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Bennett

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[54] **METHOD OF MAINTAINING CATHODES OF AN ELECTROLYTIC CELL FREE OF DEPOSITS**

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[52] **U.S. Cl.** **204/289,** 204/149, 204/284

[51] **Int. Cl.** **C02b 1/82,** B01k 3/04

[58] **Field of Search** 204/284, 149, 272, 130, 204/280, 284, 289

[56] **References Cited**

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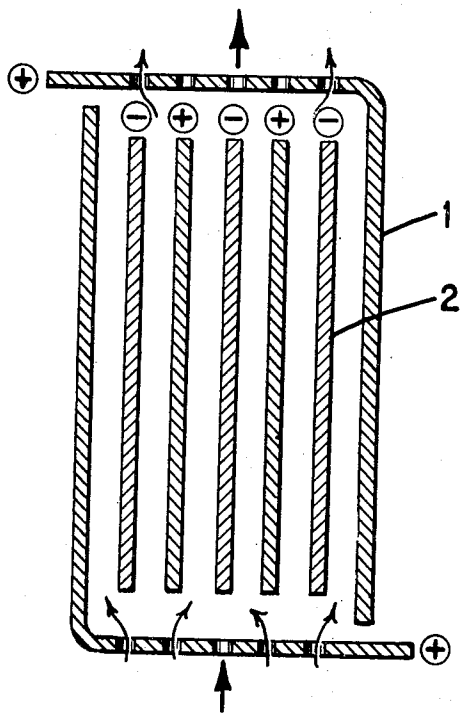
[57] **ABSTRACT**

Cathodes of an electrolytic cell wherein a number of anodes and cathodes are positioned in spaced parallel relation in an electrolyte solution are maintained free of deposits which tend to form during electrolysis of the solution by contacting at least one anode of said cell prior to contacting a cathode during the introduction of electrolyte solution to the cell and contacting at least one anode with the electrolyte solution subsequent to contacting the other electrodes just prior to removal of the solution from said cell.

2 Claims, 4 Drawing Figures



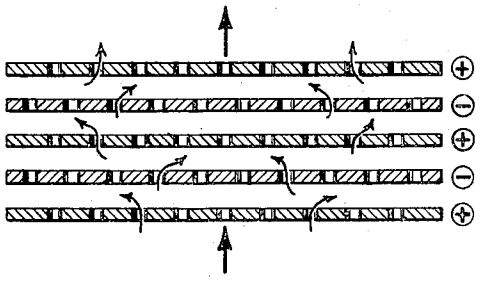


Fig. 1

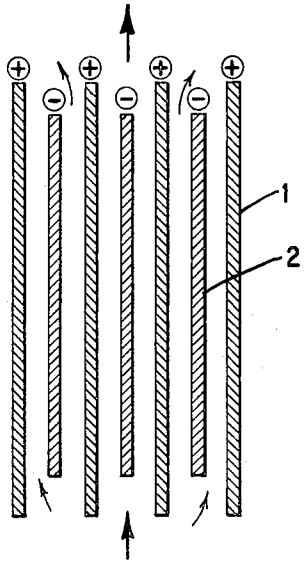


Fig. 2

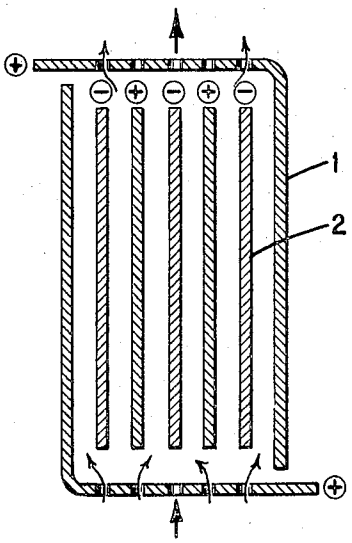


Fig. 3

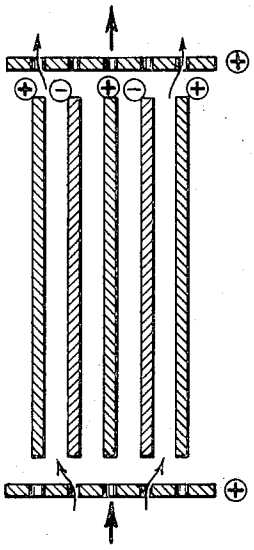


Fig. 4

METHOD OF MAINTAINING CATHODES OF AN ELECTROLYTIC CELL FREE OF DEPOSITS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to a process for maintaining cathodes positioned in opposed spaced parallel relationship to the anodes in an electrolytic cell free of deposits and in clean condition. More specifically, this invention relates to a method of maintaining such cathodes of an electrolytic cell free of deposits and in clean condition when an electrolyte solution is electrolyzed by passing a direct current between the anodes and cathodes.

