International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 5.22 (SJIF-2017), e-ISSN: 2455-2585
Volume 5, Issue 04, April-2019

Intra-City Cooling Logistics

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Abstract - The Project titled "Intra-City Cooling Logistics" is "The transport refrigeration system incorporating phase change material (PCM) is proposed to maintain refrigerated trucks at the desired thermal conditions. The phase change material (PCM) is charged by refrigeration unit located off the vehicle when stationary. The PCM is discharged and provides cooling when in service. The prototype system was constructed and test results proved that the proposed refrigeration system is feasible for mobile transport and analysis shows that delivery of refrigerated products can be made with a PCM system having a weight comparable to that of an on board conventional refrigeration system with less than half of the energy cost[1]. It will be used for intra-city transportation (within city) as it is not available in today's market. It will be used on 3-wheeler vehicle to reach at the interior parts of city. It will be used for transport of food items like bakery items, dairy products mainly ice cream, sea foods, frozen foods and also medicinal supplies.

Key Words: Phase Change Material (PCM), Intra - City refrigerated transport, thermal energy storage, super cooling, energy conservation

1. INTRODUCTION

Refrigerated transport is necessary for maintaining the quality and extend the shelf-life of fresh, frozen and perishable products during transportation. The product temperature needs to be kept at the point where metabolic and microbial decay is minimized. The population growth and the consumer's continuous demand for fresh food have contributed to an increasing demand for refrigerated transport [1]. Refrigerated transport is important because it connects the various stages between the initial production and the consumer. Road transport refrigeration equipment is required to operate reliably in much harsher environments than stationary refrigeration equipment. Due to the wide range of operating conditions and limitations which are forced by available space and weight, the transport refrigeration equipment have lower efficiencies than stationary systems. So reduction in energy consumption, however, cannot compromise the temperature control of the transported food products which is governed by body of laws [3].

At present, the existing technology in refrigerated road transport is mechanical vapor compression refrigeration driven by a diesel engine. This type of engine is relatively expensive, noisy and its efficiency is about 35–40% [1]. The basic reason for the poor performance of the refrigerator truck is the basic component installed on the refrigerator truck and the limited space available for refrigeration. Also, the evaporator is close to the condenser and the diesel engine.

Another drawback of the diesel engine driven refrigeration system currently in use is the associated Greenhouse Gas and fine dust emission. They are harmful to people's health and contribute to global warming. On average, a typical refrigerated vehicle will produce approximately 50 tons of CO_2 annually with a fuel consumption of 0.47 L/h per kW cooling capacity, operating at an outside temperature of 30° C and refrigerated space temperature of 20 C. Furthermore, the amount of CO_2 emission from a typical system is expected to increase at a rate of about 5% annually because of the old insulation in the vehicle [1].

In the current work, a new refrigeration system for a refrigerated truck is invented. The refrigeration system consists of an on vehicle phase change energy storage unit, an off-vehicle refrigeration unit, a cooling unit in the refrigerated space, a fan, compressor and a controller. The refrigerated space is required to be maintained between temperature ranges of +15°C to -25°C. Generally, frozen meat and fishery products are required to be delivered at 18° C to minimize quality loss during transportation.

1.1 PROBLEM STATEMENT

- Transport refrigeration is essential in today's society is to preserve and protect food, drugs and medical supplies for people worldwide**.**
- But in the market, transport refrigeration system are available that only maintains the temperature so required temperature is not achieved to transport the food products.
- Apart from this, the system is engine driven so it causes the environmental degradation due to excessive use of fuels.
- Also there is temperature thou obtained in food product due to this quality of products is degraded.
- It is available only for city to city transport not for transport within the city on 3 wheel vehicle.

1.2 OBJECTIVE

- To maintain quality of product in temperature controlled environmental chamber.

- To make transport refrigeration system free from engine run.
- No temperature thou of product in the cabin.
- To provide Intra-City Facilities.
- To have back up duration for 4 to 7 hours and no. of door openings 8 to 10 without electric power.
- To make passive cooling system.

2. CONSTRUCTIONAL DETAILS

- The present work consists of, PUF panel box of length 1 m, width 1 m, height 1 m and thickness 120 mm.
- Phase Change Material (PCM) is poured into Thermo Tab of dimension 300 * 235 * 32 mm. In present work there are 20 such tabs.
- 6 tabs are placed on each inner side (i.e. two side walls and back wall) of the box while 2 thermo tab are placed on front door.
- Condensing unit is kept on top of the box.
- Evaporating unit is fitted on inner side of the top wall and connection is made.
- R-404A refrigerant is passed through the system

