

PAYBACK PERIOD CALCULATION FOR VACUUM INSULATION PANELS MADE WITH CHEAPER ALTERNATIVE MATERIALS

Umer Akram¹, Sajid Kamran¹, Hafiz Zeeshan Ahmed¹

¹ Department of Mechanical Engineering, University of Engineering and Technology, Lahore, Pakistan.

umer089@gmail.com

ABSTRACT: Vacuum Insulation Panels is the most efficient insulation means available nowadays. However, the only factor that puts limit to its use is higher cost[1]. This study is aimed to have a calculation for integration of advanced insulation technique (VIP) according to construction and costing standards used in Pakistan. A room has been taken as for reference and cooling load calculations. On the basis of cooling load required, initial costing of individual cross-sections and billing estimation, the payback period has been calculated which comes out to be 2 years approximately. This provides not only a significant energy cost reduction, but also the human thermal comfort zone maintained over a wide range of temperature variations. Hence employing such an insulation with thermal conductivity as low as 0.003 W/m.K can be extremely beneficial.

Key words: Economics, Payback Period, Costing, Vacuum Insulation Panels, VIP, Insulation

1. INTRODUCTION

Vacuum Insulation Panels are among the most efficient insulation solutions nowadays. With a thermal conductivity as low as 0.003 W/m.K, VIPs can be extremely beneficial for thermal insulation[2]. VIPs consists of a specially manufactured silica core having a very low thermal conductivity, which is provided with an external protective panel to protect the core from any possible damage or permeation of moisture into the core material which can increase the value of thermal conductivity [3]. A conventional VIP has been shown in Figure 1[4].

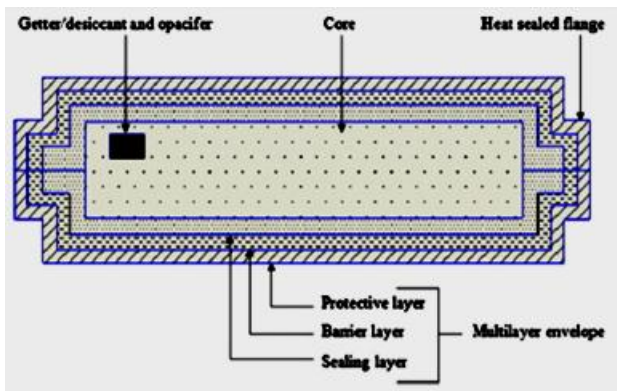


Figure 1 : Schematic Figure of VIP

Economics for integrating VIP according to local standards in Pakistan has been observed. This includes the initial costing of RCC room constructions and the VIP room construction according to local costing, and the difference between cooling loads resulting by implementation of both, hence the energy consumption by both and finally the Payback period of implementing VIP in rooms. This gives an approximate idea of what difference will it make to use VIP construction locally as far as the economics are concerned. A conventional room with dimensions in feet has been taken for the required calculations. This room measures 12x12.5 square feet, and has one single pan window and two doors. This room has been shown in Figure 2.

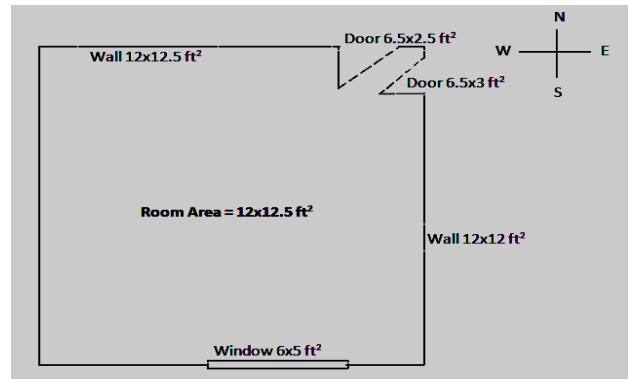


Figure 2 : Room For Cooling Load Calculations

These calculations include:

1. Cooling Load calculations.
2. Initial Costing.
3. Electricity Consumption.
4. Payback Period of conventional VIP Insulation.
5. Payback Period of suggested VIP Insulation.

2. Cooling Load Calculations

The Cooling Load calculations have been taken from the books on HVAC by authors Edward G. Pita[5] and Stocker & Johns[6]. Some R-values have been taken via weblinks. The purpose was to have a look at the difference that VIP Insulated Room makes as compared to conventional RCC room as far as the energy consumption is concerned. The cooling load caused by Walls, Roof, Doors and window has been calculated for both rooms.

