Revolutionary Electrodes Generate Hydrogen Fuel from Seawater

Description


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Seawater could be a source of clean hydrogen fuel

Tamara Kulikova / Alamy

In a groundbreaking advancement, electrodes capable of generating hydrogen from seawater—without producing corrosive and hazardous chlorine gas—are set to be manufactured on a commercial scale for the first time.

As Doug Wicks, a representative from the US Department of Energy's Advanced Research Projects Agency–Energy (ARPA-E), states in a press release, "Conventional electrolysis has primarily relied on pure water, an increasingly scarce global commodity. These electrodes eliminate this dependency and instead utilize the ocean, which is the world's most abundant water resource."

The innovative process employs a negatively charged cathode and a positively charged anode to split seawater into four distinct "streams": valuable hydrogen and oxygen, alongside innocuous acidic and alkaline byproducts that can be easily reintroduced to the ocean. Equatic, a California-based startup responsible for this technology, aims to market the resultant hydrogen and oxygen to help mitigate their operational costs.

This electrolysis occurs within a specially designed electrolyser, a device composed of electrode stacks that utilize electricity to dissociate water molecules. However, traditional systems often falter when addressing seawater, which contains dissolved salts, minerals, metals, and microorganisms detrimental to operational integrity. Moreover, the electric current that draws oxygen to the anode inadvertently splits salt, prompting the release of toxic chlorine gas that accelerates equipment deterioration.

To counteract this difficulty, Chen and his collaborators have crafted an anode that selectively extracts oxygen from water molecules while circumventing salt dissociation. This mechanism incorporates a chlorine-blocking layer, permitting water flow through the catalyst while impeding salt intrusion. Preliminary laboratory assessments indicate the anodes should endure a minimum of three years before necessitating maintenance or replacement.

Pau Farras, an academic at the University of Galway in Ireland who is unassociated with Equatic, emphasizes the potential of such oxygen-selective anodes for drawing hydrogen fuel from seawater, although he expresses the need for extensive field testing to validate their efficacy. "Real-world performance is essential for understanding their full capabilities," he asserts.

The company is poised to commence production at a California facility capable of manufacturing 4,000 anodes annually. These components will be utilized in a demonstration plant in Singapore, designed to remove 10 tonnes of CO_2 while producing 300 kilograms of hydrogen per day.

Topics:

Vocabulary List:

1. **Electrolysis** /ɪˌlɛkˈtrɒlɪsɪs/ (noun): A chemical process that uses electricity to cause a chemical change typically to split substances like water into hydrogen and oxygen.
2. **Corrosive** /kəˈroʊsɪv/ (adjective): Having the ability to cause damage or destruction to materials often due to chemical reactions.
3. **Innovative** /ˈɪnəˌveɪtɪv/ (adjective): Characterized by the creation and application of new ideas or methods.
4. **Mitigate** /ˈmɪtɪˌgeɪt/ (verb): To make less severe serious or painful; to alleviate.
5. **Operational** /ˌɒpəˈreɪʃənl/ (adjective): Relating to the operation or functioning of a system or component.
6. **Efficacy** /ˈɛfɪkəsi/ (noun): The ability to produce a desired or intended result; effectiveness.

Comprehension Questions

Multiple Choice

1. What is the main focus of the technology discussed in the article?

Option: Generating hydrogen from seawater
Option: Producing clean electricity
Option: Removing CO2 from the atmosphere
Option: Extracting minerals from seawater

2. Which organization is mentioned as being responsible for the innovative process in the article?

Option: Equatic
Option: US Department of Energy
Option: University of Galway
Option: Tata Group

3. What is the purpose of the negatively charged cathode and positively charged anode in the electrolysis process?

Option: Split seawater into valuable hydrogen and oxygen
Option: Produce toxic chlorine gas
Option: Generate electricity from seawater
Option: Extract minerals from seawater

4. What is the key feature of the anode designed by Chen and collaborators to prevent salt dissociation?

Option: Chlorine-blocking layer
Option: Increased salt intrusion
Option: Enhanced equipment deterioration
Option: Accelerated oxygen extraction