2. Status of the Prior Art

Various types of electrolytic cells have been previously used to produce desired products by passing a direct current through the solutions by imposing a desomposition potential between the anodes and cathodes arranged in spaced parallel relation in the cells. Various cell designs and materials of construction have been used and a long-standing problem has been the formation of deposits on the electrodes, particularly the cathode surfaces of such cells. Such deposits act as insulators of the electrodes and when the deposits are light, or only partially cover the surfaces, the electric current will pass between the electrodes although a higher than normal voltage will be required to maintain a predetermined current density at the anode surfaces. As the deposits increase, the voltage required to maintain the desired current density becomes excessively high, the solution temperature increases and it is economically unfeasible and also deleterious to the components of the cell to continue electrolysis operations. Consequently, it has been necessary to either attempt to remove said deposits in some manner without terminating the cell operation or to shut down the cell for either cleaning or replacement of the electrodes, particularly the cathodes on which said deposits formed. In one previously utilized method for cleaning the cathodes without their removal from the cell the flow of the electric current is reversed, the cathodes containing the deposits thereby functioning as anodes in the electrical circuit. This method of cleaning suffers the disadvantages of required mechanical alterations in the cell assembly to accomplish the current reversal and increased wear-rate of the electrode surfaces. Another method for cleaning the electrodes is to wash them with a dilute acid, usually hydrochloric acid. However, in order to effectively remove deposits by acid treatment, the cell must generally be shut down, the electrolyte drained and the electrode subjected to the acid solution for a period of time sufficient to remove the deposits. Alternatively, the electrodes may be removed from the cell and the acid treatment effected exterior the cell. Costs are considerably increased by both the loss in operating production time of the cell and the labor charges.

SUMMARY OF THE INVENTION

It is an object of this invention to provide a method for maintaining the cathodes of an electrolytic cell free of deposits and in clean condition.

It is a further object of this invention to provide a method for maintaining the cathodes of an electrolytic cell in which a number of anodes and cathodes are arranged in spaced, opposed substantially parallel position, free of deposits and in substantially clean condition which avoids shut down or disassembly of the cell for cleaning purposes.

It is a still further object of this invention to provide a method for maintaining the cathodes of an electrolytic cell in which anodes and cathodes are positioned in parallel closely spaced arrangement in substantially clean condition wherein expensive and complicated apparatus in addition to the normal cell elements is not required.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be more fully understood by reference to the following detailed description and accompanying drawings wherein:

FIG. 1 illustrates diagrammatically in vertical section one of the arrangements of the electrodes for carrying out the method of this invention where the electrodes are foraminous and horizontally disposed.

FIG. 2 illustrates another of the electrode arrangements of the method of this invention in which the electrodes are vertically disposed.

FIG. 3 illustrates a modification of the arrangement of the electrodes in accordance with the method of this invention wherein the terminal electrodes are integral and both vertically and horizontally disposed.

FIG. 4 illustrates an electrode arrangement of this invention similar to that shown in FIG. 3 in which the electrodes are not integral.

In the drawings corresponding parts are identified by corresponding numerals and characters insofar as practical.

Broadly the invention comprises a method of electrolyzing a solution in a cell having vertical or horizontal electrodes in closely spaced parallel opposed face-to-face relation by introducing electrolyte solution to the cell in a manner whereby at least one anode is contacted with said solution prior to contacting a cathode during the introduction of said solution to the cell and contacting at least one anode subsequent to contacting a cathode prior to withdrawal of the solution from the cell.

Referring to the drawings FIG. 1 shows an arrangement of horizontally disposed closely spaced substantially parallel foraminous electrodes in alternating relation with respect to polarity, the external electrodes of the assembly being anodes. In this embodiment of the invention the electrolyte solution may flow preferably upwardly through the assembly of the electrodes first contacting the lowermost or bottom terminal electrode, which is an anode, then passing through the entire electrode assembly upwardly and leaving the cell or compartment in which the assembly is disposed by contacting the uppermost or upper terminal electrode of the assembly which is an anode. The flow of the electrolyte solution may obviously be reversed, passing first through the upper most terminal anode and downwardly through the assembly and leaving the cell chamber by contacting the lowermost terminal anode prior to withdrawal from the cell.

In FIG. 2 the electrolyte solution first contacts the anodes of an electrode assembly wherein vertical parallel closely spaced opposed alternating anodes and cathodes are positioned with each of the anodes extending vertically beyond each of the upper and lower edges of each of the spaced cathodes. The electrodes are gener-

ally made from sheet but may also be foraminous. The electrolyte solution may flow upward contacting the anodes prior to contacting cathodes upon introduction to the electrode assembly within a cell or cell compartment and subsequently contacting the anodes prior to withdrawal from the upper level of the electrode assembly. The flow of the electrolyte solution may be upward upon introduction while leaving the cell at the upper level of the anodes or the flow may be reversed entering the electrode assembly at the uppermost portions of the anodes, flowing through the assembly and subsequent to contacting all other electrodes leaving the cell by lastly contacting the anodes. Referring to FIG. 3 a number of closely spaced vertical parallel electrodes are shown disposed in an electrolytic cell chamber or compartment with the two terminal electrodes being L-shaped with their long leg extending vertically and the short legs of the L being foraminous and horizontally disposed one above, one below and both perpindicular to the vertical electrodes. The long portions of the terminal electrodes and all the remaining electrodes may be sheet material, the short legs of the L-shaped terminal anodes being foraminous.

