# PERFORMANCE ENHANCEMENT OF REFRIGERATION SYSTEM USING PWM TECHNIQUE

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**ABSTRACT-** *Refrigeration systems consume a considerable amount of energy. Taking as example supermarket refrigeration systems for up to 30 minutes save of the whole energy, used pulse dimension modulation technique (pwm) consumption within the market. Because of the thermal capability created up by the refrigerated merchandise within the system there's a possibility for optimizing the power consumption by utilizing load shifting methods. Describes the dynamics and also the modeling of a vapour compression refrigeration system required for sufficiently realistic estimation of the power consumption and its minimization. This result in a non-convex operates with probably multiple extreme. Such a operate cannot directly be optimized by normal strategies and a analysis of the system's constraints is presented. The description of power consumption contains nonlinear terms that are approximated by linear functions within the control variables and also the error by doing therefore investigated. Finally a minimization procedure for the presented drawback is usually recommended. The facility conversion unit in Pulse width Modulated (PWM) drives. During this sort of drive, Current systems use on/off control, wherever the unit primarily operates within the long lasting start up transients. Supermarket refrigeration technology is developing rapidly and there is considerable interest in alternative refrigeration systems and refrigerants. The intention is to highlight differences in the key factors between today's good practice systems and possible future system alternatives with today's known technology. A large fraction (typically, concerning 80%) of practical refrigerators are of vapour compression sort and operate with energy input. In most cases the energy is derived from electrical motors. Vapour absorption refrigerators that operate with heat input are the second most generally used refrigeration systems. Modeling and analysis work was done on varied market refrigeration systems for their energy efficiency, and annual operating cost. The dimensions of the installation are often varied to suit individual needs. These cover a large vary of applications like food process, preservation and transport, comfort cooling, commercial and industrial air con, producing, energy production, commercially successful compression refrigeration systems Since then, the refrigeration technology has full-grown tremendously, influencing the majority aspects of human life. Steady-state refrigeration systems within which the cooling impact is continuous; the refrigerant flow is steady and in one direction. Vapour compression refrigeration systems employed in domestic refrigerators and air*

*conditioners are typical samples of steady-state refrigeration systems. Sterling refrigerators and sorption systems are samples of periodic refrigeration systems.*

**INTRODUCTION**

## 1.1 Supermarket Refrigeration

The purpose of this thesis is to research whether or not or not carbon dioxide could be a smart different resolution for supermarket refrigeration, to in theory and by experimentation evaluate its performance compared to a conventional/alternative system solution. By identifying the strength and weakness points in carbon dioxide system solutions it's attainable to use and check modifications to optimize the system for its best possible performance. By combining the experimental and theoretical findings it's attainable to means potential enhancements within the experimental rigs, and thereafter, concludes upon good carbon dioxide system solution/s for supermarket refrigeration. It's additionally vital to research issues of safety once carbon dioxide is applied during this application wherever a simulation model would provide a smart indication of the risks attached to using it. An extra step during this analysis of carbon dioxide in supermarket refrigeration the add this thesis started by surveying existing carbon dioxide supermarket installations in Sweden. Put in and attainable solutions wherever carbon dioxide issued are summarized as a basis for the theoretical and experimental analysis. So as to perform theoretical evaluations of the performance of various carbon dioxide system solutions simulation models are developed. They simulate dioxide indirect, NH3/CO2 cascade, CO2trans crucial and direct expansion (DX) R404A systems. The models supported the choice of the carbon dioxide system solutions to be tested through an experiment and facilitated the look of the NH3/CO2 cascade and trans-critical system test rigs. Performance analysis and systems optimizations have so been achieved. so as to verify the findings of the theoretical analysis an experimental analysis has been performed whereby a scaled-down medium size carbon dioxide supermarket has been inbuilt a laboratory setting. NH3/CO2 cascade and trans-critical systems are tested and compared to a traditional R404a system put in within the same laboratory environment.

Experimental findings were compared to the pc simulation models. Supported the theoretical analysis of the results and therefore the findings of the experimental tests it had been potential to means the benefits and limitations of using carbon dioxide in market refrigeration. Suggestions for enhancements and proposals for future analysis topics have later been drafted. A framework model has been developed to perform calculations on the ensuing concentration levels arising from totally different situations for leakage accidents within the market. The model was wont to as carbon dioxide is a recent refrigerant that has been used since the first stages of the refrigeration business in numerous applications, particularly those that needed massive amounts of refrigerant and strict safety concerns.

This was the case until the 1930's and 1940's once artificial refrigerants were introduced so carbon dioxide began to lose out faced with competition from the new refrigerants and was step by step replaced all told applications. The most reasons for the freewill phasing-out of carbon dioxide are its high in operation pressure (about 64.2 bars at 25ºC) and its low crucial temperature of 31ºC. This implied that carbon dioxide systems had containment issues. Moreover, once compression about to and rejecting heat higher than the crucial temperature the system suffered loss in cooling capability and efficiency. The technologies obtainable at that point couldn't solve the issues connected to the utilization of carbon dioxide. Synthetic refrigerants were thought-about as safe for several decades, however it proven otherwise for the surroundings. From this perspective, as a natural substance, carbon dioxide is a perfect choice; it's a by-product of the industry and using it in refrigeration applications may be thought-about as a further step before its inevitable release into the atmosphere. As a naturally existing substance within the atmosphere its long influence on the surroundings is extremely well investigated and that we will assume that there aren't any unforeseen threats that carbon dioxide poses for the atmosphere. As a results of its surplus within the atmosphere and also the inescapably large scale of its current production carbon dioxide is cheap and offered. These days' technologies will give the tools to harness the high operating pressure of CO2, running and controlling the system within the critical operates within the trans-critical region wherever the high pressure may be controlled by a throttling valve that he planned as an answer for mobile air con application. This was a breakthrough that revived interest in CO2 as refrigerant and revealed new horizons to the refrigeration trade and also the relevant analysis institutes. Since the revival of carbon dioxide as a refrigerant, a substantial quantity of analysis work has been conducted to research the "new" refrigerant's thermodynamic, thermal and transport properties and to try and explore new areas sub-critical region the pressure and temperature are coupled and this relationship is expressed within the saturation temperature pressure curve. Higher than the critical point this relationship doesn't apply, it becomes arbitrary wherever the pressure.

