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Climatization, Energy Efficiency and Environmental Protection

Galvin A. Toala Arcentales [a]
Reinaldo Guillen Gordin [b]
Antonio Vazquez Perez [c]
Alfredo Zambrano Rodriguez [d]

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Abstract

It is known that approximately 15% of the energy consumed in Ecuador is used for the operation of climate conditioning equipment and, on the other hand, most of the existing technology operates on the basis of the use of refrigerant gases Are invasive to the ozone layer. In the work, a case study is shown that allows the identification of a relevant result linked to an action of technological innovation based on the conversion of the R-22 gas by the R-290 gas, thus reducing the consumption of electric energy and reducing the Environmental inventory of the institution, achieving a better performance of the technology.

Author correspondence:
Galvin A. Toala Arcentales,
Associate Professor. School, Universidad Técnica de Manabí (UTM)
Avenida Urbina y Che Guevara, Portoviejo, Manabí, Ecuador
Email address: gtoala@utm.edu.ec

1. Introduction

For many years the cooling method used par excellence came from natural ice. Egyptians used procedures to produce ice artificially (Botero, 1987). By the twelfth century, the Chinese used mixtures of saltpeter in order to cool water (Cammacho, 2007). Today, refrigeration and air conditioning systems are of great importance for the development of an adequate organizational climate in the productive and service sectors, especially for countries located in the tropical region of the planet. Among the most widespread systems are those of steam compression, whose components include the compressor, which has an electric motor, the energy consumed by it represents about 95% of the total (Climaconfort, 2015).

Globally in 2004, demand for 47.2 million air conditioners was reported, not including 36.3 million window type. At present demand has been increasing and in many countries the electricity consumption of this equipment is

[a] Universidad de Oriente, Santiago de Cuba, Cuba
[b] Universidad de Oriente, Santiago de Cuba. Cuba
[c] Universidad de Alicante, Alicante, Espana
[d] Universidad de Oriente, Santiago de Cuba, Cuba

around 15% of the national generation, which is generally obtained from fossil fuels, contributing to the increase of gas emissions Of greenhouse effect to the atmosphere (Climaconfort, 2015). Every refrigeration installation has inside its elements a refrigerant gas, which in some cases are regulated by their negative effects to the environmental component. Among these the most used since the 1950s was the R-22 until its negative effect on the ozone was discovered. This is one of the substances that is regulated by the Montreal Protocol and therefore is expected to be completely eliminated by 2015 in developed countries and by 2030 in the rest of the nation's (Climaconfort, 2015).

The reconversion of refrigerant gases has been an issue recently. Between 1990 and 1995 in Europe, a very interesting experience in the refrigeration sector was carried out in the conversion of chlorofluorocarbon refrigerants (CFCs), which are the main cause of the thinning of the ozone layer. Some countries took as a basis the total elimination of chlorine (Rosillo & Fernando, 2011).

That is why the research problem focuses on: "how to reduce the environmental inventory of the R-22 refrigerant gas in the UTM, as well as reduce the electricity consumption derived from the use of air conditioning equipment". The case study is developed at the Technical University of Manabí and the general objective is: "to convert R-22 refrigerant to R-290 in split type air conditioners, with the possibility of achieving a higher cooling coefficient for evaporation temperatures Between 5 ° C and 12 ° C, outdoor temperature between 27 ° C and 34 ° C, reducing the existing environmental inventory and reducing the consumption of electrical energy derived from the operation of air conditioning equipment. The hypothesis is based on the criterion that, by converting the R-22 refrigerant gas to R-290, it is possible to reduce the environmental inventory of atmospheric gases and to reduce the consumption of electric energy derived from the use of air conditioning equipment in the UTM.

2. Materials and Methods

From the experimental results obtained, quantitative methods such as the mathematical analysis are used to perform the calculations associated with the conversion of the refrigerant gas and to determine the environmental and energy effects. Practical procedures were used through the use of pressure and temperature measurement equipment. Interviews with workers and students in order to define the social impact of the measure adopted. For the analysis of efficiency in relation to the developed applications, stat graphics software was applied, which is a data analysis tool that combines a wide range of analytical procedures with interactive graphics to provide an integrated analysis environment that can be applied in Each of the phases of a project, from the management protocols to the quality control processes.

3. Results and Discussions

The chemical stability of traditional refrigerant gases is what makes them so dangerous. CFCs are virtually indestructible in the troposphere (near the ground) and therefore diffuse very slowly into the stratosphere, and can be degraded by ultraviolet radiation in free chlorine atoms and various radicals. It is this free atomic chlorine that destroys ozone. It has been estimated that 100 million ozone molecules are degraded per Cl, which is removed from the atmosphere in detriment of life on earth (Contreras, 2011).

