An idea on Smart Farming: IoT monitoring of water production from dihydrogen combustion

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Abstract

Smart Farming is a concept developing rapidly and gaining momentum. The management of livestock and farm products is done in an automated way thanks to IoT technology. The large field of data at hand offers the possibility of analysis for a better understanding of issues and more efficient decision-making. The management of water consumption is one of the most relevent Smart Farming use cases. In the event of drought, the pressure on water resources becomes increasingly strong. What if we produced water then? The idea of not worrying about the consequence of drought on agricultural production would be interesting.

One of the first experiences you learn in a chemistry class is that the combustion of dihydrogen produces water. However, it is necessary to follow this experience closely because of the risk of explosion. Dihydrogen can be produced by the gasification of (agricultural) biomass. Here, the technology takes over, by the means of a supervising IoT system. This system will manage the overall process from biomass production, then dihydrogen production (biomass-to-hydrogen), to water production (dihydrogen-to-water).

If the idea proves to be viable on a large scale, the result would be valuable in reducing the issue of water scarcity, in times of drought, in agricultural areas, and even in allowing energy autonomy on farms.

Keywords

Smart Farming, IoT, Water production, dihydrogen combustion, Water Management

Overview and background

Smart Farming systems contribute to the prevention of diseases (Ahmed et al. 2020, Genaev et al. 2021), to the geolocation of areas to be treated (Raja et al. 2020, Lottes et

al. 2017), to the development of new agronomic practices, or even to the positioning and management of watering (Castañeda-Miranda and Castaño-Meneses 2020, Cordeiro et al. 2022, Nawandar and Satpute 2019). The latter is a case of the water resource management process, which is increasingly subject to research since water is becoming a rare commodity (Pisani 2009). However, water resource management only makes it possible to guide water consumption better and does not respond to the problem of water scarcity . So, the idea of producing water came. The concept of Smart Farming then takes another turn. Smart not only emphasizes the intelligence offered by technology in the management of the resources but also in the use of existing natural resources. Biomass represents an exploitation opportunity that could be used in water production by extracting dihydrogen. The latter by its combustion (in the air), produces water. This process constitutes a supply chain that could be managed with technology, particularly IoT.

Back to the combustion of hydrogen. It is one of the first experiments learned in chemistry class and achieved according to this equation: $2H_2 + O_2 \rightarrow 2H_2O$

This equation means that the combustion of two volumes of dihydrogen (fuel) by one volume of dioxygen (oxidant) produces two volumes of water (product). An explosion is a risk that could happen when the equation equilibrium is not satisfied. To avoid this, an IoT system can be built to manage the overall process of water production including:

- Biomass management (Mahajan and Naik 2019, Banerjee et al. 2021
- Supervision of hydrogen production (Biomass-to-hydrogen); Lepage et al. 2021
- Hydrogen management (Ziogou et al. 2017 Yu et al. 2019, Mohd Aman et al. 2021)
- Supervision of water production (L.Drell and Belles 1958
- Irrigation management (Ramachandran et al. 2022, Kamaruddin et al. 2019, Mohammed et al. 2021

Objectives

The objectives of this idea targeted first to find a solution for irrigation in agriculture in times of drought. Second, including the water production process into Smart Farming management by developing a dedicated IoT solution is intriguing.

Impact

If the idea proves useful, the issue of lacking water, in times of drought, in agricultural areas will be reduced. And the concept of an energy-sufficient farm would be subject to research.

Implementation

It is suggested here to set up an experiment around the production of water by combustion of dihydrogen in a closed environment such as a greenhouse where conditions for vapor

condensation must be provided. It could create a small ecosystem in which the water cycle could be retraced (evaporation: water vapor by combustion of dihydrogen; condensation, then precipitation). Moreover, it is interesting to reproduce the experiment in an open environment (in the open air on a plot of land). Biomass hydrogen extraction techniques are increasingly used and provide a wide field for research like analysis and experimentation on bioenergy-based power generation systems; hybrid configurations for biomass-based systems, or cost reduction for energy-based systems. As a matter of fact, dihydrogene combustion is an exothermic reaction. The heat produced can be exploited in the extraction of dihydrogen from biomass.

Conflicts of interest

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