Purple-B

Hydrogen production from immobilized cells in photo-bioreactors

Executive summary

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EXECUTIVE SUMMARY

Because of its great energy density and long-term viability, hydrogen has been widely recognized as a promising tool for addressing global warming issues. Although currently not commercially viable, hydrogen generation using bioprocesses is viewed as a promising technique in terms of sustainability. This is due to the moderate operating conditions, low net greenhouse gas emissions, and the ability to employ waste materials and wastewaters as carbon and energy sources.

In this context, the Purple-B project seeks to develop a two-stage sequential Dark and Photo fermentation system for processing astronaut waste (Figure 1). The implementation of a two-stage process to recover hydrogen (H2) using food waste and black water or sewage sludge, which are the principal waste streams in a space station, offers an opportunity to maximize H2 recovery from these substrates. This approach establishes a direct waste-to-energy link, cleaning the effluent while also producing H2. Moreover, the immobilization of Purple Non-Sulfur Bacteria (PNSB) on a hydrophilic matrix allows the system to work under microgravity conditions, such as those found on planets (e.g., Mars) or in a gravity-free environment such as a space station. Using an immobilized biomass photobioreactor reduces the amount of water that circulates through the system, allowing for better control of biomass growth. As a result, the Purple-B reactor is a critical component within the closed system of a space station, effectively turning waste into energy.

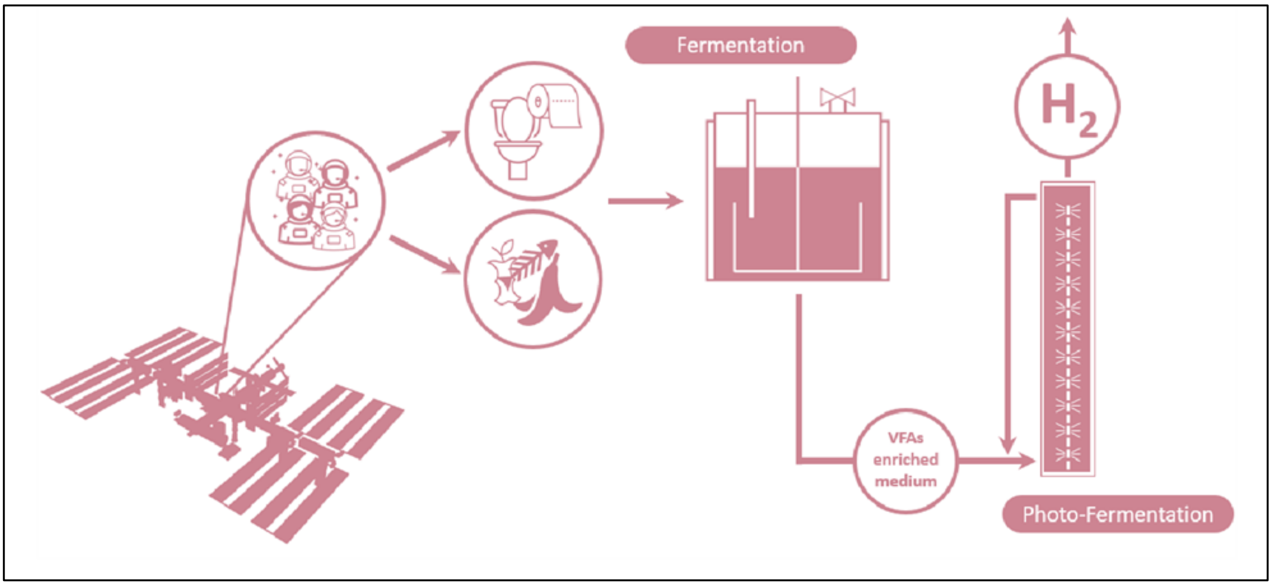

Figure 1, Purple-B project overview

The PURPLE-B project, developed on behalf of the European Space Agency, aims to test a system for producing bio hydrogen within the space station. A prototype was created consisting of three LED-illuminated reactors with Red Non-Sulphurous Bacteria (PNSB) immobilized in a gel/porous matrix isolated from the Venice Lagoon sediments. By combining a two-stage co-fermentation/photo fermentation procedure, the PNSBs were fed in continuous flow with volatile fatty acids (VFA).

