

The Green Logistics Idea Using Vacuum Insulation Panels (VIPs) For Freezer Logistics Box in Normal Truck

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ARTICLE INFO

ABSTRACT

Article history:

Received 24 July 2020

Received in revised form 31 August 2020

Accepted 9 September 2020

Available online 14 November 2020

This research presents the green logistics using vacuum insulation panels (VIPs) for freezer logistics box in normal trucks. The materials were Vacuum Insulation Panels (VIPs) with polyurethane foam box compared to polyurethane foam box that thermal conductivity for polyurethane foam and Vacuum Insulation Panels (VIPs) at > 20 and < 7 mW/m.K. The vacuum Insulation Panels (VIPs) with polyurethane foam box design with VIP inside the polyurethane foam protect some impact from losing vacuum that loss thermal resistance. According to the result, after 24 hours, the ice-cream temperature of polyurethane foam box that lost 6 Degree Celsius, calculated as 30.00%. Besides, the ice-cream temperature of that vacuum Insulation Panels (VIPs) with a polyurethane foam box has lost 1.5 Degrees Celsius, counted as 7.5%, and compared with stating temperature at -20 Degrees Celsius. The result represents ice-cream quality after testing that shows the ice-cream condition in VIP Box still freezing, and ice cream condition in the normal box is melt. This research can be applied to a cold room or freezer room in supermarkets, factories, distribution centers, and VIPs that can result from electricity saving for compressors or cold trucks and freezer trucks that can get the result of fuel-saving for engines.

Keywords:

VIP, logistics box; green logistics;
environmentally friendly

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1. Introduction

Refrigeration accounts for 15% approximately of the total energy consumption in a household, consuming 6% of the total electrical energy produced worldwide [1-2]. Heat gain load has a significant load at 57 % from total in the refrigerator, as shown in Figure 1 [3] implies the effect of power computation of the refrigeration system. The best options for reducing energy consumption are high energy efficiency and an efficient energy-management system [4]. An excellent example of energy savings in refrigeration systems is shown in the figure below [5]. Energy savings in refrigeration

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<https://doi.org/10.37934/araset.21.1.1521>

systems can be achieved through decreased power consumption of the compressor, as this is the component that utilizes the most energy [6]. Vacuum Insulation Panels (VIPs) used to reduce heat gain load and get energy saving for refrigeration system 21% by installing VIPs 56% from total coverage area refrigerators [7-8].

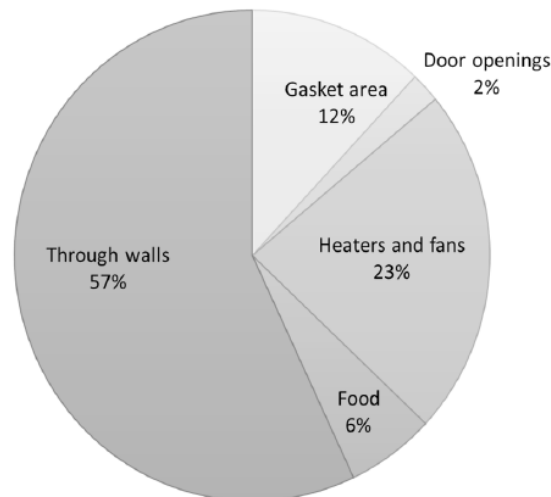


Fig. 1. Heat gain areas in refrigerator [3]

