ACTA TECHNICA CORVINIENSIS
– Bulletin of Engineering
Tome X [2017]
Fascicule 1 [January – March]
ISSN: 2067 – 3809

[1.]Kire POPOVSKI, [2.]Cvetanka MITREVSKA,
[3.]Vangelce MITREVSKI, [4.]Igor POPOVSKI

EXPECTED RESULTS FOR HEAT DEMANDS IN GLASS HOUSE SPACE, IF THE TRANSPARENT WALLS ARE COATED WITH A PROTECTIVE FILM

[1,3,4.] University "St. Kliment Ohridski", Faculty of Technical Sciences, Bitola, MACEDONIA
[2.] Internacional Slavic University Gavrilo Romanovic Derzavin, Faculty for Safety Engineering, Sveti Nikole, MACEDONIA

Abstract: This model explains the heat flow in a confined space with transparent walls (glass or plastic). A software is used to analyze the behavior of transparent walls coated with "LLumar" film. This film has many advantages, but in this paper, we will focus on energy savings. Energy savings give quick return on investment and are considered a smart investment. Energy-saving LLumar film can increase performance of almost every window system, significantly reducing energy consumption and requirements. Professional energy audits have shown that buildings with LLumar film can achieve annual energy savings of up to 15%, blocks 99% of harmful UV rays and improves comfort by reducing heat and glare. Regardless of whether it is residential, commercial or glass house space as described in this paper, LLumar the world's leading brand of architectural film for decades improves the well-known buildings around the world with proven results. LLumar films will greatly increase energy efficiency, appearance and functionality of glass partitions. The results are lower overhead expenses, increased comfort, improved privacy and better protection from accidents. Heat balance in glass house space is shown in the following pages.
Keywords: thermal resistance, glass wall, glass house, demand for heat

INTRODUCTION

Foil LLumar is a modern product for changing the characteristics of the transparent wall. Composing various elements in the structure of the foil, the manufacturer offers solutions to several problems that occur anywhere where glass partitions are used. For example, in construction, the effect of increasing the aesthetic value of the glass and protection against external views and provide a foil widely used as modern architectural material.

The main benefit of using LLumar foil is energetic efficiency. Dual layer wall foil - glass has brand new thermal characteristics compared to the mono slice transparent wall. With the addition of the foil, it controls the quality and quantity of energy flow through the transparent wall. With this, the glass gets new energy role, and the closed space new microclimate features.

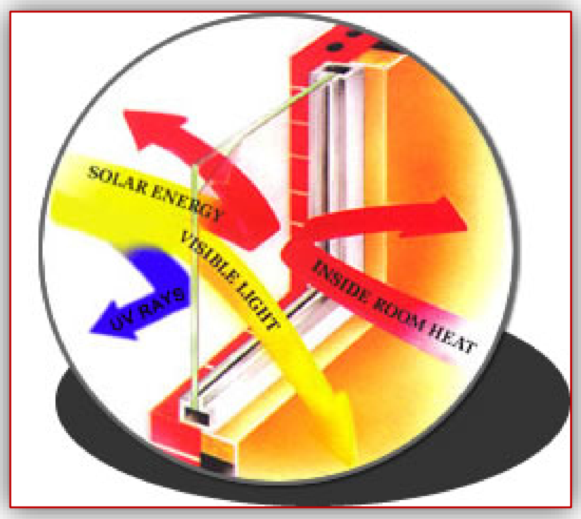

Figure 1. Foil LLumar for the transparent wall [6]

DESCRIPTION OF THE COMPUTER PROGRAM

The computer program to calculate the heat flow through transparent walls requires prior preparation, [3]. It consists of shaping the input data file, the day time, air temperature, air relative humidity, moisture contained in the air density of the air, air speed, intensity of solar radiation. The state of indoor air selects the user program. The used data is related to the city of Bitola (Macedonia) and placed in the file "LOTUS".

Once you take the input values into account the program goes on to calculate the following: coefficients of heat transfer, temperatures of transparent walls and heat flows. The calculation is repeated for every hour of the day and the output values are registered.

Table 1. Hourly data for external and internal conditions, temperature of: transparent wall on the inside and outside and heat needs for February, [1], [3], [4].

Hour	t_{vn} °C	φ_{vn} %	vn m/s	Fsz W/m²	t_{vv} °C	t_{zv} °C	t_{zn} °C	Q W
1	-1	85	2.3	0	16	7	1	20786
2	-1	85	2.3	0	16	7	1	20786
3	-1	85	2.3	0	16	7	1	20786
4	-1	85	2.5	0	16	7	1	20885
5	-1	85	2.5	0	16	7	1	20885
6	-1	85	2.3	0	16	7	1	20786
7	-1	85	2.3	8	19	9	3	22384
8	-1	85	2.3	185	23	11	1	25126
9	0	85	2.5	385	23	16	5	16005
10	1	83	2.5	449	23	16	3	15733
11	2	80	3.0	509	23	17	3	15339
12	3	75	3.0	528	23	18	4	13288
13	3	70	3.5	543	23	20	6	11225
14	4	70	4.0	524	23	18	5	13733
15	4	70	3.5	486	23	19	6	12476
16	4	70	3.5	430	23	18	6	13946
17	3	70	3.0	192	23	14	4	22036
18	3	75	2.5	0	19	10	4	21282
19	2	77	2.5	0	16	9	6	16035
20	1	80	2.5	0	16	9	6	16027
21	1	80	2.5	0	16	9	6	16027
22	0	80	2.5	0	16	6	1	20920
23	0	85	2.5	0	16	6	1	20844
24	0	85	2.5	0	16	6	1	20844
Total								438183

The hourly data is taken over a period from 1967 to 1976. This data exists for every month and every hour, and in Table 1 the average values for this period are being considered. These values exist for the whole period of growth (from September until May) of the culture (in this case a tomato) in a greenhouse. February is just taken as an example so we can give a presentation which is shown in Table 1, [1], [3], [4].

