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Research Article

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Assembly of Petrol Engine Driven Vaccine Refrigerating System for Rural Areas Using Gx 160 Two Stroke Spark Ignition Engine and Nissan Micra AC Components

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Abstract Vaccine is a substance put into the body of a person or animal to protect them from disease by causing them to produce antibodies, a protein that fights diseases [4]. Vaccination is very important in disease prevention for public health. Storage of vaccines is crucial, especially in rural areas. The vaccines must be stored at proper temperature, usually at 0-8 °C. For remote areas where national power grid connection is not available, the storage of vaccine can be a tremendous challenge. It must be transported from nearby storehouses to be utilized, this poses some difficulty. In these areas, power must be obtained from distributed generation which has led to this research work; Assembly of Petrol Engine Driven Vaccine Refrigeration System.

In this work, development and performance evaluation of a vaccine refrigerating system that is petrol driven by Gx 160 and that uses Nissan Micra AC component were carried out. The weight and COPmax of the system are 982N and 12.2 respectively and the working temperature is from 31o C to 8oC for the purpose of preserving vaccine. The engine consumes 0.8 liters of petrol in 18.35min of cooling to 8oC.

Keywords Engine, Refrigerator, Refrigerant, Vaccine, Preservation

Introduction

Refrigeration is defined as any process of heat removal [5]. It is the process of removing heat from an enclosed space or from a substance for the purpose of lowering the temperature. In the industrialized nations and affluent regions in the developing world, refrigeration is chiefly used to store foodstuffs at low temperatures, thus inhibiting the destructive action of bacteria, yeast, and mold. Many perishable products can be frozen, permitting them to be kept for months and even years with little loss in nutrition or flavor or change in appearance [3]. In general, refrigeration which can also be known as air conditioning is defined as the simultaneous processing of temperature, humidity, purification and distribution of air current in compliance with the requirement of space needing air conditioning [5]. Air-conditioning is the use of refrigeration for comfort cooling, has also become widespread in more developed nations [3].

The refrigeration system makes a cold room work. It is simply a process of transporting heat continuously from a colder region to a hotter region according to Claudius statement of the second law of thermodynamics. The vapor-compression system is the most commonly used method of refrigeration. It is frequently used in large cold rooms like industrial chillers. The main components of a refrigeration system are the condenser, the compressor, the evaporator and the expansion valve.

Components of refrigeration system [1]:-

Condenser: Its main purpose is to convert the compressed vapor refrigerant coming from the compressor to liquid refrigerant under specified conditions of pressure and temperature. As condensation begins, the heat will flow from the condenser into the air, only if the condensation temperature is higher than that of the atmosphere. The liquid refrigerant will then flow from the condenser to through a liquid line to the expansion valve otherwise known as throttling valve.

Compressor: The function of the compressor is to compress the low pressure, low temperature vapor refrigerant leaving the evaporator through the suction line to compressor. Once the vapor is drawn, it will be compressed leading to r ise in temperature and pressure of vapor refrigerant. The compressed refrigerant leaves the compressor via the discharge line

Evaporator: The evaporator is used to turn any liquid material into gas. In this process, heat is absorbed. The evaporator transfers heat from the refrigerated space into a heat pump through a liquid refrigerant, which boils in the evaporator at a low-pressure. In achieving heat transfer, the liquid refrigerant should be lower than the goods being cooled. After the transfer, liquid refrigerant is drawn by the compressor from the evaporator through a suction line. Liquid refrigerant will be in vapor form upon leaving the evaporator coil.

Expansion Valve: Commonly placed before the evaporator and at the end of the liquid line, the expansion valve is reached by the liquid refrigerant after it has been condensed. Reducing the pressure of the refrigerant, its temperature will decrease to a level below its atmosphere. This liquid refrigerant then flows into the evaporator.[1].

The mechanical refrigeration system is essentially the same whether the system be a domestic refrigerator, a low-temperature freezer, comfort air conditioning system, industrial chiller, or commercial cooling equipment. Refrigerants will be different and size of the equipment will vary greatly, but the principle of operation and the refrigeration cycle remains the same [2].