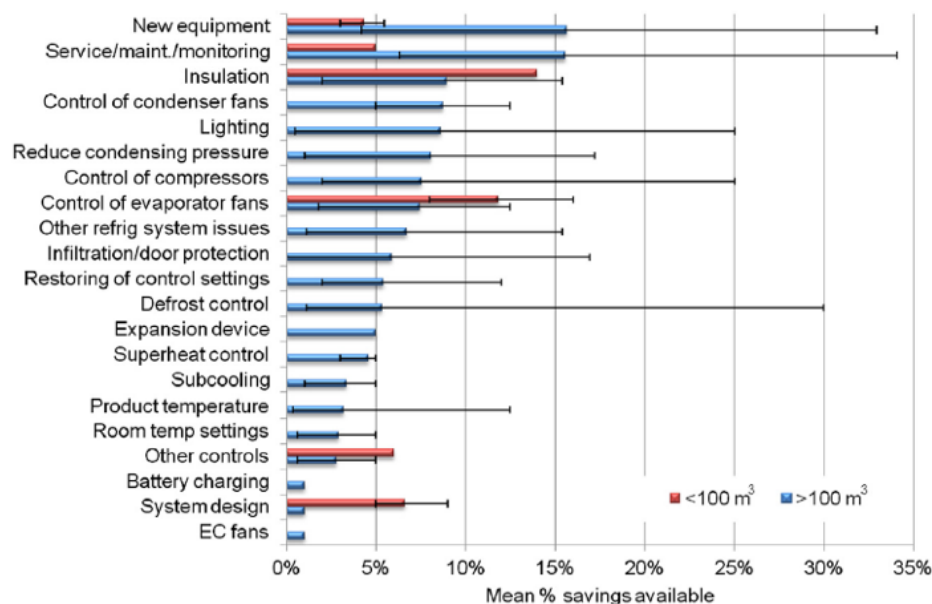


Fig. 2. Examples of energy savings in refrigeration systems [4]

Nowadays, the logistics model uses a frozen truck with the temperature at -25 to -23 degrees celsius, chiller trucks 0 to -2 degrees from the factory to the distribution center, and end-user. The type and size of trucks in this model will differ from length to the destination or product type [9-10]. When using many types or many trucks, the cost will be high and difficult to control. The green logistics model happens to solve the effect of environmental from logistics, such as fuel in logistics and carbon dioxide from engines [11-12]. This research will present the idea of the green logistics using vacuum insulation panels (VIPs) for freezer logistics box in a normal truck that use vacuum insulation panels (VIPs) that u-value better than polyurethane foam 80% as shown in Figures 3 and 4 [13-14]. The green logistics model can only use with normal trucks by use VIPs box and cooling supply

by the cold pack or freezer pack because it can save the expenditure of freezer trucks and normal trucks [15-16].

