# Carbon Emissions Reduction in the Refrigeration Air Conditioning Process in Bauxite Mining

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**Abstract**

This paper presents a pioneering case study in Brazil, carried out at Hydro Paragominas Bauxite Mine, whose objective is to reduce greenhouse gas emissions from refrigeration/air conditioning equipment, contributing to the sustainability of the process. Tests were carried out with a new fluid for air conditioning that reduces by up to four times the emission of elements that contribute to global warming potential (GWP). Called Ideal Eco Safe, the fluid is operating in MPSA appliances replacing commonly used R-22 and R-410A refrigerants. The replacement of these gases showed highly promising results, with the use of the new gas the devices are operating with less electrical current, with more efficiency, more safety and without change in performance. The operation began in December/2020, under the coordination of the refrigeration and air conditioning team, new assessments were carried out monthly to verify the performance of Ideal Eco Safe at different temperatures over time with the potential to achieve an annual reduction of up to 623 tonnes of $CO_2$ in the atmosphere.

**Keywords:** Carbon emission reduction, Refrigeration, Air conditioning, GWP, OWP.

## 1. Introduction

The refrigeration and air conditioning fluids currently used in the air conditioners installed in the plant of a mining in Pará (Hydro Paragominas), are the R-22 and R-410A. Table 1 indicates the chemical composition of these fluids and their relationship with the environment (ODP – Ozone Depletion Potential and GWP – Global Warming Potential).

Analyzing Table 1 we conclude that the R-22 fluid has non-zero ODP and GWP, contributing to ozone layer degradation and global warming (greenhouse effect). R-410A, although harmless to the ozone layer (ODP null because it does not have chlorine in its composition) is a greenhouse gas.

**Table 1. Refrigerant fluids information.**

| Fluid | Chemical composition | | Relationship with the Environment | |
|---|---|---|---|---|
| | Guy | Chemical formula | GWP [$CO_2$=1] | ODP [R-11=1] |
| R-410A | HFC - Hidrofluorcarbon | $CH_2F_2$/ $CHF_2CF_3$ | 2088 | 0 |
| R-22 | HCFC - Hydro**chlorine**fluorocarbon | $CHCLF_4$ | 1760 | 0.05 |

The countdown to full replacement of R-22 and R-410A has begun worldwide. According to the Montreal Protocol [1] and the Kigali amendment these fluids will have their import gradually reduced from 2020 until the shutdown in 2045.

Brazil has committed to adopt appropriate legislative and administrative measures and to cooperate in harmonizing appropriate policies to control, limit and reduce the emission of chemical substances that result in modifications or probable modifications of the ozone layer. To this end, IBAMA – Brazilian Institute of the Environment and Renewable Natural Resources has determined a schedule for the elimination of imports by Brazil. Figure 1 shows the schedule for eliminating the import of R-22 and R-410A.

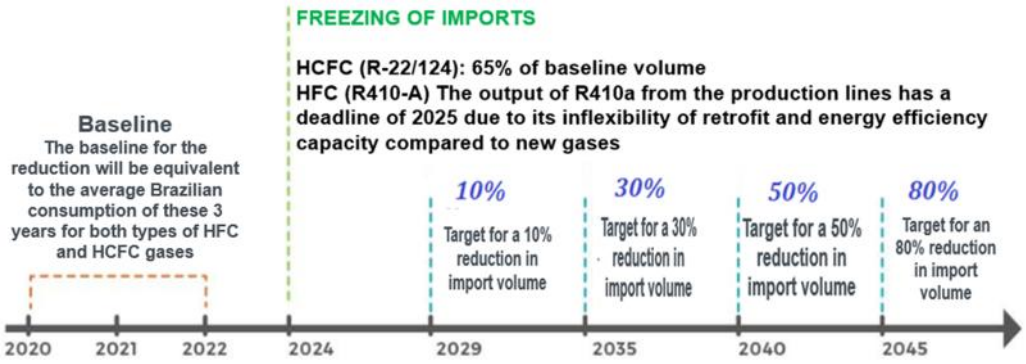


**Figure 1. Timeline for elimination of HCFCS and HFCS [2].**

Figure 1 shows that from 2024 the import volume of HCFC (R-22) will be 65 % of its average consumption between 2020 and 2022 (baseline). The volume of HCF (R-410A) will be 100 % of its average consumption. Subsequently, reductions in imports will be made until the shutdown in 2045.