## 1.2 R134(a)

Production of chlorofluorocarbons (CFCs) has been phased out (Refrigerant like R-10, R-11, R-12) because of their potential to eat the layer that is three millimeter thick and filtering UV-rays emitting from sun.

Environmentally acceptable replacement compounds are thus required to be used in existing medium and low temperature refrigeration applications. Refrigerant R134a or HFC-134a was developed to fulfill these desires. Refrigerant R134a or HFC-134a could be a commercially accessible hydro fluorocarbon (HFC) refrigerant to be used as a long-run replacement for R-12 in new instrumentality and for retrofitting medium temperature CFC-12 systems.

R-134a: 1,1,1,2-tetra –fluoro-ethane CH2FCF3 R134a is a single hydro fluorocarbon or HFC Compound.

No chlorine content, no ozone depletion potential

Boiling point = −26.6 °C (−15.9 °F).

Density and phase 0.00425 g/cm³, gas.

Solubility in water Insoluble.

Melting point -103.3°C (169.85 K).

**Advantages:**

First and foremost, R134a don't contain Cl atom so it afford to undermine the role of part ozone; besides, R134a features a good safety performance (non-flammable, non-explosive, non-toxic, non-irritating no rot resistance), additionally, R134a is simpler to retrofit refrigeration system so the heat transfer performance is nearer. Last however no least, R134a heat transfer performance higher than the R12 which might facilitate the number of refrigerant greatly reduced.

## METHODOLOGY

There are following methods used in vapor compression refrigeration system with and without pwm techniques:-

Fabrication and assembling of V.C.R.S. working unit utilizing a rotary vertical compressor (a key, a spring, and an eccentric sleeve for capacity modulation), a condenser, a expansion device, L.C. Coils, thermostat, switch, evaporator, voltmeter, ammeter and energy meter.

The measurement of power consumption in V.C.R.S. without pulse width modulation technique at control temperature 0ºC, -5ºC, -25ºC.

The measurement of power consumption in V.C.R.S. with pulse width modulation technique at control temperature 0ºC, -5ºC, -25ºC.

The measurement of Coefficient of Performance in V.C.R.S. without pulse width modulation technique at control temperature 0ºC, -5ºC, -25ºC.

The measurement of Coefficient of Performance in V.C.R.S. with pulse width modulation technique at control temperature 0ºC, -5ºC, -25ºC.

The comparative analysis of power consumption of V.C.R.S. with and without pulse width modulation.

The comparative analysis of coefficient of performance of V.C.R.S. with and without pulse width modulation.

### 2.1 Components of Experimental Setup

**(a) Compressor**

The main purpose of compressor to compresses the refrigerant gases. This increases the refrigerant's pressure and temperature, so the heat-exchanging coils outside the refrigerator allows to the refrigerant to dissipate the energy of pressurization. After the cooling, the refrigerant converts into liquid form and flows through the expansion valve. When it flows through the expansion valve, the liquid refrigerants having a permission to go from a higher pressure zone to a lower pressure zone.

**(b) Evaporator**

The evaporator provides many functions, the main purpose of evaporator to remove heat from inside of the fridge and another purpose is to dehumidification. As hot air goes through the aluminium’s extended surfaces of the evaporator. Coil and the moisture contained in the air condense on its surface. The comfortable temperature of the evaporator is 0° Celsius. Refrigerant enters to evaporator as a low pressure and low temperature liquid phase and its absorbs heat from inside space of the fridge and to convert lower pressure and lower temperature vapour refrigerant.

**(c) Condenser**

The Air-cooled condenser is used to condense higher pressure and higher temperature vapour refrigerant into higher pressure and higher temperature liquid refrigerant. Due to heat transfer by convection process in the presence of air medium and to transfer into expansion device.

**(d) Thermostat**

Many types of sensors are used for the purpose of measurement of temperature. One of them is the thermostat. Most of the thermostats have a non positive temperature coefficient (NTC), meaning the resistance works as per the temperature .The non active temperature measurement sensors, thermostats have the most accurate system. Thermostats have non linear temperature/resistance curve. Figure shows a typical circuit that is basically used to allow a processor to measure temperature using such device. A resistor ($R_1$) pulls the thermostat up to a preferred voltage. The combination of thermostat and resister makes a voltage divider. The accuracy of this depends on the thermostat tolerance, resistor tolerance, and preferred accuracy.

**(e) Relay Coils**

Many electronic circuits have oscillatory systems providing the central "clock" signal that provide the sequential operation of the whole system. The electronic system used for providing the central clock signal convert a direct current (the supply voltage) into an alternate current means a waveform. This instrument is also used in pieces of test equipment producing waves, triangular shaped waveforms. Such device is basically utilized in radio-frequency because of the important characteristics and utilization. Such is basically an Amplifier with "Non negative Feedback", and one of the many problems in circuit design. Oscillators, reduces the losses of their feedback. In other words, such device is an amplifier which uses non negative feedback that generates output frequency without the use of any input signal. It is self sustaining.

**1. Sinusoidal Oscillators**: These are known as Harmonic Oscillators and are generally a LC or RC tuned feedback type Oscillator. The use of such oscillators to generates a sine waveform which has constant amplitude and frequency.