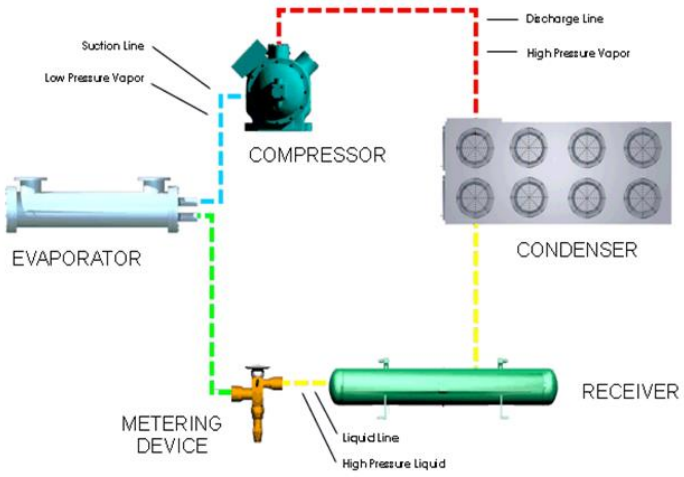


Figure 1: A Simple refrigerating System [2]

Materials and Method

Materials: The materials used in this work were obtained from the local markets within Ibadan and Lagos Nigeria. They include: GX 160 petrol engine, Nissan Micra car alternator, mild steel 50x50x5mm angle iron, 75a-12v battery, Pulley, castor wheel, Freezer casing or compartment, Nissan Micra car compressor, evaporator, Dryer/Expansion valve, Condenser, Fan, Battery (12v, 75amp)

Equipment/tools

The tools and equipment used in this research include: electric arc welding machine, cutting machine, grinding machine, drilling machine, measuring tape, plier cutting, 10 kva generator.

Design consideration

Engineering Design of the refrigerating system

The general layout and profile of the refrigerating system consists of a two-blower motor (fan), petrol engine, alternator and base, compressor, evaporator, condenser, expansion valve and the freezer compartment. See the design drawing in fig. 2 and fig. 3

Design specifications

i. The Evaporator Compartment

Height = 780mm, breadth = 520mm, Width = 580mm and Mass of freezer compartment = 6kg

ii. The Compressor

Type =DKV-08 Nissan compressor
Horse power= 5h.p
Discharge pressure= 7 bars
Cooling method = Air cooled
Material = Mild steel
Speed = 1500-200 rpm
Flow rate =0-20cfm
Mass of compressor = 8kg

CFM is cubic feet per minute, which indicates the compressor's flow rate - or the amount of air that a compressor can produce at a given pressure level. Typically, compressors that have higher CFM ratings are able to provide more air, which makes them ideal for larger applications

iii. The Alternator

Weight = 4.5kg
System main current = 12volts
Alternative charge current = 65.0A
Type- Nissan Mitsubishi
Model No- CA1652IR LRA03075 112457 23173

iv. The evaporator

The cooling fin material = Aluminum
Core length = 212mm
Core width = 240mm
Core depth = 60mm
Weight = 1.3kg

v. The condenser

Cooling fins material = Aluminum
Height =494mm
Width = 435mm
Thickness = 17mm
Type = Nissan Micra comes with dryer
Weight = 13.5kg

vi. The condenser fan

Gross Weight = 3kg
Model – condenser cooling fan Nissan Micra 1.0 petrol automatic

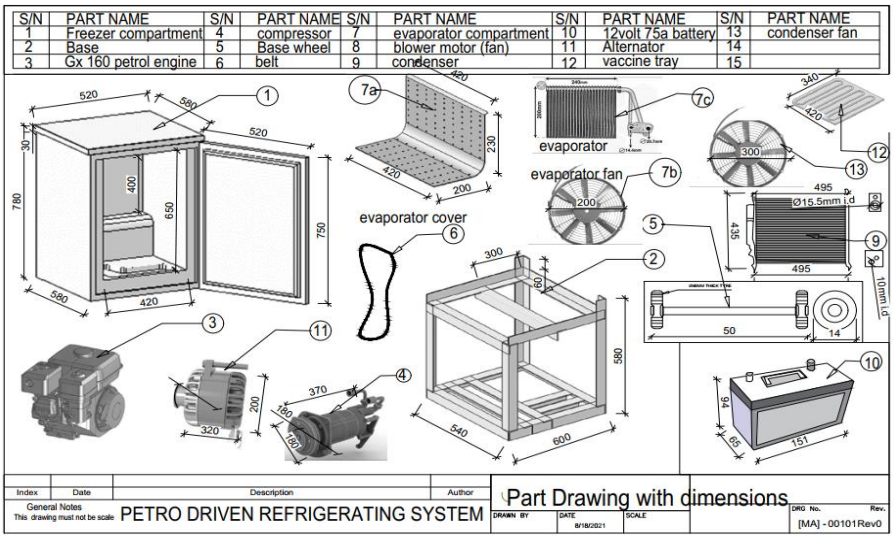
vii. Battery

Core length = 151mm
Core width = 65mm
Core depth = 94mm
Weight of battery = 14kg
Battery main current= 12volts
Alternative charge current = 75A

viii. Petrol engine (Gx160)