It is then concluded that the refrigerant R-22, for suffering the greatest reduction initially in its importation, will not be found for acquisition with ease. The refrigerant R-410A, despite being a greenhouse gas, will have a longer term for its replacement. Thus, it is recommended immediately to replace R-22 with alternative refrigerants. The following chapters will present the alternative refrigerants, for application in equipment in use, with their advantages and disadvantages.

## 2. Theoretical Foundations

In 1987, the Montreal Protocol established regulations on refrigerants that affect the ozone layer and imposed targets for the elimination of CFCs. The term ODP (Ozone Layer Aggression Potential) was introduced and the refrigerant industry quickly introduced HFCs and their mixtures as substitutes for CFCs and HCFCs. The basic difference of these products is that HCFCs (hydrochlorofluorocarbons) still have the chlorine molecule harmful to the ozone and HFCs (hydrofluorocarbons) do not have chlorine [1]. It is then understood that the world starts to look differently at equipment that uses refrigerants with low OWP and GWP. Efficient equipment, which meets these requirements, are the new bets of the future.

HFCs are not controlled by the Montreal Protocol, these are listed under the Kyoto Protocol (1997). In 2005, the UNFCCC Convention (United Nations Framework Convention on Climate Change), implemented targets for these substances whose emissions must be limited or reduced. HFCs are considered long-term alternative fluids with respect to ozone depletion. As greenhouse gases, HFCs are controlled by the Kyoto Protocol, and a considerable number of countries are implementing regulations to control their use [2].

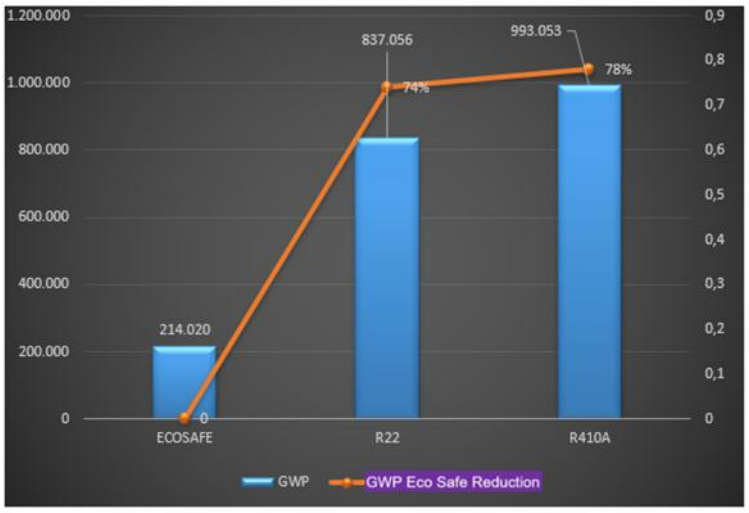


**Figure 2. GWP Reduction.**

## 5. Final Considerations

For the ODP, the impact would only be with R-22 gas because it is an HCFC. Thus, because it is null, R410A and Ideal Eco Safe would not cause impacts on the Ozone Layer.

The Ideal Eco Safe refrigerant fluid proved satisfactory. The performance was evaluated for 4 months where the variations were irrelevant showing that the gas is ready for a safe and sustainable retrofit process without loss of efficiency in temperatures and problems caused to components to MPSA equipment. putting the company one step ahead on the path of reducing pollutants according to the latest Paris agreement that aims to strengthen the global response to the threat of climate change by reducing greenhouse gas emissions by 37 % below 2005 levels by 2025 and by 43 % by 2030.

## 6. References

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