**2.Non-Sinusoidal Oscillators**: These are known as Relaxation Oscillators and generate unpredective non-sinusoidal waveforms that changes fast from one condition of stability to another wave which is known as "Square wave", etc. type waveforms.

### (f) PWM Convertor

Basic function of pulse with modulation converter is to modulate the pulse. In refrigeration process pwm converter has robust role. Best utilization of this setup proved an efficient system .In refrigeration industry; it provides help in the increment of cooling capacity. And also increase the performance of the system

In addition to less energy consumption and better process control, pwm can provide other advantages as follows:

- A pwm may be used for control temperature, pressure of process or flow without the use of another controller.
- Maintenance costs can be lower, since less available rpm. Results in increment in the life of component.
- Eliminating the energy dissipation mechanism also does away with controlling these devices and all associated system.
- A soft initiator for the motor is no longer required maintenances and can eliminate water pressure problems.

### REFRIGERENT R-134 (a)

The refrigerant chemical name is Tetra fluoro-ethane.This properties is similar to R-12but with less ozone depletion potential.

| | | |
|---|---|---|
| Formula | : | $CH_2FCF_3$ |
| Molar mass | : | 102.03 g / mol |
| Normal Boiling point | : | $-26.3^0$ C |
| Density | : | 4.25kg / $m^3$ |
| Melting point | : | $103.3^0$C |
| Soluble | : | Water |

## 2.2 Procedure

In this work we are using pulse with modulation technique for reducing power consumption. So here ultimately we are comparing pulse with modulation technique with simple refrigeration technique (without pwm technique). The working of setup with and without pwm technique as follows:

### (a) Without PWM Refrigeration

The refrigeration system uses a moving liquid refrigerant as the medium which takes and exits heat from the space which is going to be cooled and subsequently rejects such heat elsewhere. Systems have four main components without Pulse width modulation technique and with Pulse width modulation technique, we are using five components. Moving refrigerant enters in to the compressor. This hotter vapour is moved through a component where it looses the energy and converted into a liquid by moving through a tube with cold liquid moving across the tubes. Heat is passed gone by either the reduced liquid refrigerant, now the saturated liquid, is next stimulated through an expansion valve where it undergoes a sudden reduction in pressure.

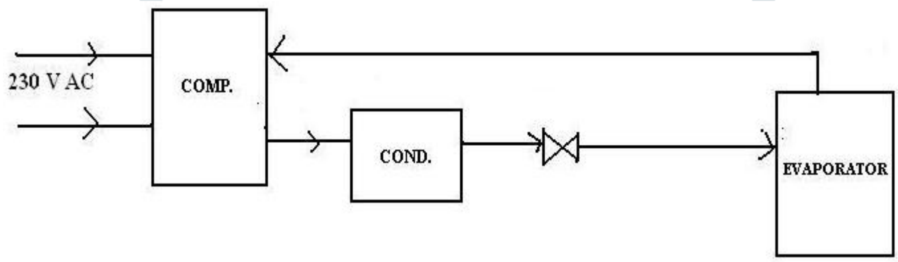



**Figure 2.1: Line Diagram for pwm Less Refrigeration**

This reduces the temperature of the liquid and vapour refrigerant mixture to wherever it's below the internal temperature of the white goods. The cold mixture is then moves through the tubes within the evaporator. A fan circulates the air within the internal half across the tubes having the cold refrigerant liquid and vapour mixture. That heat air evaporates the liquid a part of the cold refrigerant mixture. At a similar time, the moving air is cooled and so reduces the temperature of the internal half to the favourable temperature. The evaporator is wherever the current refrigerant takes and exits energy that is later on exhaust within the condenser and transferred air utilized in the condenser. For the completion of the refrigeration cycle, the refrigerant vapour from the evaporator is once more a saturated vapour and is come into the compressor.

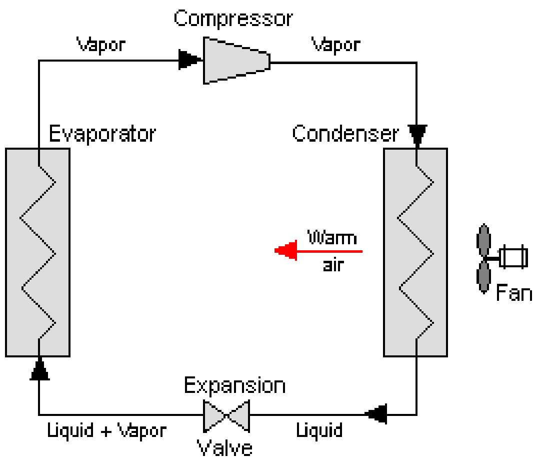



**Figure 2.2: Sketch of PWM Less Refrigeration**

### (b) With PWM Refrigeration

Basic function of pulse with modulation converter is to modulate the pulse. In refrigeration process pwm converter has robust role. Best utilization of this setup proved an efficient system .In refrigeration industry; it provides help in the increment of cooling capacity. And also increase the performance of the system **.**To obtain the rotor commutation point, and through the pulse width modulation technique control to improve system versatility .After testing, the system has robust stability and controllability, both to reduce the costs, with higher non theoretical value.

