International Journal of Engineering Technology and Applied Science

(ISSN: 2395 3853), Vol. 2 Issue 9 September 2016

A Review Analysis of Alternative of R-22 Using Vapour Compression Cooling System

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Abstract

A theoretical performance study on a conventional vapour-compression cooling with refrigerant mixtures supported HFC134a, HFC152a, HFC32, HC290, HC1270, HC600, and HC600a was done for numerous ratios and their results square measure compared with CFC12, CFC22 as potential different replacements. In spite of the HC refrigerants' extremely combustible characteristics, they're utilized in several applications, paying attention being paid to the protection of the outflow from the system, as different refrigerants in recent years aren't connected with any result on the depletion of the ozonosphere and increase in warming. Theoretical results showed that every one of the choice refrigerants investigated within the analysis have a rather lower performance coefficient (COP) than CFC12, CFC22, and HFC134a for the condensation temperature of 50 °C and evaporating temperatures go between −30 °C and 10 °C. Refrigerant blends of HC290/HC600a (40/60 by wt. %) rather than CFC12 and HC290/HC1270 (20/80 by wt. %) rather than CFC22 square measure found to be replacement refrigerants among different alternatives during this paper as a results of the analysis. the results of the most parameters of performance analysis like refrigerant kind, degree of sub cooling, and superheating on the cold result, coefficient of performance and volumetrically refrigeration capability also are investigated for numerous evaporating temperatures.

KEYWORDS: Refrigeration, Alternative refrigerant, CFC12, CFC22, Hydro Chloro Fluoro Carbon

1. INTRODUCTION

Recently, the gas depleting potential (ODP) and heating potential (GWP) became the foremost vitalcriteria within the development of recent refrigerants excluding the refrigerant CFCs and HCFCs, each of that have high ODP and GWP, owing to the their contribution to ozonosphere depletion and heating. In spite of their high GWP, alternatives to refrigerant CFCs and HCFCs like hydro halocarbon (HFC) refrigerants with their zero ODP are most popular to be used in several industrial and domestic applications intensively for a decade. HFC refrigerants even have appropriate specifications like non-flammability, stability, and similar vapor pressure to the refrigerant CFCs and HCFCs. the issues of the depletion of ozonosphere and increase in heating caused scientists to analyze a lot of setting ally friendly refrigerants than HFC refrigerants for the protection of the environment like organic compound (HC) refrigerants of gas, isobutene, n-butane, or organic compound mixtures as operating fluids in refrigeration and air con systems. though HC refrigerants have extremely ignitable characteristics (A3) consistent with the standards of ASHRAE as a negative specification, they need not solely many desirable specifications like zero gas depletion potential, terribly low heating, non-toxicity, and better performance than different refrigerant sorts however conjointly high miscibility with oil and smart accordance with the present refrigerant systems.

They are employed in several applications attentively being paid to safety of the leak from the system as for different refrigerants in recent years.

Many investigations are conducted within the analysis into substitutes for CFC12 and CFC22. Wongwises et al. [1] given associate experimental study on the applying of organic compound mixtures to interchange HFC134a in automotive air conditioners. The hydrocarbons investigated are gas (R290), alkane series (R600), and isobutene (R600a). The measured knowledge are obtained from Associate in Nursing automotive air con take a look at facility utilizing HFC134a because the refrigerant.

Wongwises associated Chimres [2] given an experimental study on the applying of a combination

