METAL ANODE ASSEMBLY

Inventor: James M. Ford, Cleveland, Ohio
Assignee: Olin Corporation, New Haven, Conn.

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References Cited

UNITED STATES PATENTS
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3,404,081 10/1968 Cummings et al. 204/286
3,515,661 6/1970 Coutler et al. 204/286
3,671,415 6/1972 King et al. 204/284
3,676,325 7/1972 Smith et al. 204/286
3,725,223 4/1973 DeNora et al. 204/220
3,759,815 9/1973 Larsson 204/290 F

An improved metal anode assembly is described having at least one anode post secured to the top of a distributor plate, wherein the distributor plate has the form of an inverted channel comprised of a web and two legs, one leg extending downwardly from each side of the web. Secured to the bottom of each leg is a bandolier comprised of a foraminous anodic surface secured at two of its opposite edges to one of two metal strips, each metal strip being secured to one of the legs of the distributor plate. Securing the foraminous anodic surface to the distributor plate as a bandolier in this manner permits easy removal of the bandolier from the anode assembly for reprocessing such as recoating. In addition, use of the novel bandolier reduces the cost of shipping and handling anodes when having the foraminous anodic surface reprocessed for use in electrolytic cells.

12 Claims, 3 Drawing Figures
METAL ANODE ASSEMBLY

This invention relates to an improved metal anode assembly. More particularly it relates to a metal anode assembly which permits easy removal of the foraminous anodic surface component of the metal anode assembly to facilitate reprocessing of the anode surface without the need for packing and shipping the entire anode assembly.

In the operation of electrolytic cells employing a mercury amalgam cathode in the production of chlorine, numerous attempts have been made recently to replace conventional graphite anodes with metal anodes of various designs and compositions. Generally, these metal anode designs include a distributor having at least one anode post secured to the top thereof for supplying an electrolytic current to the distributor. The distributor is generally in the form of an inverted channel having a web with two legs extending downwardly therefrom. A foraminous anodic surface is secured to the bottom of the two legs of the distributor in electric contact with each of the legs and spaced apart from the distributor surface. Current fed through the anode post to the distributor is conveyed across the distributor web to the exterior legs thereof and then is transmitted to the foraminous anodic surface through the salt brine and liquid metal cathode below the foraminous anodic surface to effect the generation of chlorine gas on the foraminous anodic surface. The foraminous anodic surface is generally a resistant metal base such as titanium, niobium, tantalum or zirconium, which is coated with at least one oxide of a platinum metal such as ruthenium, platinum, iridium, rhodium and osmium and mixtures thereof. Materials of construction useful as a base metal and as an oxide coating are described by Henri Bernard Beer in U.S. Pat. No. 3,236,756, issued Feb. 22, 1966, U.S. Pat. No. 3,265,526, issued Aug. 19, 1966, U.S. Pat. No. 3,632,498, issued Jan. 4, 1972 and U.S. Pat. No. 3,711,385, issued Jan. 16, 1973.

Although metal anodes of this type are generally more stable under electrolytic conditions than conventional graphite anodes, the effective oxide coating on the foraminous anodic surface degrades after extended operation and it becomes necessary to remove the anode from the cell and recoat the foraminous anodic surface with a metallic oxide or mixture thereof. Generally, the facility for recoating the metal anodes is located at a different location than the electrolytic cell facility. It then becomes necessary to package and ship the inactivated metal anode requiring recoating to the coating facility, and after recoating the anode must be repacked and reshipped to the electrolytic cell facility. Not only is it expensive to package and ship the bulky metal anodes, but also damage to the anode frequency occurs because the anodes are not ideally designed for frequent handling, shipping and packaging. As a result, some of the advantages obtained by using metal anodes, as compared to conventional graphite anodes, is lost because of the excessive damage and cost incurred in handling, packaging and shipping of the metal anodes for recoating or other reprocessing.

It is an object of this invention to provide an improved metal anode assembly.

It is another object of this invention to provide a metal anode assembly which permits easy separation of the foraminous anodic surface from the distributor plate.

Still another object of the invention is to provide a novel metal anode assembly which facilitates recoating of the foraminous anodic surface without the need for shipping the entire anode assembly to the recoating facility.

These and other objects of the invention will be apparent from the following detailed description thereof.

