ELECTROLYTIC CELL HAVING BIPOLARLY CONNECTED POROUS ELECTRODES

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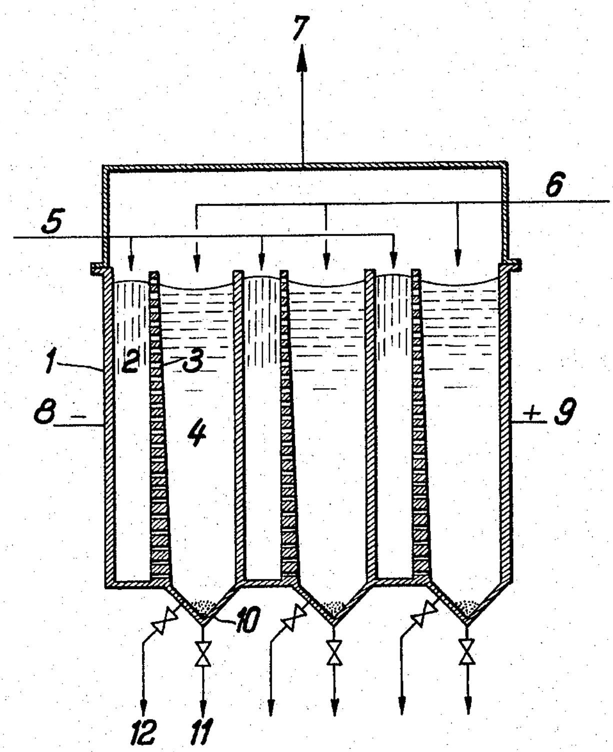

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ABSTRACT OF THE DISCLOSURE

The electrolytic cell has porous electrode plates through which mercury seeps to react with aqueous alkali metal chloride solutions.

This invention relates to electrolytic cells useful for the electrolysis of brine having improved structure and particularly improved vertical mercury cathodes.

Electrolytic apparatus having mercury cathodes in general have rather large space requirements because the mercury serving as the cathode, as all liquids, forms a horizontal upper surface. Electrolytic cells are therefor mostly flat, horizontal apparatus providing poor utilization of space.

There certainly has not been a lack of research to find a compact form of construction for electrolytic cells having mercury cathodes, but most of the proposals have found no acceptance in practice because their means of construction or operation were too complicated.

Of the cells having compact construction, practically the only cells used today have rotating amalgamated iron discs, serving as the cathode, immersed in a pool of mercury whereby such discs are rewetted with fresh mercury with each rotation. These electrolytic cells have a disadvantage in that they have moving parts in that it is necessary to provide for the entrance of rotating shafts into the cells with proper seals. Moreover, the control of clearance between the electrodes provides difficulties in continuous operation. On these grounds, up to now, only smaller units having a capacity of 30 ka. could be built.

Cathodes are also known having a liquid mercury layer which is renewed constantly by trickling mercury onto an amalgamated stationary inclined or vertical metal surface. However, these have found no acceptance in practice, above all, because in order to obtain sufficient coverage with the mercury, it must flow at such a great rate that no technically efficient or sufficient sodium concentration can be achieved in the amalgam.

Electrolytic cells are also known which have anodes and cathodes formed of hollow plates filled with mercury whose walls consist of fine meshed wire sieve or glass or synthetic fiber fabric through which the mercury trickles. In addition, electrolytic cells are known which have a large number of vertical porous electrodes filled with mercury amalgam, the electrodes being arranged in the form of known very compact filter press cells. These latter electrolytic cells, disregarding temporary use in very small apparatus, have found no acceptance in practice because they are not suitable for large technically efficient apparatus. That is, it is not possible to connect the known vertical porous mercury or mercury amalgam electrodes bipolarly, which is an indispensable prerequisite for efficient use in large scale operations. With the known electrolytic cells, all the electrodes must alternately be connected only as cathodes or as anodes, and each be provided with its own individual power supply. The use of the known vertical porous mercury or mer-

cury amalgam electrodes with a bipolar connection fail namely in that the anodically formed chlorine reacts with the cathodically formed sodium amalgam.

The electrolytic cell according to the invention has as an object the elimination of these disadvantages and the provision of alkali metal chloride electrolysis in a large cell having as many electrodes as desired connected bipolarly and a single current inlet and outlet for the entire cell, while still retaining the advantages of the vertical porous mercury of mercury amalgam electrodes, which have an effective outer surface formed by a mercury or mercury amalgam film flowing down the side of the porous outer surface.