International Journal of Engineering Technology and Applied Science

(ISSN: 2395 3853), Vol. 2 Issue 9 September 2016

of gas, butane, and isobutene to interchange HFC134a in a very domestic icebox. The results showed that a 60%/40% propane/butane mixture was the foremost acceptable different refrigerant. Hammad and Alsaad [3] investigated the performance of a domestic icebox mistreatment LPG (24.4% propane, 56.4% butane, and 17.2% isobutane), that is obtainable regionally in several countries, is cheap, associated possesses an environmentally friendly nature with no gas depletion potential (ODP), as another refrigerant to CFC12. Jung et al. [4] used a propane/isobutane (R290/R600a) mixture to work out their performance for domestic refrigerators. consistent with their physics cycle analysis, the propane/isobutane mix within the composition vary from zero.2 to 0.6 mass fraction of gas yields a rise within the constant of performance (COP) of up to a pair of.3% compared to CFC12. Granryd [5] mentioned the probabilities and issues of mistreatment hydrocarbons as operating fluids in refrigeration instrumentation. In spite of their flammability specification, it's shown in his paper that different refrigerants is obtained by suggests that of hydrocarbons for energy economical and environmentally friendly refrigerant instrumentation and warmth pumps. Han et al. [6] studied a replacement organic compound refrigerant mixture rather than R407C for vapour-compression refrigeration systems through an experiment. As a results of the experimental and theoretical analyses, their new ternary non-a-zeotropic mixture of R32/R125/R161, whose ODP and GWP are zero and below

R407C severally, showed higher refrigerant capability and constant of performance (COP) than R407C. Park et al. [7] tested two pure hydrocarbons and 7 mixtures composed of gas, propane, HFC152a, and di-methyl ether as another to HCFC22 in residential air-conditioners and warmth pumps. Their experimental results show that the constant of performance (COP) of those mixtures is up to five.7% more than that of HCFC22. Mani and Selladurai [8] performed experiments employing a vapour-compression cooling with the new R290/R600a refrigerant mixture as a substitute refrigerant for CFC12 and HFC134a. Consistent with the results of their experiments, the refrigerant R290/R600a had a refrigerant capability 19.9% to 50.1% more than that of R12 and 28.6% to 87.2% than that of R134a. The R290/R600a blend's performance coefficient (COP) is improved by three.9–25.1% compared thereto of R12 at lower evaporating temperatures and by eleven.8–17.6% at higher evaporating temperatures. The refrigerant R134a had a rather lower coefficient of performance (COP) than R12. Chen and Yu [9] given a replacement refrigeration cycle, introduced as another refrigeration cycle applied in residential air-conditioners, mistreatment the binary non-a-zeotropic refrigerant mixture R32/R134a. As a results of the comparison between the traditional cycle configuration and therefore the new one, the constant of performance (COP) will increase by 8 May 1945 to 11th of September compared to the traditional cycle configuration, and therefore the meter refrigerant capability is augmented by close to nine.5%. During this paper, a vapour-compression refrigeration cycle for binary non-a-zeotropic mixed refrigerants is employed so as to get higher performance. The current study principally concentrates on a theoretical investigation of the performance of the vapour-compression refrigeration cycle. The binary non-a- zeotropic mixtures R-290/R-600, R-290/R-600a, R-290/R-1270, R-290/R-152a, and R-32/R-134a in numerous concentrations like R-290/R-600(50/50), R-290/R-600(60/40), R-290/R-600(70/30), R-290/R-600(80/20), R-290/R-600a(40/60), R-290/R-600a(50/50), R-290/R-600a(60/40), R-290/R-600a(70/30), R-290/R-1270(20/80), R-290/R-1270(50/50), R-290/R-1270(60/40), R-290/R-1270(80/20), R-290/R-152a(60/40), R-290/R-152a(70/30), R-290/R-152a(80/20), and R-32/R-134a(30/70) are used because the operating fluid for the comparison with the traditional refrigerants R12, R134a, and R22. Results or consequences of the most parameters of performance analysis like refrigerant sort and degree of sub cooling and superheating on the refrigerant effect (RE), coefficient of performance (COP) and volumetrically refrigeration capability (VRC) square measure investigated for varied evaporating temperatures loco mote between −30 and 5 °C and a relentless condensation temperature of 50 °C.

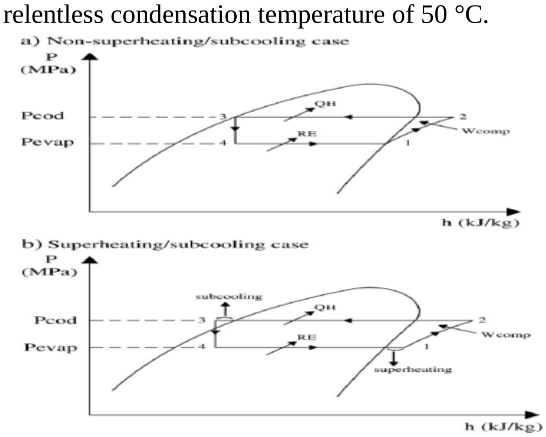


Fig.1 Traditionavapour-compression refrigeration cycle used in the analysis for the cases of (a) non-

superheating/sub cooling and (b) superheating/sub cooling.

