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PRODUCTION OF HYDROGEN BY ELECTROLYSIS

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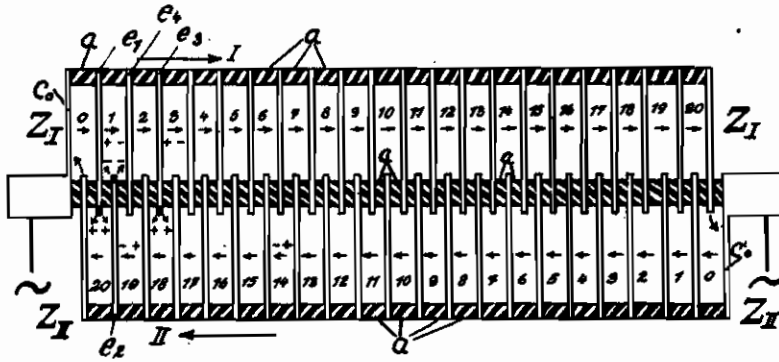
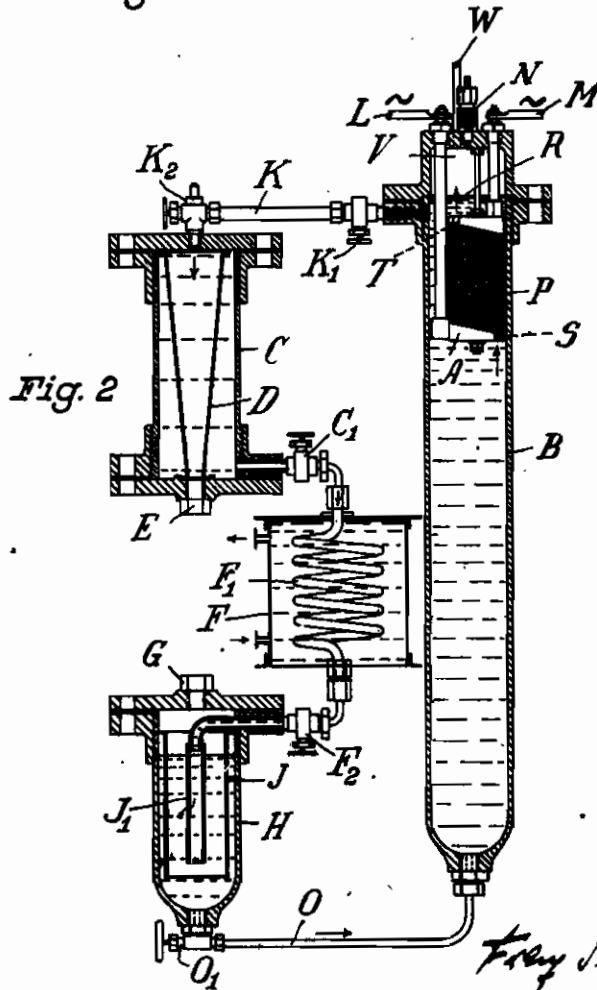


Fig. 1



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PRODUCTION OF HYDROGEN BY ELECTROLYSIS

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This invention relates to a method, system and plant for the production of hydrogen by electrolysis, using alternating current.

According to the present invention the hydrogen is produced from an aqueous solution by means of electrolyser cells filled with the electrolyte, said cells having pairs of mutually staggered electrode surfaces of high electric load and being connected to a source of alternating current. The system briefly stated operates in this manner that the electrolyte is enriched with an agent capable of fixing the oxygen which is set free during the electrolysis, the oxidation products being separated from the electrolyte.

Advantageously the cell aggregate of the electrolyser is constructed as a double cell aggregate including electrodes with extensions projecting into the respective opposite cell of the double cell aggregate.

The electric load of the electrodes may be, e. g., up to 300 amperes per square decimeter of the electrode surface, and the voltage may be about 1.6 to 1.8 volts per cell. Advantageously the temperature, current intensity and, as far as possible, also the concentration of the electrolyte are maintained constant during the electrolysis.

