Compact, light, efficient and reliable turbo compressor for fuel cell vehicles

Rendicontazione

Informazioni relative al progetto

Turbo-FCell

ID dell'accordo di sovvenzione: 858504

Sito web del progetto

DOI
10.3030/858504

Progetto chiuso

Data della firma CE
23 Maggio 2019

Data di avvio
1 Giugno 2019

Data di completamento
30 Novembre 2021

Finanziato da
INDUSTRIAL LEADERSHIP - Innovation In SMEs

Costo totale
€ 2 468 750,00

Contributo UE
€ 1 728 125,00

Coordinato da
CELEROTON AG
Switzerland

Periodic Reporting for period 2 - Turbo-FCell (Compact, light, efficient and reliable turbo compressor for fuel cell vehicles)

Periodo di rendicontazione: 2020-06-01 al 2021-11-30

Sintesi del contesto e degli obiettivi generali del progetto

Energy transformation transition is mandatory if mankind wants to limit global warming for the safety of our environment and own survival. Transportation represented 14% of global greenhouse gas emissions in 2014, and almost all of its energy needs (95%) were satisfied by petroleum-based fuels. Hence, the transportation sector will experiment in the following years the switch to alternative energy sources.

Fuel cell electric vehicles (FCEV) have irrupted in the market aiming to diminish the greenhouse gas emission as they only emit water and heat. Moreover, FCEVs are powered by the energy released by the reaction of two widely-abundant sources: hydrogen (H2) and oxygen (O2). While much attention has been put on specific components of the FCEV, such as the catalytic fuel cell and the hydrogen supply and storage; the oxygen supply delivered by the compressor has not yet been optimized. Thus, air management for fuel cell systems remains a challenge: current compressors provide low mass O2 flow delivery, low efficiency, high weight, large size, low air quality feed due to greased ball bearings, and noise pollution.

Celeroton´s Turbo-FCell Compressor System is composed by a turbo compressor designed for FCEV and its own energy supply converter, with the following USPs:
1. Up to 20 times smaller and lighter than conventional compressors. This weight and size enable the fitting into the smallest powertrain, in contrast to any other solution in the market.
2. Rotational speed up 300 times faster than market compressors. This speed in combination with our proprietary speed control allows for highly dynamic control of both pressure and O2 mass flow delivered to the catalytic fuel cell.
3. Holds air bearing technology, without the need for lubricants in contrast to current compressors, that limits the lifetime of the fuel cell stack to as low as 20,000 km due to oil contamination. Our system guarantees pure air delivered to the fuel cell, ensuring a long lifetime of the fuel cell without maintenance, while noise and vibration levels are kept to a minimum.

The current Turb-FCell prototypes are functional and reliable but yet too expensive to meet market demand. In addition, the Turbo-FCell product needs to be tested under specific conditions that might occurs during driving and affect its performance. Hereby, the overall objectives of the project are to (1) reduce the cost of the manufacturing, and (2) to expand the current testing to comply with market demands.

The project could be concluded and the objectives could be achieved.

Lavoro eseguito dall’inizio del progetto fino alla fine del periodo coperto dalla relazione e principali risultati finora ottenuti

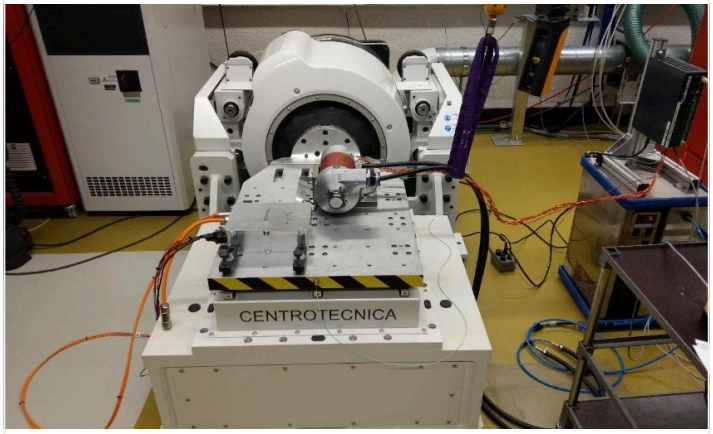
WP1 “Test development & optimization” has been completed in year 1:
o The four tests foreseen at the submission of the proposal have been executed:
- Condensation testing with the compressor
- Particles testing with the compressor

