



A Novel Analysis Method For The Effect of Coefficient of Performance (Cop) on Solar Refrigerator With Axial D.C. Fans

Kapil Khandelwal¹, Rupanshu Suhane^{2,3}, M. K. Chopra³
Mechanical Department, SRK University, Bhopal, India^{1,2,3}

Abstract- A domestic fridge is utilized practically in each home for safeguarding food things, cooling the water, and some more. A cooler has primarily four parts that run the fridge and these are the blower, condenser, choking valve, and evaporator. This test examination is done on a homegrown fridge controlled by a sunlight-powered charger. This examination is explored on a cooler with additional fans fitted on the backboard of the fridge. These fans were the primary alteration in this analysis since it works on the presentation of the cooler. Crafted by the fans is to cool the condenser (cylinder and wire network). This cooling is finished by constrained air cooling which isn't finished by the normal air cooling in a straightforward fridge. The air conveys the warmth of the condenser and moved it to the climate. The fans utilized here are hub fans. These fans were worked by an immediate current which is provided by the battery. In this test, the refrigerant which is coursing through the cooler chills off by fans thus the temperature lets down. This refrigerant is extended (by the choking gadget) and afterward, the temperature of the refrigerant diminished to a lot lesser worth in contrast with the cooler which is worked without fans. Then, at that point, this lower temperature refrigerant went to the evaporator. The evaporator removes heat from the food things and cools the food things in lesser time because of this additional decrement in temperature. In this exploratory arrangement refrigerant, R134a is utilized in the fridge. Here the solar-powered charger is utilized to run the fridge. The solar-powered charger is a sustainable wellspring of energy. An inexhaustible wellspring of energy is that energy that can be recharged over and over. It never closes because solar-based energy is accessible in an exceptionally large sum. The energy utilized in this examination is without contamination. This work will build the reliance on sustainable power since it just takes a one-time venture and the support is less. In this test set-up, execution tests were done under the controlled surrounding condition. At the point when the fridge is worked without a fan the cooling got is less and the cooling got by the fan-worked cooler is extremely high. The fridge without fans sets aside more effort to changes water into ice in examination over to the fans-worked cooler in the cooler. So this fan-worked cooler gives excellent outcomes. There is a lot of contrast between fridges worked with fans and without fans. The outcome shows that the homegrown fridge with D.C. pivotal fans gives a superior coefficient of execution (COP) in contrast with the basic homegrown cooler. This outcome shows that the normal coefficient of execution (COP) of the homegrown fridge with D.C. pivotal fans was 0.038 higher than the basic homegrown cooler in the concentrated range. It is seen that for the main hour COP was lower for the cooler with a fan yet it then, at that point expanded for the remainder of the time. The exploratory examination result shows the refrigeration impact for the cooler with the fan was about 7.02% higher than the fridge without a fan. In this exploratory perception, the cooler lodge temperature was additionally diminished for the fridge with a fan. Additionally, the condenser temperature was lesser for the cooler with a fan and higher without a fan. So this test gives the further developed presentation of the fridge. After the change, it upgrades the coefficient of execution just as the refrigeration impact.



Keywords:- D C Fan, Solar Panel, Solar Energy, COP.

Introduction

A cooler that is utilized in the family is by and large called a homegrown fridge and its compartment is protected thermally. It moves heat from within compartment to the external climate by the utilization heat siphon and in this manner the cooler is cooled to the underneath room temperature. The term refrigeration is depicted as diminishing the temperature of an encompassed shut space when it eliminates heat from shut space to the climate. A fridge is a gadget that devours power. Because of the expanding interest for fridges power utilization is intensely expanded lately. In India, a larger piece of power is delivered by coal-terminated force plant which runs on non-renewable energy source (coal). These fossils are restricted and in this way these are finished very soon. So we are currently moving towards inexhaustible wellsprings of energy like sun oriented energy, wind energy, geothermal energy, and some more. Different investigates are going on in which the presentation of the VCRS framework is expanded. M.Z. Sharif explored in the field of VCRS where he utilized nanorefrigerant and nano ointments hence expanded the warmth move, warm conductivity, and COP [1]. Presently, in this work sun based energy is used to run the fridge. This sun based energy is utilized to created power by the utilization of a sunlight based charger (a semiconductor material).

