CLAIMS

1. Process for the production of hydrogen starting from an aqueous solution (20) containing hydrochloric acid in dissociated form, said solution containing hydronium ions (H_3O^+), within said aqueous solution there being present at least one electrode composed of a metal alloy containing a plurality of metals with different standard reduction potentials,

   the process comprising the following steps:

   reduction to hydrogen gas (H_2) of the hydronium ions (H_3O) present in the solution, as a result of a flow of electrons generated in said at least one electrode between pairs of metals, from the metal having a lower potential to the metal having a higher potential, and

   extraction of the so obtained hydrogen gas from said aqueous solution,

   wherein said metal alloy comprises magnesium and at least one metal from among: beryllium (Be), aluminum (Al), manganese (Mn), zinc (Zn), iron (Fe), copper (Cu), silicon (Si), nickel (Ni).

2. Process according to claim 1, wherein said metal alloy comprises mainly magnesium.

3. Process according to claim 2, wherein said metal alloy contains an amount of magnesium in the range of 85% to 95% by weight, preferably 90% to 91% by weight.

4. Process according to any one of claims 1 to 3, wherein the metal alloy of said at least one electrode is composed of:

   A) 90.81% Mg; 5.83% Al; 2.85% Zn; 0.45% Mn; 0046% Si; 0.0036% Cu; 0.0012% Be; 0.0010% Fe; 0.00050% Ni, or

   b) 90.65% Mg; 5.92% Al; 2.92% Zn; 0.46% Mn; 0043% Si; 0.0036% Cu; 0.0012% Be; 0.0010% Fe; 0.00050% Ni.

5. Process according to any one of the preceding claims, wherein said at least one electrode is coated on its outer surface with a coating which comprises at least one metal fluoride, preferably a magnesium fluoride, aluminum fluoride and/or zinc fluoride.

6. Process according to claim 5, wherein said coating comprises said at least one metal fluoride mixed with a methacrylic resin.

7. Process according to claim 6, wherein said methacrylic resin comprises 50%-70% (by weight) PFTE, 15%-25% (by weight) 1,2-propanediol monomethacrylate (CAS.27813-02-1) and 15%-25% (by weight) hydroxyethyl methacrylate (CAS 868-77-9) .

8. Process according to claim 7, wherein said methacrylic resin comprises 60% (by weight) PFTE, 20% (by weight) 1,2-propanediol monomethacrylate (CAS.27813-02-1) and 20% (by weight) hydroxyethyl methacrylate (CAS 868-77-9) .

9. Process according to one of claims 5 to 8, wherein said coating of said at least one electrode has a thickness of 0.5 mm – 3.0 mm, more preferably of 1.0 mm - 2.0 mm.

10. Process according to one of claims 5 to 9, wherein said at least one electrode has at one of its ends a graphite element, and wherein said coating of the outer surface of said at least one electrode does not cover said graphite element.

11. Process according to claim 10, wherein a metal element is provided inside said at least one electrode, preferably an iron or carbon steel bar, said metal element being in contact with said graphite element.

12. Process according to one of claims 5 to 11, wherein said outer coating is wrapped with a perforated tape or a PTFE mesh or with a semi-permeable fabric tape, which is permeable to the passage of the aqueous solution towards the electrode and is impermeable to the aqueous solution in the opposite direction.

13. Process according to any one of the preceding claims, wherein said aqueous solution comprises hydrochloric acid in a concentration of 5 to 10%.

14. Process according to any one of the preceding claims, wherein the pH of said aqueous solution is in the range 2 to 4.

15. Process according to any one of the preceding claims, wherein the reduction reaction of the hydronium ions to hydrogen gas occurs at a temperature of between 20 and 70°C, preferably between 55 and 60°C.

16. Process according to any one of the preceding claims, wherein the reaction of reduction of the hydronium ions to hydrogen gas occurs at a pressure below atmospheric pressure.

17. Process according to any one of the preceding claims, wherein said aqueous solution is regenerated by means of a recirculation step and a degassing step of the aqueous solution and said degassing step comprises a filtration step where oxygen is removed from the aqueous solution.

18. Process according to claim 17, wherein said filtration step is performed using porous baffle membrane filters, preferably charged with MnO_2, where both oxygen (O_2) and chlorine (Cl_2) are released separately.

19. Process according to claim 18, wherein the chlorine thus released is recovered and reintroduced into the aqueous solution, preferably by bubbling.

20. Process according to one of claims 17 to 19, wherein the recirculation step comprises a step of cooling the aqueous solution adapted to keep the reaction temperature substantially constant.

