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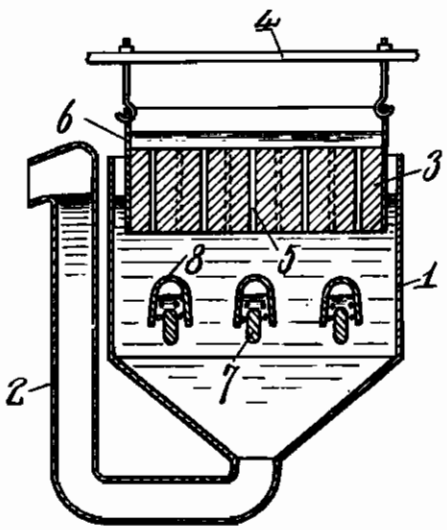

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ELECTROLYTIC APPARATUS FOR PRODUCING A HYDROXIDE OF METAL

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This invention relates to improvements in an electrolytic apparatus for producing a hydroxide of metal, which comprises a metallic anode and a cathode, the anode being placed at the upper part and the cathode at the lower part in an electrolytic cell, and a means to flow the electrolytic solution through the anode towards the cathode.

The main object of the invention is to obtain a pure hydroxide of metal preventing the formation of a basic salt during electrolysis in the electrolytic solution, which retards the action of the anode and makes the product impure.

Another object of the invention is to obtain an apparatus for circulation of electrolytic solution whereby the solution is flowed through the anode towards the cathode carrying the metallic salt produced at the anode to prevent caustic alkali produced at the cathode from coming towards anode.

When electrolysis is carried out with a metallic anode such as nickel, copper, etc., in an aqueous solution of an alkali salt, e. g. sulphate of sodium, the anode metal is dissolved and a metallic salt is produced while hydrogen is generated at the cathode whereby a caustic alkali is produced.

The metallic salt and the caustic alkali thus formed diffuse each other in the bath and finally mix and react.

For instance, when copper and sulphate of sodium are used as the anode and the electrolyte respectively, adding a stabilizer to the electrolyte in order to have hydroxide of copper stably present in the bath, the reaction by electrolysis is shown by the formula

$$Cu+Na_2SO_4+2H_2O=CuSO_4+2NaOH+H_2$$

the anode copper being dissolved and hydrogen being generated at the cathode, and hydroxide of copper is further produced by the following reaction:

$$CuSO_4+2NaOH=Cu(OH)_2+Na_2SO_4$$

However, due to difference of the diffusion velocity of the electrolytic products, a by-reaction is apt to be taken place in the bath. In the above instance, caustic soda which has been produced at the cathode and has a greater diffusion velocity comes to sulphate of copper which has been produced at the anode and is still wandering near there, so that the following reaction is taken place between dense sulphate of copper and dilute caustic soda forming a basic salt:

$$4CuSO_4+6NaOH=CuSO_4\cdot 3Cu(OH)_2+3Na_2SO_4$$

In case a basic salt is formed free caustic soda appears in the electrolytic solution, so that the basic salt abovementioned would be turned into hydroxide of copper and sulphate of sodium by the reaction with the caustic soda as shown by the following formula.

$$CuSO_4\cdot 3Cu(OH)_2+2NaOH=4Cu(OH)_2+Na_2SO_4$$

But this is not the case. Actually, if free caustic soda is present in the solution, the abovementioned reaction does not occur, and oxygen is generated at the anode so that the anode copper is no more dissolved.

The reason that a basic salt is produced instead of hydroxide of metal in the solution is the caustic alkali produced at the cathode has a greater diffusion velocity, so that the caustic alkali comes to the metallic salt which has been produced at the anode and is still wandering thereabout, and dense metallic salt reacts with dilute caustic alkali.

According to this invention, electrolytic solution is flowed from the anode toward the cathode to prevent the diffusion of caustic alkali from cathode towards anode and to bring the metallic salt produced at the anode having a smaller diffusion velocity towards cathode, so as to have the caustic alkali reacts on the metallic salt under a condition that dense metallic salt does not react on dilute caustic alkali, whereby hydroxide of metal without containing a basic salt is obtained.

The accompanying drawing shows a sectional elevation of an electrolytic apparatus according to this invention.

An electrolytic cell **1** provides a pipe **2** which opens at the bottom of the cell, and the solution in the cell is circulated by a pump, not shown, through this pipe and is returned to the cell.

An anode **3** is made of a proper metal and is hung on an anode pole **4**. As the anode metal is dissolved in course of electrolysis, the hanging device for the anode has a provision for adjusting the height of the anode so as to keep the distance between the electrodes constant. Of course the metal can be replaced with a new one when it is consumed.

The anode provides many vertical passages **5** through its body and a circumferential wall **6** encircles the upper part of the metal and makes an open room above the metal. The circulated solution drawn from the pipe **2** is received by this room and flows downwards through the vertical passages in the anode.

Cathodes **7** are provided in the cell below the anode and a well known hydrogen collector **8** made of an insulating material in the form of an inverted trough or an enclosed diaphragm is provided for each cathode covering the latter so that hydrogen produced at the surface of the cathode is collected in the top space of the collector and is taken out of the cell by way of pipes, not shown, so that the disturbance of a

regular flow of the solution by the rising hydrogen bubbles is avoided.

In practice, the solution is circulated in the cell downwards through the anode, and carries the metallic salt which is produced at the anode. The circulation is so regulated as to produce hydroxide of metal when the electrolytic solution is passing in the neighborhood of the cathodes. If the circulation is too active the reacting zone for producing hydroxide of metal moves to the place beneath the cathodes, while if the circulation is inactive the zone moves to the place above the cathodes.

The solution taken out the cell contains precipitates of hydroxide of metal, and larger particles thereof are sedimentated and then separated from the solution by filtration while the finer particles suspend in the solution and are returned to the top of the anode. When the finer particles are passing through the reacting zone with the solution, some of the newly produced hydroxide of metal grows up around the nucleus of the precipitate and make the fine particles larger and larger until they are separated from the circulating electrolytic solution by sedimentation.

In this invention, the anode has many vertical passages in its body so that the circulating solution is scattered when it passes through the passages and evenly distributed in the cell. Therefore the reaction between the electrolytic products in the cell is carried out in good order.

Further, an anode having vertical passages therein affords a larger effective electrode surface area per unit sectional area of anode, so that an anode with a smaller sectional area is available, or the floor space for the cell can be saved.

In the drawing, the anode is made of a solid metallic block with vertical perforations, but it can be made in different constructions, for example, a bundle of metallic strips, therefore it is not limited to the one above illustrated.

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