The cooler is an extremely helpful machine in houses since it lessens the propagation pace of microscopic organisms. All things considered, in the cooler, the temperature is extremely low and at this temperature, microscopic organisms are not created. The accompanying table is intended for various food varieties and their stockpiling life and capacity temperature:

Coolers are utilized all over and in each field. In the clinical field, coolers are extremely fundamental in light of the fact that there are many prescriptions and medications which will ruin in typical surrounding conditions. One model is the rabies immunization which is safeguarded in the fridge. It is utilized in the assembling business for the cool treatment of metals. The elements of precession parts and check blocks are doused at around - 90 °C and it very well may be settled at this temperature. The existence of the cutting instrument can be expanded by keeping the cutting device at - 100°C for 15 minutes. Refrigeration frameworks in rustic regions are extremely helpful. In rustic regions, the immunization is put away by utilizing a sun powered energy-driven refrigeration framework. It is additionally utilized in food preparing plants. For the debasement of food, there are some capable microscopic organisms, and enzymatic preparing cause aging of the products of the soil. At low temperatures, the development of microorganisms and enzymatic cycles are diminished. This refrigeration framework is controlled by a sunlight powered charger. Jai Kishor Verma researched the financial measuring of the sun based photovoltaic framework for the homegrown fridge [3]. For the homegrown employments of PV cells, they should be upgraded. Because of the upgraded framework, it decreases energy utilizations. R. Rawat likewise explored the enhancement of the PV-based framework. In this examination, the framework is streamlined by numerical demonstrating conditions and philosophies [8].

II. Related Work

M.Z. Sharif et al. investigated the instrument for upgrade in VCRS framework execution. In this paper the warmth move and the sanitization of refrigerant oil combination trademark and furthermore the tribology properties upgrades have been seen which influence the VCRS execution. Furthermore, by this review we came to realize that the utilization of nanorefrigerants expanded the warmth move execution of VCRS uncommonly in pool bubbling and nucleate bubbling warmth move and furthermore expanded by the utilization of nanolubricants. The usage of these expanded the general presentation of VCRS which identified with the cooling limit and coefficient of execution (COP) of the framework. In this test the use of these expanded the warmth move coefficient from 12% to 101%. Warm conductivity was expanded up to 4%. The



nanolubricants utilized in these examinations decreased the grinding coefficient by 32% and wear rate up to 13%. The warmth move, refrigerant oil combination was expanded because of the impact of nanolubricants and in this way it expanded the 24% of COP. It additionally lessens 11% blower work in this manner enhanced the general exhibitions of the VCRS framework. [1]

Jai kishor Verma et al. examined about acquiring the ideal size of the photovoltaic framework for refrigeration framework and by this paper we come to realize that to meet the prerequisite 1.3 units of 100W photovoltaic are required, a 150W photovoltaic unit which is accessible in external market might be worked for something very similar and the inverter size based on test computation is came to be 462.3W. [2]

F. Illán-Gómez et al. researched the exhibition of a water chiller which is utilized for private AC when an alternate kind of condenser is utilized known as mini channel rather than an ordinary fin and tube condenser. On concentrating on this paper we come to realize that in practically all cases concentrated on the all out mass of refrigerant is lower utilizing a mini channel curl as condenser. Sub cooling is just the vitally trademark conduct that causes the mass decrease when utilizing the mini channel. [3]

Zhenya Zhang et al. researched for the improving of the wind stream field by putting the condenser, fan and blower are put in a line and inside the fridge base. By this paper we came to realize that general wind current rate will drop by some worth. In this analysis the twisting sort condenser is utilized in which froth is put in the external and focal ring. The fan which was place in the middle of the twisting condenser and blower incited the air from winding condenser and constrained the air to the blower. The external froth ring and focal froth were utilized in this paper so it further develops the wind stream dispersion around the twisting wire on tube condenser (SWTC). The focal froth ring was introduced in the upstream part to deter the empty focal point of the twisting condenser. Accordingly more wind current was coordinated to go through and trades heat with twisting wire on tube condenser (SWTC) and in this manner causing decrement in condenser center and outlet temperature by 0.76°C and 0.72°C. The gathering temperature was diminished which added to less refrigerant warmth relocation into evaporator from twisting condenser during blower off period. Because of this blower off time was expanded by 4.09%. In this manner fridge energy utilization was diminished by 2.37%. [4]

