The 6th International Conference on Life Cycle Management in Gothenburg 2013

EVALUATION OF BRAZILIAN SCENARIOS OF REVERSE LOGISTICS OF AIR COMPRESSORS USING THE LIFE CYCLE ASSESMENT

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Keywords: Reverse logistic scenarios; air compressor; Life Cycle Assessment.

ABSTRACT

In order to reduce environmental damage on the activity of transporting goods, this article carried out the environmental analysis of reverse logistics for an air compressor. We compared three scenarios: a Hypothetical Scenario (HS), a Possible Scenario (PS) and a scenario suggested in the literature called Reference Scenario (RS), using the methodology of Life Cycle Assessment (LCA), standardized by the ISO 14040/14044 (2006). The results showed that the possible scenario of reverse logistics which uses almost exclusively railroad has approximately 20% less environmental impacts than the reference scenario.

INTRODUCTION

Currently the demand from consumers regarding environmental issues has required industry seek for more sustainable solutions in production and final disposal of their products. The National Policy on Solid Waste in Brazil, created in 2010 states that the industry is responsible to manage the end-of-life of their products. Thereby, the reverse logistics has an important role to reduce costs and environmental impacts on the supply chain.

Therefore this paper aims to compare, from an environmental point of view, three scenarios of reverse logistics of a product, not accounting the impacts of the production of this product.

The first reverse logistics scenario was proposed by Zanghelini (2013), who considered, on his analysis, only the transport of old compressors made only by truck. The second scenario is hypothetical: it considers transportation using rail lines in Brazil, and the third will be called a “possible scenario”: it considers transportation using rail lines and roads. The methodology used was the Life Cycle Assessment (LCA) standardized by ISO 14040 and 14044 (2006). The functional unit was the reverse logistic of 1 air compressor delivered in Joinville, Santa Catarina State in southern Brazil.

METHODS

The Reference Scenario (RS) was taken from Zanghelini (2013), who proposed a model based on regional spots of collection of compressors. In the South of Brazil the collection spot is

located in Florianópolis. In the Southeast, it is in São Paulo; Center West in Campo Grande; North in Marabá, Northeast in Salvador. After being collected, the compressors will be sent to Joinville-SC, where the company that will recycle the compressors is located. The quantities of products generated after the end-of-life were determined according to their consumption flow, given by the industrial concentration of each region of Brazil, considering that for each old compressor there would have a new one to replace it. All the transportation in this scenario is by truck.

For Hypothetical Scenario (HS) it was used the same collection spots of the RS however the transportation of the compressors was done by railroads only, some of which already exists in Brazil and some of them are still expected to be implemented by the Brazilian government.

The Possible Scenario (PS) used the same collections spots of RS and HS, but with the transportation was done partly by railroad and partly by truck. This scenario represents a feasible alternative for the actual reverse logistic applied by the company.

In these scenarios, quantities of compressors collected after its usage were determined according to the specific Gross Domestic Product (GDP) of each Brazilian region. Regarding the technical procedures, the study aimed to collect data through observations and analysis of hypothetical distribution channels of the company through rail networks, based on ANTF, 2012 (National Association of Railway).

The environmental impacts of the three distribution channels were analysed qualitatively and quantitatively through the SimaPro software with the CML baseline 2000 method regarding to the following impact categories: Abiotic Depletion and Global Warming Potential plus the Total Accumulated Energy Demand.

RESULTS

The results showed that the Hypothetical Scenario (HS) it's the preferable scenario from an environmental point of view, followed by the Possible Scenario (PS). The Reference Scenario (RS) was the worst alternative. The distribution channels that have more railroads presented less environmental impacts, justifying investment in railroad construction in Brazil. Figure **1** shows that Scenario HS has approximately 55% less impact than RS and approximately 13% less impact than PS in all categories.

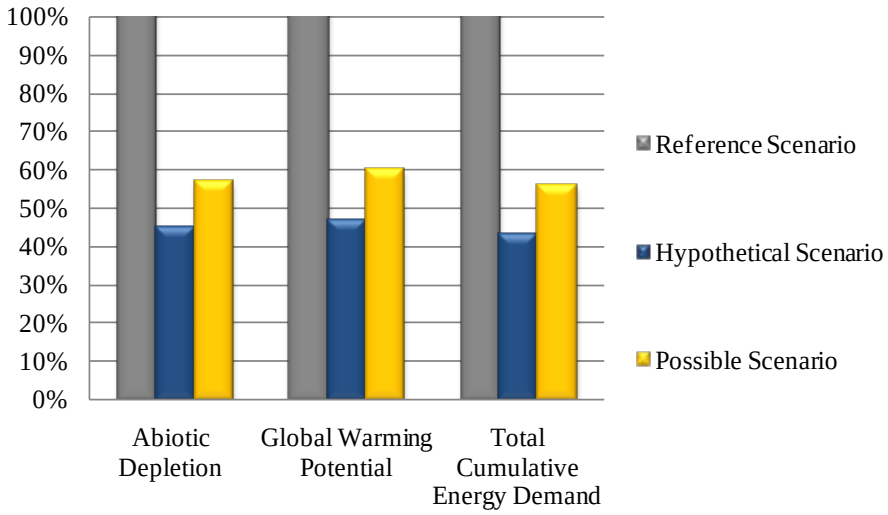

Figure 1- Graph comparing the environmental impact categories analysed between scenarios RS, HS and PS.