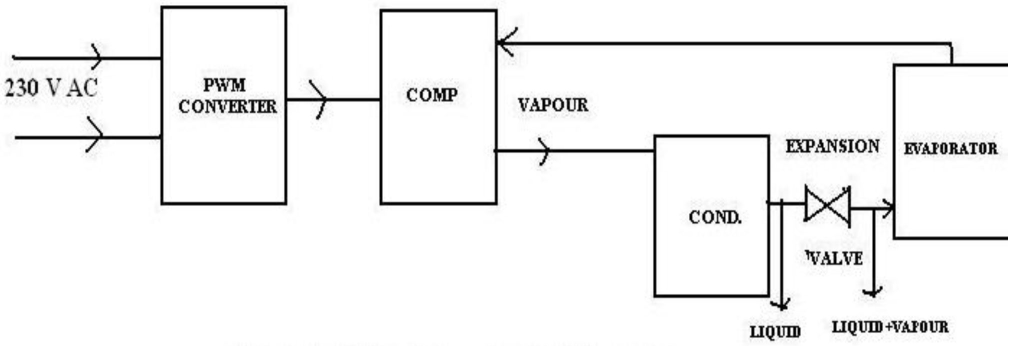



**Figure 2.3: Line Diagram for pwm Refrigeration**

To improve the efficiency of the refrigerator system, a system is required on the compressor motor speed control as the motor starts back electromagnetic force zero or very less, this method using the motor to start frequently. Detecting the back electromagnetic force zero-crossing point to determine motor situation, a refrigerator/freezer uses one alternate current induction motor/compressor with a constant frequency and a respective fixed rotation speed. The on/off operation mode is largely used to maintain its refrigeration storage temperature. Among an appropriate temperature vary, the compressor turns on and off following the signal of relay within the refrigeration/freezer. For on/off control methodology by using associate alternate current compressor, the storage temperature of fridge fluctuates robustly and also the energy consumption is over that by inverter-controlled product. typically the refrigeration capability of inverter-controlled refrigerators/ freezers is adjusted through variable speed regulation; that the main power turning on/off frequency may be reduced, and therefore the energy consumption may be also decrease because of the rise of refrigeration cycling efficiency.

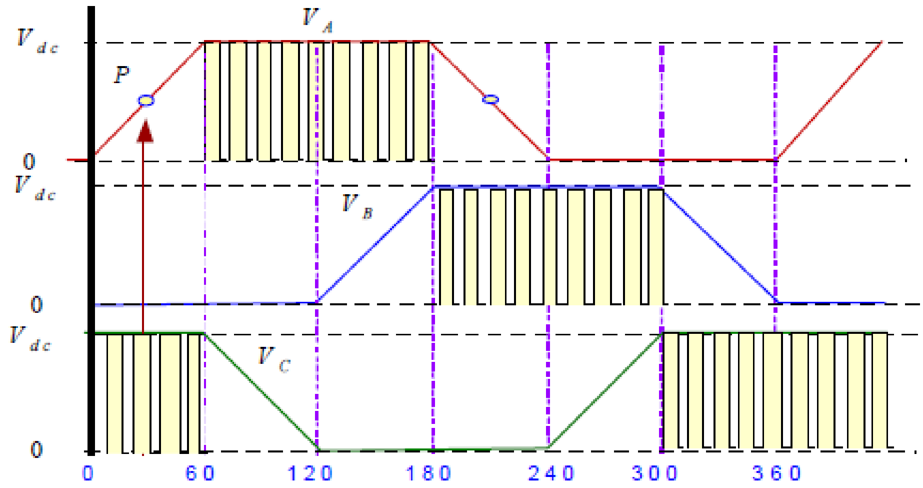



**Figure 2.4: Pulse Width Modulated Voltage Waveform**

The working procedure of process as follows:

(a) Experiment conduct at -25$^0$C (Evaporator temp.) with 3000 rpm (compressor speed) with and without pwm technique.

(b) Use of MATLAB for simulation result with same variables (3000rpm at -25$^0$C temp.) with and without pwm technique.

(c) Comparison of experimental result with simulation result.

(d) Simulation result obtained at a speed of 3000rpm (compressor speed) for temp -0$^o$C & -5$^o$C with and without pwm technique.

## 2.3 Formula Used

**(a) Work done/min** = $m_g$ x (n/n-1) × ($p_2$ $v_2$- $p_1v_1$) in KJ/min

where,

| | | |
|---|---|---|
| $m_g$ | = | Mass flow rate of refrigerant in Kg/min |
| n | = | index of expansion |
| $p_1$ | = | suction pressure in N/m$^2$ |
| $p_2$ | = | Discharge pressure in N/m$^2$ |
| $v_1$ | = | suction volume in m$^3$/kg |
| $v_2$ | = | Discharge volume in m$^3$/kg |

(b) **Power** = Work done(KJ/min) in KW
60

(c) **Coefficient of Performance (COP)** = Total Refrigeration effect

Work done

**(d) Mass Flow Rate of Refrigerant** = Cooling capacity (KJ/min) / Refrigeration effect (KJ/Kg)

## 2.4 Sample Calculation

### (a) Coefficient of Performance & Power Consumption (Without PWM)

| | | |
|---|---|---|
| Speed of the compressor | = | 3000 rpm |
| Control temperature (Evaporation temperature) | = | $-25^0C$ |
| Compressor inlet temperature | = | $-8^0C$ |
| Condensation temperature | = | $35^0C$ |
| Cooling capacity | = | 0.75 Tones |
| Expansion temperature | = | $30^0C$ |
| Suction pressure | = | $0.118 \times 10^5$ N/m$^2$ |
| Discharge pressure | = | $0.23 \times 10^5$ N/m$^2$ |
| Refrigerant | = | R-134 (a) |

The following properties given with the help of (R-134(a)) refrigeration chart.

$h_2 = 450$ KJ/Kg, $h_{f3} = h_4 = 238$ KJ/Kg, $v_1 = 0.0140$ m$^3$/Kg, $v_2 = 0.0442$ m$^3$/Kg, $h_1 = 420$ KJ/Kg.