Wen-long Cheng et al. read for the making do of the warmth move of the condensers and evaporators. In this paper double energy stockpiling (DES) cooler and it is fitted with both warmth stockpiling condenser (HSC) and cold stockpiling evaporator (CSE). By the utilization of dynamic recreation models it was dissected between HSC, CSE and DES and examinations were completed to discover the most ideal alternatives among them. On concentrating on this paper it result came that the DES fridge has the best H.T. also, trademark execution among all. It further develops the refrigeration effectiveness, cooling limit, fume pressure and evaporator temp. [5]

K. Harby et al. presents a broad survey of the cutting edge of evaporative condensers utilized in private cooling frameworks refrigeration, cooling, and warmth siphon frameworks. By this we came to realize that the force utilization was diminished up to 58% and the COP can be improved by about 113.4% by the utilization of air cooled condenser. [6]

Rahul Rawat et al. dissected on a thorough planning cycle of sun powered photovoltaic water siphoning framework, independent V framework and matrix associated photovoltaic framework is introduced. In this paper of photovoltaic units, cell temperature, water siphoning framework and battery condition of charge were demonstrated and these were organized. Because of this demonstrating, it can propose a photovoltaic framework which can base on techno-financial factors. By this paper the outcome came out to be the fundamental variables for ideal measuring of SWPS, independent and framework associated photovoltaic frameworks were that the engine force, load the executives and effectiveness bend of inverters. [7]

J.G. Bustamante et al. examined on a model of an agent air-cooled condenser (ACC) framework which is created to investigate the possibility to alleviate this punishment through methods that diminish the air-side warm obstruction. By concentrating on this paper the outcome came out to be that wet-cooled power-plant proficiency levels could be accomplished with upgraded ACCs if wind current rates are essentially expanded



(+68%), convection protections fundamentally diminished (−66%), and pressure misfortunes kept up with near customary levels (+24%). [8].

III. Experimental Setup

This test arrangement is a sun oriented controlled homegrown fridge. The all out parts of this set-up are a homegrown cooler, an inverter, a battery and a sunlight based charger. In this set-up the homegrown cooler utilized is of 165 liter which burn-through 92 watt of power. The parts of the fridge are blower, evaporator, condenser, development gadget. This fridge gets power from inverter. DC battery offers inverter to the immediate current and the battery is charged by sunlight based charger (poly translucent sun powered cell). In this set-up condenser has been overhauled and created by four D.C. hub fans (75×75mm) put rear of the fridge and within the condenser so that more warmth move happen. These fans are fixed with the twofold tape on the back board of the fridge. After that these were affixed by the electric tape, so it didn't move when it run. These four fans were fixed at four corners of the condenser. These fans are fueled by battery. The fans were made out of plastic material.

One more manufacture has been done in the higher and lower pressure side of the fridge by pressure measures. One tension measure is added on higher strain side which is soon after the blower. These strain measures were added by welding measure. Right off the bat tubes were cut and afterward additional container of copper metal was welded with this cylinder. High tension measure was fixed by the nut with the copper tube and was appended to the back bureau. Same was finished with the lower pressure measure. High tension check shows the high strain of the refrigerant. This tension check tone is red. Second strain check is added on lower pressure side which is evaporator pressure. It is added before the blower and after the evaporator and this shows the lower tension of the refrigerant. Its tone is blue.

One iron line stand is made for the sun powered charger which has the base 4×2 feet. Back leg is 3 feet and front leg is 2 feet this made the stand 1 feet incline. At this measurement it has a point of 14° however for the point 23° one little piece of the greater line is welded in rear of the construction. One more modest size however longer line is set inside it and made an opening. One pole is put inside the opening so it firms at that point, so when sun powered charger is set on that length it makes a point 23°.

For the temperature estimation thermocouple has been utilized. Here 5 thermocouples of J type were utilized. For showing the temperature at better places one temperature marker was utilized. In this marker two wires of the thermocouple were fixed in the two terminals. In the other two terminals positive and adverse terminals of AC supply were fixed which gave it power for show. After that these thermocouples were put at better places. One thermocouple was put over the container of evaporator delta. Second was put over the container of evaporator outlet. Third was put over the container of blower outlet. Fourth was put over the container of condenser outlet. Last was put inside the cooler. After that this load of changes this set-up was prepared for the test readings.

