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Refurbishing an old machine or replacing it by a new one: comparative study of environmental impacts.

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ABSTRACT

This article is based on the Life Cycle Assessment performed with Simapro software. It concerns a high-power asynchronous motor (1.9MW) dating from the 1950s and with poor efficiency compared to the performances of a new one. The aim is to compare the environmental impacts of the four possibilities:

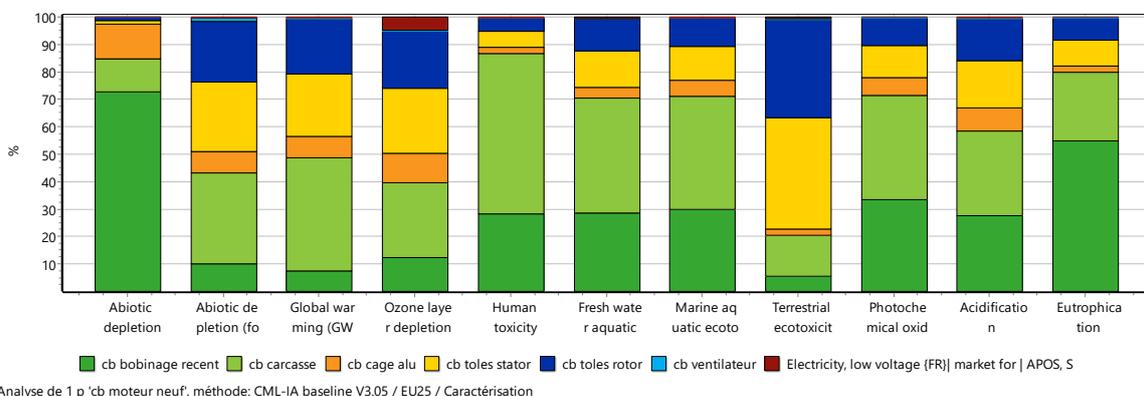
- leaving the old machine in place despite relatively high losses.
- replace the machine by a new one with better efficiency and therefore lower losses. In this case, the manufacture and transport of the new machine generates environmental impacts that will have to be compensated by a less impacting running.
- renovate the old machine by replacing the winding with a new one with thinner insulation. This technique increases the copper cross-section and therefore reduces losses due to the Joule effect. By keeping the other parts of the machine, we minimize the impacts of material manufacturing.
- Renovate the old machine by replacing the winding as before, but also the stator laminations. Indeed, the new laminations have higher magnetic properties and allow less iron losses. In this case, the losses will be similar to those of a new machine, but the "material" impacts will be lower since the frame and the rotor are conserved.

Keywords : Refurbishment, Life Cycle Assessment, environmental effects, induction machine, magnetic circuit, electrical insulation

The study is based on an estimation of the efficiency gains associated with changes in insulation and laminations. It is necessary to estimate the masses of the main parts of the machine, the energy consumed in refurbishment and transport. It is also necessary to consider the machine's operating time, that determines the energy losses, as well as the type of electrical mix.

Several parts will be included in the final article:

- Background, machine description, differences between old and new materials,
- Principles of LCA: masses and materials considered in the study,
- Environmental impacts of manufacturing a new engine

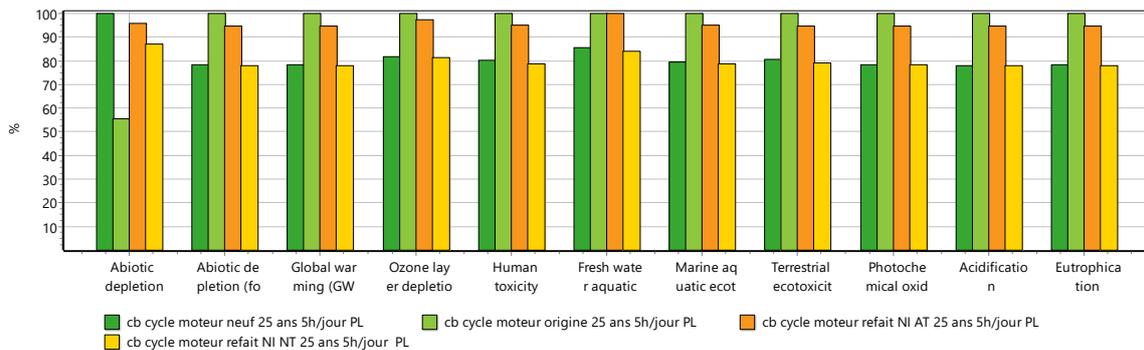


For example, the graph below shows that the frame and the winding represent the major part of the impacts. Keeping the frame is therefore an important advantage in reducing the environmental footprint.

- Impacts of refurbishment compared to manufacturing, without taking into account the life cycle

- Life cycle impacts based on service life and efficiency.

Here the lowest electricity consumption of a new or renovated machine comes into consideration. We can see that, over a long lifetime, the use phase is very important.



Comparaison de 1 p 'cb cycle moteur neuf 25 ans 5h/jour PL', 1 p 'cb cycle moteur origine 25 ans 5h/jour PL', 1 p 'cb cycle moteur refait NI AT 25 ans 5h/jour PL' et 1 p 'cb cycle moteur refait NI NT 25 ans 5h/jour PL'

The graph below takes into account, for the 4 possibilities, the impacts related to manufacturing or refurbishment, and of the impacts related to electricity consumption.

- Influence of the origin of the electricity: depending on the country considered and the means of electricity production, the environmental impacts are not the same.

Conclusion:

The LCA allows us to affirm that the complete renovation of a machine, magnetic laminations and windings, is generally the technique that leads to the least environmental impact.

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