Engine type = 4-stroke single cylinder, OHV petrol engine, 25° inclined cylinder, Horizontal shaft

Cylinder sleeve type = Cast iron sleeve
Bore x Stroke = 68 x 45 mm
Compression ratio = 9.0: 1
Net power = 3.6 kW (4.8 HP) / 3600 rpm
Continuous rated power = 2.5 kW (3.4 HP) / 3000 rpm, 2.9 kW (3.9 HP) / 3600 rpm
Max. Net torque = 10.3 Nm / 1.05 kgfm / 2500 rpm
Ignition System = Transistorized
Fuel tank capacity = 3.1 Liter
Engine oil capacity = 0.6 Liter
Dimensions (L x W x H) = 312 x 362 x 346 mm
Dry weight = 15.1



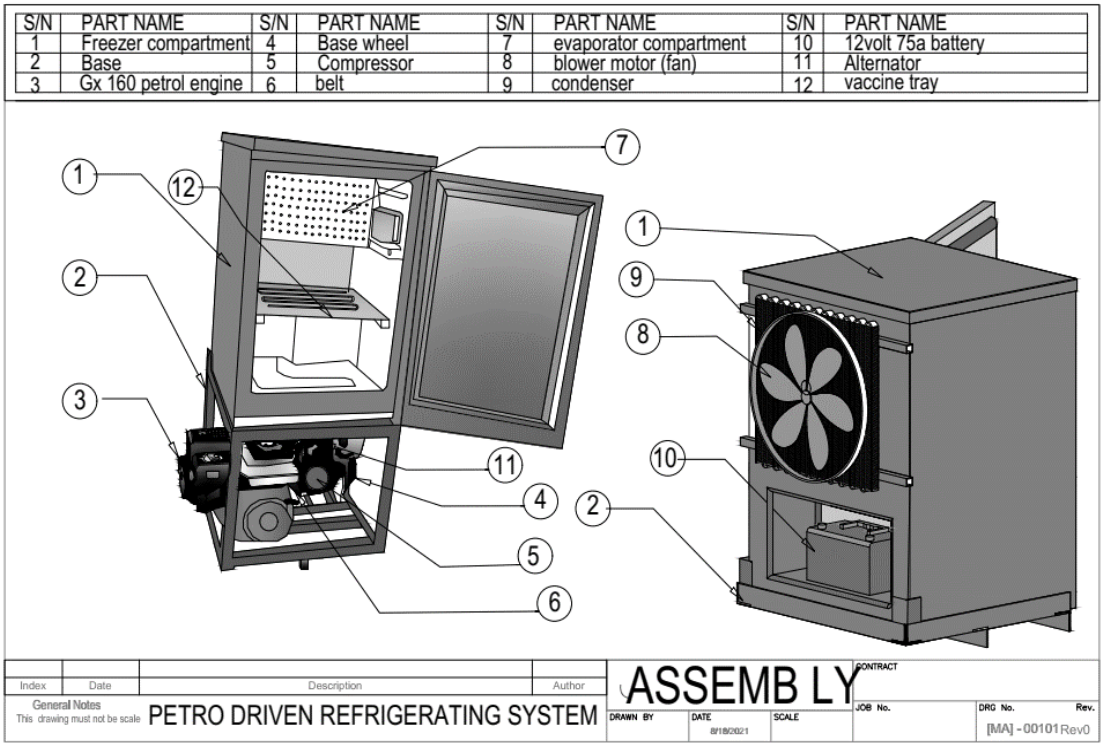


Figure 2 and 3: Part Drawing of the Vaccine Refrigerator

Methods of Construction and Assembly

i. Fabrication of base

Four 540mm, two 600mm, and two 580mm length were measured with measuring tape and were cut from 50x50x5mm mild steel angle iron as the vertical and horizontal respectively with the help of cutting machine and was fitted and welded together with the aid of an electric arc welding machine at the same time two 350mm was also measured, cut and welded to it to serve as re-enforcement and to carry the compressor and the alternator was install in vertical alignment with compressor. The tires obtained from local market which are at 560mm apart was welded to bottom of the base. The joints were properly grounded to check holes in the welding and it was corrected and in addition, it was primed and painted with red oxide and grey paint respectively for anticorrosion.

ii. Gx 160 Petrol engine

The Gx 160 petrol engine was selected due to the cost and the availability in the market to serve as an engine to drive the system compressor and alternator with belt. This engine is placed on the first platform of the base.

