



**INCREASING THE EFFICIENCY OF REFRIGERATOR BY USING
INTERMEDIATE DOOR**

Sunil Patel (BE, mechanical Engineering, 7th sem)

Mr. Amit Galphade (Assistant Professor, Mechanical Department)

Shroff S. R. Rotary Institute of Chemical technology.

ABSTRACT

The global increasing demand for refrigeration field of refrigeration air conditioning, food preservation, medical services etc. led to production of more electricity and consequently more release of CO₂. Domestic refrigerator consumes significant energy in percentage of total energy. To improve the efficiency of refrigerator, it is required that compressor work should decrease and refrigeration effect should increase. To increase refrigerating effect we need to decrease losses from evaporator. Many times we just open the door, searching whatever we want, if that thing is not present inside the refrigerator then we closed the door without taking anything. Experimental survey says that energy consumption increases with number of times door opening. In this paper we describe the new design (fitting see through intermediate door) for saving energy consumption by reducing the evaporator losses and also minimizing the compressor work.

INTRODUCTION

A household R/F is one of the most energy consuming home appliances accounting for 14% of electricity consumption of US household in 2001 [EIA, 2004]. Liu et al. [2004] studied and revealed that the energy consumption of R/F is about 15% to 20% of domestic electricity usage. Mahlia et al. [2003] investigated that R/F consumes about 26% of residential electricity in Malaysia. In India 13% of residential electricity is used by refrigeration system [BEE, energy & building 2014]. Energy consumption of refrigerator with door opening was found to increase compared to same product without door opening. Depending on the number of door openings about 7% to 30% more energy consumption has been observed compared to closed door condition. The experimental result also confirms that the energy consumption increases about 15% to 53% because the ambient temperature increases from 20°C to 30°C.

The test results also prove that, a significant amount of energy consumption increase because cabinet load increased. Depending different cabinet loads about 18% to 59% more energy consumption has been observed as compared to non-load condition.

Laguerre et al. [2002] conducted a customer survey and found that the number of door opening during breakfast, lunch, dinner, and between meals is estimated to be 19%(below 10 times per day) 43%(10 to 20 times per day) 38%(over 20 times per day).Gage [1995] investigated the daily energy consumption of the nine unit refrigerator that range from 1.7 to 5.3 kWh/day. It consumes 1.4 kWh/day (12 % increases) more energy in 26 door opening compared to no door opening. It increases about 1.6kwh/day with the ambient temp increase by 1°C. Saidar et al. [2002] conducted an experiment and found about 12.4 Wh increase in energy consumption for each door opening of 300L R/F with 12 sec door opening. They also found that energy consumption increases around 53Wh/day for 1°C increase in temperature. Meier [1995] estimated that average family open the door approximately 50 times during the day .Knackstedt et al [1995] concluded flow visualization of the cabinet as well as bulk air transport during open door conditions.

LITERATURE REVIEW AND DISCUSSION

Effect of number of door opening on energy consumption: Figure 1 and 2 show the effect of number of door opening on energy consumption and percentage of energy consumption of a household refrigerator respectively. Depending on the number of door opening for 12-48 times per 6 h about 6.67-30% higher energy consumption has been observed as compared to closed door condition. It increases by 39 Wh per door opening.

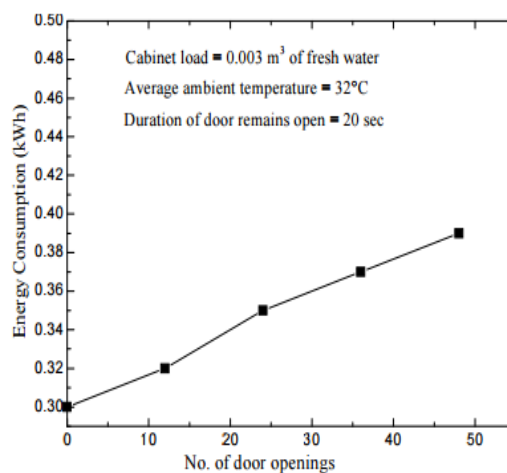


Fig. 1 Variation of energy consumption with number of door openings

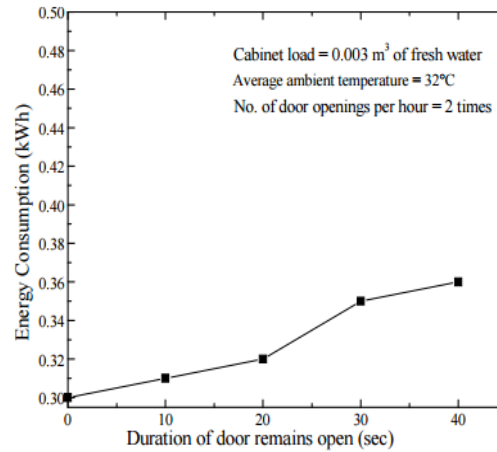


Fig 2 Energy Consumption Vs Duration Of Each Door Opening

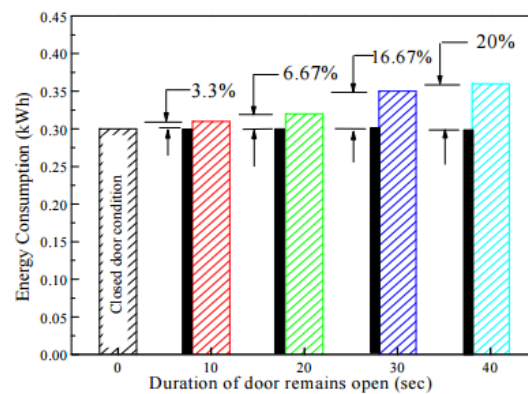


Fig .3 Comparison of Energy Consumption At Different Duration Of Door Remains Open Condition With Closed Condition