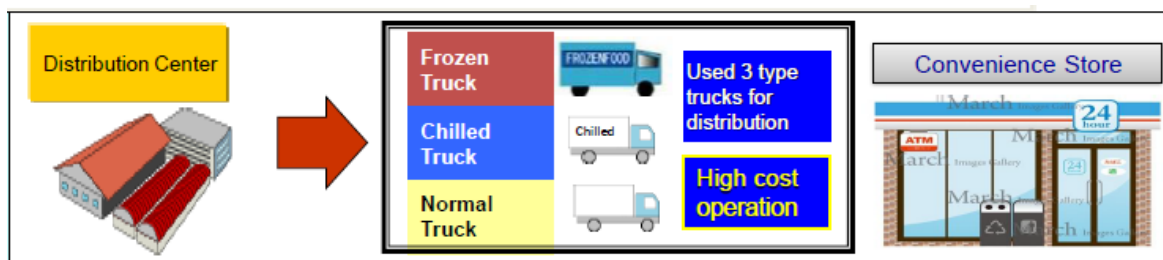


Fig. 3. Current Logistics model

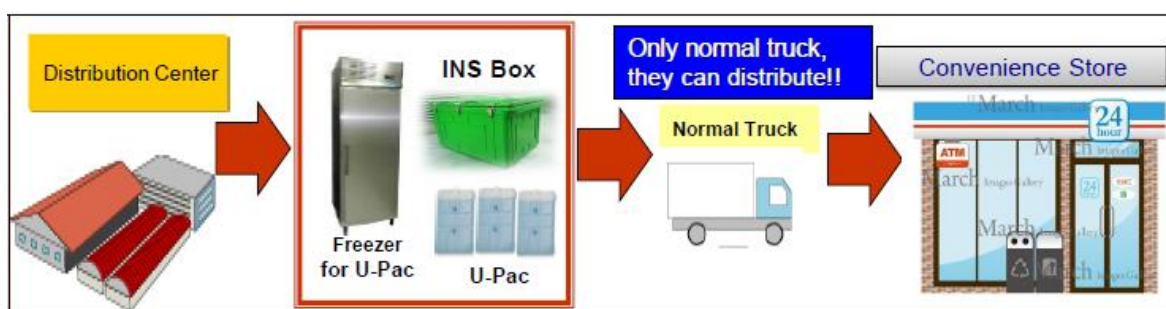


Fig. 4. Green Logistics model

2. Materials and Methods

The materials were vacuum Insulation Panels (VIPs) with polyurethane foam box comparing with polyurethane foam box that thermal conductivity for polyurethane foam and Vacuum Insulation Panels (VIPs) at > 20 and < 7 mW/m.K [17], respectively. Besides, the IPs insulation was better as showing the thermal conductivity of insulation in Figure 5 below. The vacuum Insulation Panels (VIPs) with polyurethane foam box design helps to protect some impact from losing vacuum that loss thermal resistance, as shown in Figure 6 below. Therefore, The VIPs box design should keep the temperature for the product's quality, as shown in Figure 7 below 11 [18]. The thickness of VIPs was 35mm while the thickness of PU foam inside and outside layer was 2.5 mm, as shown in Figure 8. The thickness of VIPs was lower than another insulation [19], as shown in Figure 8 below, which can design to improve thermal conductivity with another insulation [20].

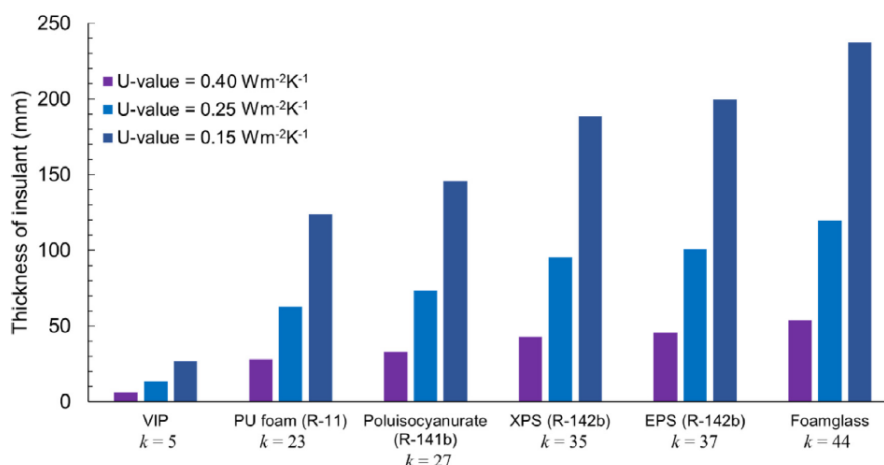


Fig. 5. thermal conductivity of insulation [1]



Fig. 6. VIPs box design [8]



Fig. 7. Blue: VIPs Box, Red: PU Box

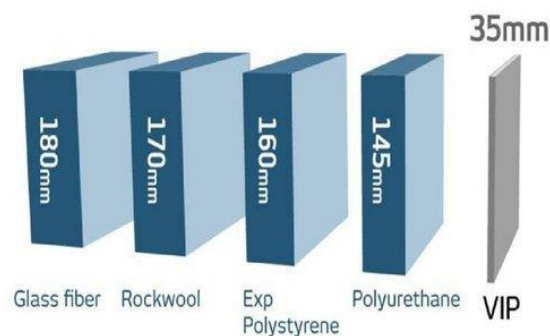


Fig. 8. Thickness of insulation

3. Results and Discussion

Keeping ice-cream's temperature by freezing with dry ice 6 kg for keep ice cream 1.88 kg with temperature not over than -18 degrees celsius, as shown in Figure 9 [21], indicates the Vacuum Insulation Panels (VIPs) with polyurethane foam box can keep temperature better than polyurethane foam box at the average of 24.58%. The ice-cream temperature starts at -20 degrees celsius. After 12 hours, ice-cream in the polyurethane foam box temperature has lost 2 degrees celsius or calculated as 10.00%. In contrast, the ice-cream temperature of vacuum Insulation Panels (VIPs) with polyurethane foam box has no temperature loss, compare with stating temperature. After 24 hours, the ice-cream temperature of polyurethane foam box has lost 6 degrees celsius, or 30.00%, but the ice-cream temperature of Vacuum Insulation Panels (VIPs) with polyurethane foam box has loss 1.5 degrees celsius, which calculated as 7.5%, compared with stating temperature. After 36 hours, the ice-cream temperature of polyurethane foam box that lost 9.5 degrees celsius, or 47.50%. However, the ice-cream temperature of Vacuum Insulation Panels (VIPs) with polyurethane foam box has loss 3.5 degrees celsius, or 17.5%, compared with stating temperature, shown in Figure 10 below.