IV. Result Analysis

Trial information has been gathered in the encompassing climate and estimations for all boundaries on execution of homegrown coolers without fans and with fans have been done. The readings were taken at same surrounding temperature and relative stickiness for the homegrown fridges without fans and with fans. For the correlation of homegrown coolers without fans and with fans COPs have been determined on my noticed incentive for both the conditions. Likewise correlations between cooler temperatures, condenser outlet temperatures and so forth have been done.

The outcomes acquired for every one of the investigations which were created utilizing the homegrown cooler without fan and with fan contemplated are displayed underneath. As per chart 4.1 the estimations got for the cooler without fan and with fan which shows the variety of COP with time has the expanding incline for the fridge with fan. The outcome shows that the cooler with fan has a normal COP addition was 4.326%.



Additionally different boundaries for the cooler with fan were better in contrast with the fridge without fan. RE for the cooler with fan was more than the fridge without fan which has displayed in chart 4.2. Cooler temperature for the fridge with fan was lower than the fridge without fan which has displayed in diagram 4.3. Condenser outlet temperature for the cooler with fan was lower than the fridge without fan which has displayed in diagram 4.4. Blower outlet temperature for the cooler with fan was lower than the fridge without fan which has displayed in diagram 4.5.

4.1. Average experimental data for the refrigerator without fan:

Time	Compressor Outlet temp.(°C)	Condenser Outlet temp.(°C)	Freezer Temp.(°C)	Refrigeration Effect (KJ/Kg)	COP
11:30 AM	54.285	37.857	3.57		
12:00 PM	66.571	42.714	1.850	141.714	4.034
12:30 PM	67.857	43.142	0.142		
1:00 PM	69.428	44.142	-1.285	134.285	3.020
1:30 PM	69.714	44.714	-2.142		
2:00 PM	70.714	44.714	-2.428	131.142	2.680
2:30 PM	71.000	44.857	-2.857		
3:00 PM	71.428	44.857	-3.142	130.428	2.540

Table 4.9.1: Average experimental data for the refrigerator without fan

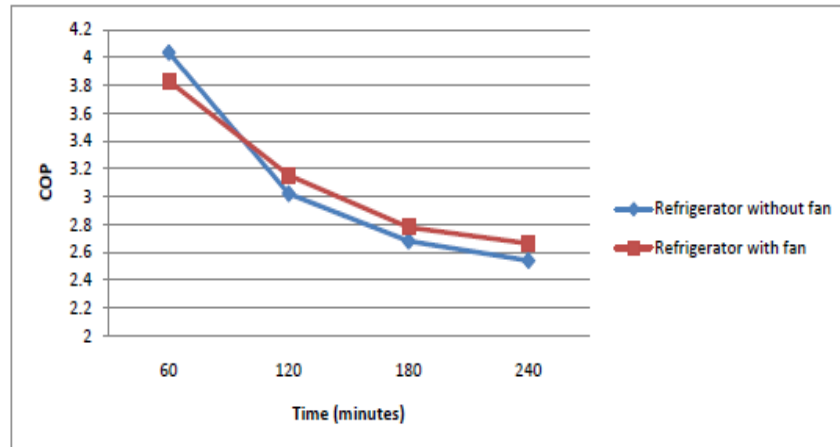
4.2. Average experimental data for the refrigerator with fan:

Time	Compressor Outlet temp.(°C)	Condenser Outlet temp.(°C)	Freezer Temp.(°C)	Refrigeration Effect(KJ/Kg)	COP
11:30 AM	56.857	34.000	1.285		
12:00 PM	63.714	35.571	-0.285	150.142	3.831
12:30 PM	64.571	36.714	-1.714		
1:00 PM	64.857	37.000	-2.285	145.142	3.153
1:30 PM	65.285	37.428	-3.142		
2:00 PM	65.428	37.714	-3.714	139.857	2.779
2:30 PM	66.428	37.857	-4.000		
3:00 PM	66.428	37.714	-4.285	139.142	2.664