Plate 1: The Engine Installation

Plate 2: Aligning the alternator compressor and the Engine

iii. The Alternator

The alternator works by converting mechanical energy from the petrol engine into electricity. When the engine is on operation, it drives the belt that connects engine' shaft and the pulley attached to the alternator. The pulley turns the alternator's rotor shaft, which spins a set of magnets around a coil. The alternator makes more voltage than a battery can handle ($13^1/_2$ to 15volts) compared to the 12volts batteries can hold on to. When the engine on, the alternator continuously recharges the battery. It is mounted on the base at a specific distance away and in vertical alignment with compressor.

iv. The Compressor

The belt that drives the alternator drives the compressor at the front of the engine, Nissan Micra compressor was selected due to the cost and availability. It takes in and pumps out refrigerant. When the compressor starts working the job is to pressurize or compressed the refrigerant as the pressure increases it also increase the temperature then the high pressure and high temperature refrigerant will flow into the condenser through pipe in form of vapor. The compressor is placed on the based and was aligned with the alternator for the belt to be able to drive it together with the engine.

Plate 3: Installation of the Compressor and the Alternator

In the condenser this high temperature and high-pressure refrigerant will change it form from gas to liquid in the same temperature. It was placed outside, behind the freezer compartment gotten from the local market within Ibadan. It is mounted on the 20x20x1.6mm SHS welded at the back of the freezer casing. The compressor is incorporated with fan, the heat is expelled from the condensing environment Nissan Micra condenser was selected due to its low cost and availability.

Plate 4: installation of the Condenser to position

Plate 5: Installation of the Evaporator

vi. The Evaporator

Nissan Micra vehicle air-conditioning compressor was selected based on seize specification and capacity. The evaporator is placed inside the evaporator compartment and it is covered with the evaporator cover. It work is to receive low pressure liquid from the expansion valve.

Plate 6: Assembly of the evaparator and blower motor(fan)

Plate 7: Assembled Vaccine Refrigerating system.

vii. The Full Assembly of the Vaccine Refrigerator

The assembly consists of the evaporator and the blower motor with the protecting cover, condenser with fan, dryer, alternator, 12v battery, the petrol engine, the base, the freezer compartment, the base tire, the vaccine tray and working substance (refrigerant).

Result and Discussion

Experimental Results

Having constructed the petrol engine refrigerating system, it was tested to determine the time it takes to cool the temperature of the space up to 8^{o}C. A thermometer and a stop watch were used for this test. The enclose vaccine refrigerator's space temperature before starting the engine was measured to be 31°. The engine was started and it drives the belt at a revolution of 2500 rpm and started cooling the system. The result shows that it takes 18.35 min for the engine to cool enclosed refrigerator space to 8°C and 0.8litres of fuel was consumed. It takes an average time of 12hrs 35min for the system to return to the temperature 31^{o}C after the engine was put off.

Conclusion

A refrigerating system has been developed using Nissan micro car AC component and it is powered by Gx 160 petrol engine. The co-efficient of performance of the system was found to be 12.2. From the result it takes 18.35mins to cool the vaccine room to 8^{o}C and 12hrs 35min for the system to return the room temperature. The system consumed 0.8litres 18.35mins.

Reference

[1]. 1 coldltd. (2014). Major Elements of Refrigeration System and their Functions. Retrieved 31 July, 2021, from https://1cold.com/blogs/major-elements-refrigeration-system-functions.

[2]. Berg Chilling Systems Inc (2021). Science Behind Refrigeration, Introduction to basics refrigeration. Retrieved 31 July, 2021, From https://berg-group.com/engineered-solutions/the-science-behind-refrigeration

[3]. Britannica, T. Editors of Encyclopaedia (2020, July 14). Refrigeration. Encyclopedia Britannica. https://www.britannica.com/technology/refrigeration,

[4]. Cambridge Dictionary, Vaccine, Retrieved 31 July, 2021

[5]. Sahoo M., Rout I. (2016). Design, fabrication and performance analysis of solar PV air conditioning system. International Journal of Scientific and Research Publications, Vol. 6, pp 277- 282