RESEARCH ARTICLE OPEN ACCESS

The Impact of using R-410A in Kuwait

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ABSTRACT:
Chlorofluorocarbon (CFC) refrigerants was phased out. Also, Hydrochlorofluorocarbon (HCFC) will be eliminated in the next few years. Researchers and scientists found that those mentioned refrigerants are the main cause of Ozone depletion among other chemicals used for other purposes. R-22, a type of CFC, is used widely in Kuwait and the Middle East region for air conditioning units but recently R-410A is getting more popular. However, Kuwait Market is still selling R-22 itself for maintenance and new units with R-22 for commercial and residential uses. R-410A has higher pressure than R-22 at the same saturated temperature. Therefore, new units must be redesigned, and existing units must retrofit so it can handle this type of pressure.

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I. INTRODUCTION

The HCFCs and CFCs are causing the Ozone to be depleted due to misuse and releasing those refrigerants into the atmosphere. Montreal protocol in 1996 advise to phase out CFCs immediately and accept the usage of HCFC until 2020. Many studies were conducted to discover new refringent that can replace R-22 with similar properties and characteristics. The first alternative refrigerant was R-407C which was mostly accepted around the globe. The second alternative was R-410A which is a blend of R-32 and R-125 with almost the same properties of R-22. R-410 has good thermal exchange compared with R-22 when was tested on high cooling capacity.

R-410A Properties

R-410A (HFC), Hydrofluorocarbon, is azeotropic mixture of R-32 and R-125. Polyolester oil (POE) must be added to use R-410A in refrigeration cycle because other type of oils is not miscible with R-410A or other HFCs. R-410A generates 50% high pressure than R-22. Moreover, R-410 is non-toxic and non-flammable refrigerants.

Table 1: R-22 vs R-410A properties

Properties	R-22	R-410A
Chemical Formula	$CHClF_2$	R-32 and R-125
Molecular	86.5 g/mol	72.6 g/mol
Vapor Pressure **25°C** **50°C**	 10.3 bar 19.3 bar	 16.3 bar 30.5 bar
Ozone Depletion Potential (ODP)	0.055	0

Experiment Description

In this experiment, calculating Energy Efficiency Rating (EER) is important to understand how many BTU are used for each input power in Watt. Therefore, the higher rate of EER, the more efficiency of the unit.One model of Coolex unit PNG-076 uses R-22 and same model uses R-410A with variable-speed compressor to reduce power consumption, have been chosen to conduct this experiment. PNG stand for Package New Generation (Rooftop Unit) is one of the fast-moving products as per Coolex sales department. The mentioned units have those components and specification:

Table 2: Units Specification

Model		PNG-076 R-22	PNG-076 R-410A
Power Supply (Volt/Phase/Hz)		450 V / 3 Ph / 50 Hz	
Compressor		Scroll Hermetic	
Expansion Device		Thermal Expansion Valve	
Condenser		Enhance find & tub	
Condenser Fan	**Type**	Propeller	
	Diameter	610 mm	
	HP	¾	
	RPM	900	
Evaporator		Enhance find & tub	
Evaporator Blower	**Type**	Centrifugal	
	HP	1	

Experimental Procedure and Result

The experiment has been conducted in Coolex laboratory which is approved and certified

by UL and AHRI and passed all the requirements needed by Saudi Standards, Metrology and Quality Organization, ISO 14001, ISO 18001, and Eurovent Certification. These units are tested on ambient temperature of 95°F, 115°F and 118.4°F.

Table 3: Experiment result

Model	CFM	Ambient Temp. 95°F				Ambient Temp. 115°F				Ambient Temp. 118.4°F			
		Cooling Capacity (MBH)	Total Power (KW)	kW/Ton	EER	Cooling Capacity (MBH)	Total Power (KW)	kW/Ton	EER	Cooling Capacity (MBH)	Total Power (KW)	kW/Ton	EER
PNG -076 R-22	2600	79.16	6.7	1.02	12.55	71.24	7.93	1.34	8.98	69.78	8.12	1.4	8.59
PNG-076 R-410A		80.27	6.05	0.90	13.27	72.65	7.21	1.19	10.07	71.35	7.41	1.25	9.63