With these values you can calculated the amount of heat you need for a year, Table 2. These examples relate to a specific transparent wall.

Table 2. Heat needs for one heating season for structures with an area of 208 m² and a volume of 613 m³ dual hard plastic wall with air layer 15 mm, [2], [3]

Month	Q Wh/month
9	-9241140
10	2111937
11	5008170
12	7923290
1	14110022
2	12269124
3	11449974
4	8616300
5	5473081
6	2383110
Total	60103868

An example of calculations for heat need at different transparent walls is given in Table 3.

When we assume that the same structures are protected by a glass partition that has a thermal resistance of 0.01 m²K/W and we glue LLumar foil on it, it changes the transparency of the plastic wall. Different films have different transparency, and therefore the heat needs are different. We have no further calculations for walls made out of different materials, other than plastic.

Table 3. Thermal resistance and annual heat needs for different kinds of transparent walls for structures with an area of 208 m² and a volume of 613 m³, [3], [5], [6]

Material for transparent walls	R m2K/W	Q MWh/year
Single plastic wall thickness 1 mm	0.01	127
Dual plastic walls with air space between walls:		
– 5 mm	0.08	100
– 12 mm	0.15	81
Dual hard plastic walls with air space between walls:		
– 6 mm	0.09	98
– 12 mm	0.11	92
– 15 mm	0.24	60

In Table 4 the heat needs for February with transparency of 10-90% are presented, while in the Table 5 the annual heat needs for the heating season with varying transparency are presented.

Table 4. Heat needs in February for a different transparency walls, [2], [3].

Transparency %	Q W
10	1300583
20	1274131
30	1247680
40	1221229
50	1194777
60	1168326
70	1141875
80	1115423
90	1088972

Table 5. Annual heat needs for different transparency walls, [2], [3].

Transparency %	Q W
10	6734351
20	6453539
30	6172726
40	5891914
50	5611101
60	5330289
70	5049476
80	4768663
90	4487851

CONCLUSIONS

LLumar foils, which already have commercial level achieved: venting the sunshine of 10-90%, reflecting the sun's rays by 10-50% and absorption of sunlight by 30-60%. Composition of the foil is determined by the required barrier properties that are specified by designers. The foil is used for setting new glass areas and for already completed projects as a corrector of the condition. The foil is mounted by gluing (pressed or water) on the outside or inside of the transparent wall according to function, to reject or retain the sun's rays, thereby, to reduce or retain heat inside the building.

NOMENCLATURE

F_{sz} W/m^2 - intensity of solar radiation
R m^{2}K/W - thermal resistance
Q W - demand for heat
t_{vn} ^{o}C - external air temperature
t_{vv} ^{o}C - internal air temperature
t_{zv} ^{o}C - temperature inside of the transparent wall
t_{zn} ^{o}C - temperature outside of the transparent wall
v_n m/s - speed of wind
φ_{vn} % - relative humidity of the external air

Note
This paper is based on the paper presented at The VIth International Conference Industrial Engineering and Environmental Protection 2016 – IIZS 2016, organized by University of Novi Sad, Technical Faculty "Mihajlo Pupin" Zrenjanin, in Zrenjanin, SERBIA, October 13–14, 2016, referred here as [8].

References

[1] Weather foundation for the stack of T.E. Bitola (2 x 210 MW) RHMS, Skopje, Macedonia, 1978.
[2] 2011 ASHRAE HANDBOOK HVAC Applications SI Edition Supported by ASHRAE Research, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 1791 Tullie Circle NE, Atlanta, GA 30329-2305, USA, 2011.
[3] Popovski, K., Empirical model of heat flows in glass house space, Master Thesis, Faculty of Mechanical Engineering, Skopje, Macedonia, 1993.
[4] Temperature Reporting, RHMS, Skopje, Macedonia, 2016.
[5] http://www.cacfolija.ba/karakteristike/12-folija-za-objekte.
[6] http://www.llumar.ba/epuletfolia.html
[7] Pekez, J., Radovanović, Lj., Desnica, E., Lambić, M., Increase of exploitability of renewable energy sources, Energy Sources, Part B: Economics, Planning, and Policy, vol.11, no. 1, 2016., pp. 51-57
[8] Kire Popovski, Cvetanka Mitrevska, Vangelce Mitrevski, Igor Popovski, Expected results for heat demands in glass house space, if the transparent walls are coated with a protective film, The VIth International Conference Industrial Engineering and Environmental Protection 2016 – IIZS 2016, Zrenjanin, SERBIA, 2016

ISSN:2067-3809