It has now been discovered that the foregoing objects of this invention are accomplished in a metal anode comprised of a distributor having at least one anode post secured to the top thereof and having a web with a leg extending from each of two opposite sides thereof and a bandolier containing a foraminous anodic surface secured in electric contact with the bottom of each leg. The bandolier is comprised of a foraminous anodic surface with two metal strips secured at each edge of opposite sides of the foraminous anodic surface, and the top of each metal strip is secured to the bottom of each leg of the distributor. In a preferred embodiment, a flange is secured to the end of each leg, the bottom of each flange being substantially coplanar. The bandolier is secured to the bottom of each flange. The foraminous anodic surface, which is in electric contact with each of said legs is a base metal coated with at least one oxide of a platinum group metal such as described in one of the above-mentioned Beer patents. When continued use of the metal anode assembly in electrolysis causes deterioration of the metal oxide coating to an undesirable degree, the anode assembly is removed from the electrolytic cell and the bandolier is separated from the distributor. A new recoated bandolier is secured to the legs or flanges of the distributor and the anode assembly is placed back into operation, while the inactive bandolier is returned for recoating.

FIG. 1 shows a sectional elevation view of the novel metal anode assembly of this invention through plane 1—1 of FIG. 2.

FIG. 2 shows a partial sectional bottom view of the novel metal anode of this invention wherein the foraminous anodic surface is a series of parallel metal rods.

FIG. 3 is a sectional elevational view of another embodiment of the invention wherein the bandolier is secured directly to the legs of the distributor.

More in detail in the embodiment of FIG. 1, metal anode assembly 1 is comprised of an anode post 10 a distributor 11 which is comprised of web 12 having a top, a bottom and two opposite sides, anode post 10 being secured to and being substantially perpendicular to the top of web 12. Web 12 also has legs 13 and 14 secured at opposite sides of web 12, and extending downwardly therefrom. Although legs 13 and 14 are generally perpendicular to web 12, this is not an essential configuration of distributor 11. If desired, legs 13 and 14 may slope away from each other, for example, at an angle from about 0° to about 75°, the angle being formed by the intersection of a plane passing parallel to the leg with a plane passing longitudinally through the central axis of anode post 10. In addition, legs 13 and 14 may slope toward each other at an angle of from about 0° to about 5°, the angle being formed by the intersection of a plane passing parallel to the leg with a plane extending longitudinally through the central axis of anode post 10.

In a preferred embodiment of the invention, there are secured to the end of legs 13 and 14 and extending outwardly therefrom flanges 15 and 16 respectively, which are substantially parallel to the bottom of web 12.
Flange bottom 17 and flange bottom 18 which are the bottoms of flange 15 and 16, respectively, are substance 5 co-planar. Secured to flange bottom 17 is the top of bandolier strip 19 and secured to flange bottom 18 is the top of bandolier strip 20. Bandolier strips 19 and 20 are each 10 secured to the flange bottoms 17 and 18 by filet welds 21 and 22, respectively, or another conventional current conducting technique such as spot welding, bolting, clamping or the like. Bandolier strips 19 and 20 as well as distributor 11 are constructed of a film forming metal such as titanium or other metal or alloy which resists corrosion when submerged in the brine, and which permits welding of the bandolier strips 19 and 20 to distributor 11 as well as foraminous anodic surface 23. Foraminous anodic surface 23 is secured by welds 24 and 25 to the bottom of bandolier strips 19 and 20, respectively. In a preferred embodiment of the invention, as described more fully below in FIG. 2, foraminous anodic surface 23 is a series of parallel spaced-apart metal rods 26. The rods may be round, flattened, or rectangular. However, foraminous anodic surface 23 may be in the form of a perforated plate, screen or grid, expanded metal or the like. Openings in the foraminous anodic surface generally comprise from about 25 to about 70 percent and preferably from about 40 to about 60 percent of the foraminous anodic surface 23. Metal bandolier strips 19 and 20 are positioned substantially parallel to each other and are secured to foraminous anodic surface 23 on the same side thereof, one of the bandolier strips 19 and 20 being secured to each of two opposite ends, respectively, of the foraminous anodic surface. The top of one metal bandolier strips 19 extends continuously throughout the length of one of the legs 13 or flanges 15 and is secured thereto. The top of the other metal bandolier strip 20 extends continuously throughout the length of the other leg 14 or flange 16 and is secured thereto on the opposite end of web 12. The means for securing the metal strips 19 and 20 to legs 13 and 14 or flanges 15 and 16, respectively, is accessible from the exterior of the metal strips 19 and 20, legs 13 and 14 and flanges 15 and 16 in order to simplify separation and reinstallation of the foraminous anodic surface.