Refrigeration effect $r_f = h_1 - h_{f\,3} = (420 - 238) = 182$ KJ/Kg

Mass flow of the refrigerant $m_g$ = (0.75 x 210KJ/min)/182 KJ/Kg

= 0.86 Kg/min

Total Refrigeration effect (T.R.E.) = $m_g \times r_f = 0.86 \times 182$ KJ/min

= 156.52 KJ/min

Work done = $m_g$ x $(n/n-1) \times (p_2v_2 - p_1v_1)(n=1.01)$

= $0.86 \times (1.01/1.01-1) \times (0.23\times10^5 \times 0.0442 - 0.118 \times 10^5 \times 0.0140)$

= 73.95 KJ/min

**Power** = work done in KJ/min / 60 = 73.95/60

= 1.23 KW

**Coefficient of performance** = (T.R.E / work done)

**Coefficient of performance** = 156.52/73.95

= 2.1

### (b) Coefficient of performance & power consumption (With PWM)

Speed of the compressor = 3000 rpm

| | | |
|---|---|---|
| Control temperature (Evaporation temperature) | = | $-25^0$C |
| Compressor inlet temperature | = | $-8^0$C |
| Condensation temperature | = | $35^0$C |
| Cooling capacity | = | 0.75Tones |
| Expansion temperature | = | $30^0$C |
| Suction pressure | = | $0.118 \times 10^5$ N/m$^2$ |
| Discharge pressure | = | $0.23 \times 10^5$ N/m$^2$ |
| Refrigerant | = | R–134 (a) |

There are following properties given with the help of (R-134(a)) refrigeration chart.$h_2$= 450 KJ/Kg, $h_{f\,3} = h_4$ =238 KJ/Kg, $v_1$= 0.00286m$^3$/Kg, $v_2$=0.03m$^3$/Kg, $h_1$= 398 KJ/Kg.

Refrigeration effect $r_f$ = $h1-h_{f\,3}$=(398–238)=160 KJ/Kg

Mass flow of the refrigerant $m_g$ = $(0.75 \times 210$KJ/min)/160 KJ/Kg

= 0.98 Kg/min

Total Refrigeration Effect (T.R.E.) = $m_g \times r_f = 0.98 \times 160$ KJ/min

= 156.8 KJ/min

Work done = $m_g \times (n/n\text{-}1) \times (p_2v_2 - p_1v_1)$ (n=1.01)

$= 0.98 \times (1.01/1.01\text{-}1) \times (0.23 \times 10^5 \times 0.03 - 0.118 \times 10^5 \times 0.00286)$

= 64.95 KJ/min

**Power** = work done in KJ/min = 64.95/60
60

= 1.08 KW

**Coefficient of Performance** = (T.R.E / work done)

**Coefficient of Performance** = 156.8/64.95

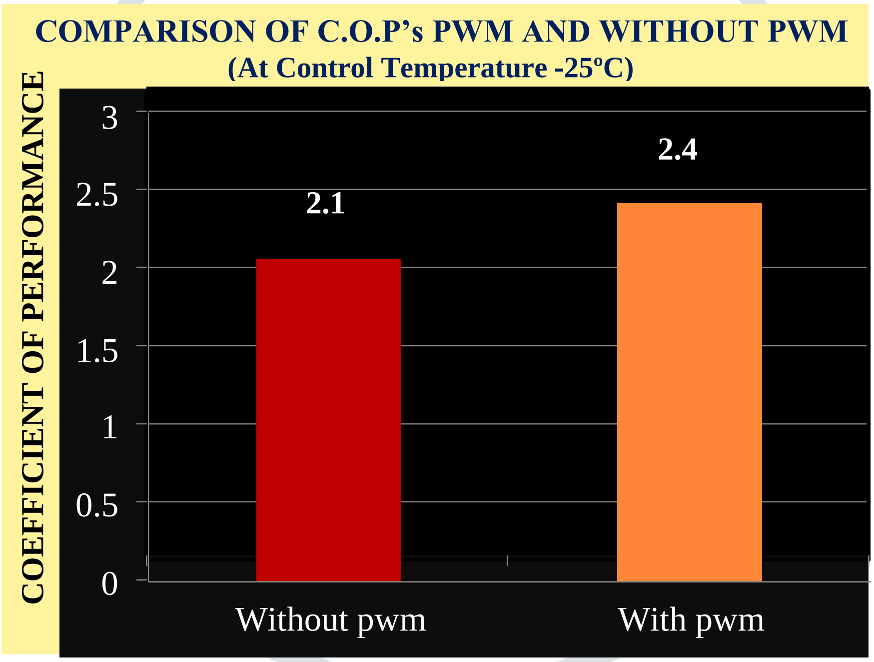
= 2.4

**Now Results are found by simulation, using MATLAB at evaporating temperature of -25°C and compressor speed of 3000 rpm (With and without pwm)**

### 2.4.1 Power Consumption

| SR. N0. | TIME (Min.) | VOLTAGE (V) | CURRENT (Amp.) | | TEMPERATURE ($^{o}C$) | | POWER CONSUMPTION (Kwh/hr) | |
|---|---|---|---|---|---|---|---|---|
| | | | WITHOUT PWM | WITH PWM | WITHOUT PWM | WITH PWM | WITHOUT PWM | WITH PWM |
| 1 | 0 | 250 | 5 | 1.7 | 25 | 25 | 0.0375 | 0.019 |
| 2 | 5 | 250 | 2.5 | 1.4 | 22 | 20 | | |
| 3 | 10 | 250 | 2.3 | 1.3 | 15 | 11 | | |
| 4 | 15 | 250 | 2.2 | 1.2 | 11 | 0 | | |
| 5 | 20 | 250 | 2.1 | 0 | 0 | -15 | | |
| 6 | 25 | 250 | 2.1 | 0 | -5 | -25 | | |
| 7 | 30 | 250 | 2 | 0 | -14 | | | |
| 8 | 35 | 250 | 2 | 0 | -18 | | | |
| 9 | 40 | 250 | 1.9 | 0 | -22 | | | |
| 10 | 45 | 250 | 1.9 | 0 | -25 | | | |

### 2.4.2 Coefficient of Performance




**Result:** The COP with pulse width modulation is 2.4 and 2.1 without pulse width modulation.

### 2.5 Comparison of Experimental Results with Simulation Results

It is observed that results obtained by conducting experiment with simulation results are comparable.

