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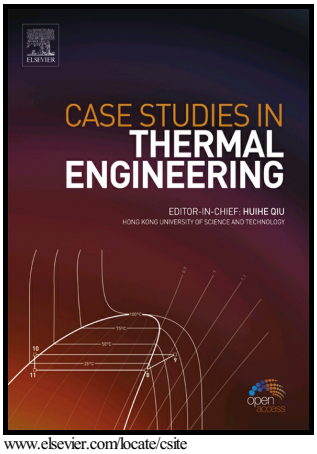

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THE EFFECT OF SOLAR RADIATION ON THE ENERGY CONSUMPTION OF REFRIGERATED CONTAINER

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Abstract

Refrigerated containers are a special type of cargo container, equipped with an integral refrigeration unit. External power supply is required to run the refrigeration system to control the temperatures inside the container during transporting perishable goods. The amount of power consumption of Refrigerated container will change depending on many external variables. This paper provides an investigation of the effect of solar radiation on the energy consumption of Refrigerated container through experimentation. 40ft high cube Refrigerated container is employed as a measurement object. Environmental parameters have been collected, i.e., solar radiation, surface temperature, and air temperature. Data analysis shows that the direct effect of solar radiation on the container surface causes the temperature penetration of the container wall and increases the amount of energy consumption. With the maximum solar radiation of about 700 W/m2 causes the surface temperature to reach up to 35°C, and the maximum power consumption reaches 7.5kW/h during the noon.

Keywords: Refrigerated container, energy consumption, solar radiation, environmental parameters, temperature penetration

1.0 INTRODUCTION

The global container trades are growing year by year with immense cargo volume. In 2014, the global container trade accounted for 5.3% annual increase from the total international seaborne trade with a volume of 171 million TEUs [1]. This growth was predicted to continue to increase with large shares from developing countries that have significant population growth and economic development [2]. Following the container growth, considerable trade of Refrigerated cargo allows the number of container traffic to increase [3]. As a consequence, there are tremendous energy consumption and environmental impacts that follow. In general, total energy consumption by Refrigerated container can be estimated through multiplying the number of container traffic with energy consumed per container, while the environmental impacts are assessed from the product of the total energy consumption with the emission factors per container.

Several studies have investigated the energy consumption of refrigerated containers under given conditions for a fixed time. From the measurement of 20 feet and 40 feet Refrigerated containers, the overall mean rate of energy consumption is around 3.6 kW per TEU [4]. The other investigator conducted experimentation by using temperatures ranging from −18 to +13.4 °C, which gave the energy consumption values between 4.42 kW and 8.63 kW respectively [5]. The other study assumed the mean energy consumption rate of the Refrigerated container to be 2.7 kW/TEU and indicated potential variations of around 60% due to various factor [6]. The amount of energy consumed by Refrigerated container will change depending on many external variables. A thermal study of a container for international transport was investigated considering the environment effect. The ambient temperature, particularly the solar effect, has a significant influence on the internal temperature [7]. The average sun-to-shade difference for external temperature reaches more than 7°C, and walls exposed to the sun radiation show a clear difference in thermal patterns compared to the shade ones [8]. In the previous study, Shinoda and Budiyanto [7] found that the energy consumption at the reefer storage yard contributes to half of the total electricity consumption and estimated to be continuously increasing over the year. Energy efficiency measures and strategies are rarely present in this area. The inadequate literature survey about the energy consumption of refrigerated container motivates us to provide the baseline of energy consumption of the refrigerated container for further development of energy efficiency measures. This study aims to investigate the energy consumption of refrigerated container from the viewpoint of solar radiation effect. The energy consumption of refrigerated container would be measured under three different weather conditions to get the baseline of the power condition under that condition.