Analysis of the impact on the environment of cars with gasoline and electric motors

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Abstract - In this work, the analysis of the environmental impact of cars with gasoline and electric engines was carried out using computer software for the analysis and modeling of the SimaPro Life Cycle Assessment, as well as PRé Sustainability databases. For the comparative characteristics were selected 3 exemples of modulated vehicles with identical tonnage and traveling distance.

Keywords – Life-Cycle Assessment, SimaPro, cars, environmental impact, modeling, forecasting.

Introduction

The development and distribution of vehicles using alternative energy sources is one of the most promising ways to ensure the concept of sustainable development, which contributes to the harmonious combination the needs of the three components - society, economic development and the environment. The leading standards for LCA are: DSTU ISO 14040: 2006 and ISO 14044: 2006.

Description of the problem

The purpose of the research is to conduct their own experimental studies on the environmental impact of cars with gasoline and electric motors through the modeling of the Life Cycle Assessment. The result of the research will be the confirmation of the effectiveness of one or another variant of cars. Methods of research: analytical and laboratorical.

Various computer programs have been developed to characterize the environmental impacts of the product, in particular: "Umberto-LCA +", "GaBi Software LCA" and "SimaPro". We have chosen the SimaPro 8 program, which is a tool for quantifying the environmental performance of products, taking in meaning of the full life cycle, from raw material production to final disposal of products, including recycling of materials, if necessary [1]. Regarding to this, it is possible to design different scenarios of influence on all components of the environment, as using a direct method (for ordinary cars), or indirectly (for electric cars).

The research consists of four main steps:

Step 1. Determine the purpose and scale of the research.

Step 2: Create a product lifecycle model with all the resources and products in the environment. This collection of data is usually referred as a lifecycle inventory.

Step 3: Understanding the environmental responsibility of all inputs and outputs. This is called the impact assessment life cycle.

Step 4: Interpretation of the research.

For the program calculation of the LCA, the SimaPro (computer program) was used in the "Inventory" mode.

For the comparative characteristics were selected 3 exemples of modulated vehicles with identical tonnage and traveling distance. Specific models of EURO-3 and EURO-5 tracks are not

necessary, because of the algorithms written in the scenarios of the LCA program give universal results, based only on the specific indicators of the components sought.

In the case of gasoline units, the unit of measurement of specific energy consumption is "ton-kilometer" (tkm). Under this unit of measurement is the number of tons transported per unit distance in kilometers. For two gasoline representatives, we will take this value for 1000 tkm, which in practice will be described as 10 tonnes of transported weight per 100 kilometers of the way. When choosing the Processes category, the choice comes from the most common transportation class - "Transport, truck 10-20t". Under the "Low Fluence" category, the category "80% LF" is chosen as the most commonly used group of vehicles of this class.

The third vehicle for which the calculation was made is Tesla Semi. The necessary output data is the specific capacity of the batteries and the supply range. They are 1,320 kilowatt hours and 800 kilometers respectively.

For carrying out analytical calculations the standard of calculation of ISO 14044 is used - Overall transport of EURO-3 and EURO-5 standards (Transport, truck 10-20t, EURO3 or EURO5, 80% LF, default / GLO Energy), both with the Standard of calculation of ISO 14044 - Electricity Low Voltage (Electricity, low voltage {ASCC} | market for | Alloc Def, S). The method "IMPACT 2002+ V2.14 / IMPACT 2002+" was used, which currently contains the most effective and extensive database on transport and energy. The calculation was made using the LCA Wizard, which is developed by PRé Sustainability. Because it is written specifically for this software, it simplifies the work and does not require the use of third-party software and its plug-in to the program.

The results of the simulation of the LCA are called "Network". In this calculation mode, a network of contaminants has been created that are directed to one common mark in the - Impact Points. They are a non-system unit of measurement created and described by "IMPACT 2002+ V2.14 / IMPACT 2002+". Outside the limits, they have no practical application, but are ideal units for comparing the effects on the environment, processes, products and materials, reducing the factors underlying one single denominator.

Also, using the "Network" results there is an opportunity to look at a simplified scheme for the creation and distribution of fossil and energy resources. This scheme has practical application in describing complex and detailed technological, industrial or waste processes and shows the dependence of factors as a closed network of matter and energy.

The results of simulations of the LCA have become estimates in Impact Points, which are: for EURO-3 0,0735 Pt; for EURO-5 0,0649 Pt; and 0,0424 Pt for the low-voltage electrosupply standard. This means that even with using fossil fuels for transport, including all stages of its transformation, and taking into account the method of conversion of fossil fuels into electric energy, the use of electric aggregates is more efficient - 1.73 compared to standard fuel EURO-3 and 1.53 in compared to the Euro 5 fuel standard, even if the same type of fossil fuel is used.

Conclusion

Usege of the program gives opportunity the auto-producers to prioritize the expansion of the list of alternative energy sources, to control the impact on the environment and public health, thus increasing the level of environmental safety and resource efficiency.

References

[1] SimaPro Introduction Main Tab. – https://www.pre-sustainability.com/download/SimaPro 8. Introduction To LCA.pdf.