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# Advances of Eco Fluor gas

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**ABSTRACT**
Discovered in 1991 by Honeywell (formerly known as Allied Signal), the R-410A was a Hydrofluorocarbon gas that was intended to replace the R-22 gas and eventually did so after the phasing out of R-22 by 1st January 2020 which was the date stipulated by the U.S. EPA (Environmental Protection Agency), after which a bantook place on the manufacture and importation of the gas due to its harmful effects on the ozone layer. The R-410 made its entry into the air conditioning market with the help of giants like Carrier Corporation, Copeland Scroll Compressors, Emerson Climate Technologies, Inc., and Allied Signal. In 1996, Carrier Corporation introduced the first residential air conditioning unit that was based on R-410A under the trademark of Puron. Eventually, R-410A replaced the R-22 gas in Japan, Europe, and the United States. After the invention of R-410, other companies were granted the production and licensing rights as a result of which we can find the gas under the trademark names of Puron, AZ-20, and Suva-410A, but even then, Honeywell remains the leader in the production and sales of R-410A. While the growth of R-410A was significant in the early 2000s, it saw an exponential rise after the phasing out of the R-22 gas which came after a result of the Montreal Protocol and the U.S. EPA mandating a ban on the R-22 gas. Today, the R-410 is readily available in the market and is found in most air conditioning appliances.

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## I. INTRODUCTION

This research paper focuses on the illustration of the advances of the R-410A gas which is popularly sold under the trademark names ofPuron and AZ-20. A comparison is drawn between R-410A and its predecessor, the R-22 gas, and the different temperature parameters are compared between R-410 and some other HFCs as well. We also list out the benefits of using the R-410A over the R-22 gas which was the main factor behind the phasing out of R-22. Apart from this; we even calculate the temperature of the R-410A gas by using the ideal gas equation. Furthermore, a comparative study between R-410A gas and other HFCs gives us a better idea about the gas along with its major applications in the air conditioning market segment and the reason for adopting the same.

### Physical Properties and Characteristics

The R-410A is a zeotropic mixture of difluoromethane ($CH_2F_2$, called R-32) and pentafluoroethane ($CHF_2CF_3$, called R-125) and the comparative study for different types of HFC's that are present in the market. Firstly, we compare the saturation pressures and critical temperatures of the gas along with its other counterparts which can be observed from the chart depicted in Figure 1.

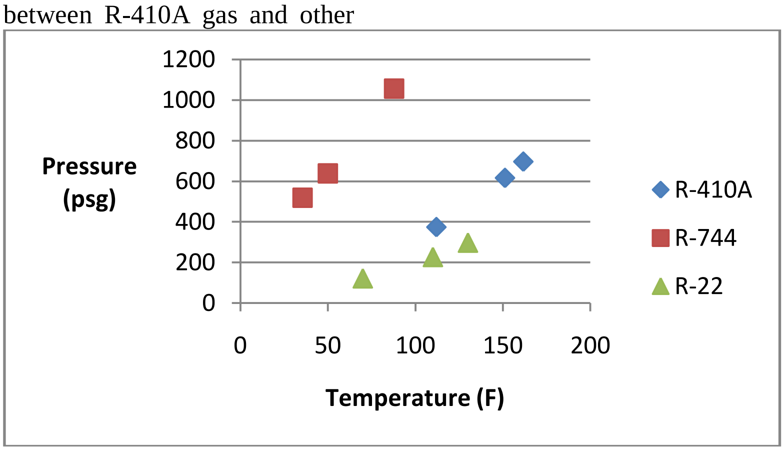


**Figure 1**

Hence the general trend as observed from the scatter plot we can observe that the R-410 has a critical temperature of 163.04Farheniet at a critical pressure of 699.8psig. Another physical property of the R-410A includes the melting point of the gas which can be observed from Figure 2 wherein we have compared the melting point of the gas with other similar counterparts.

