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Creation of Innovative Systems for Sustainable Mobility Based on Hydrogen

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Abstract

he company needed to build and develop an experimental innovation transmission model based on the "ECOROAD 4.0" project. Matra S.r.l. Autotrasporti di Vasto carries out transport activities for third parties throughout the national territory and, indirectly, internationally.
Founded in 1998 on the initiative of the Mazzeo family, after prolonged experience in companies in the sector, it has had a gradual development since the first year, earning the respect and trust of Lafarge, a multinational company, world leader in the cement production sector and among the first in cement conglomerates, which in 1999 decided to entrust him with all the logistics services for the Pescara production plant and related terminals in the commercial area.
The research project *creation of innovative systems for sustainable mobility based on hydrogen* involves the study of the applications of hydrogen engines for sustainable mobility. Evaluations will be carried out to understand which hydrogen-powered engine is suitable for the main vehicles of society and evaluate the impact on the environment also in terms of CO2 emissions.

Keywords: Sustainability, Mobility, Hydrogen, Prototype, Fuel Cells

1. Introduction

The creation of innovative systems for sustainable mobility based on hydrogen involves the development and integration of hydrogen production, storage, and utilization technologies to enable clean and efficient transportation solutions. Hydrogen, as an energy carrier, offers significant potential for reducing green-

house gas emissions and dependency on fossil fuels.

The aims of the Research and Development activity expressed through the project identified above are mainly linked to five types of different objectives:

1. Develop and implement new paths for technology transfer within the Company: the Company's reference sector is constantly evolving. Precisely this evolution has determined the need to create new technical-operational processes and procedures that are increasingly performing and specifically linked to the evolution of the technological innovation system in the specific sector of the Company.
2. Penetrate new markets: the study's prerogatives are to understand and evaluate new opportunities on the market (evolution of the infrastructure market which opens up business opportunities in the provision of services connected to data transmission).
3. Increase competitive advantage over the competition;
4. Develop prototypes at a high quality level, engineering the production process and at the same time thinking about products built with a view to cost-effectiveness;
5. Promote the relocation of workers into other professional roles resulting from company organizational evolution, internalization policies and market trends, i.e. integrating resources and skills transversally and interfunctionally in order to generate management savings and make it more timely flexible and effective ability to offer its services to the reference markets. The desire to update, expand and complete workers' knowledge will prevent the danger of professional obsolescence, conveying the skills necessary to manage new technologies, new services and new operating procedures.

2. Materials and methods

Objectives of the project

The conceptualization for the Company is based on a sequence of unique, complex and connected activities, aimed at achieving a specific objective carried out within precise time constraints (time schedule), cost, in accordance with the expected specifications/quality, through coordination and the integration of physical resources, knowledge and multidisciplinary skills present internally with the support of external research skills, which share the technical, economic and initiative risk. The final product is the materialized outcome of a production process and has particular physical characteristics (such as design and format). Conceptualization for the Company is a high-level conception phase of the product in which, in close relationship with the client/customer, the product requirements are identified, the economic-financial factors and business prospects are analyzed, and the the best possible product “concept” and the product development program is designed.

The conceptualization of the project is based on the following points:

1. Identification of new combinations of existing functions with new functions (product and/or process innovation).
2. 2. Identification of new combinations of technologies for process improvement (process innovation).
3. 3. Definition of new production techniques that combine lower costs with higher quality.
4. 4. Balance between organizational innovation and technological innovation to be acquired.
5. 5. Indications on the performance of the technologies and their impact on quality and cost of implementation
6. 6. Decisions regarding outsourcing of activities or components to suppliers and partners
7. 7. Support the competitive analysis of the product in terms of technologies and functions compared to competitors
8. 8. Support a customer-centric strategy while ensuring high product quality conditions.

The aforementioned points were the basis of the conceptualization of the corporate research project for the study, design and implementation of innovation in the Company.
The project, carried out with the use of internal and external resources, involved an initial study of the types of fuel cells most suitable for the reference sector, based on operational technical variables such as the electrolyte (alkaline cells, polymer electrolyte, acid phosphoric, molten carbonates, solid oxides) or the operating temperature (low and high temperature cells).
The electrolyte determines or strongly conditions:
- the operating temperature range,
- the type of ions and the direction in which they diffuse through the cell,
- the nature of the construction materials,
- the composition of the reagent gases,
- the methods of disposal of reaction products,
- the characteristics of mechanical resistance and use,
- the life of the cell,
- operation (for example efficiency in terms of kWel and kWth produced).

Furthermore, a laboratory test was carried out to understand the technical-scientific characteristics of the fuel cells most suitable for use in a co-generative setup by connecting them in series.