2. REFRIGERATION

Refrigeration may be a method of moving heat from one location to a different. The work of warmth transport is historically driven by mechanical work, however can even be driven by heat, magnetism, electricity, laser, or alternative means that. Refrigeration has several applications, including, however not restricted to: household refrigerators, industrial freezers, cryogenics, and air-con. Heat pumps might use the warmth output of the refrigeration method, and conjointly is also designed to be reversible, however square measure otherwise almost like refrigeration units.

Refrigeration has had an outsized impact on business, lifestyle, agriculture and settlement patterns. The thought of protective food dates back to the traditional Roman and Chinese empires. However, refrigeration technology has speedily evolved within the last century, from ice harvest to temperature-controlled rail cars. The introduction of cold rail cars contributed to the westward growth of the u. s., permitting settlement in areas that weren't on main transport channels like rivers, harbors, or depression trails. Settlements were conjointly developing in sterilized components of the country, full of new natural resources. These new settlement patterns sparked the building of enormous cities that square measure able to thrive in areas that were otherwise thought to be inhospitable, like Houston, Lone-Star State and metropolis, Nevada. In most developed countries, cities are heavily dependent upon refrigeration in supermarkets, so as to get their food for daily consumption. The rise in food sources has LED to a bigger concentration of agricultural sales returning from a smaller share of existing farms. Farms these days have a way larger output per person as compared to the late 1800s. This has resulted in new food sources accessible to entire populations that has had an outsized impact on the nutrition of society.

3. STRATEGIES OF REFRIGERATION

The strategies of refrigeration are often classified as follows:

• Non cyclic
• Cyclic
• Thermoelectrical
• Magnetic

Cyclic refrigeration: this is often sub-divided into Vapour cycle Gas cycle Vapour cycle refrigeration is additional classified as Vapour compression refrigeration Vapour absorption refrigeration

4. VAPOUR COMPRESSION COOLING SYSTEM

A vapour compression cooling system uses a refrigerant sealed in associate airtight and leak proof mechanism. The refrigerant is circulated through the system and it undergoes a no of changes in its state whereas passing through varied elements of the system. Every such modification within the state of vapour is termed a method. The method of repetition of an analogous order of operation is termed a cycle.

The compression cycle is given this name as a result of it's the compression of the refrigerant by the mechanical device which allows transfer of warmth energy. The refrigerant absorbs that from one place and releases it to a different place. In alternative words the mechanical device is employed to place the warmth laden refrigerant vapour in such a condition that it's going to dispute the warmth it absorbed at low from the cold house, to associate simply accessible cooling medium.

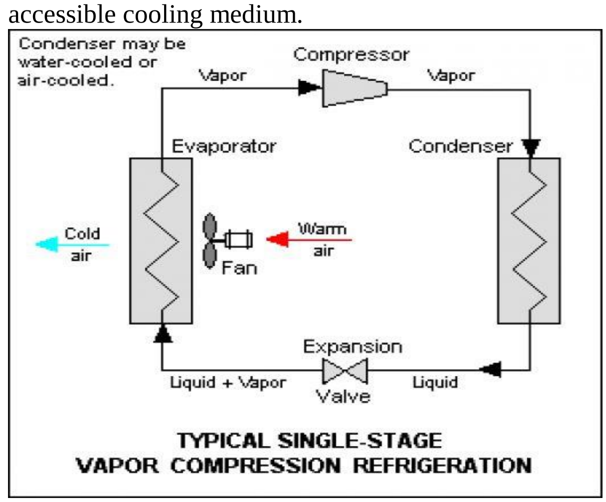


Fig: 2 Block Diagram of Vapour Compression Refrigeration System

5. VAPOR COMPRESSION REFRIGERATION CYCLE

Most of the trendy refrigerators work on this cycle. In its simplest kind there are four basic operations need to finish one cycle.