Following are the results of calculations made:

Cooling Load for conventional room with RCC roofing = 13923.412 Btu/hr.

Cooling Load For VIP Insulated room = 3730 Btu/hr.

Difference = 10193.412 Btu/hr.

3. Initial Costing

By the use of standard data of Punjab Works Department (PWD) including labour, transportation, etc., the initial costs of both the rooms has been estimated by the Standards of costs of material and Labour (MRS-Lahore0115 & Labour-0115)[7] in Lahore, Pakistan provided by Punjab Works Department. The conventional RCC room's initial can directly be taken from the standard data, however, for VIP

the costs of individual materials, Panel, labour and transportation has been added. The difference between the initial costs of two room has been calculated. This difference value can be helpful towards estimating the Payback period of VIP Insulated Rooms. Following results have been observed:

Conventional RCC Room = Rs. 84990 approximately.

VIP Insulated Room = Rs. 2,86,341.6 approximately.

Difference = Rs. 2,01,351.6.

4. Electricity / Energy Consumption Costs (Annual)

After initial costing, the average annual energy consumption costs in local residential buildings have been estimated by the annual billing data of 5 residential buildings in Lahore.

- a) 10 Marla house : 473-E Block Sabzazar.
- b) 1 Canal house : 26-F Block Sabzazar.
- c) 10 Marla house : 265-F Block Sabzazar.
- d) 10 Marla house : 271-K Block Sabzazar.
- e) 5 Marla house : 53-L Block Sabzazar.

The average billing fraction corresponding to 1 ton has been taken and average is calculated. This average gives us the electricity consumption costs for 1 ton cooling load for conventional rooms with RCC roofing. For the estimation of annual cost for VIP Insulated room, ratio of 1/3.8 has been applied to conventional room cost from the knowledge of cooling load for both rooms (i.e. cooling load of conventional room / cooling load of VIP insulated room = 3.8). The following results have been observed:

Conventional RCC Room = Rs. 66133.354 approx.

VIP Insulated Room = Rs. 17403.514 approx.

Difference = Rs. 48729.84 per year.

5. Payback Period of Conventional VIP Insulation

Payback period is important because we need to know how long it will take to payback the initial expenses for implementation of Vacuum Insulation Panels (VIP) as it was relatively much expensive as compared to conventional room. Payback Period defined as the duration required for the payback of initial cost of implementing a certain technique (VIP). For this case, the difference in initial costing of two rooms is to be paid back by lower energy costs of VIP insulated room over a specified period of time. Hence it will be the ratio of Difference in initial costing to the difference in annual energy costs i.e.

Payback Period = Difference in initial costing / Difference in Energy costs.

$$= 2,01,351.6 / 48,729.84$$

$$= 4.132 \text{ Years.}$$

Hence it can be seen that in 4 years and 2 months approximately, the initial extra expenditure will be paid back and after that VIP insulation is only an added advantage for the rest life of the building.

6. Payback Period of Conventional VIP

Initial Cost of Conventional RCC Room = Rs. 84990 approximately.

Initial Cost of Suggested VIP Insulated Room = Rs. 1,86,121.65 approximately.

Difference = Rs. 1,01,131.65.

Payback Period for Suggested VIP with Alternative Materials = Difference in initial costing / Difference in Energy costs.

$$= 101,131.65 / 48,729.84$$

$$= 2.0753 \text{ Years.}$$

Hence expenditure has been further lessened, decreasing payback period up to 2 years and 1 month approximately. This alternative VIP can be a great choice to use as efficient insulation means.

7. CONCLUSIONS:

Calculations have been for integration of advanced insulation technique (VIP) according to construction and costing standards used in Pakistan. A room has been taken as for reference and cooling load calculations have been carried out. On the basis of cooling load required, initial costing of individual cross-sections and billing estimation, the payback period has been calculated which comes out to be 2 years. This provides not only significant energy cost reduction but also the human thermal comfort zone maintained over a wide range of temperature variations.

As far as the economics are concerned, the initial costs for integrating VIP in local buildings are higher, but implementation of this technique pays back in just 2 years. This means that after this period VIP implementation is only an added advantage. Also during this period the electricity costs will be substantially lower and thermal comfort zone is consistently maintained. The concept of such energy-efficient buildings in Pakistan will help decreasing the overall energy demand which will contribute towards lowering the energy crises. Hence such advanced insulation techniques can prove to be extremely beneficial if implemented in Pakistan.

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