Renewable Energy and Stable Development Project № 3 for International Cooperation in 2017

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Research area: **Environmentally friendly transport systems, working on renewable energy sources. Energy efficiency in agriculture.**

Title of project: **Development of environmentally friendly cryogenic (pneumatic) power system for agriculture**

Abstract

The finite quantity of hydrocarbon fuels that are available, the increasing cost of such fuels, the harmful pollutants and greenhouse effect produced by combustion of such fuels, and as a result, the decreasing of oxygen content, global warming and negative environmental impact, together indicate that it is necessary to develop alternatives to the power sources in current widespread use. This is especially crucial in agriculture, where the ecological aspect is the most essential for human health and sustainable development. One alternative that has been investigated is the use of cryogenic power systems, a concept in which a cryogenic substance is used as a working fluid and free heat energy is taken from the environment, specifying the working cycle opposite to internal combustion engines.

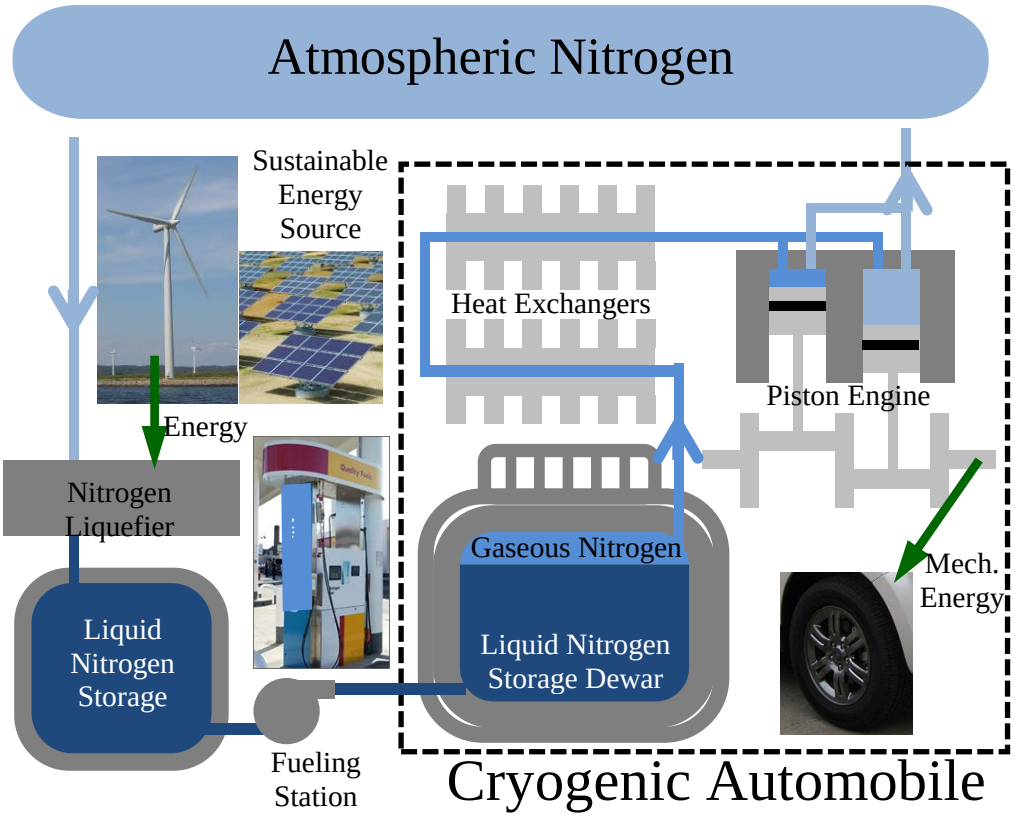

Figure 1. *Schematic flowchart of the automotive cryogenic power system.*

Examples of such power systems include those that utilize liquid nitrogen (LN2) to propel vehicles that have been designed and built in the USA at the University of North Texas (UNT), the University of Washington, and in the Ukraine by the Kharkov Research Team (KRT), including leading Kharkov research and academic institutes. In the power systems of these vehicles, liquid nitrogen, which has a boiling temperature of 77 K (-196 ºC), is stored at the cryogenic tank and can be easily vaporized in the evaporator, due to heat exchange with the environment. The gaseous nitrogen obtained has increased pressure, and after heating in the heat exchanger, it is supplied to the pneumatic engine, where it can produce useful work (see Figure 1). The same power system can operate on compressed air, which can be stored in light carbon fiber-reinforced plastic high-pressure vessels, which are well represented in industry.

This project proposes the development of an environmentally friendly cryogenic propulsion system, operating on liquid nitrogen or compressed air, which can be used for ecologically clean production in agriculture. For the first stage of the project, theoretical calculations of the efficiency of propulsion system and gas consumption will be carried out. For the second stage, a working model of the cryogenic propulsion system will be designed, assembled and tested with measurements of its main operating and power characteristics. The purpose of our proposed project is to improve the environmental sustainability and ecology by the development of appropriate scientific and technical bases of a cryogenic/pneumatic power source for robust ecologically friendly and fire-safe machines, the construction of vehicles and trucks for agricultural purposes not requiring the usage of the hydrocarbon fuels or chemical batteries, and the demonstration of their usage with low operating costs relative to existing vehicles and trucks.

Advantages in agriculture and rural areas

(1) Sustainable development of local areas; (2) using renewable energy sources; (3) unrestricted nitrogen deposits in the atmosphere; (4) using the same LN2 reservoirs as for food cooling and storage; (5) no pollution along with easy operation; (6) reduction in noise; (7) significantly-reduced dependence on gasoline; (8) possibility of using low nighttime prices of electricity; (9) convenient energy storage; (10) the exhaust of a cryogenically-powered vehicle could be used to begin cooling freshly picked fruits and vegetables for a greater degree of preservation before canning or freezing, and (11) relatively low prices for manufacturing and liquefaction.

Subjects of research and implementation

- *Non-polluting pneumatic grass movers, based on tractors, which have been used for some hours in a week and do not need large vessels. They can be easy charged by the compressor in a garage anywhere by using electricity.*
- *Environmentally-friendly cryogenic or pneumatic tractors for agricultural purposes with local fueling by liquid nitrogen. Usually they are working not far from the farm and can be easily refueled throughout the day by using the same LN2 reservoirs as for cooling the products.*
- *Farm working equipment, which often has hydraulic drive and could be replaced by carefully-controlled pneumatic equipment.*
- *Energy storage by compressing the air or liquefying nitrogen for automotive propulsion systems proposed above, by using wind or solar local power stations. This can avoid utilization of electrical energy in expensive and short-lived chemical batteries. Here we can propose an entire green cycle of producing and utilizing energy for agricultural purposes.*