Table 4.9.2: Average experimental data for the refrigerator with fan



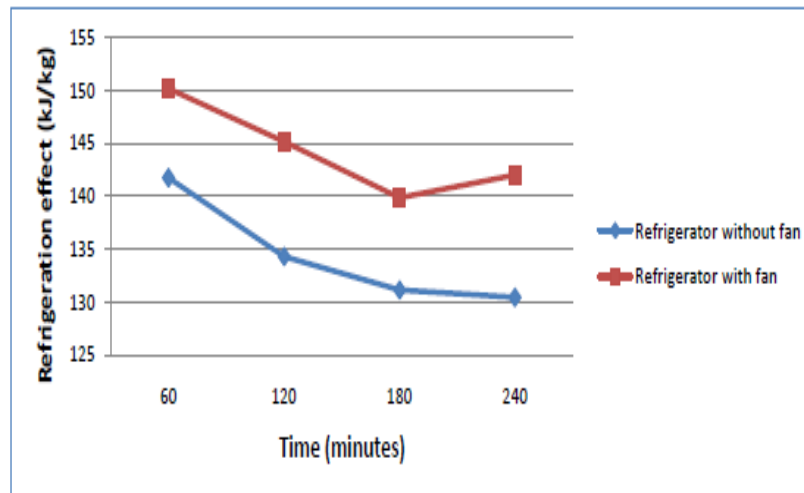
4.3. Variation of COP with time:



Graph 4.9.1: Variation of COP of without fan and with fan

It is seen that COP of cooler with fans was lower in initial an hour then it expanded in contrast with fridge without fans and continued expanding. So the COP of fridge with fans was higher. The negative slant of COPs shows that RE gets brought down with the time. This outcome shows the normal coefficient of execution (COP) of the homegrown fridge with D.C. pivotal fan has 0.038 higher than basic homegrown cooler in the concentrated on range.

4.4. Variation of refrigeration effect (RE) with time:

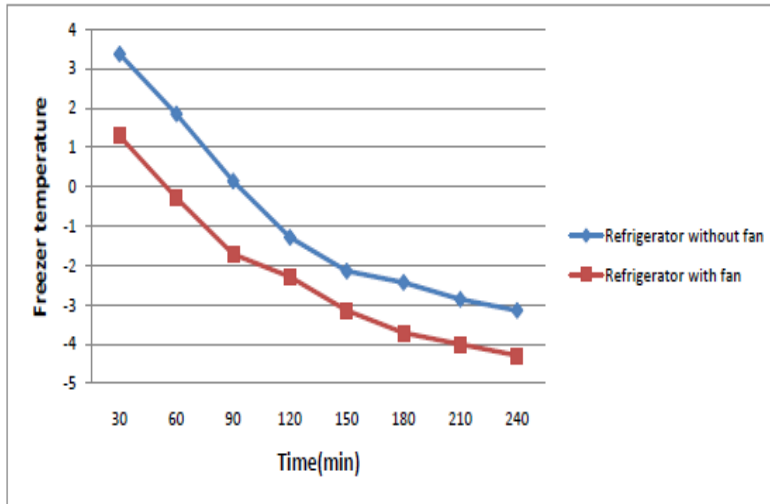


Graph 4.9.2: Variation between R.E. and time (min) of without fan and with fan

It is seen that refrigeration impact (RE) of fridge with fan was higher and has expanding incline. It was happened in light of the fact that the fan chills off the condenser at lower temperature than cooler without fan, so the extension made a much lower temperature and subsequently RE was expanded.



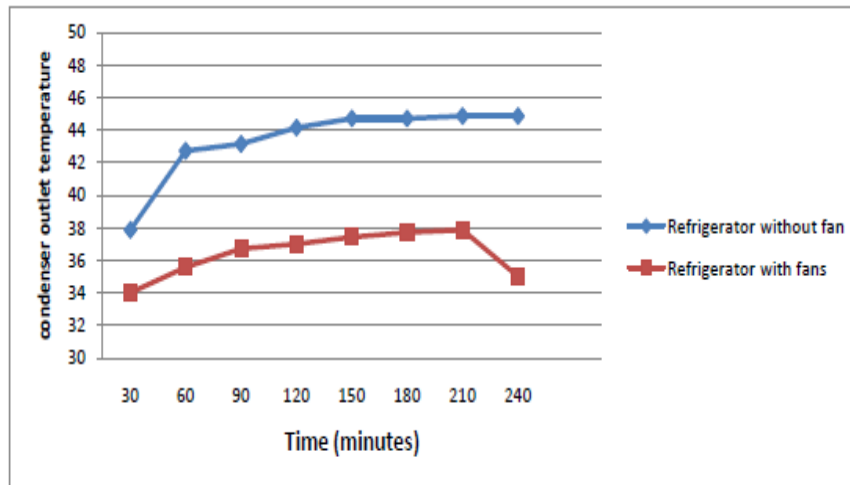
4.5. Variation of freezer temperature with time:



Graph 4.9.3: Variation between freezer temperature and time (min) of without fan and with fan

It is seen that the cooler lodge temperature of fridge with fan was lower than the fridge without fan. It is excellent outcome on the grounds that as much as lower the cooler lodge temperature it chills off the food things in lesser time.