Web 12 is provided with a series of openings 27 to permit the release of chlorine gas which forms during electrolysis on foraminous anodic surface 23, through web 12 to the top of the electrolytic cell for collection. Foraminous anodic surface 23 is coated with at least one oxide of a platinum metal (not shown) and preferably with a mixture of metal oxides, for example, as described in the above-identified Patent papers. The preferred coating of oxides is one which includes, ruthe- 40 nium oxide, but any convenient mixture of oxides may be employed. Typical examples of suitable metal oxides include platinum oxide, ruthenium oxide, iridium oxide, rhodium oxide, palladium oxide and osmium oxide. FIG. 2 is a partial sectional bottom view of the metal anode assembly of FIG. 1 wherein foraminous anodic surface 23 is a series of parallel metal rods 26 secured at each end to bandolier strips 19 and 20 by welds 24 and 25, respectively. A series of gas openings 27 are provided in web 12 to permit the release of chlorine gas through the web and up to the top of the cell (not shown) for collection by conventional techniques. Bandolier strip 19 and bandolier strip 20 are each secured at the top to flange bottom 17 and flange bottom 18, respectively, by means of filet welds (not shown), but as pointed out above, securing of the bandolier strips to the flange bottoms may be effected by an suitable electroconductive technique. Anode posts 10 are secured to the top of web 12 by friction welding or other convenient techniques.

FIG. 3 is a sectional elevation view of another embodiment of the invention wherein bandolier strips 19 and 20 are secured directly to legs 13 and 14 of distributor 11. In this embodiment, flanges 15 and 16 are omitted and legs 13 and 14 are welded by means of filet welds 21 and 22, respectively, to the top of bandolier strips 19 and 20, respectively. In addition, in the embodiment of FIG. 3, foraminous anodic surface 23 extends beyond bandolier strips 19 and 20. In this embodiment, the distance from the outside edge of bandolier strip 19 to the outside edge of bandolier strip 20 is less than the distance from outside edge 28 of foraminous anodic surface 25 to the opposite outside edge 29. The width of foraminous anodic surface 23 (the distance between outside edges 28 and 29) generally ranges from about 100 to about 300 percent and preferably from about 100 to about 200 percent of the distance between the outside edges of bandolier strips 19 and 20. When these distances are equal, the design is especially suitable for handling, packaging and shipping since the edges of foraminous anodic surface 23 are stiffened by bandolier strips 19 and 20 to resist bending, breaking and warping. Increasing the width of foraminous anodic surface 23 beyond the extremities of bandolier strips 19 and 20, as shown in FIG. 3, may diminish the suitability of the bandolier for shipping, but frequently improved current distribution of the foraminous anodic surface 23 may be obtained with a design of the embodiment shown in FIG. 3. If desired, stiffening members 30 and 31 are secured by welding (not shown) or otherwise to the top of each outer edge 28 and 29, respectively, of foraminous anodic surface 23. Stiffening members 30 and 31 are preferably positioned parallel to bandolier strips 19 and 20, and preferably extend throughout the entire length of each outer edge 28 and 29 of the foraminous anodic surface. Positioning stiffening members 30 and 31 on the bottom of foraminous anodic surface 23 is undesirable since contact of these metal strips with the cathode may cause short circuiting of the cell. Stiffening members 30 and 31 are shown in FIG. 3 as rectangular rods, but any other suitable form, such as L-shaped and U-shaped channels, wire rods, either round or square, or the like, may be used. Stiffening members 30 and 31 are preferably constructed of the same material as bandolier strips 19 and 20. Those skilled in the art will recognize that the extended foraminous anodic surface 23 having a width wider than extremities of bandolier strips 19 and 20 may also be used in the embodiment of FIGS. 1 and 2. If desired, stiffening members 30 and 31 may also be utilized in the embodiments of FIGS. 1 and 2 when foraminous anodic surface 23 is extended beyond the extremities of bandolier strips 19 and 20.

U.S. Pat. No. 3,676,325, which issued July 11, 1972 to Smith et al. also describes typical anode structures and materials of construction which can be utilized in combination with the novel anode assembly of this invention. Accordingly, U.S. Pat. No. 3,676,325 is incorporated herein by reference in its entirety. The anode post described therein which employs a titanium sleeve
The novel anode assembly of this invention is very stable and resists warping due to the metal strips of the bandolier in conjunction with the channel construction of the distributor. As a result, consistent control of the gap between the anode and molten mercury cathode can be maintained without undesirable short circuits caused by one section of the foraminous anodic surface being lower than another. In addition, when the foraminous anodic surface does not extend past the metal strips of the bandolier, there is relatively little deformation of the ends of the metal rods or other type of anodic surface. However, if portions of the foraminous anodic surface extend beyond metal bandolier strips 19 and 20, these portions may be bent in shipment and using these anodes in a bent form may cause short circuits or poor current distribution for the same reasons set forth above. Addition of stiffening members 30 and 31 to the outer edges 28 and 29 of foraminous anodic surface 23 helps to avoid these problems.

