19.467</li> <li>13.206</li> </ul>	People Gains (KW) 0.084 0.125 15.743 9.799 6.395	Solar Gaine (KW) 0.000 0.000 3.346 3.243 1.591
ntitled, Building 1 Zone Building 1 Block1:2192 Block2:2202 Block2:227Room Block2:227Room Block2:227Room3 Block4:229Room3 Block5:231Room4	Electric Equipment Gair 0.130 0.194 24.381 15.161 9.889 9.899 9.364	nz Lighting Gains (kW) (0.221 (0.329 35.839 19.467 13.206 14.228	People Gains (Kw) 0.084 0.125 15.743 9.799 6.385 6.434	Solar Gaine (I.W) 0.000 0.000 3.346 3.243 1.591 1.519
ntitled, Building 1 Anayas Summary Zone Block12192 Block122002 Block222002 Block222000 Block4229Room3 Block4229Room3 Block4229Room4 Block5223Room5	Electric E quipment Gali 0.130 0.194 24.381 15.161 3.989 3.954 13.957	<ul> <li>Lighting Gains (KW)</li> <li>0.221</li> <li>0.329</li> <li>35.039</li> <li>19.467</li> <li>13.206</li> <li>14.228</li> <li>19.795</li> </ul>	People Gains (Aw) 0.084 0.125 15.743 9.709 6.395 6.434 9.012	Solar Gaine (KW) 0.000 0.000 3.346 3.243 1.591 1.519 2.148
Intitled, Building 1 Samayac Jaulang 1 Block 12192 Block 22002 Block 2207Room Block 4208Room3 Block 2208Room3 Block 5208Room5 Block 2328Room5 Block 7238Room8	Electric Equipment Gair 0.130 0.134 24.391 15.161 9.899 9.964 13.957 23.952	<ul> <li>Lighting Game (kW)</li> <li>0.221</li> <li>0.329</li> <li>36399</li> <li>19.467</li> <li>13.266</li> <li>14.228</li> <li>19.795</li> <li>40.717</li> </ul>	People Gains (kW/) 0.084 0.125 15.743 9.789 6.385 6.434 9.012 15.472	Solar Gains (MW) 0.000 0.000 3.346 3.243 1.591 1.519 2.148 0.000
htitled, Btilding 1 Varyag Surmary Zone Block12192 Block22020 Block22202 Block2290cm3 Block42900m3 Block42900m3 Block423000m5 Block52310.0m4 Block52310.0m5 Block72330.0m5	Electric Equipment Gair 0.130 0.134 0.4.39 15.161 9.069 9.364 13.957 23.962 0.224	<ul> <li>Lighting Gains (kW)</li> <li>0.221</li> <li>0.329</li> <li>35.039</li> <li>19.467</li> <li>13.206</li> <li>14.228</li> <li>19.795</li> <li>40.717</li> <li>0.269</li> </ul>	People Gains (kW) 0.064 0.125 1.5,74.3 9.769 6.365 6.434 9.012 1.5.472 0.145	Solar Gains (I/W) 0.000 0.000 3.346 3.243 1.591 1.519 2.148 0.000 0.025
httled, Building 1 kadya Surmary Zoni Bioki 2019 Bioki 2020 Bioki 22270 cm Bioki 22270 cm Bioki 22370 cm Bioki 22370 cm Bioki 22370 cm Bioki 22370 cm Bioki 22360 cm	Electric Equipment Gail 0.130 0.134 24.301 15.161 9.089 9.964 13.967 23.962 0.224 0.016	<ol> <li>Lipiting Game (kW)</li> <li>0.221</li> <li>0.329</li> <li>58.03</li> <li>13.467</li> <li>13.206</li> <li>14.228</li> <li>13.795</li> <li>40.717</li> <li>0.269</li> <li>0.005</li> </ol>	People Gains (kw) 0.084 0.125 0.375 0.365 0.365 0.365 0.365 0.302 15.472 0.145 0.010	Solar Gains (Mw) 0.000 0.000 0.243 1.591 1.591 1.519 2.148 0.000 0.025 0.000
Ititled         Brilding         1           Valya         Summary         2           Bouling         Book         2           Book         2         2           Book         2         2         2           Book         2         2         2         2           Book         2         2         3         3         3           Book         2         3	Electric Equipment Gali 0.130 0.134 0.134 15.161 13.939 3.9364 13.957 23.952 0.224 0.016 5.5434	<ul> <li>Liphtrog Gains (kW)</li> <li>0.221</li> <li>0.229</li> <li>36.829</li> <li>18.467</li> <li>13.266</li> <li>14.228</li> <li>19.795</li> <li>40.717</li> <li>0.269</li> <li>0.026</li> <li>33.171</li> </ul>	People Gains (KV) 0.084 0.125 15.743 3.769 6.365 6.454 9.012 11.6422 0.445 0.010 11.6423	Solar Gains (I/W)           0.000           0.000           3.346           3.243           3.243           1.551           2.148           0.000           0.000           0.025           0.000           3.889
httled, Building 1 kadya Surmary Zoni Bioki 2019 Bioki 2020 Bioki 22270 cm Bioki 22270 cm Bioki 22370 cm Bioki 22370 cm Bioki 22370 cm Bioki 22370 cm Bioki 22360 cm	Electric Equipment Gail 0.130 0.134 24.301 15.161 9.089 9.964 13.967 23.962 0.224 0.016	<ol> <li>Lipiting Game (kW)</li> <li>0.221</li> <li>0.329</li> <li>58.03</li> <li>13.467</li> <li>13.206</li> <li>14.228</li> <li>13.795</li> <li>40.717</li> <li>0.269</li> <li>0.005</li> </ol>	People Gains (kw) 0.084 0.125 0.375 0.365 0.365 0.365 0.365 0.302 15.472 0.145 0.010	Solar Gain (Nw) 0.000 0.000 0.243 1.591 1.591 1.519 2.148 0.000 0.025 0.000