Evaluating separately each scenario it was noticed that for the HS the South/South route showed the best environmental performance (Figure 2) with 3% of the total impact caused by this scenario, this can be explained due to the short distance between the collection spot and the company in Joinville and a percentage of contribution in mass of 16.5% of the total compressors used in Brazil, followed by routes North/South and Center West/South with approximately 14% of the environmental impacts. The route Northeast/South had a contribution of 30% of impacts mainly due the long distance between the collection spot and the company once the mass contribution percentage (13.5%) of the compressors are closely to the South/South and North/South routes. The Southeast/South route was the main contributor of environmental impacts, with approximately 37% of total impacts caused by the reverse logistics. Despite the distance being not too large, this route accounts for 55.3% of the total weight of the countries compressor.

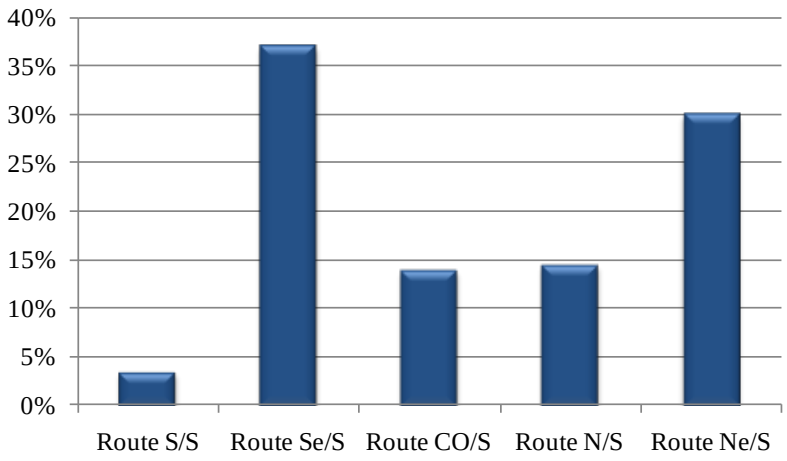

Figure 2- Graph of environmental impacts comparing the distribution channels in HS.

Analysing the PS, we can verify that South/South route was the one with the best performance (Figure 3) with 5% of the total impact caused by this scenario. However this

scenario still represents a greater impact when compared to HS. This is due to the fact that in the South/South route in PS the transportation was made only by truck once currently in Brazil there aren't any available railroads in this route.

The short distance and a percentage of 16.5% mass contribution of compressors still represent lower environmental impacts in South/South route when comparing the five routes. Center West/South, North/South and Northeast/South routes has a contribution of 14%, 23% and 27% in environmental impacts, respectively. The transport (i.e. only by railroad) Northeast/South remains the same as in HS, but by having a large distance from the other regions the impact in this route remains high. The route Southeast/South remains the one with the greatest environmental impact with 33% of the impacts in this scenario. For despite the small distance between the collection point and the company in Joinville this route continues contributing 55.3% of the total mass of compressors of the country.

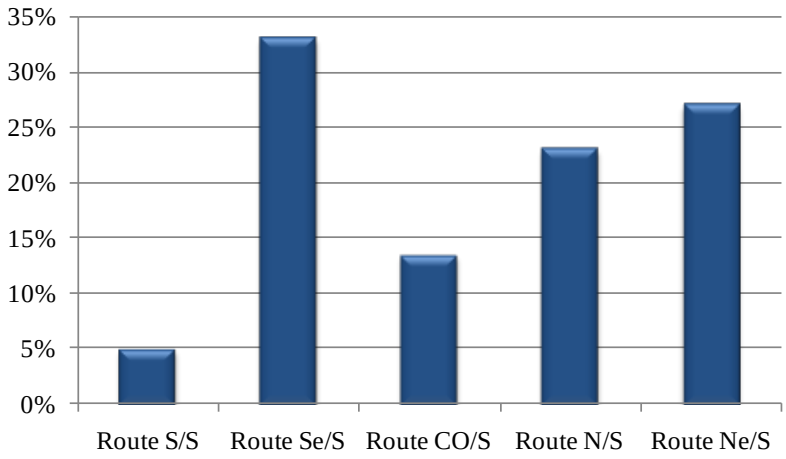

Figure 3- Graph of environmental impacts comparing the distribution channels in PS.

CONCLUSIONS

It can be concluded that among the three scenarios, Hypothetical Scenario is the best environmental one due the exclusively use of railroads. We could also notice that the route from Florianópolis to Joinville, both in HS and PS, has a small contribution to the environmental impacts on the LCA of the reverse logistics of this product because of the short distances.

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