CYCLE FOR THE CONVERSION OF LOW ENTHALPY THERMAL ENERGY INTO ELECTRICAL ENERGY

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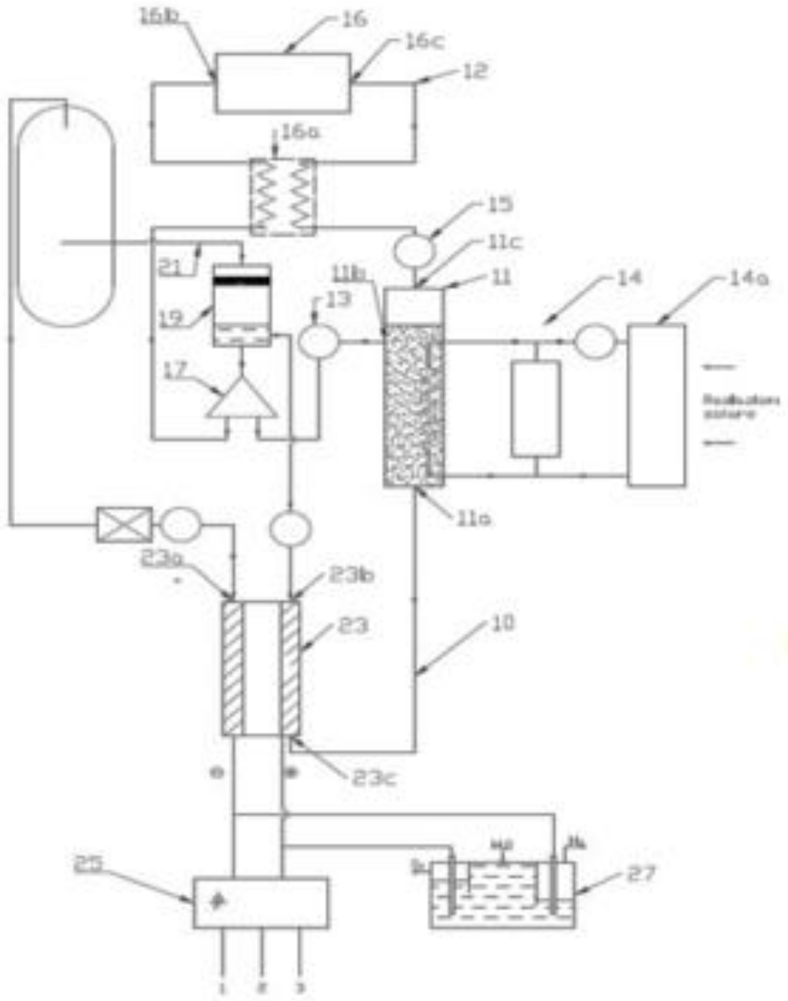
Invention

The innovative system for the production of electricity is based on the use of fuel cells within a high-efficiency cycle that converts the thermal energy provided by "low" temperature (e.g. ~ 80 °C) and low enthalpy heat sources, such as solar thermal energy and/or waste heat from industrial processes (e.g. from thermal power plants), thanks to a chemical reaction of molecular dissociation characteristic of the cycle. The proposed electrochemical cycle is a thermally regenerative closed cycle.

The cycle is based on the chemical and electrochemical transformation of hydrogen iodide (HI) and is a thermal regenerative cycle applied to an H_2/I_2 fuel cell.

In the chemical semi-cycle, thermal energy, supplied at low temperature (≥ 80 °C), increases the enthalpy of the system by evaporating the hydrogen iodide in an aqueous solution at low pressure/temperature; subsequently, the HI can be thermally decomposed into oxidant and reductant by tapping electricity from the cell and bringing the mixture to a high temperature through the 'Joule' effect; then, the mixture is brought back down to low pressure/temperature, allowing all substances except the hydrogen to condense and thus be separated from the mixture. In the electrochemical semi-cycle, the chemical energy (enthalpy) is converted into electrical energy through a fuel cell (flow battery), recombining the substance and thus "closing the loop", which is characterized by an efficiency of up to 55% and a useful energy density of >18 kW per mole of dissociated HI.

Drawings & pictures



11-evaporator
13-pump/ Compressor
14-circuit heat energy carrier
15-compressor
16-dissociation reactor
16-heat exchanger
17-mixer
19-separator
21-branch hydrogen
23-hydrogen
23b-water solution poly iodide ions
23-fuel cell PEM
25-Three-Phase Inverter
27-cell electrolytic H2O

Industrial applications

The main applications of the invention are:

- electricity production from renewable energy sources;
- production of electrical energy from low/non-concentration solar thermal systems;
- recovery of waste heat (at medium-low temperature) from industrial processes or thermal power plants, avoiding energy waste;
- production of hydrogen H_2 and oxygen O_2 with high efficiency.

The technology presents the following advantages:

- a closed chemical-electrochemical cycle;
- a thermal regenerative cycle;
- highly efficient conversion of solar thermal energy or energy generated in thermal power plants;
- fuel cell cooled by the operating fluid itself.

Possible developments

The patented system (TRL 2) allows the design of a sustainable and environmentally friendly energy conversion prototype.
The studies carried out require future implementations for the realization of the prototype and the execution of the relevant experimental tests to achieve a TRL 3-4.

Future collaborations with companies or other partners interested in sustainable energy and recycling could make the technology successfully applicable in an industrial environment.

The research team is interested in collaborating with industrial partners to increase the technological development of the invention and to consider a licensing out of the patented system.

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