21. Plant for the production of hydrogen in accordance with the process according to claims 1-20, said plant comprising:

    at least one buffer tank (1) for storing an aqueous solution (20) containing hydrochloric acid in dissociated form;

    at least one reactor (2, 3) for the production of hydrogen, inside which at least one electrode composed of a metal alloy containing a plurality of metals with different standard reduction potentials is housed;

at least one feed line (22, 23) for feeding of the aqueous solution from said at least one buffer tank (1) to said at least one reactor (2, 3);

at least one recirculation line (26, 28; 27, 28) for recirculation of the aqueous solution from said at least one reactor (2, 3) to said at least one buffer tank (1);

at least one device (10) for regeneration of the aqueous solution, said device being positioned along said at least one recirculation line (26, 28; 27, 28), and

means (4, 5) for extracting hydrogen gas from said at least one reactor.

22. Plant according to claim 21, wherein said at least one regeneration device (10) comprises a filtering device comprising at least one porous baffle membrane filter, preferably charged with MnO_2, able to separate oxygen (O_2) from said aqueous solution.

23. Plant according to claim 22, wherein said filtering device operates under vacuum.

24. Plant according to any one of claims 21 to 23, comprising at least one cooling device (8, 9) along said at least one recirculation line (26, 28; 27, 28).

25. Electrode for use in the hydrogen production process according to claims 1-21, composed of a metal alloy containing magnesium and at least one metal from among: beryllium (Be), aluminum (Al), manganese (Mn), zinc (Zn), iron (Fe), copper (Cu), silicon (Si), nickel (Ni),

wherein said metal alloy contains an amount of magnesium in the range of 85% to 95% by weight, preferably 90% to 91% by weight,

and wherein said metal alloy is composed of:

A) 90.81% Mg; 5.83% Al; 2.85% Zn; 0.45% Mn; 0046% Si; 0.0036% Cu; 0.0012% Be; 0.0010% Fe; 0.00050% Ni, or

b) 90.65% Mg; 5.92% Al; 2.92% Zn; 0.46% Mn; 0043% Si; 0.0036% Cu; 0.0012% Be; 0.0010% Fe; 0.00050% Ni.

26. Electrode according to claim 25, wherein said electrode is coated on its outer surface with a coating which comprises at least one metal fluoride, preferably a magnesium fluoride, aluminum fluoride and/or zinc fluoride.

27. Electrode according to claim 26, wherein said coating comprises said at least one metal fluoride mixed with a methacrylic resin.

28. Electrode according to claim 27, wherein said methacrylic resin comprises 50%-70% (by weight) PFTE, 15%-25% (by weight) 1,2-propanediol monomethacrylate (CAS.27813-02-1) and 15%-25% (by weight) hydroxyethyl methacrylate (CAS 868-77-9).

29. Electrode according to claim 28, wherein said methacrylic resin comprises 60% (by weight) PFTE, 20% (by weight) 1,2-propanediol monomethacrylate (CAS.27813-02-1) and 20% (by weight) hydroxyethyl methacrylate (CAS 868-77-9).

30. Electrode according to one of the claims 26 to 29, wherein said coating of said electrode has a thickness of 0.5 mm – 3.0 mm, more preferably of 1.0 mm - 2.0 mm.

31. Electrode according to one of claims from 26 to 30, wherein said electrode has at one of its ends a graphite element, and wherein said coating of the outer surface of said electrode does not cover said graphite element.

32. Electrode according to claim 31, wherein a metal element is provided inside said electrode, preferably an iron or carbon steel bar, said metal element being in contact with said graphite element.

33. Electrode according to one of claims 26 to 32, wherein said outer coating is wrapped with a perforated tape or a PTFE mesh or with a semi-permeable fabric tape, which is permeable to the passage of the aqueous solution towards the electrode and is impermeable to the aqueous solution in the opposite direction.

34. Method for coating an electrode composed of a metal alloy containing a plurality of metals with different standard reduction potentials, said electrode being for use in the process for the production of hydrogen according to claims 1-20, the

coating method comprising:

- a step of dipping the electrode in a hydrofluoric acid and water bath, in which the metals that make up the outer surface of the electrode react with the hydrofluoric acid to form a fluorinated patina of metal fluoride salts;

- a first step of drying said fluorinated patina of metal fluoride salts;

- a step of smearing a methacrylic resin gel on said fluorinated patina;

- a second step of drying the mixture thus obtained comprising metal fluorides and methacrylic resin.

35. Method for coating an electrode according to claim 34, wherein said methacrylic resin comprises 50%-70% (by weight) PFTE, 15%-25% (by weight) 1,2-propanediol monomethacrylate (CAS.27813-02-1) and 15%-25% (by weight) hydroxyethyl methacrylate (CAS 868-77-9).

36. Method for coating an electrode according to claim 34 or 35, wherein at the end of said second drying step, said electrode is wrapped with a perforated tape or a PTFE mesh or with a semi-permeable fabric tape, which is permeable to the passage of the aqueous solution towards the electrode and is impermeable to the aqueous solution in the opposite direction.