Prototype system

As regards an important aspect of this technological application, the installation of hydrogen kits does not require approval. In fact, they can be installed as safe economizers and in accordance with the law, in relation to the "type of hydrogen-powered motor vehicle" approval, the amendment to Directive 2007/46/EC has established harmonized standards on the manufacturing of motor vehicles in order to guarantee the proper functioning of the internal market and, at the same time, a high level of protection of public safety and the environment. In essence,

the legislation attached at the end of the article specifies that there are NO provisions governing the field of the proposal, in practice there is no law! If in the field of traction there is currently no legal provision, in the field of electricity generators the GSE has thought about it; there are many installations of hydrogen cells on vegetable oil generators, so much so that the GSE issues green certificates for these upgrades, see: Ministerial Decree. 21/12/2007: "Approval of the procedures for the qualification of renewable energy systems and hydrogen, fuel cell and cogeneration systems combined with district heating for the purposes of issuing green certificates" (Official Gazette 19/01/2008 , no. 16, S.O.).

Figure 1: Prototype system

The device has been sized to be applied in order to obtain complete combustion and an increase in specific power and therefore efficiency thanks to the presence of the atomic hydrogen (hydrino) component, oxygen and OH ions. It is well known that combustion is a chemical reaction that occurs with the oxidation of a fuel by an oxidizer (which is generally represented by the oxygen present in the air), with the development of heat and electromagnetic radiation. From a chemical point of view, combustion is an exothermic oxidation-reduction process in which one compound is oxidized while another is reduced (in the case of hydrocarbons, carbon is oxidized, oxygen is reduced) with the release of energy and the formation of new compounds, mainly carbon dioxide and water. There are three essential elements: • fuel • oxidizer • ignition The fuel can be of various types and in our case petrol, diesel and methane (CH_4). The oxidizer is the oxygen present in the air. The fuel and the oxidizer must be in adequate proportions for combustion to take place, delimited by the so-called "flammability range". A solution to the problems highlighted above by the combustion of fossil fuels is the NCH0S device. The device is totally innovative, there are no similar ones available today and it is also

inventive, as it was designed to definitively solve the combustion problems directly and indirectly connected to the reduction/elimination of emissions (greenhouse gases) linked to fossil fuel feeding for abatement to eliminate NO_X, SO_X, HC, CO_2 and resolve both environmental and energy critical issues. The main purpose of this device is to optimize combustion and reduce harmful emissions, contribute to the complete exploitation of the fuel and provide a surplus of energy. The "H_2O New Compact Hydrogen System" solution is based on the introduction of hydrogas/toning gas to have both an air-fuel mixing process in stoichiometric terms, and to obtain an available reserve of oxygen above 600°C, and a mixture which favors at an atomic level in the combustion chamber a quantity of hydrogas containing hydrines, OH and O_2 in the right proportions. The production of hydrogas (detonating gas) is based on a resonant catalytic electrolyser which ensures the production of a modulated flow of OH groups in gaseous form through electrolysis of water with additives placed inside a sealed chamber where a pack consisting of assembly of metal plates in a special alloy insulated from each other in the shape of a lobe (Al Co Pa Ni Va Ti-alloy in Cobalt, Pt, Palladium, Nickel and Vanadium/Chromium etc), to which a voltage is applied via the generator device variable DC/AC.

3. Conclusion

The prototype described above was installed on some engines from the company's fleet, testing power supplies.
In order to define the performance of fuel cells, and in particular MCFCs, it is important to analyze the operation of these devices from the point of view of operating conditions.
The main parameters that determine the performance of an Fuel Cells are:

- Pressure;
- Temperature;
- Cell life;
- Current density;
- Composition of the reagent gases;
- Utilization coefficients;
- Humidification coefficient;
- Dilution coefficient;
- Fuel gas;
- Concentration of contaminants.

The battery is connected via the H3P PWM to the cell, as soon as the engine is started the "New Compact Hydrogen System" starts, but begins to deliver hydrogas after about a minute: the pressure transducer senses the suction depression (0.9 mbar) and activates the controller which closes the circuit by passing the current from the battery/power supply circuit to the cell together with trains of variable frequency electromagnetic waves (from 50 Hz to 12500 kHz up to the third harmonic) such as to also induce the mechanical vibration of the electrodes and

with cyclically reversed polarity. The current goes from .3A with suction pressure of 0.9 mbar, to the max value of 6 A with max suction pressure of 0.78 mbar and max number of engine revolutions (5000 rpm). The device emits the hydrogas which modifies the fuel/oxidant mixing at an atomic level, i.e. the dosing of the fuel: the flow field inside the cylinder is completely modified and slaved to the inlet air mass meter, guaranteeing the mixing process atomic air - fuel with a superfine mixing that homogenizes and uniforms the combustion process, the heat exchange with the walls of the duct and therefore makes the most of the energy of the fuel and hydrogas, decreasing the concentration of pollutants at the exhaust.

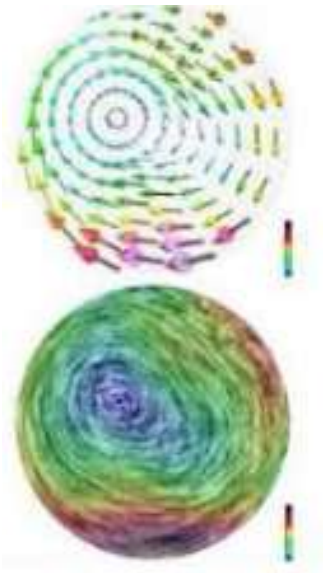

Figure 2: Idrogas production

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