- Temperature and pressure testing with the compressor
- Vibration testing with the compressor
o To achieve the project objective of 100% testing maturity, the following additional tests defined after submission of the proposal have been executed:
- Thermal hotspot testing with the converter
- Water cooling loop pressure drop testing with the compressor and the converter
- EMC testing with the compressor and converter
- Vibration testing with the converter
o For all tests, an assessment, based on an FMEA, has been executed and required adaptions to be implemented in WP3 “Compressor redesign” have been defined.
WP2 “Manufacturing cost decrease” has been completed in year 2:
o A new rotor concept has been selected and experimentally verified.
o A casted spiral casing has been designed, manufactured and experimentally verified.
o A cost reduced impeller has been designed, manufactured and experimentally verified.
o The initial evaluation of cost reduction potential, manufacturing feasibility and performance requirements has shown the very low potential for the casing. Therefore, this task has been stopped early and the resources have been reallocated to other tasks.
o A new motor concept has been developed manufactured and experimentally verified.
o Cost reduction measures in the assembly time and casing parts of the converter have been undertaken.
o A manufacturing cost assessment and a remaining risk assessment has been undertaken and required adaptions to be implemented in WP3 “Compressor redesign” have been defined.
WP3 “Compressor redesign, realization and final testing” has been completed in year 2:
o A redesigned Turbo-FCell prototype has been designed including the required adaptions identified, assessed and selected in WP2 and WP3.
o A redesigned Turbo-FCell prototype has been manufactured
o A redesigned Turbo-FCell prototype has been tested.
WP4 “Dissemination, Exploitation & IPR Management” has been completed in year 2:
o For new features resulting out of WP1 and WP2, two freedom-to-operate (FTO) searches have been conducted.
o Two patents have been filed.
o Product documentation has been established.
o Direct dissemination to customers was undertaken .
o Public dissemination was undertaken at 7 fairs/Exhibitions and in 5 articles.
o The product launch has been prepared.
o Fairs, a new website, and other marketing measures have been prepared.
WP5 “Project Management and QA” has been completed in year 2:
o Celeroton has requested an extension of the project by 6 months, and it was acknowledged.
o All deliverables have been handed in and milestones have been achieved in according to the schedule.

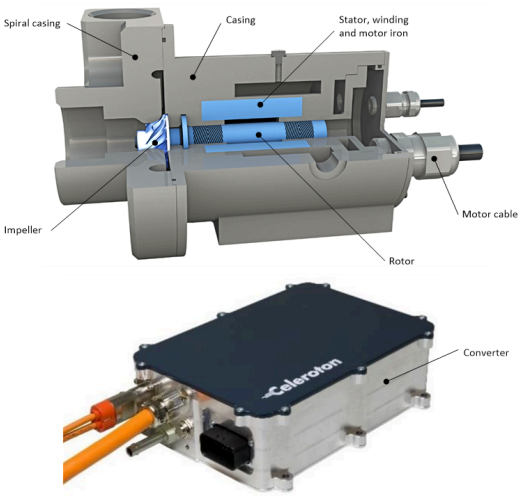
Progressi oltre lo stato dell’arte e potenziale impatto previsto (incluso l’impatto socioeconomico e le implicazioni sociali più

ampie del progetto fino ad ora)

The potential impacts, beyond the project, are:
• Economic impact: Turbo-FCell system guarantees pure air delivered to the fuel cell, ensuring a long lifetime of the fuel cell
• Environmental impact: Since our compressors do not use any oil, it presents an important environmental benefit as there is no waste from the lubricant, which is difficult to recycle. Moreover, as mentioned above, since the compressor consumes less power than competitors, this translates into a higher overall efficiency of the system and lower hydrogen consumption. The production of hydrogen at short and mid-term will be dependent on natural gas. Thus, saving 3.6 kg of H2 every 100 driving hours will save emissions of 36 kg of CO2. More importantly, by improving the overall efficiency of FCEVs, Celeroton will contribute to the successful deployment of FCEV which will have a very positive impact on the environment.
• Social impact: Celeroton will contribute to the European economy by increasing our competitiveness on the high-tech sector. Currently, the main compressor manufacturers are located in Asia and the United States. Thus, most of these products are imported from those geographies. The development of our beyond-the-state-of-the-art turbo compressors with converters will position Switzerland as the world-leading manufacturer, enhancing the technical competitiveness of Europe.



Vibration testing of Turbo-FCell compressor prototype on shaker



Turbo-FCell system overview

Ultimo aggiornamento: 21 Marzo 2022

Permalink: https://cordis.europa.eu/project/id/858504/reporting/it