Chart 1: EER Comparison

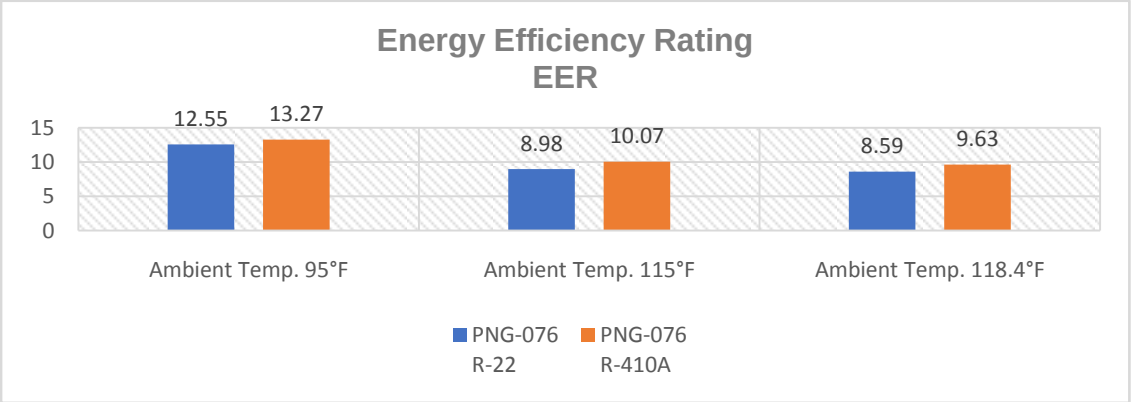


Chart 2: EER for R-22

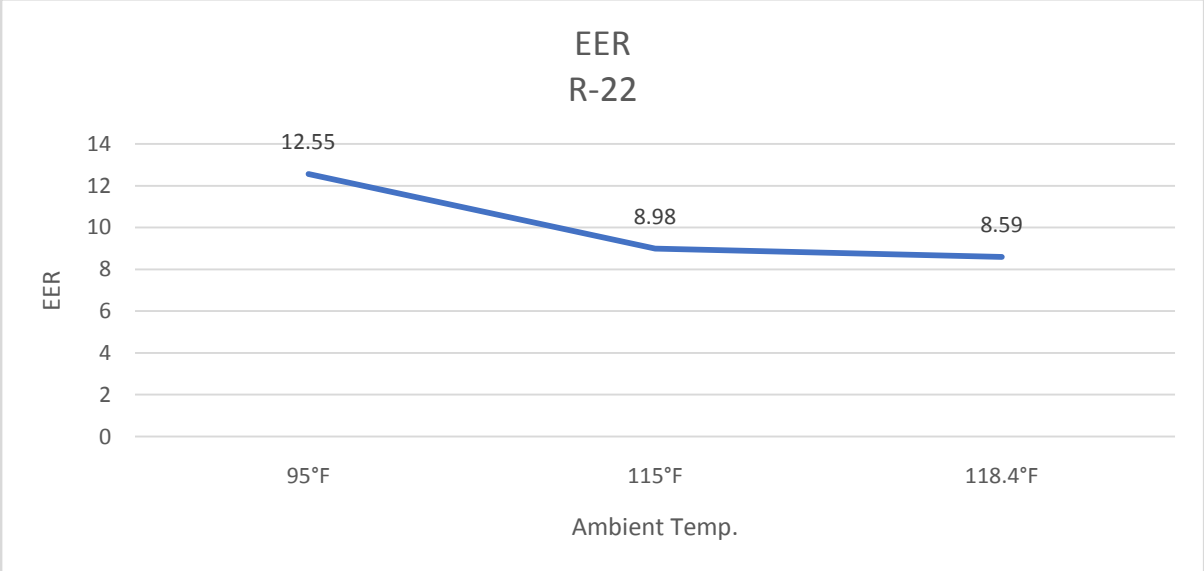
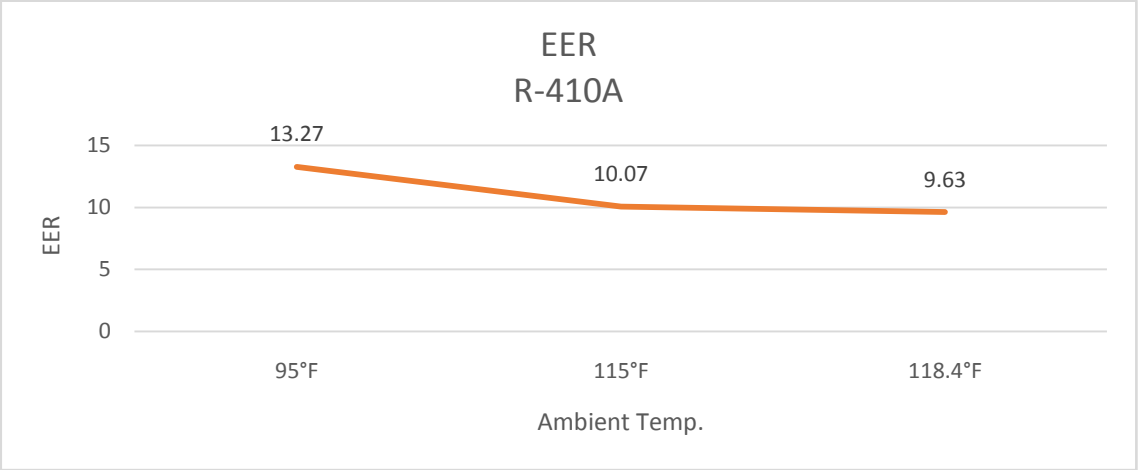