When it has been determined that the foraminous anodic surface of the anodic assembly of this invention requires recoating or other reprocessing due to distortion of the surface because of mishandling or otherwise, the anode assembly is removed from the cell. The need for replacement of the foraminous anodic surface can be determined by observing increased resistance to the passage of electrical current in operations or by standard measurements of the coating remaining. After removal from the cell, the bandolier is separated from the remainder of the anode assembly by planing or milling, or the like. A new bandolier is secured to the anode assembly and the cell is placed back in operation with a minimum of down time. The damaged or ineffective bandolier is then shipped for reprocessing and when placed in operating condition, is stored for use when another bandolier must be replaced.

By utilizing the novel metal anode assembly of this invention, simple separation of the foraminous anodic surface from the distributor can be obtained to facilitate recoating of the foraminous anodic surface and reinstallation of the resulting recoated foraminous anodic surface is simplified.

The following examples are provided to define the invention more fully. All parts and percentages are by weight unless otherwise specified.

EXAMPLE 1

Fifty metal anodes were constructed for use in a mercury amalgam electrolytic cell for the production of chlorine. Dimensions of the electrolytic cell were about 42 feet long, 4.5 feet wide and 1 foot high. Each of the metal anodes was comprised of two anode posts secured to a distributor, with a bandolier-type anodic surface secured to the distributor.

Each anode post was comprised of an upper rod made of copper having a diameter of about 1/4 inch and a height of about 4 inches. This copper rod was friction welded to an aluminum rod having a diameter of 1 inch. The bottom of the aluminum rod was friction welded to the top of a distributor plate. Surrounding the aluminum-copper post was a titanium sleeve which was also friction welded at one end to the top of the distributor. The titanium sleeve had a height of about 10.35 inches and an outside diameter of about 2 inches.

The distributor was an inverted channel having a web with an inside width between legs of about 7%. Legs extending downwardly from each side of the web were substantially parallel and had a height of about 1 inch. Extending outwardly from the end of each leg, and parallel to the web was a flange of about ¾ inch in width.

The bottoms of each flange on each set of channel legs were machined to be coplanar with each other for the length of each flange bottom.

The anodic surface was secured as a bandolier to the flange bottoms. Each bandolier was comprised of a series of parallel, spaced-apart rods which were secured on one end by welding to one of two bandolier strips which were spaced parallel to each other at the ends of the rods. Each rod had a titanium core and was coated with an oxide coating containing ruthenium oxide. Each rod had a length of about 9.4 inches and a diameter of about 0.118 inch. Approximately 260 rods were spaced equidistant from each other along the length of the bandolier strips, which were approximately 4 feet long. Each bandolier strip was constructed of titanium and had a width of 0.35 inch and a height of 0.15 inch. The bandolier-type anode was secured to the distributor by filet welding the top of each bandolier strip to the bottom of one of the flanges secured to the channel legs.

Each metal anode had a surface area of 48 inches by 9 5/16 inches with an overall height of about 16% inches. The height of the distributor and bandolier combined was approximately 1/4 inches. The anode posts were positioned in the center of the top of the distributor, the centers of the post being approximately 12 inches from each end of the distributor.

Five metal anodes of this type were formed into a set and placed into the cell parallel to each other using the apparatus for adjusting the gap between anode and cathode as described in U.S. Pat. No. 3,574,073, issued Apr. 6, 1971 to R. W. Ralston, Jr. Ten sets of five anodes each were placed into the cell in this manner.

Operation of the cell began by flowing mercury and salt brine through the cell, with conventional recovery techniques for chlorine, amalgam and brine regeneration.

The cell was operated at 4.3 volts, with a voltage coefficient of about 0.12. After an extended period of operation, these metal anodes were removed from the cell, the bandolier and rods were separated from the bottom of the flanges by planing off the filet welds. Recoated anode bandoliers were secured by filet welding to the flanges to replace the inactive bandoliers and the metal anodes and electrolytic cells were placed back into service. The inactive anode bandoliers that were removed were packed and shipped for recoating, thereby resulting in a minimum of down time for the cell.