According to a preferred embodiment of the invention, a cyclic process is maintained by continuously separating the oxidation products from the electrolyte and re-enriching the electrolyte with fresh oxygen-fixing agent. An attack upon or decomposition of the electrode substance of the electrodes which, for instance, may consist of nickel plates of a large effective surface, is counter-acted in my process by the symmetrical arrangement of the voltage potentials and the anode depolarisation.

According to one embodiment of the invention the electrolysis is carried out under pressure, the pressure advantageously being adjustable. In this case the cell aggregate is arranged electrically insulated in a pressure tank which advantageously is provided with a water supply and a pressure control organ, the electrolyte passing through the pressure tank and the cell aggregate in a closed cycle. The pressure tank with the electrode aggregate may be provided with a collecting chamber for the hydrogen which is being produced in the electrolysis, the hydrogen being drawn from this collecting chamber and delivered to its place of use or to storage tanks.

According to a preferred embodiment of the invention a filter separator and a saturation vessel for the electrolyte mixture are connected to the pressure tank, through pipe lines including

shutting-off and control means, as well as a cooling device for the electrolyte. The filter separator and the saturation vessel should be constructed to permit their convenient filling and discharge. The electrodes are preferably disposed at different heights, in a slanting relationship, whereby the passage of gas and electrolyte and the separation of the oxidation products are facilitated.

My novel electrolytic system for the production of hydrogen is economic and reliable in operation, yielding a hydrogen of high purity; it is very suitable also for portable plants, since the hydrogen can be produced practically under any pressure by means of a plant of relatively simple and robust construction. The invention will be better understood by reference to the following detailed description in connection with the accompanying drawing showing by way of example and schematically an embodiment of the invention and in which:

Fig. 1 is a diagrammatic view of an electrode double cell aggregate having the invention applied thereto and

Fig. 2 is a longitudinal section through a pressure electrolyser plant including a cell aggregate in accordance with Fig. 1 disposed in the pressure tank.

Referring to Fig. 1, there are shown 20 working cells I to 20 in each cell aggregate Z_I and Z_{II}, respectively, the electrodes e of the two cells being disposed in pairs which are mutually staggered and insulated from each other. In addition, a converter cell O is arranged in series before each set of cells I to 20. The end of each electrode e extends into the opposite cell of the opposite cell aggregate. An electrolytic solution is disposed in, or passing through, all the cells, consisting, for instance, of an aqueous KOH solution of 30% strength enriched with an oxygen-fixing agent, for instance, sodium sulfite. The load of the electrode surface by the alternating current connected to the end cells may be, for instance, up to 300 amperes per square decimeter. The current after passing through the converter cells O causes production of hydrogen in the cells I to 20 of the two groups of cells Z_I and Z_{II}. The oxygen produced in the electrolyte owing to the effect of the reciprocal anode voltage and the depolarisation effect of the anode is fixed and crystallised out of the KOH solution in the form of a salt which can be eliminated, while the electrolyte in the course of the process is again enriched with the oxygen-fixing agent. If the electrolysis is carried into effect under pressure, the

speed of reaction of the oxidation increases with the pressure. The formation of the anode potential is favoured by the ends of the electrodes e extending with a certain area into the opposite cell, as indicated in Fig. 1.

Assuming for instance, that the alternating current enters into cell I of the upper series of cells Z_I in the direction of arrow I, Fig. 1, oxygen is produced at the electrode surface e_1 while hydrogen is produced on the electrode surface e_2 . A potential is produced which is rising until the maximum current intensity has been reached. On the other hand, a considerable stray effect with respect to the current is produced on the end of electrode plate e_2 of the lower series of cells Z_{II} extending into cell I of the upper series of cells Z_I , during the opposite half wave of the alternating current flowing in the direction indicated by arrow II. Said stray effect acts as a counter potential, so that the oxygen is fixed to the oxygen-fixing agent, for example, sodium sulfite. Hence, only the hydrogen is continuously set free and may be collected in a suitable manner and drawn off from the cell aggregate. The above described process repeats itself in the direction of current indicated by arrow II as indicated with respect to cell II at the electrode e_3 in the lower series of cells Z_{II} and similar effects are produced in the rest of the cells of the double cell aggregate.