Chart 3: EER for R-410A



According to the tables and charts above, EER for PNG-076 using R-410A is slightly higher than the other unit which means better efficiency of R-410A unit with variable speed compressor. Installing variable speed compressor or retrofitting existing unit has high cost effect on consumer. Moreover, technicians and specialists need training and certification to handle R-410A due its high pressure.

Environmental Impact

Kuwait mainly generates power by using fuel, but lately new renewable energy introduced by the government is aimed to reduce the amount of all types of pollutions and cut the cost on power stations. The power stations and transportation plants are solely owned and supported by the Kuwaiti Government.

75% of electricity bills belong to the consumption of A/C units due to high ambient temperature during summer season in Kuwait, which sometimes exceed 50°C, and the summer season lasts for 9 to 10 months a year. Each Residential villa installed at least 480,000 BTU of A/C units (package or ducted split units). For example, if the total bill is 100 KWD per month, 75 KWD is for using A/C units. Therefore, replacing CFC to any HFC will not reduce the environmental impact or pollution.

Environmental Impact:

Using R-410A in A/C units will consume more power because of its high pressure in high ambient temperature which means more burning of fossil fuel and that leads to air, land and water pollution. Power stationsgenerate high temperature due to fuel burning, uses of mechanical machines and chemical reactions and that will increase the ambient temperature rapidly in the future.

The retrofit procedure is to replace the compressor, expansion devices, piping joints, and charging units with R-410A. This procedure will have material and oil waste which will affect the environment indirectly. Yet, there are no recycling plants to reproduce those material and liquid waste in Kuwait.

Technicians are not trained on handling and recycling any kind of refrigerants. Therefore, there will be refrigerant leakage during the retrofit procedure, even if HCF is environmentally friendly.

Financial Impact:

All power station in Kuwait are managed and operated by Kuwait Government, and all the cost of electrical consumption by residence is supported financially by the government. That lead to a direct impact on the annual government budgeting plans.

Moreover, there are about 150,000 (use R-22) residential villas based on the latest statistics done by The Public Authority for Civil Information (PACI) in June 2018. Minimum BTU used in each villa is about 480,000 which means about 6 A/C units of 76,000 BTU due to high ambient temperature that last approximately for 9 months during the year. With simple calculation:

BTU per villa x No. of residential villas

480,000 x 150,000 = 7,200,000,000 BTU

Total BTU in villas / 76,000 BTU

7,200,000,000 / 76,000 = 94,736 A/C units

To use R-410A, a retrofit of 98,000 units must be done by consumers in their own expense to obey the environmental regulations and Montreal Protocol, the cost of retrofit for each residential villa is:

No. of units per villa x Retrofit cost

6 x 350 KWD = 2100 KWD ($6900)

Total cost to retrofit all existing residential villa:
Cost for each villa x total units
2100 x 150,000 = 315,000,000 KWD ($1,032,786,885)

II. CONCLUSION

Retrofit existing units will continue harming the environment through its waste. Also, using R-410A will not reduce the pollution due to higher power consumption by A/C units unless using variable-speed which cost more than regular compressor. The Best reasonable solutions are:

- Training and certifying technicians to use refrigerant recycling equipment during maintenance.
- Training courses on brazing will reduce the R-22 leakage for existing units and any refrigerants leakage.
- Implementing renewable energy will reduce fuel burning in power stations.
- New punishable regulation on handling and recycling refrigerants.
- Conducting awareness programs for the public on ideal thermostat temperature setting, villa insulation materials, preventive maintenance schedule, and using PVC for windows and door frames instead of aluminum or other metal material.
- Installing smart home thermostat to control the temperature.
- District cooling need to be implemented in new residential cities and towns.
- More research and studies to discover new refrigerants.

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