The Montreal Protocol and its various amendments outline the world policy for the protection of the ozone layer. In 1987, the original document was approved, which proposes the phased reduction of CFCs, and a goal of elimination is outlined within 5 years; But in 1990 the London Amendment was adopted, which proposes the total phase-out of CFCs in 1996 in developed countries and their phased reduction until their disappearance by 2030 in developed countries (Contreras, 2011). Some strategies have been defined to preserve the ozone layer by returning to more environmentally friendly refrigeration through three fundamental routes: Absorption Cooling; Water as Refrigerant and; Ammonia as Soda. Another strategy focuses on the conversion of refrigerant gases, replacing those substances that are aggressors of the ozone layer and within this vision is the conversion of R-22 refrigerant gas by R-290 (Contreras, 2011).

At the present time, most of the specialists in the world are proposing the application of air conditioning with ecological refrigerants that do not affect the ozone layer, that does not provoke greenhouse effect and also provide greater energy efficiency, that is to say, save energy. Propane (R-290) (Rosillo & Fernando, 2011) stands out as an organic refrigerant. At the UTM, there is a total of 305 air-conditioning equipment of different types and brands, which accumulate more than seven and a half million BTUs, which is equivalent to significant energy consumption that entails a high turnover of the electric service. The analysis of the information allows to notice that the installed capacity in the equipment of air conditioning in the institution is of 2205 kW of power, this would be equivalent to having a power station of 2.2 MW of power only to satisfy the demand of Such equipment.

The retrofitting of the refrigerant gas R 22 by R 290 is a technical procedure which must be observed with extreme care, given the environmental and technical risk that can arise from not taking the appropriate measures in the performance of the work. It was decided to carry out a demonstration of the reconversion in three air conditioners: One model-MC, Capacity 24000 BTU; One Brand-Premium, Capacity 18,000 BTU and; Other Brand-Connor star, Capacity 12000 BTU. The refrigerant gas R-290 that constitutes the substitute, does not present environmental hazards, but due to its characteristics must be manipulated and supplied to the equipment under strict technical control measures, since a perfect system emptying and gas injection must be guaranteed in absence Total oxygen.

The sealing of the pipes will be done by welding with silver between 5% and 15%. This ensures that no pores remain in the welds. During the investigation, certain technical parameters were recorded before and after the conversion of the refrigerant gas into the three air conditioners chosen for the study. Table 1 shows the comparative data of the registry of the technical parameters measured before and after conversion.

Table 1
Measured technical data

Parameter	MC 24000 BTU Brand		18000 BTU Brand		Marca CONFORSTAR 12000 BTU	
	Before	After	Before	After	Before	After
Airflow (m3/h)	1720	1800	1643	1843	1445	1730
Internal temperature (° C)	14,5	13,6	15,2	14,1	10,2	9,5
Humidity ratio (g/kg)	9,7	10,05	9,8	8,5	7,35	6,99
Humidity (%)	94,2	93,1	91,6	90,7	95,7	94,5
Bulb temperature (° C)	13,6	11,2	14,6	13,5	9,7	9,2
Wind speed (m/s)	4,8	5,5	4,7	6,02	3,9	4,8
Current flow (A)	11,02	8,82	12,22	9,65	7,31	5,84
External temperature (° C)	26,9	24,5	27,2	24	26,9	25,8

The analysis of the above data allows to verify the technical advantages of the conversion of the R-22 refrigerant gas by R-290, being able to verify after the study the following results:

a) The internal temperature of the room can be lowered to 1.1 ° C less;
b) The temperature of the bulb can drop to 1.1 ° C less;
c) The speed of the wind when leaving the equipment can be greater in 1.32m / sg and;
d) The current flow may be lower up to about 2.57A, which represents approximately 80% of the previous total, being able to save up to 20% of the energy.

Figure 1 shows the comparative performance of the energy efficiency during the operation of the air conditioning equipment with the refrigerant gas R 22 and R 290.