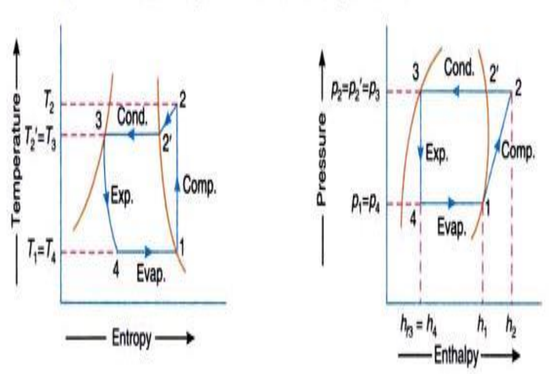
· **Compression**
· **Condensation**
· **Enlargement**
· **Vaporization**

Compression: The low vapor in dry state is drawn from the evaporator throughout the suction stroke of the mechanical device. Throughout compression stroke the pressure and temperature increase till vapor temperature is larger than the temperature of condenser cooling medium.

Condensation: once the high refrigerant vapor enters the condenser heat flows from condenser to cooling medium therefore permitting the gaseous refrigerant to come to liquid state.

Expansion: once condenser the liquid refrigerant is hold on within the liquid receiver till required. From the receiver it passes through associate growth valve wherever the pressure is reduced sufficiently to permit the vaporization of liquid a coffee temperature of regarding -10C.

Vaporization: The low refrigerant vapour once growth within the growth valve enters the evaporator or cold house wherever a substantial quantity of warmth is absorbed by it and refrigeration is well-appointed.



(a) T-s diagram. (b) p-h diagram.

Fig: 3 T-S and P-H Diagram

Coeffieient of performance – it's the quantitative relation of desired impact and work provided .in case of a refrigeratin plant functioning on vapour compression refrigeration cycle , desired impact is that the quantity of warmth extracted from the system continiously and also the work done by the mechanical device for that heat extraction represent the work provided.Above diagram represent the T-S and P-H diadram of vapour compression refrigeration cycle. Acoording thereto diagram theoratical c.o.p is calculated as

(c.o.p) theo = desired effect/work done = (h1-h4)/(h2-h1)

6. RECENT STATE OF AFFIARS

R22 has been wide employed in compression primarily based refrigeration, air-con and warmth pump systems because of its smart physics and thermo-physical properties. because of its poor environmental properties, it absolutely was phased enter several developed countries, whereas the developing countries are in transient to end R22 [1]. throughout last decade, several R22 alternatives refrigerant mixtures are developed, that are summarized and according in review articles [2]. Among the alternatives, the hydrocarbons (HCs) like R290, R1270 and its mixtures R432A, R433A, hydroflurocarbon mixtures (HFCs) like R404A, R407C and R410A and HFC/HC mixtures like R417A and R422A are known because the leading replacements for R22 in refrigeration, air-con and warmth pumps units. The properties of such R22 alternatives are compared in Table one.