External thermal energy rates for internal vacuums:

Fig. 21. The thermal energy gained in this case is the presence of (Nano mineral fibers) in the roofs, walls, floors and (Aerogel) in the windows through the interior of the building

Rates of thermal energy consumption in force to internal spaces through architectural building elements (ceilings, exterior walls, windows and floors). During the summer months, it's clear:

- Glazing Gains and Solar Gains = 87.532 kW.
- Wall Gains = 33.269kW.
- Floor Gains = -2.443kW.
- Roof and Ceiling Gains = 29.497kW.

Compare the results of the study case simulation using materials before and after you used Nano technology:

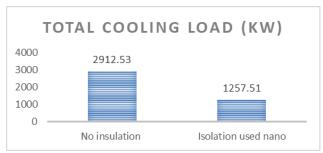
From previous results can be observed the extent of changes in the internal thermal environment of the external layers of the building of walls, ceilings and glass windows by the difference in energy consumed in cooling and the rates of passage of thermal energy to and from the external environment and consumption of electric power during the whole months of the year.

Energy consumed in refrigeration processes:

First case: No insulation (Status quo)

• Total Cooling =2912.53 kW.

Second case: By adding nanotechnology-modified insulation materials.



• Total Cooling = 1257.51kW.

Fig. 22. Comparison between energy consumed in refrigeration processes between studied cases

Thermal energy window through building elements: Comparison of thermal energy through windows: First case: No insulation (Status quo)

• Glazing Gains and Solar Gains = 186.269 kW. Second case: By adding nanotechnology-modified insulation materials.

• Glazing Gains and Solar Gains = 87.532 kW.

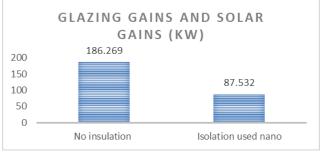


Fig. 23. Comparison of thermal energy through windows in areas of studied cases

Comparison of thermal energy through walls:

First case: No insulation (Status quo)

• Wall Gains = 62.975kW.

Second case: By adding nanotechnology-modified insulation materials.

• Wall Gains = 33.269kW.



Fig. 24. Comparison of thermal energy through walls in areas of studied cases

Comparison of the thermal energy that is in effect through the roofs:

First case: No insulation (Status quo)

• Roof and Ceiling Gains =129.942 kW.

Second case: By adding nanotechnology-modified insulation materials.

• Roof and Ceiling Gains = 29.497 kW.

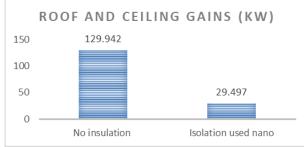


Fig. 25. Comparison of the thermal energy that is in effect through the roofs in the areas of studied cases

# Analysis of the results of the applied study: Energy results consumed in the cooling process:

• Achieving integrated nanomaterials with the outer shell the lowest scientific and applied recorded values of the values of the thermal transition laboratory (U-value), where cooling in the summer months is with nanomaterials 1257.51kW, and traditional insulation materials 2839.6kW, the cooling rate of Nanoinsulation materials reduced is much lower to 56.8%.

Window thermal energy results by roof and ceiling in studied cases:

• The power of the roof without insulation was 129,942 kW, and with the addition of Nano-insulation materials, the energy in force became 29,497 kW, as the energy in force through the roof reduced is in the case of the addition of nanomaterials 77.29%.

Window of thermal energy results through walls in studied cases:

• The window power from the walls without insulation

materials was 62.975kW, and with the addition of nanoscale insulation materials, the power in force became 33.269kW. Since the energy that is powered through the walls reduced, if nanomaterials are added, it's a percentage46.98%.

Window of thermal energy results through windows in studied cases:

• The power of the roof without insulation was 186,269 kW, and with the addition of Nano-insulation materials, the power in force was 87,532 kW, where the power that is in the window reduced is in case of the addition of nanomaterials, it is by53%.

# 4. Conclusion

The research aims to the importance of nanotechnology in the building and the areas of construction to activate the efficiency of buildings for an appropriate internal and external environment, (1) Nanotechnology allows us to move into new high value areas through new structures or traditional changes. (2) The connection between nanotechnology and architecture leads to a change in architectural thought and the emergence of new patterns of buildings. (3) The use of nanomaterial applications in the building from early design stages to the final finishing stages of the building leads to increased efficiency of the building. (4) Employing applications and nanomaterials in all parts of the building in analytical examples, the cover of the building and the internal and external environment that achieves sustainable standards. (5) Cooling in the summer months is with nanomaterials 1257.51kW, conventional insulation materials 2839.6kW. The cooling rate of nanoinsulation material reduced is much lower to 56.8%. (6) The energy from the roofs with the addition of nano-insulation materials is better, reducing by 77.29%. The power through the walls using nanomaterials is also 46.98% better. In openings and windows, they are 53% better at using nano-insulating materials.

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