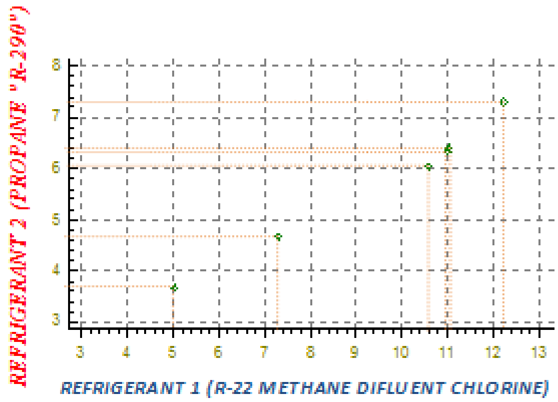

Figure 1. Comparative behaviour of energy efficiency

The comparative graph shows the saving of up to 20% of energy when the equipment operates with the refrigerant gas R 290, which represents a greater operational efficiency of the technology.
Table 2 shows the result of the comparative statistical analysis of the wind speed during the operation of the equipment with the refrigerant gas R 22 and R 290.

Table 2
Comparative statistical analysis of wind speed

Category	Refrigerant R 22	Refrigerant R 290
Count	6	6
Average	4,56667	5,62
Standard deviation	1,19944	1,42857
Coefficient of variation	26,27%	25,42%
Mínimo	2,7	3,7
Maximum	63	8
Rank	3,6	4,3
Standardized bias	-0,260161	0,60864
Standardized curtosis	0,494469	0,753525

It is possible to appreciate the increase of the wind speed when the equipment is operating with the refrigerant gas R 290, demonstrating a greater technological advantage.
Figure 2 shows the comparative behaviour of the bulb temperature during the operation with the refrigerant gas R 22 and R 290.

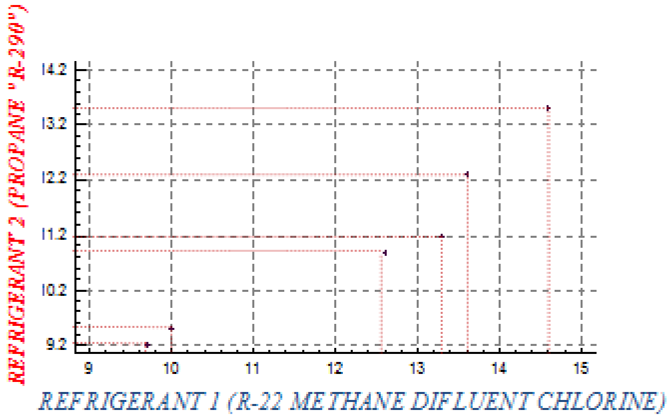

Figure 2. Comparative behaviour of the bulb temperature between the use of the Refrigerant gas R 22 and R 290.

It can be seen that the temperature of the bulb is usually lower when the equipment is operating with the refrigerant gas R 290, demonstrating a greater efficiency of the technology. Table 3 shows the result of the comparative statistical analysis of the internal temperature of the room during the operation of the equipment with the refrigerant gas R 22 and R 290.

Table 3
Comparative statistical analysis of temperature

Category	Refrigerant R 22	Refrigerant R 290
Count	6	6
Average	13,2167	12,36
Standard deviation	255767	23
Coefficient of variation	19,3518 %	18,6746%
Mínimo	10,1	9,5
Maximum	16.1	15,1
Rank	6	5,6
Standardized bias	-0,427467	0,299432
Standardized curtosis	-0,961935	0,974881

It can be seen that the internal temperature of the room is usually lower when the equipment is operating with the refrigerant gas R 290, demonstrating a greater operational efficiency of the technology.

4. Conclusion

The research allowed the development of a case study based on the conversion of the refrigerant R-22 to R-290 into three air conditioners of the Split type, with different brands and cooling power. With the new refrigerant gas, a higher cooling coefficient can be achieved for evaporation temperatures between 5° C and 12° C, outdoor temperature between 27° C and 34° C, reducing the existing environmental inventory and reducing the consumption of electric energy Up to 20%, which can mean a reduction in the amount of the electric bill of the institution, contributing to the reduction of CO_2 emissions to the atmosphere.

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Biography of Authors

	Professor of Professor of Mechanical Engineering, Mechanical Engineer, Master in Energetic Efficiency and Refrigeration. At the moment doing a study of Doctorates in the program of Mechanical Engineering of the University of the East, Cuba, Cuba *Email: gtoala@utm.edu.ec*
	Corporate systems, project management of renewable energy sources, professor in environmental law and natural disasters. scientific collaborator at the Faculty of Sciences of the Universidad Técnica de Manabí
	Engineer mechanical, Master in education, Professor holder. Currently, teaches different subjects. Manufacturer of industrial machines and innovative, currently doing doctoral studies in engineering mechanics. At the moment doing a study of Doctorates program of Mechanical Engineering of the University of the Oriente, Cuba