In FIG. 4 the electrode arrangement is similar to that in FIG. 3, with the exception that the terminal horizontally disposed anodes, that is, those perpendicular to the plurality of vertically disposed anodes and cathodes in alternate parallel array, are not integral with the terminal vertically disposed anodes, one being spaced above and the other below said vertical array.

The process of the invention is useful in a number of electrode arrangements. An important concept of the invention is that upon introduction of an electrolyte solution to a cell the solution must be contacted by an anode prior to contacting the other electrodes and after passage through the electrodes of the cell must be subsequently contacted by an anode prior to withdrawal of the solution from the cell. It will be obvious to one knowledgeable in this art that a large number of electrode assemblies and arrangements may be utilized in conjunction with the application of the process of this invention while maintaining the essential features thereof. The invention has been found applicable in the electrolysis of saline solutions including salted water, brackish water and synthetic sea water, the latter being made in conformance to known, established formulas for such synthetic solution. The electrolysis of the saline solution has been carried out in diaphragm-less cells for production of sodium hypochlorite wherein sodium hydroxide and hydrogen have been formed at the cathode and chlorine at the anode with the chemical reaction of the electrolytic products in situ to provide the sodium hypochlorite. This process has been found to operate for long periods of time with satisfactory current efficiency and with the cathodes remaining in clean condition free of deposits and without plugging. By comparison in cells for sodium hypochlorite production wherein the electrodes have been contacted simultaneously or indiscriminately by electrolyte solution upon its introduction and withdrawal from the cell, the cathodes have been found to operate for limited periods of time before deposits and precipitates form on the cathodes and reduce the cell efficiency. While the reasons for the results obtained in the practice of the process of this invention are not completely understood the invention is not intended to be limited by any theory of operation.

The following examples are presented for purposes of illustrating the process of the invention and are not to be considered limitative of the invention in any manner.

EXAMPLE 1

An electrolytic cell including a horizontally disposed electrode assembly as shown in FIG. 1 was continuously operated for the production of sodium hypochlorite. Aqueous sodium chloride solution containing about 30 g/l sodium chloride was continuously introduced into the cell chamber by charging a predetermined amount of tap water and saturated brine solution into the chamber in separate streams. The aqueous sodium chloride solution was continuously electrolyzed to form sodium hypochlorite by passing a direct current from the anodes to the cathodes. The temperature of the electrolyte solution ranged from about 10°C. to about 35°C. with water flowing through an electrically insulated cooling coil immersed in the solution. The hard tap water feed was found by chemical analysis to have a calcium content of about 150 parts per million. The mixed water feed and saturated brine solution were introduced to the cell beneath the lowermost electrode, a terminal anode, of the electrode assembly. The cell was operated continuously for a period of three months without formation on the electrodes of deposits which detrimentally affect operation of the cell. At the end of the three month period the surfaces of the cell chamber, cooling coils and all other equipment arranged within the cell, with the exception of the electrodes, were covered by a heavy calcium carbonate deposit.

EXAMPLE 2

The same type of electrolytic cell and assembly of electrodes used in Example 1 was employed for the continuous production of sodium hypochlorite. The feed solution in this case was sea water and the cell was operated at 0.75 amps/sq.in. The cell was operated for a 10 day period without the formation on the electrodes of deposits which detrimentally affect cell operation. The cell was then operated in the same manner with the exception that the terminal anodes previously used were replaced by terminal cathodes. After 12 hours, deposits which formed on the electrodes substantially plugged the openings and prevented flow of the electrolyte solution. The cell was incapable of operating and had to be shutdown.

While the invention has been described with reference to specific and preferred embodiments thereof, it should be understood that these references are not intended to be limiting since alterations and modifications may be made therein without departing from the intended scope and spirit of this invention as defined in the appended claims.

I claim:

1. An improvement in an electrolytic cell including a cell chamber having side, bottom, and end walls, means for introducing solution to and removing solution from said cell, and a plurality of vertically disposed anodes and cathodes in alternate parallel array, which improvement comprises terminal vertical anodes in said array and terminal, horizontal, foraminous anodes disposed above and below and perpendicular to said array.

2. The improvement of claim **1** wherein each of said horizontal terminal anodes is integral with one of said vertical terminal anodes, thereby forming two L-shaped terminal anodes.

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