EXAMPLE 2

The procedure of Example 1 was repeated using metal anodes of a similar design, except that the rods had a diameter of about 0.115 inch and approximately 300 rods were used to form the anodic surface.

EXAMPLE 3

The procedure of Example 1 was repeated with the
exception that the rods were flattened on the top and bottom and had a thickness of about 0.10 inch. The space between the rods was about 0.05 inch, and approximately 260 rods were used to form the anodic surface.

**EXAMPLE 4**

The procedure of Example 1 was repeated with the exception that the rods had a length of about 9 inches and extended approximately 1.9 inches beyond the outer edge of each bandolier strip.

**EXAMPLE 5**

The procedure of Example 1 may be repeated, using metal anodes similar to the design of those of Example 1 with the exception that the distributor does not have flanges at the end of each leg and the leg ends were secured by welding directly to the top of the bandolier strips.

In Examples 2–5, the replacement of anodes was effected in the same manner as in Example 1. In Examples 1–5 significant savings in shipping and handling costs were realized.

What is claimed is:

1. A metal anode assembly for use in a mercury cell having a distributor in the form of an inverted channel, said distributor being comprised of:
   a. A web having a top, a bottom and two opposite sides,
   b. At least one anode post secured to said top of said web,
   c. Said web having a leg extending downwardly from each of said two opposite sides,
   d. A foraminous anodic surface in electric contact with each of said legs, whereby current is passed through said anode post across said web through said legs to said foraminous anodic surface, through a salt brine and liquid metal cathode below said foraminous anodic surface, to effect the generation of chlorine gas on said foraminous anodic surface, the improvement which comprises a bandolier secured in electric contact with said legs, said bandolier being comprised of:
      1. Said foraminous anodic surface
      2. Two continuous metal strips positioned substantially parallel to each other secured to said foraminous anodic surface on the same side thereof, one of said metal strips being secured to each of two opposite ends of said foraminous anodic surface, and
      3. The top of one of said metal strips extending continuously throughout the length of one of said legs and being secured thereto, and the top of the other said metal strip extending continuously throughout the length of the other said leg and being secured thereto on the opposite end of said web, the means for securing said metal strips to said legs being accessible from the exterior of said strips and legs, whereby simple separation of the foraminous anodic surface from said distributor can be obtained to facilitate recoating of said foraminous anodic surface, and reinstallation of the resulting recoated foraminous anodic surface is simplified.

2. The metal anode assembly of claim 1 wherein said foraminous anodic surface contains openings which are equal in area to from about 25 to about 70 percent of the entire foraminous anodic surface.

3. The metal anode assembly of claim 2 wherein the width of said foraminous anodic surface is equal to the distance between the outside edge of each metal strip in said bandolier.

4. The metal anode assembly of claim 3 wherein each of said legs has a flange secured to the end thereof and extending outwardly therefrom, the bottom of each flange being substantially coplanar, each flange being parallel to and spaced from the bottom of said web, the top of one of said metal strips being secured to the bottom of one of said flanges and the top of the said other metal strip being secured to the bottom of the other said flange.

5. The metal anode assembly of claim 4 wherein said foraminous anodic surface is a series of parallel spaced-apart metal rods secured at each end to the bottom of one of said metal strips.

6. The metal anode assembly of claim 5 wherein said legs slope away from each other at an angle from about 0° to about 75°, said angle being formed by the intersection of a plane passing parallel to the leg with a plane passing longitudinally through the central axis of said anode post.

7. The metal anode assembly of claim 6 wherein said metal strips are constructed of titanium and said legs are substantially parallel to each other.

8. The metal anode assembly of claim 7 wherein said metal strips are spaced apart metal rods secured at each end to the bottom of one of said metal strips.

9. The metal anode assembly of claim 8 wherein a stiffening member is secured to the top of each outside edge of said foraminous anodic surface.

10. The metal anode assembly of claim 9 wherein said foraminous anodic surface is a series of parallel spaced-apart metal rods secured at each end to the bottom of one of said metal strips.

11. The metal anode assembly of claim 10 wherein each of said legs has a flange secured to the end thereof and extending outwardly therefrom, the bottom of each flange being substantially coplanar, each flange being parallel to and spaced from the bottom of said web, the top of one of said metal strips being secured to the bottom of one of said flanges and the top of the said other metal strip being secured to the bottom of the other said flange.

12. The metal anode assembly of claim 11 wherein the width of said foraminous anodic surface is from about 100 to about 300 percent of the distance between the outside edges of said metal strips of said bandolier.