The invention accordingly concerns a cell which has a plurality of bipolarly connected electrodes in the form of vertical hollow plates filled with mercury or mercury amalgam, only having the wall which is connected cathodically formed of a metallic or nonmetallic porous material which allows the passage of mercury therethrough, while the wall connected anodically consists of an impermeable conductive material which is chemically resistant in chlorine. Preferably platinized titanium sheets are used for this purpose. Basically any chlorine resistant material is suitable as the material for the porous electrode wall. Porous ceramic or plastic materials are advantageously used for this purpose. It is possible, however, to use specific metals, especially titanium. It has been found that it is possible to produce sintered metal plates with any desired sizes of pores, especially with titanium without difficulty. The faces of the vertical electrode plates are spaced horizontally from each other with the cathodically and anodically connected faces of the adjacent electrodes opposite.

According to a preferred embodiment of the invention, the characteristic differences in the discharge rate of mercury resulting from the prevailing different hydrostatic pressures at the different heights of the electrode are compensated by progressively diminishing the porosity of the electrode wall from top to bottom. This can be accomplished, for example, by progressively diminishing the pore size or increasing the wall thickness in the same direction.

Formation of a cohesive mercury film can be favored by a relatively small inclination of the electrodes according to the invention. An angle of 1–10°, preferably 3°, is desirable.

The means by which this and other objects of the invention are obtained, are described more fully with reference to the accompanying diagrammatic drawing and example, in which the figure is a longitudinal cross section of an electrolytic cell with 3 electrodes.

Each electrode consists of an impermeable electrode plate **1** consisting of platinised titanium sheet and a porous ceramic plate **3**. By inlet **5** mercury is introduced into the chamber **2** between the electrode plate **1** and the electrode plate **3**. Through inlet **6** the sole is introduced into chamber **4**. The mercury trickles through the ceramic electrode plate **3** and reacts with the sodium of the sole. The chlorine formed by this process is drawn off from the cell by the outlet **7**. The current supply is performed by the connections **8**, **9** respectively.

The amalgam formed aggregates at **10** and is drawn off by outlet **11**.

The sole is released by outlet **12**. The electrode plates **1** and **3** have an inclination of 10° with respect to the vertical. The size of the pores of the ceramic plate **3** diminishes progressively from top to bottom, the wall thickness increasing in the same direction.

Into an electrolytic cell consisting of 30 hollow bipolarly connected electrodes filled with mercury one wall of which consists of platinised titanium sheet and the other wall of a porous ceramic plate each of which having an area of 1 square meter, a saturated solution of sodium chloride (sole) having a concentration of 315 gr./liter NaCl and a temperature of 70° C. is introduced. A single current of 125 v. is applied to the outer plates of the electrolytic cell. The strength of the current is 15,000 a. By this current the solution of the sodium chloride is decomposed, the chlorine formed thereby rises to the surface of the solution and is drawn off from the cell, whereas the sodium forms a 0.4% amalgam by reacting with the mercury trickling through the porous ceramic plate. This amalgam is decomposed in a decomposing device by means of carbon plates and water into mercury, sodium hydroxide and hydrogen. The recovered mercury is then recycled into the hollow electrodes. The temperature of the sole in the cell reaches 80° C. It is drawn off in the lower part of the cell above the level of the amalgam. The supply of the sole is controlled in such a way that the concentration of the effluent is 265 g. NaCl/liter.

We claim:

1. In an electrolytic cell for the electrolysis of aqueous alkali metal chloride solutions having a plurality of vertically disposed hollow electrode plates filled with mercury and having porous walls through which the mercury

escapes to the exterior of such electrode plates, the faces of which are spaced horizontally, the combinaton therewith of only one current inlet and only one current outlet for said cell, bipolar connections to all of the electrode plates in such cell excepting both end electrode plates, said electrode plates being provided with a porous face only on the cathodically connected side of sufficient porosity to permit escape of the mercury within the electrodes to the exterior of said porous wall and with a chlorine resistant impermeable conductive face on the anodically connected side.

2. An electrolytic cell as in claim **1** wherein the porosity of said cathode wall progressively diminishes from top to bottom of said verticle electrode.

3. An electrolytic cell as in claim **1** wherein said electrodes are inclined 1–10° from the vertical position.

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