5. Who emphasizes the need for extensive field testing in the article?

Option: Doug Wicks
Option: Chen
Option: Pau Farras
Option: Tamara Kulikova

6. Where is the demonstration plant utilizing the technology located?

Option: Singapore
Option: California
Option: Ireland
Option: Galway

Answer

Multiple Choice: 1. Generating hydrogen from seawater 2. Equatic 3. Split seawater into valuable hydrogen and oxygen 4. Chlorine-blocking layer 5. Pau Farras 6. Singapore

Vocabulary quizzes

Multiple Choice (Select the Correct answer for each question.)

1. What is the efficient use of resources called?

Option: Transformation
Option: Utilization
Option: Disposal
Option: Creation

2. What term refers to being open and honest in actions?

Option: Opacity
Option: Transparency
Option: Evasion
Option: Secrecy

3. What word describes a substance that causes gradual damage by chemical reactions?

Option: Innocuous
Option: Neutral
Option: Resilient
Option: Corrosive

4. Which term relates to the functioning of a machine or system?

Option: Theoretical
Option: Functional
Option: Operational
Option: Inactive

5. What is the ability to produce a desired effect or result called?

Option: Inefficacy
Option: Efficiency
Option: Efficacy
Option: Ineffectiveness

6. Which term best describes introducing new ideas or methods?

Option: Conventional
Option: Predictable
Option: Standard
Option: Innovative

7. What term is related to the functions and activities of living organisms?

Option: Psychological
Option: Biological
Option: Physical
Option: Physiological

8. What are difficulties that test one's abilities or resources called?

Option: Rewards
Option: Obstacles
Option: Facilitators
Option: Challenges

9. Which term describes showing no signs of stopping or lessening?

Option: Merciful
Option: Relentless
Option: Kind
Option: Compassionate

10. What is the state of being more powerful or noticeable than others called?

Option: Equality

Option: Submissiveness
Option: Dominance
Option: Equivalence

Gap-Fill (Fill in the blanks with the correct word from the vocabulary list.)

11. _____ is essential for resolving conflicts peacefully.

12. The project launch date was eagerly _____ by the entire team.

13. The decision had far-reaching _____ on the company's future.

14. Effective risk management strategies help _____ potential damages.

15. The transformation journey towards sustainability requires dedication and effort.

16. The unexpected _____ in the plot kept the audience engaged.

17. The discovery of a new species holds great _____ for the field of biology.

18. Astronauts conduct _____ activities during spacewalks outside the spacecraft.

19. The mountain climbers faced _____ conditions as they ascended.

20. Efficient resource _____ is crucial for sustainability.

Matching Sentences (Match each definition to the correct word from the vocabulary list.)

21. The artist's workshop was a space where new ideas flourished.
22. The government enacted new measures to protect the environment.
23. is the process of using electricity to break down a compound.
24. The jeweler was known for his attention to detail in crafting each piece.
25. Graduating from college was a significant in her academic journey.
26. A is a space entirely devoid of matter.
27. Interactive learning activities students in the classroom.

28. Winning the award was a well-deserved for his hard work.
29. The sudden loss of a loved one sent waves throughout the community.
30. Effective between team members leads to better collaboration.

Answer

Multiple Choice: 1. Utilization 2. Transparency 3. Corrosive 4. Operational 5. Efficacy 6. Innovative 7. Physiological 8. Challenges 9. Relentless 10. Dominance
Gap-Fill: 11. Dialogue 12. anticipated 13. implications 14. mitigate 15. Journey 16. twist 17. significance 18. extravehicular 19. perilous 20. utilization
Matching sentence: 1. Generative 2. Regulatory 3. Electrolysis 4. Meticulous 5. Milestone 6. Vacuum 7. Engage 8. Accolade 9. Shock 10. Dialogue

CATEGORY

1. Sci/Tech - LEVEL5

Date Created
2024/09/20
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