Referring now to Fig. 2, it has been assumed that an electrode cell body A constructed in accordance with the principle of Fig. 1 has been mounted in insulated relationship in a pressure tank B. The plant of Fig. 2 is intended for carrying out a high pressure alternating current electrolysis. It will be noted that the electrode system B of the cell body A is disposed in a slanting relationship so as to favour the circulation of gas and electrolyte. The electrolyte may be the same as above, namely, an aqueous KOH solution of 30% strength which is enriched or saturated, for example, with sodium sulfite.

The electrolyte level R in the pressure tank B is provided to be somewhat above the cell body A. The hollow spaces of the salt separator C which is connected to the pressure tank B and provided with a salt filter insert D, as well as the cooling serpentine F_1 and the saturation vessel H and the connecting pipes are also filled with the electrolyte. The screening basket J, J_1 of the saturation vessel H is filled with the fresh oxygen-fixing agent, for instance, sodium sulfite.

If an alternating current of high current intensity is connected across the terminals L and M of the cell body A, the electrolytic process described above with reference to Fig. 1 takes place in the cell body A, at the electrodes P thereof. While the agent contained in the electrolyte, for instance, sodium sulfite, is enriched by the oxygen produced in this process and converted in the case of sodium sulfite, into sodium sulfate, the hydrogen which is being produced, rises with the heated electrolyte, through the discharge channel T, from the cell body A to the top and

is collected in the gas dome V thereof. The electrolyte current acts to wash or rinse the sulfate which is separated in the form of salt through the pipe line K and the control and shut-off organs K_1 , K_2 into the sieve insert of the separator C in which the sodium sulfate is eliminated from the electrolyte. The electrolyte which after this elimination consists substantially of KOH solution only passes through the separator C, D and the control and shutting-off member C_1 into the cooling serpentine F_1 of the cooler F where it is cooled and allowed to pass, through the control and shutting-off member F_2 , into the saturation vessel H. The electrolyte passes through the sieving basket J, J_1 which is filled with sodium sulfite, thus again being saturated with fresh oxygen fixing agent, i.e., sodium sulfite. The electrolyte which is thus saturated, is directed from the saturation vessel H through the shutting-off and control member O_1 and the pipe line O into the lower portion of the pressure tank B and, rising through the channel S in the cell body A, to the electrodes P thereof, where the above described electrolytic process and cycle is repeated.

The pressure of the hydrogen which is being produced during the electrolysis and collected in the gas dome V of the pressure tank B may be adjusted as desired by the overpressure valve N of the pressure tank and directed from the pressure tank to its place of use or to a storage tank. From time to time the salt filter D of the salt separator C must be discharged by means of the closure screw E; the sieve basket J of the saturation vessel H is filled at intervals by means of the closure screw G; the feed of water to the pressure vessel B at W should be maintained constant.

In the process according to the present invention there is substantially required the supply of electric energy, water, and oxygen fixing admixture only. The oxidation products which may be of different nature, depending upon the nature of the admixtures, are also commercially useful; if desired, these by-products may be dressed or prepared and improved in further processes, for rendering the electrolyte process still more economic.

If the temperature and current intensity are maintained constant, there is practically hardly any using up of the electrode material which for instance, may consist of nickel plates having a larger effective surface. Another advantage of the invention is the small space occupied by the plant and the simple and handy operation thereof.

The method and apparatus of the present invention have been described in detail with reference to specific embodiments. It is to be understood, however, that the invention is not limited by such specific reference but is broader in scope and capable of other embodiments than those specifically described and illustrated in the drawing.

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