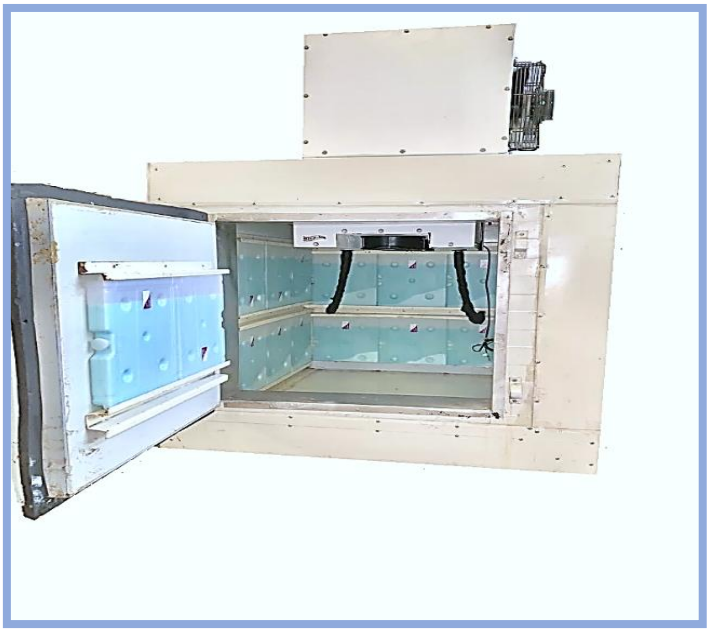

Fig – 1: Setup

3. WORKING PRINCIPLE

The system is charged from the grid for 12 to 15 hrs. R-404A refrigerant gas is passed through condensing unit which cools the ambient air flowing through evaporator and this air is flown to the cabin, this cool air freezes the phase change material (PCM).After this the system is plugged off from the grid. Then the food products or medicinal supplies or sea food that are needed to be transported at required temperature is put into the cabin. The temperature inside the cabin is maintained for 5 to 8 hrs. This freeze PCM absorbs the latent heat of the product and thus maintains the quality of the product during transportation and the whole system is engine free unlike the conventional transport refrigeration system.

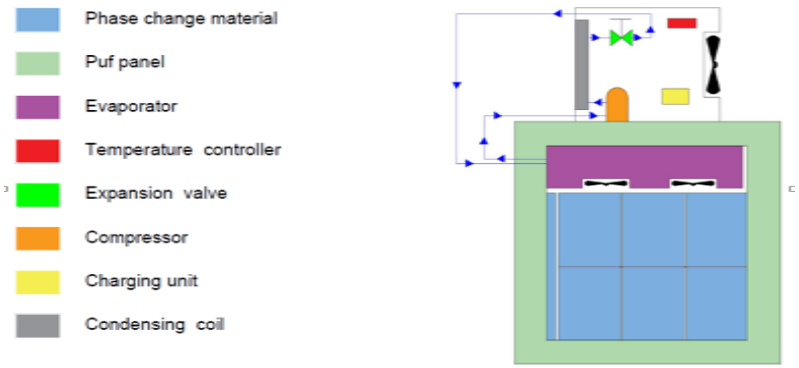

Fig – 2: Schematic Diagram

4. METHODOLOGY

In the present work first of all the pressure of the refrigerant is adjusted. The time for freezing the phase change material (PCM) is noted down. Then the time till the temperature inside the cabin is maintained is noted down. Number of door openings are also noted down. This is done for 3 to 5 times and the performance is compared.

5. OBSERVATION

Table 1: Trial 1

Time	Temperature(℃)	Power (w)	Ampere (A)	Voltage (V)
11:15 AM	27	600	3.2	230
12:38 PM	-6	600	3.2	230
12:47 PM	-7	600	3.16	230
2:54 PM	-14	500	2.95	220
4:28 PM	-16	500	2.8	230
5:09 PM	-17	500	2.8	230
8:44 PM	-21	500	2.8	240
11:55 PM	-23	500	2.75	250

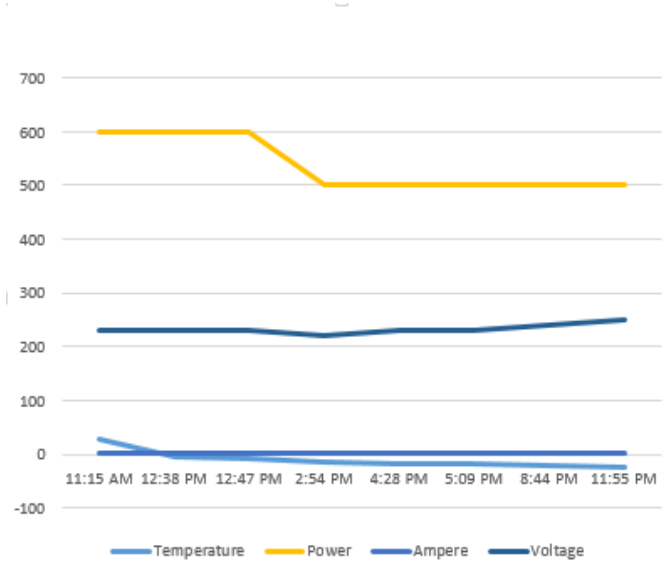

Table 2: Trail 2

Time	Temperature(℃)	Power (w)	Ampere (A)	Voltage (V)
9:30 AM	10	600	3.1	230
10:38 AM	-13	400	2.8	220
10:39 AM	-14	400	2.8	220
10:40 AM	-15	400	2.8	220
10:43 AM	-18	400	2.79	220
10:46 AM	-20	400	2.79	220
10:55 AM	-22	400	2.69	220
12:00 PM	-23	400	2.72	225
12:25 PM	-24	400	2.72	230