Effect of Ambient Temperature on energy consumption: Fig.4 show the energy consumption due to the increased ambient temperature. Depending on ambient temperatures for 25 to 33° C about 14.3% to 52.38% energy consumption has been increased as compared to 20°C ambient temperature. It increase by about 101 Wh/ 6h for a 1°C **increase** in the ambient temperature.

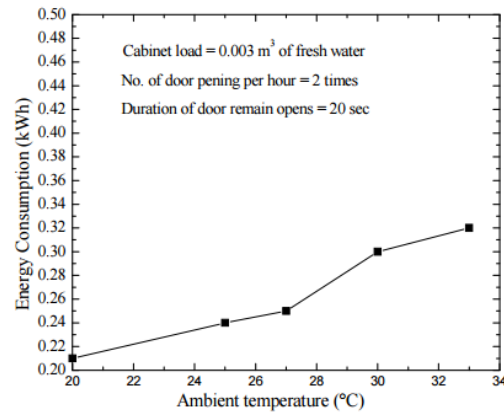


Fig. 5 Energy Consumption Vs Ambient Temperature

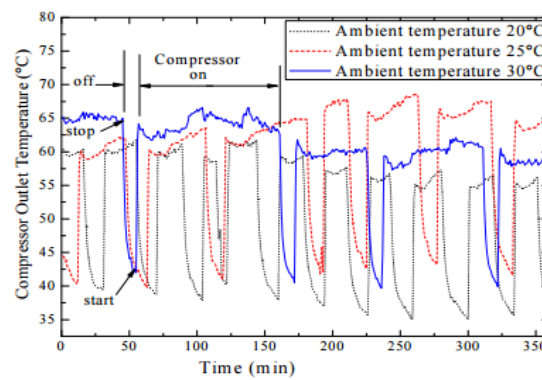


Fig. 6 Compressor Outlet Temperature Vs Time At Different Ambient Temperatures

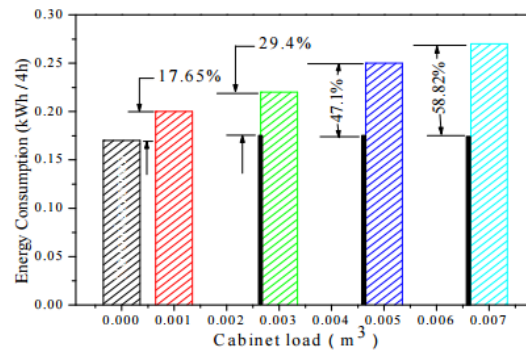


Fig.7 Percentage Of Energy Consumption At Different Cabinet Loads Compared With No Load Conditions.

SOLUTION

Many times we just open the door and searching whatever we want, if that things is not present then we closed the door without taking anything. Most of, kids and Gents doing this type of things. This type of happening 6 to 8 times per day, and in summer it happens more than 8 times. From experimental investigation, 12.4 Wh increase in energy consumption for each door opening of 300L R/F with 12 sec door opening.

For preventing this type of happening we just put one see through door between outer door and cabinet. Because of Intermediate door is see through, we look inside without opening the cabinet.

If energy consumption is 12.4 Wh per each door opening then we save the approx. 99.2 Wh energy per day (36.2 kWh per year). If charge of per 1 kWh electricity consumption is 5 rupees then we save 0.5 rupees per day.

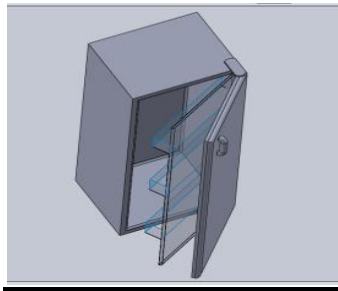


Fig.8 Model of refrigerator

CALCULATION

300 L refrigerator

Time duration - 12 sec.

No of time opening door - 1 times

Increase in energy consumption = 12.4 Wh = 0.012 unit

If the cost of 1 unit is Rs.5

Then $(0.012 * 5) = \text{Rs. } 0.06$ / each door opening

Now, we consider average 15 times door opening in each day.

Then, $0.06 * 15 = \text{Rs. } 0.9 / \text{day}$

$= \text{Rs. } 324 / \text{year}$

Also we save approximately 13.54 % electricity.

CONCLUSION –

By providing intermediate door(see through) in our domestic refrigerator we reduce the energy losses approximately 12-14Wh. Also we save 324 rupees per year and save approximately 13.54 % electricity. We increase the cop of refrigerator by providing intermediate door(see through).

REFERENCES

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