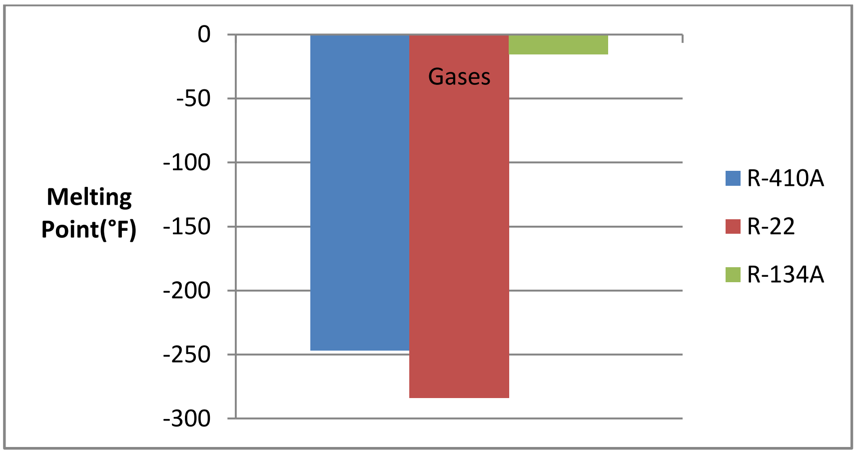


**Figure 2**

As it can be observed from the figure above, the R-410A has a melting point of -247 °F. Moreover, another physical parameter that can be taken into consideration is the boiling point of R-410A which can be observed from Figure 3 which has been depicted in the same comparative fashion.

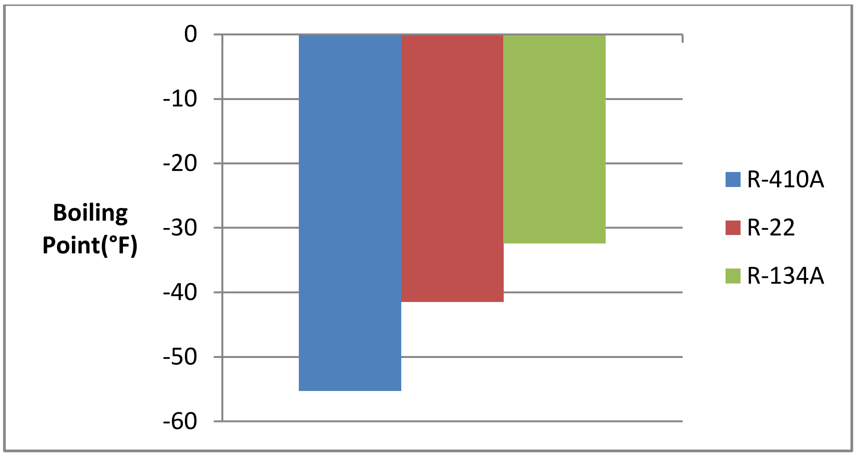


Figure 3

Hence it can be observed that the R-410A gas has a boiling point of -55.3 °F which seems to be significantly higher than its refrigerant counterparts. The next comparative result that can be observed is the molecular weight of the compound in comparison to the other refrigerant gases.

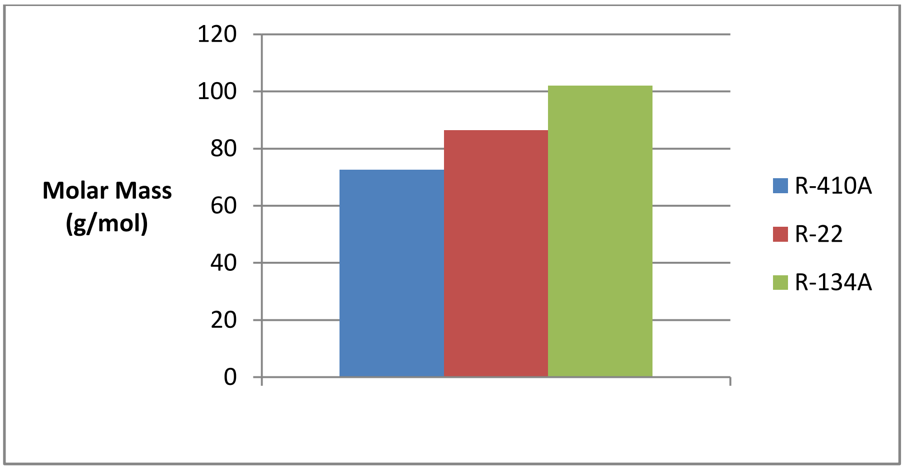


**Figure 4**

As it can be observed from the figure, the R-410A seems to be significantly lighter than its refrigerant counterparts which are explained by its chemical composition of difluoromethaneand pentafluoroethane.

**Calculation of the temperature using Ideal gas equation**

The ideal gas equation is represented by the following equation which can be deduced by combining Charles' Law, Boyle's Law, and Avogadro's Law.

$$P*V=n*R*T$$

In the above equation, P stands for Pressure and V stands for volume, n represents the amount of substance whereas R and T specify the ideal gas constant and the Temperature respectively.
Here we assume the pressure to be 1 ATM (101.325 kPa) and the R = 8.314 J/ (mole) (K) for the gas. We also assume its volume as 22.414 L and the value of n is 1 mole.