At evaporating temperature of -25ºC and compressor speed of 3000 rpm (with and without pwm) power consumption and COP with experimental setup and simulation as follows.

**Experimental Result:**

Power Consumption = 1.23 KW (without PWM)

= 0.0384 Kwh/hr

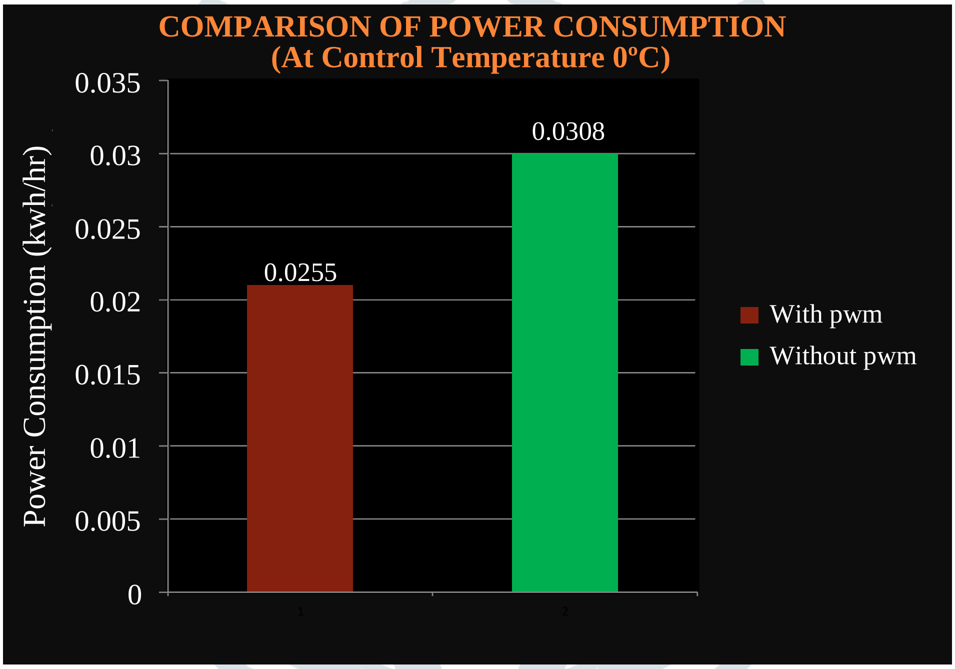
Coefficient of Performance = 2.1(without PWM)

| | | |
|---|---|---|
| Power Consumption | = | 1.08 KW (with PWM) |
| | = | 0.01875 Kwh/hr |
| Coefficient of Performance | = | 2.4 (with PWM) |

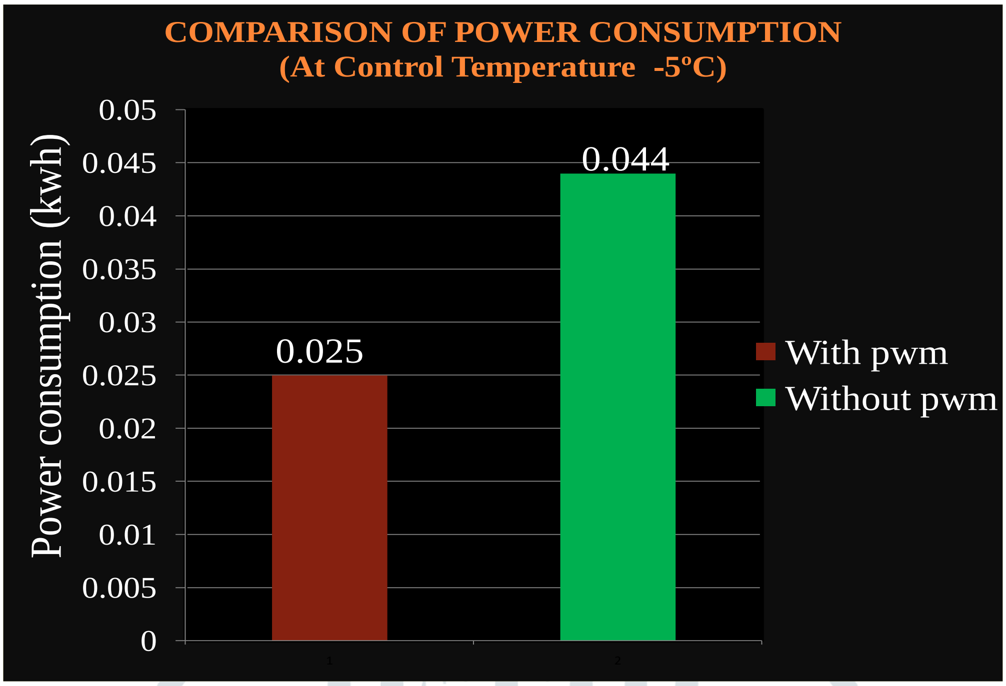
**Simulation Results:**

| | | |
|---|---|---|
| Power Consumption | = | 0.0375Kwh/hr (without PWM) |
| Coefficient of Performance | = | 2.1 (without PWM) |
| Power Consumption | = | 0.019 Kwh/hr (with PWM) |
| Coefficient of Performance | = | 2.4 (with PWM) |

