Bioelectrochemical wastewater treatment coupled to biogas upgrading through CO_2 sorption

KEYWORDS

- ❑ BIOMETHANE
- ❑ BIOGAS UPGRADING
- ❑ WASTEWATER TREATMENT
- ❑ GREEN HYDROGEN
- ❑ HYTHANE

AREA

- ❑ ENERGY & ENVIRONMENT

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Patent for invention

Ownership
Sapienza University of Rome 100%

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Industrial & Commercial Reference
Biogas and biomethane production, renewable energies market

Time to Market
The proposed invention has been validated in the laboratory with TRL 4

Availability
Cession,Research,Development, Experimentation,

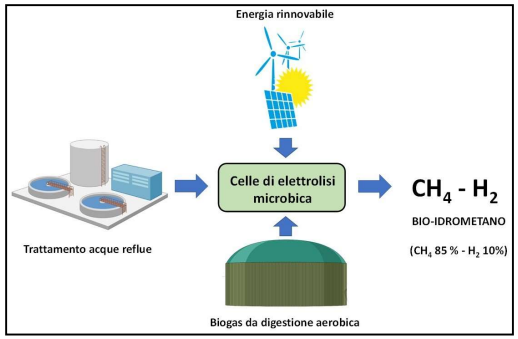

Fig.1 Wastewater treatment, biogas upgrading and renewable energystorage operations using a microbial electrolysis cell.

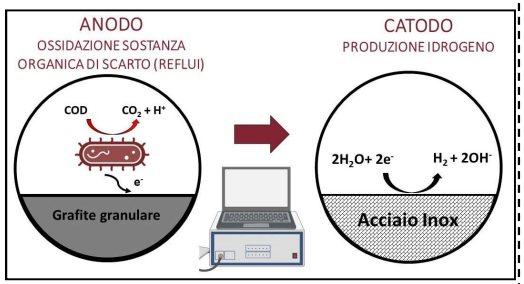

Fig.2 Schematic representation of the anodic and cathodic bioelectrochemical reactions in the microbial electrolysis cell.

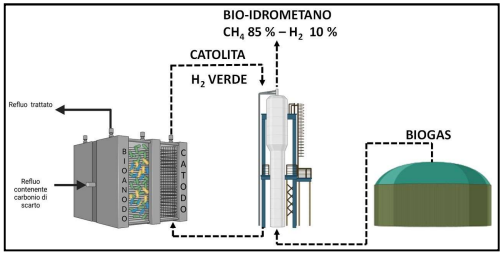

Fig.3 Integration of wastewater treatment and anaerobic digestion biogas upgrading through the use of a gas-liquid absorption column.

Abstract
Object of the invention is a microbial electrolysis cell used for green hydrogen production, wastewater treatment and absorption of CO_2 present in a biogas. The proposed invention is based on the possibility of generating an electric current through the action of electroactive microorganisms that oxidize organic matter by transferring electrons to a cathode for hydrogen production. The production of alkalinity in the catholyte is used for the absorption of CO_2 contained in a biogas, thus enabling the production of biomethane (CH_4>94%) or bio-hydromethane (CH_4>84% H_2 10%).

Technical Description

The invention is based on experimental results obtained by the use of an electrolysis cell with two chambers (anode and cathode) separated by a cation exchange membrane (CEM) Within the anode chamber, oxidation of organic substances contained in wastewater takes place, while at the cathode, hydrogen production takes place. The electrolysis cell has been kept polarized by means of a potentiostat. This evidence highlights how it is possible, through adjustment of the CO_2 inlet gas flow rate load, to achieve a high degree of purity of the gas mixture.

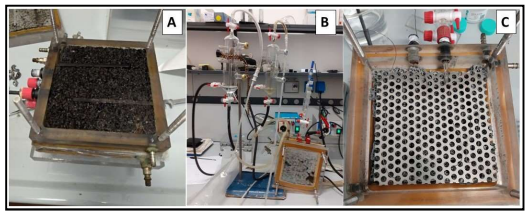

Fig.4 Graphite granules (A), assembled microbial electrolysis cell (B) and stainless-steel cathode (C) of the reactor utilized for the patent deposit)

Technologies & Advantages

The invention describes an adsorption method of CO_2 present in a biogas by in situ alkalinity generation supported by a biological process to purify wastewater and produce green hydrogen. Current generation and subsequent ion transport through ion exchange membranes results in progressive acidification of the anolyte and alkalinization of the catholyte. The progressive alkalinization of the catholyte can be exploited to absorb the CO_2 present in the biogas through the cathode compartment integration of a gas-liquid adsorption column. By varying the process configuration, it is possible to obtain bioCH_4 and H_2 in two separate lines or to produce a gaseous mixture called bio-hydromethane consisting of biomethane and hydrogen (at 10 percent max.). Presenting the advantage of faster ignition, lowering nitrogen oxide and CO emissions by 50%.

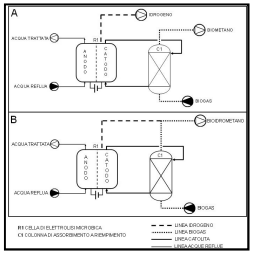

Fig.5 Process diagram of wastewater treatment and biogas refining using microbial electrolysis cell and absorption column: biomethane and hydrogen production (A), biohythane production (B)

Applications

The competitive advantage of the invention lies in the valorization of wastes and organic wastes by producing gaseous biofuels through the use of renewable energy. The invention is proposed as a virtuous approach for the purification and upgrading of biogas and the production of biomethane. In addition to biomethane, obtained by removal of CO_2 from biogas, the invention enables the enrichment of biomethane with hydrogen thus obtaining, an innovative biofuel called biohydromethane.

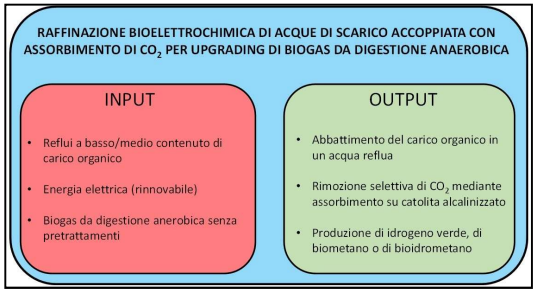

Fig.6 Input (INPUT) and output (OUTPUT) matrices from the proposed invention proposed

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