: Ice cream 4 boxes (1.88 kg)
: Dry Ice Weight 6 kg.

Fig. 9. The freezing supply by dry ice 6 kg for keep ice cream 1.88 kg in temperature not over than -18 Degree Celsius [11]

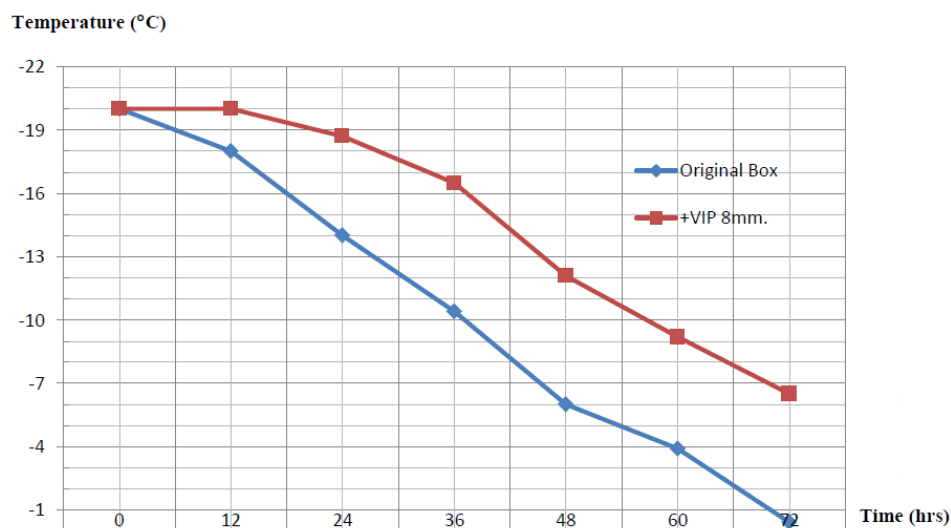


Fig. 10. The result of ice-cream temperature

After 48 hours, the ice-cream temperature of polyurethane foam box has lost 14.0 degrees celsius or counted as 70.00%. However, the ice-cream temperature of Vacuum Insulation Panels (VIPs) with polyurethane foam box has lost 8.0 degrees celsius, which is calculated to be 40.00%, compared with stating temperature. After 60 hours, the ice-cream temperature of polyurethane foam box has lost 16.0 Degree celsius, 80.00%, but the ice-cream temperature of Vacuum Insulation Panels (VIPs) with polyurethane foam box has lost 11.0 degrees celsius, 55.00%, compared with stating temperature. After 72 hours, the ice-cream temperature of polyurethane foam box has lost 19.5 degrees celsius, 97.50%, but the ice-cream temperature of that vacuum Insulation Panels (VIPs) with polyurethane foam box has lost 13.5 degrees celsius or counted as 67.50%, compared with stating temperature. The result of ice- cream quality after testing indicates that the ice-cream condition in VIP Box still freezing and ice cream condition in the usual box is melt, as shown in Figure 11 below.



Fig. 11. The result of ice-cream condition

Typically, the freezer product manufacturer keeps storage temperature at -25 to -23 degrees celsius to keep freezer product temperature at -18 degrees celsius. The result of ice-cream's temperature of the polyurethane foam box for 24 hours was at -18.5 degrees celsius, which is over than -18 degrees celsius means the delivery of freezer product by freezer trucks has no difference in 24 hours from origin to destination. For example, freeze products to the distribution center, hub, or shops. Thus, logistics managers can change from frozen trucks to standard trucks that can save trucks' fuel and investment costs. Also, using green logistics that has low fuel consumption and environmentally friendly. The result can be applied to another logistics type, such as air or sea freight and train.

4. Conclusions

Researchers should apply the cold room or freezer room in supermarkets, factories, and distribution centers, with VIPs that can get the result of electricity saving for compressors or cold trucks, as well as freezer trucks that can get the result of fuel-saving for engines.

Acknowledgement

This study was supported by Prince of Songkla University and SANYO S.M.I. (Thailand) Co., Ltd. This research was funded by Prince of Songkla University and SANYO S.M.I. (Thailand) Co., Ltd.

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