Hence by changing subject to the formula, we get the equation that provides us with the Temperature of the gas.

$$T = (P*V) / (n*R)$$

On substitution of values into the equation to obtain the temperature, we get the following equation:

$$T = (101.325*22.414) / (1*8.314)$$
$$T= 2271.09855 / 8.314$$
$$T=273.165 \text{ K}$$

Hence it can be seen that under standard conditions, the standard temperature of 273 K is obtained.

**Ideal Gas equation explaining the time taken to cool a room under given conditions**

With the given problem statement of cooling a room of the given dimensions (3m*3m*3m) wherein we need to calculate the time based upon the following assumptions:

- Standard pressure of 1 ATM (101325 Pa) is assumed.
- We can assume the heat load to be 10000 BTU/h = 2.9 kW = 2900 J/sec. wherein BTU stands for British Thermal Unit
- Compressor's flow rate which is indicated by cubic feet per minute to be 700
- The heat capacity of air at constant pressure is Cp = 7R/2 = 29 J/mol K
- Temperature is to be dropped from 30 °C (303 K) to 20 °C (293 K)

Hence we begin the calculation by estimating the volume of the room which is given by the below formula:

$$\text{Volume} = \text{Length*Breadth*Height}$$
$$\text{Volume} = 3*3*3 = 27 \text{ m}^3$$

Hence we can estimate the number of moles of air in the room tobe given by the ideal gas equation:

$$P*V = n*R*T$$
$$n = (P*V) / (R*T)$$
$$n = (101325 * 27) / (8.31*303)$$
$$n = 1086.5 \text{ moles}$$

We can assume that the heat capacity of air at constant pressure is Cpwhich can be calculated by the formula:

$$Cp = 7R/2 = 29 \text{ J/mol K}$$

Hence for a temperature difference (ΔT) of 10 °C, we find the energy required to reduce the temperature by 10 °C:

$$Q = Cp*n*\Delta T$$
$$Q = 29*1086.5*10$$
$$Q = 315085 \text{ Joules}$$

Since we have the capability of removing the heat by 2900 Joules/ second, we can estimate the time by using the formula:

$$\text{Time required} = Q / \text{heat load}$$
$$\text{Time required} = 315085 / 2900$$
$$\text{Time required} = 108.65 \text{ seconds}$$
$$\text{Time required (approx)} = 1 \text{ minute } 49 \text{ seconds}$$

Hence we can estimate the time required to cool a room of 27 $m^3$ to be around 1 minute and 48 seconds.

**Environmental Impact of using R-410A**

The measure of a refrigerant to have an adverse effect on the environment is gauged by the Global Warming Potential (GWP) which gives us an estimate about the amount of energythe emissions of 1 ton of gas is expected to absorb over a given time in comparison to the emissions of 1 ton of carbon dioxide (CO2). The R-22 has a GWP of 1810 where the R-410A has a GWP of 2088, now it to be noted that even though the R-410A has a higher GWP in comparison; it has no Ozone Depleting Potential due to which it is considered better than the R-22 which has an ODP value of 0.05. Moreover, since it causes no damage to the Ozone layer, its GWP index is greatly outweighed by its ODP index due to which it is considered to be a better and viable replacement for R-22.

**Advantages of R-410A over R-22**

The numerous advantages of R-410A over R-22were evident from the fact that R-22 was slowly phased out after R-410Awas commercialized into the air conditioning segment. The primary advantages can be noted as follows:

1. One of the major causes of adopting R-410A over R-22 is the reduced damage that the R-410A causes to the environment in comparison to the R-22 since the latter leaks out of the system and causes damage to the ozone layer once it is released in the environment.
2. Another primary reason for the replacement of R-22 was its lower efficiency of about 13 SEER in comparison to the efficiency provided by the R-410A which has a value of about 14.5 SEER since it can absorb and release heat better than R-22; it has a higher SEER (Seasonal Energy Efficiency Ratio) value.
3. Another significant advantage of R-410A over R-22 is the lower cost that R-410A has in comparison to the R-22, which is simply a result of the lower supply that R-22 has today because of it being phased out primarily after the Montreal Protocol and the U.S. EPA mandating a ban on the R-22 gas.
4. The R-410A system uses synthetic lubricants in comparison to the mineral oils used by the R-22 due to which it has less wear and tear in the system in comparison to the R-22 and hence it results in increased durability of the system in comparison to the R-22 systems.

## II. CONCLUSION

In the end, we can conclusively deduce that the advantages of R-410A over its predecessor were reasons enough for the phasing out of the R-22. The R-410A has numerous benefits over R-22, the environmental impact being the greatest and with the phasing out of R-22 in place;the R-410A is a change that should be welcomed for the better.

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