A stable process was achieved, throughout the course of the 18-month project, producing around 23.75 mLH2L-1h-1 of gas.

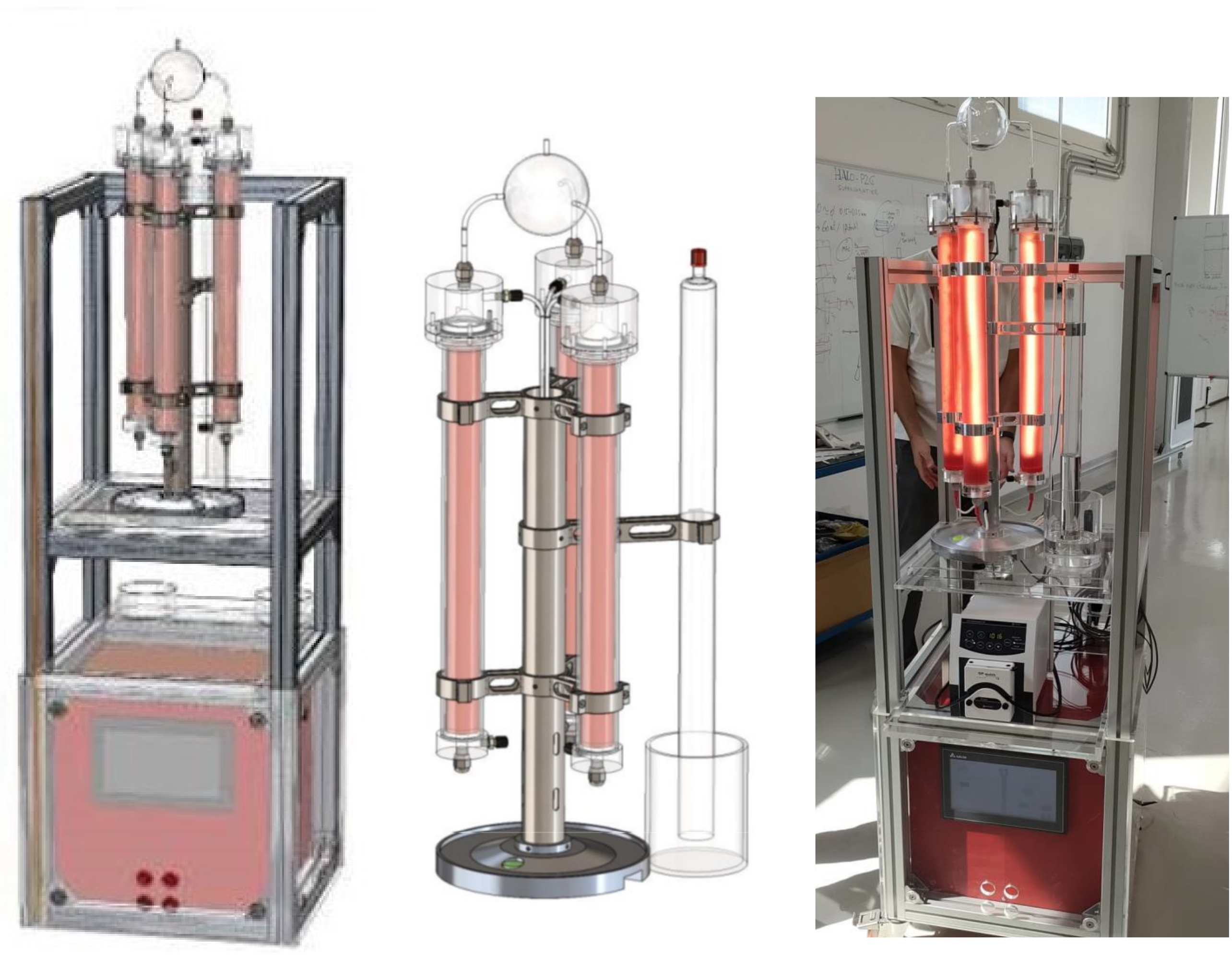

Figure 2: The complete purple-B reactor