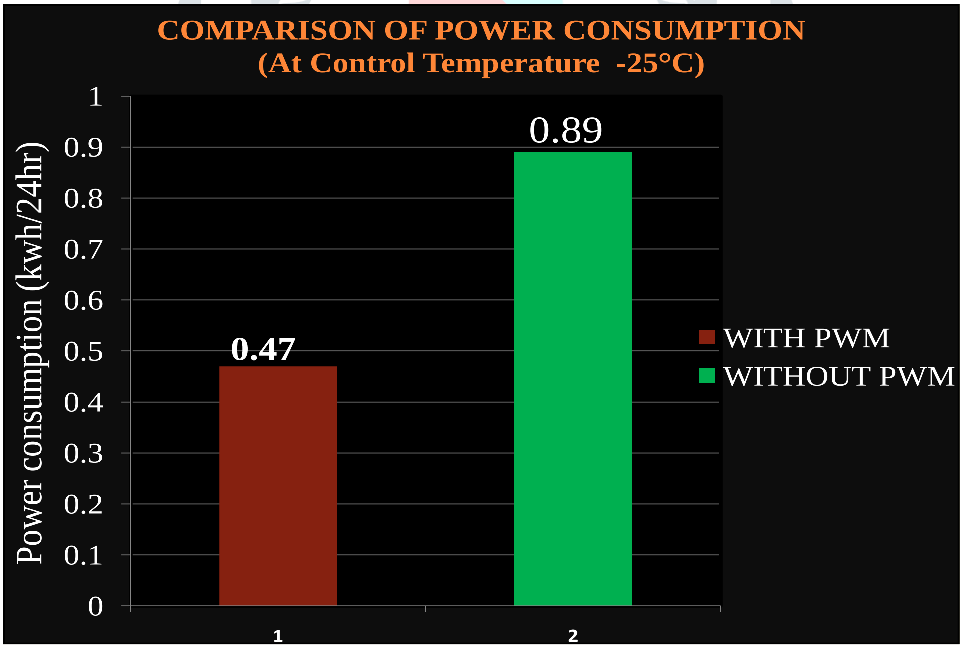
## RESULTS AND DISCUSSION



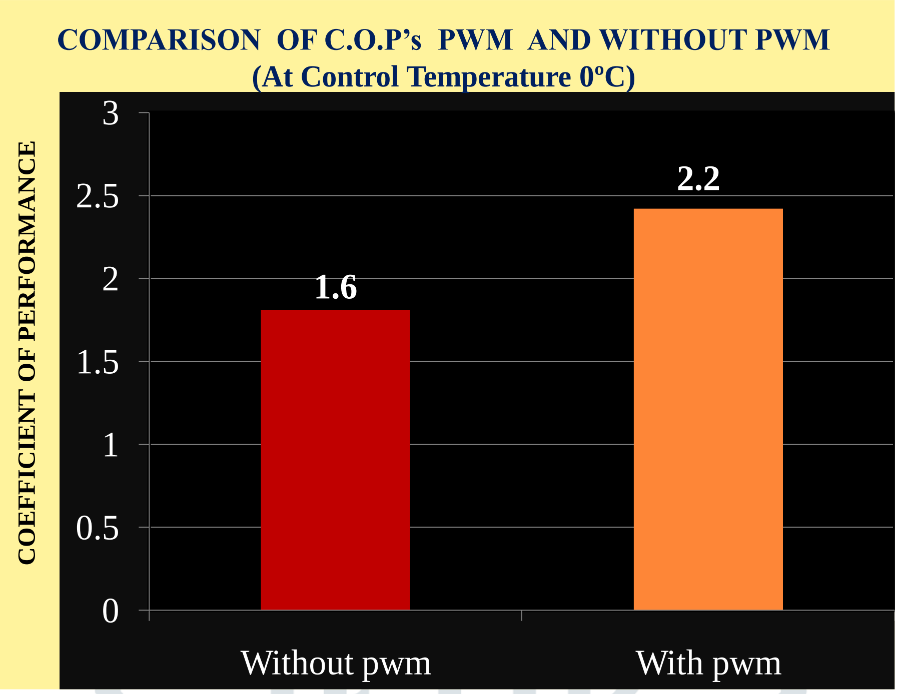

**RESULT: -** The power consumption of graph, 0 to 0.035 Kwh/hr in the performance temperature 0ºC pulse-width modulation (PWM) and without pwm averaged against expected conditions. Will be output automatically. This is very useful in applications such as controlling.



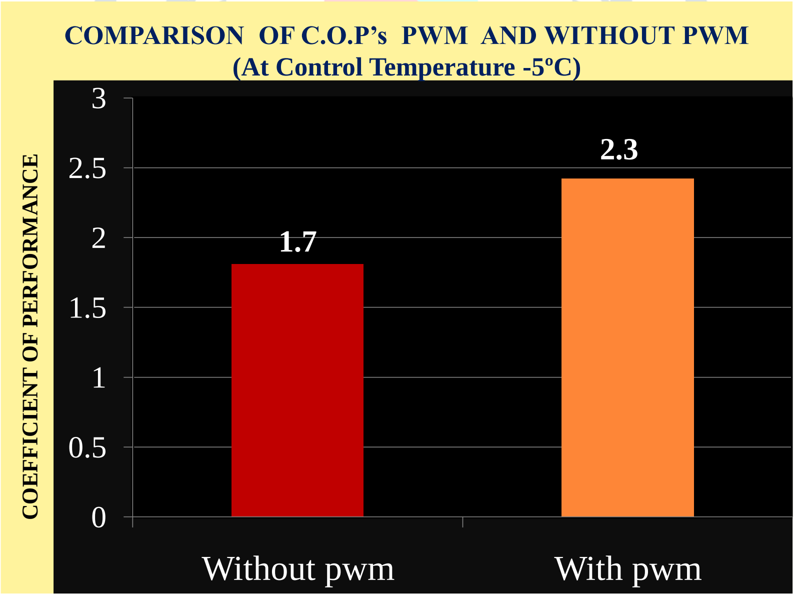

**RESULT:-**The power consumption of graph, o to 0.05 Kwh/hr in the performance temperature -5ºC pulse-width modulation (PWM) and without pwm averaged against expected conditions. Will be output automatically. This is very useful in applications such as controlling