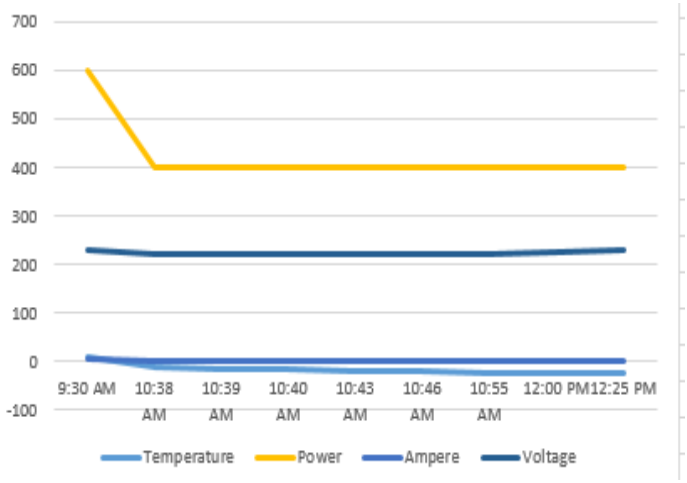

Chart – 2: Trial 2

Table 3: Trail 3

Time	Temperature(℃)	Power (w)	Ampere (A)	Voltage (V)
4:40 PM	0	500	2.9	230
4:50 PM	-3	500	2.9	225
4:55 PM	-5	500	2.9	225
4:59 PM	-7	500	2.9	225
5:00 PM	-8	500	2.9	225
5:05 PM	-10	500	2.9	230
5:20 PM	-11	470	2.9	230
9:09 PM	-25	400	2.8	230
12:04 AM	-28	400	2.75	240
2:14 AM	-29	400	2.75	250
5:50 AM	-30	400	2.75	250

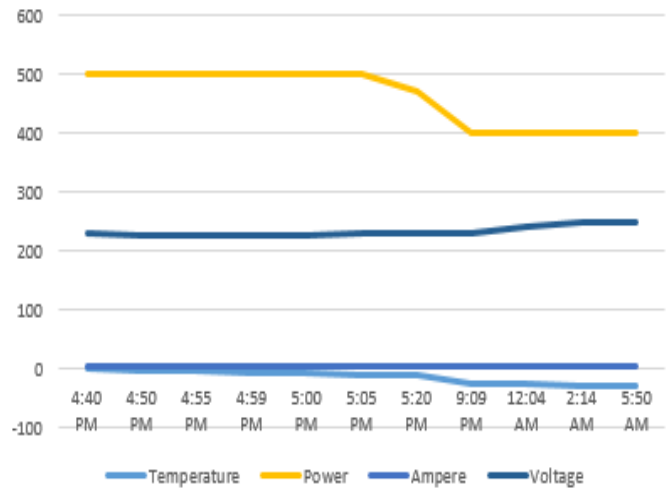

Chart – 3: Trial 3

Table: 4 Comparison between cabinet temperature and no. of door opening.

Time	Cabinet Temp.	No. of Door Opening
10:00am	-29	0
10:30am	-19	1
11:00am	-18	2

11:30am	-17	3
12:00pm	-16	4
12:30pm	-15	5
1:00pm	-12	6

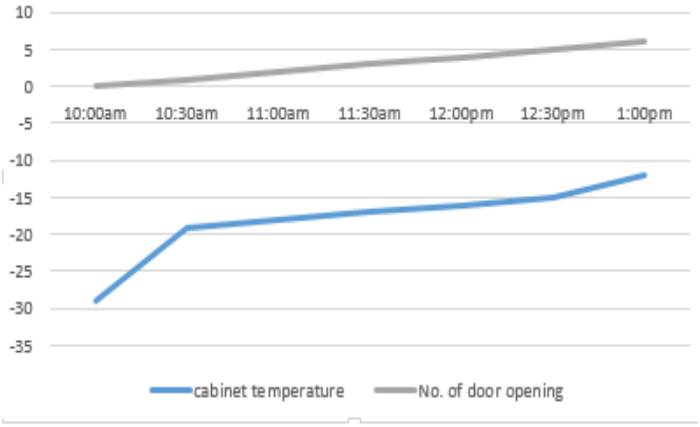

Chart – 4: Comparison between cabinet temperature and door opening

6. RESULT

- From the table and chart it is clearly observed that as temperature decreases power and ampere also decreases.
- As no. of door openings are incresed temperature also increases due to inclusion of outer air.

7. CONCLUSION

The major conclusion of the present work are:

- Since the required temperature is achieved and the tempeature required for the product is maintained it is better than the conventinal transport refrigeratin system.
- As it is charged from the grid for cooling of the PCM and after that it is loaded for transport of products, the energy conserved is very much less than conventional system.
- Also it is environsment friendly as no use of engine for refrigeration pupose, as a result less consumption of fuel.
- No. of door openings are also increased while transporting products.
- No temperature thou while tranporting.
- Beneficial for Intra-City facilities and provides employment.

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