4.6. Variation of condenser outlet temperature with time

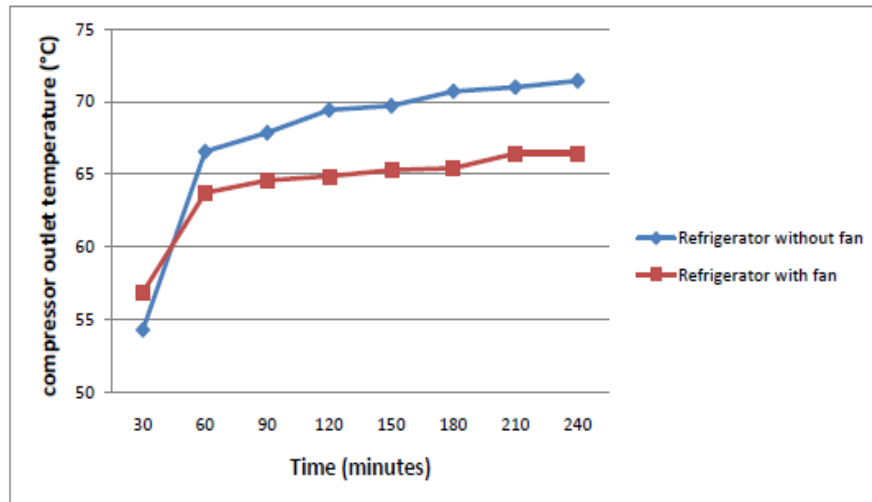


Graph 4.9.4: Variation between condenser outlet temperature and time of without fan and with fan

It is seen that condenser outlet temperature of cooler with fan was lower than the fridge without fan. It is generally excellent outcome as a result of it COP of fridge with fan expanded.



4.7. Variation of compressor outlet temperature with time



Graph 4.9.5: Variation between compressor outlet temperature and time (min) of without fan and with fan

It is seen that blower outlet temperature of fridge with fan was lower than the cooler without fan. It is awesome outcome. Because of the lower blower outlet temperature the pressure proportion was brought down and hence the pressure work has brought down. So the COP was expanded.

V. Conclusion

An exploratory examination contemplated on homegrown fridge having D.C. pivotal fans for the investigation of coefficient of execution has been made. A progression of test tests have been done for the examination of homegrown cooler with fan and without fan where D.C. pivotal fans were included the set-up. In every one of the trial tests result shows that normal COP for the cooler with fan is about 0.038 higher than the fridge without fan. Just for the first hour COP of the cooler with fan was less however after that COP got an expanding pattern and it keep going for the 4 hours. The rate addition was 4.326%. In this manner the general COP for the fridge with fan has higher than the cooler without fan. It has been seen that RE for the cooler with fan is about 7.02% higher than the fridge without fan. The tests show that the condenser temperature for the fridge with fan was lower than the cooler without fan. The condenser temperature for the cooler with fan let down up to 35°C yet it went up to 40°C for the fridge without fan. Investigation additionally shows the distinction in cooler lodge temperature around 1-2 °C. The cooler with fan has lower temperature than the fridge without fan in the cooler lodge. The cooler temperature for the fourth hour has gone up to - 5°C yet in the fridge without fan it goes simply up to - 4°C. In future there might be greater fans be utilized for the homegrown cooler with the goal that higher warmth move might happen. In future there is extension for fans with higher rpm. In future in the homegrown cooler number of fans might be expanded. In future fan position might be changed and utilized as actuated draft fan. In future the surface space of condenser might be expanded.

References:-

[1] M.Z. Sharif, W.H. Azmi, R. Mamat, A.I.M. Shaiful "Mechanism for improvement in refrigeration system performance by using nanorefrigerants and nanolubricants" International Communications in Heat and Mass Transfer, Vol.92, (2018),pp. 56-63.