The hydrocarbons like R290 and R1270 are according because the attainable alternatives to R22 for residential air conditioners and warmth pumps [3]. Similarly, the organic compound mixtures like LPG mixture composed of R290, R170, R600a (in the quantitative relation of 98.95: 1.007: 0.0397, by mass) [4], R290/R170 mixture (in the quantitative relation of 94:6, by mass) [5], R432A (near azeotrope mixture composed of R1270 and RE170, within the quantitative relation of 80:20, by mass) [6], R433A (near azeotrope mixture composed of R1270 and R290, within the quantitative relation of 70:30, by mass) [7], mixtures composed of R1270, R290, RE170 and R152a [8] are according as alternatives to R22 in compression primarily based refrigeration and air-con units. The according studies confirmed that organic compound primarily based refrigerant mixtures are the nice energy economical and atmosphere friendly different choice to replace the R22 in residential air conditioners. However, because of inconvenience of organic compound refrigerant mixtures according during this section, it's unfeasible to exchange within the existing refrigeration, air-con and warmth pump systems. The flammability is another disadvantage to use it in existing compression primarily based refrigeration systems. Similarly, several investigators tried with greenhouse emission mixtures like R404A, R407C and R410A as leading substitutes for replacement R22 in compression primarily based refrigeration, air-con and warmth pump systems. Out of those 3 substitutes, 404A could be a smart R22 replacement for temperature applications [9]. Similarly, R407C was according as a attainable R22 different for compression primarily based systems used for refrigeration, air-con and warmth pump systems by dynamic the material [10]. variety of investigators tried with R410A as a attainable different to R22 in air conditioners and warmth pumps [11]. the most important drawback related to R410A is its lower essential temperature, that restricts its usage in compression primarily based systems engaging at higher compressing temperatures. Wu et al. [12] investigated the performance of greenhouse emission mixture composed of R152a, R125 and R32, within the quantitative relation of 48:18:34, by mass in a very R22 primarily based domestic air conditioning. Similarly, the performance of binary R32/R134a mixture was investigated for air-con [13] and warmth pump applications [14]. the 2 major issues faced by greenhouse emission refrigerant ar its GWP [15] and its unmixable nature with typical oil [16]. Hence, polyol organic compound oil (POE) is usually recommended for the compression systems operating with greenhouse emission refrigerants. The high absorbent nature of poe demands demanding service practices to avoid wet absorption [17]. because of the on top of limitations with poe, oil lubricants ar most popular. to beat the drawbacks with HC and greenhouse emission refrigerants, the mixtures composed of HC and greenhouse emission was developed [18]. Park et al. [18] investigated the performance of residential air conditioning operating with R22 and R431A mixture composed of R290/R152a (in the quantitative relation of 71:29, by mass). In similar work, Jabaraj et al. [19, 20] used HC composed of R290 and R600a (in the quantitative relation of 45.2:54.8, by mass) to tackle the miscibility issue of R407C with oil in a very residential air conditioning. In another work, Mohanraj et al. [21, 22] used LPG mixture as associate additive with R407C to beat the miscibility issue with oil material. Similarly, the low volatile organic compound part (R600) within the R417A mixture tackles the miscibility issue with oil [23]. The performance of R417A was evaluated for cold storage, heat pump, hair-raiser and residential air conditioners [24].

Similarly, 422 series of refrigerant mixtures were used as alternatives to R22 in a very compression primarily based refrigeration and air-con systems [25-27]. In another work, Nanxi et al. [28] studied the performance, physics properties, miscibility with oil and flammability of a close to azeotropic refrigerant mixture composed of R124/R142b/R600a within the quantitative relation of 0.9:0.08:0.02 (by mass fraction) in a very apparatus. The inconvenience of R417A and R422 series of refrigerants in Indian market is that the major drawback facing in R22 replacement.

In India, the mixture composed of R32 and R125 (in the quantitative relation of 50:50, by mass) could be a without delay out there underneath the business name of R410A. during this work, an effort has been created to mix the R410A with R600a to tackle the miscibility issue and also the drawbacks related to R410A. in addition, the energy performance of the residential air conditioning is in theory assessed with new refrigerant mixtures composed of R32/R125/R600a with completely different mass fractions of R600a.

7. CONCLUSION

In this study, a perfect vapour-compression cooling system is employed for the performance analysis of other new refrigerant mixtures as substitutes for CFC12 and CFC22. Considering the comparison of performance coefficients (COP) and pressure ratios of the tested refrigerants and additionally the most environmental impacts of layer depletion and warming, refrigerant blends of HC290/HC600a (40/60 by wt.%) and HC290/HC1270 (20/80 by wt.%) area unit found to be the foremost appropriate alternatives among refrigerants tested for R12 and R22 severally. The refrigeration potency, the performance constant (COP) of the system, will increase with increasing evaporating temperature for a continuing compressing temperature within the analysis. All systems together with varied refrigerant blends were improved by analyzing the result of the superheating/sub cooling case. higher performance constant values (COP) than those of the non-superheating/sub cooling case area unit obtained as a results of this improvement.

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