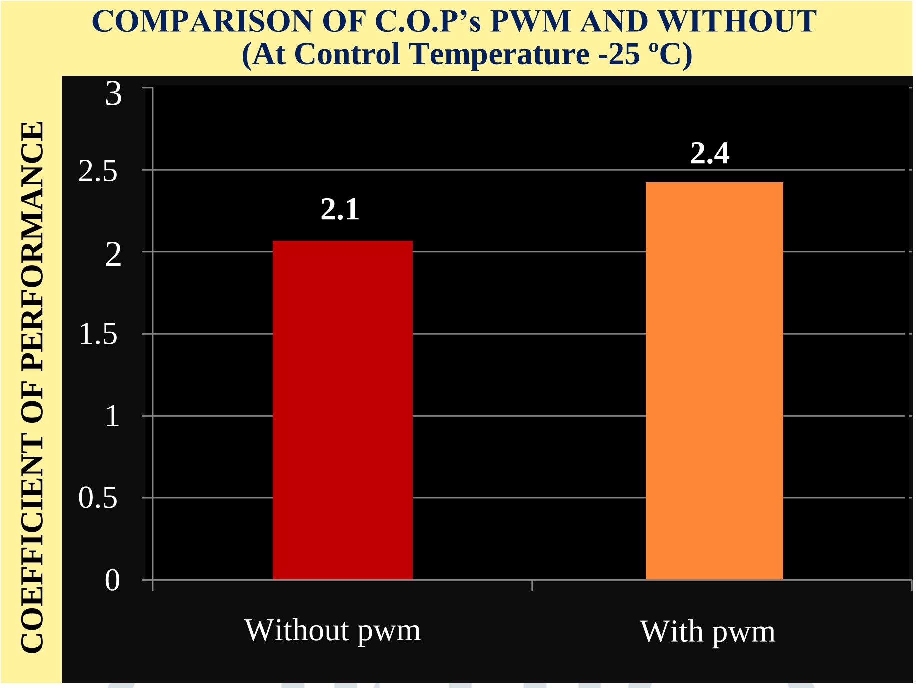

**RESULT:-**The power consumption of graph, o to 1 Kwh/24hr in the performance temperature -25ºC pulse-width modulation (PWM) and without pwm averaged against expected conditions. Will be output automatically. This is very useful in applications such as controlling.




**RESULT: -**The coefficient of performance of graph, maximum time three minute in the performance temperature -0ºC pulse-width modulation (PWM) 2.2 and without pwm 1.6 averaged against expected conditions. Will be output automatically. This is very useful in applications such as controlling.




**RESULT: -** The coefficient of performance of graph, maximum time three minute in the performance temperature -5ºC pulse-width modulation (PWM) 2.3 and without pwm 1.7 averaged against expected conditions. Will be output automatically. This is very useful in applications such as controlling.




**RESULT: -** The coefficient of performance pulse-width modulation (PWM) module giving up to 2.4 maximum COP and while not pwm 2.1 min. coefficient of performance of a heat pump may be a ratio of heating or cooling tried that consumes power. Higher COP equate to less operating cost. The coefficient of performance could exceed one, as a result of it's a ratio of output: loss, not like the thermal efficiency ratio of output input energy For complete systems COP ought to include energy consumption of all auxiliaries COP is extremely dependent on operative conditions, particularly temperature and relative temperature between sink and system, and is commonly graphed or averaged against expected conditions are output mechanically. This is often very useful in applications like controlling.

## CONCLUSION

A supermarket refrigeration system that is performed on a timed basis consumes excess current. Defrosting of show cases additionally disturbs the temperature control of the case leading to temperatures that exceed the planning temperature over a major period of time. The energy consumption throughout the defrost method are often reduced using additional advanced defrost initiation and termination techniques supported demand instead of timed defrost. Though variety of various demands defrost ways are projected within the past, none has found wide acceptance within the food retail refrigeration industry because of poor reliability and high cost of capital. Nowadays there are several applications to reduce the absorbed Powers needs of refrigeration hardware in method cooling industries, commercial air conditioning and information centers facilities. The optimum operation of refrigeration instrumentation at partial masses is particularly important in condition wherever the medium annual close air temperatures are between +5°C and +20°C, typical for the vast majority of conditions. For even lower close temperatures the combination of inverter technology as well as that of free-cooling, whereby chilled water are often produce using only fans energy, are often effectively accustomed produce excitation units with even larger efficiencies than previously thought-about possible .I have developed a new experimental working model of V.C.R.S. with PWM technique and applied it for supermarket refrigeration system .This technique is appropriate to be used by power management schemes for reduction of refrigeration masses. This technique gives reduction in power consumption of operating system, saving in money and saving in time because of faster cooling rates.

In supermarket refrigeration systems pwm techniques play an advantageous role. Refrigeration system consume power at $0^oC$; 0.0308 Kwh/hr without pwm and consume power 0.0255 kwh/hr with pwm technique. And at $-5^0C$; power consumption is 0.044 kwh/hr without pwm and 0.0251 kwh/hr with pwm technique. Power consumption at $-25^0C$ is 0.89 kwh/24hr without pwm and 0.47 kwh/24hr with pwm. With the help of pwm technique, we can increase the coefficient of performance of the system. The COP of the system at $0^oC$ is 2.2 with pwm and 1.6 without pwm technique. The COP at $-5^0C$ is 2.3 with pwm technique and 1.7 without pwm technique. The COP at $-25^0C$ is 2.4 with pwm technique and 2.1 without pwm technique.

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