-
- [2] Jai kishor Verma, Raja Sekhar Dondapati “Techno-economic sizing analysis of solar PV system for Domestic Refrigerators” in *Energy and Building*, Vol- 144, (2017),pp. 286-292.
- [3] F. Illán-Gómez, J.R. García-Cascales, F. Hidalgo-Mompeán, A. López-Belchí “Experimental assessment of the replacement of a conventional fin-and-tube condenser by a mini channel heat exchanger in an air/water chiller for residential air conditioning” in *Energy and Building*, Vol. 144,(2017),pp. 104-116.
- [4] Zhenya Zhang, Dong Huang,Rijing Zhao, Yongqiang Leng “Effect of airflow field optimization around spiral wire-on-tube condenser (SWTC) on a frost-free refrigerator performance” in *Applied thermal engineering*, Vol-114, (2016), pp. 785-792.
- [5] Wen-long Cheng, Miao Ding, Xu-dong Yuan, Bing-Chuan Han “Analysis of energy saving performance for household refrigerator with thermal storage of condenser and evaporator” in *Energy conversion and management*, Vol-132, (2016), pp. 180-188.
- [6] K. Harby, Doaa R. Gebaly, Nader S. Koura, Mohamed S. Hassan “Performance improvement of vapor compression cooling systems using evaporative condenser: An overview” in *Renewable and sustainable energy review* Vol-58, (2015), pp. 347-360.
- [7] Rahul Rawat, S.C.Kaushik, Ravita Lamba “A review on modeling, design methodology and size optimization of photovoltaic based water pumping, standalone and grid connected system” in *Renewable And Sustainable Energy Review*, Vol- 57,(2015), pp.1506-1519.
- [8] J.G. Bustamante, A.S. Rattner “Achieving near-water-cooled power plant performance with air-cooled Condensers” in *Applied thermal engineering*, Vol-105,(2015), pp. 1359-4311.
- [9] B.L. Gupta, Mayank Bhatnagar, Jyotirmay Mathur “Optimum sizing of PV panel, battery capacity and insulation thickness for a photovoltaic operated domestic refrigerator” in *Sustainable Energy Technologies and Assessments*, Vol- 7,(2014), pp. 55-67.
- [10] Fatemeh Ghadiri, Mehdi Rasti “The effect of selecting proper refrigeration cycle components on optimizing energy consumption of the household refrigerators” *Applied thermal engineering*, Vol-67, (2014), pp. 335-340.
- [11] Vahid Vakiloroayaa, Bijan Samalib, Kambiz Pishghadam “A comparative study on the effect of different strategies for energy saving of air-cooled vapor compression air conditioning systems” in *Energy and building*, Vol-74, (2014), pp. 163-172.
- [12] B.O. Bolaji, M.A. Akintunde, and T.O. Falade, “A performance comparison of vapor compression refrigeration system using various alternative refrigerants” *International communications in heat and mass transfer*, Vol-37, (2011), pp. 1340-1349.
- [13] Tzong-Shing Lee, Wu-Chieh Wu, Yew-Khoy Chuah, Sheng-Kai Wang “An improvement of airflow and heat transfer performance of multi-coil condensers by different coil configurations” *International journal of refrigeration*, Vol-33,(2010), pp. 1370-1376.
-



[14] A.S.Dalkilic, S. Wongwises “A performance comparison of vapor compression refrigeration system using various alternative refrigerants” international communications in heat and mass transfer, Vol-37, (2010), pp. 1340-1349.

[15] Ching-Song Jwo, Chen-Ching Tin, Wei-Ru Wang, “Efficiency analysis of home refrigerators by replacing hydrocarbon refrigerants” Measurement, Vol-42, (2009), pp. 697-701.

[16] https://www.brighthubengineering.com/hvac/66729-domestic-refrigerator-parts-and-their-working/#imgn_1

[17] <http://www.enggcyclopedia.com/2012/01/typical-vapor-compression-refrigeration-cycle-vcr/>

[18] Refrigeration and air conditioning – author REX MILLER, page no. 274

[19] <https://www.friopecas.com.br/evaporador-referigerador-crp38a-326003377/p>

[20] <https://mygreenmontgomery.org/2016/solar-energy-demystified/>

[21] <https://www.greenmatch.co.uk/blog/2015/09/types-of-solar-panels>.