

Dec. 10, 1940.

K. PAUL

2,224,831

ELECTROLYSIS CELL

Filed April 19, 1937

2 Sheets-Sheet 1

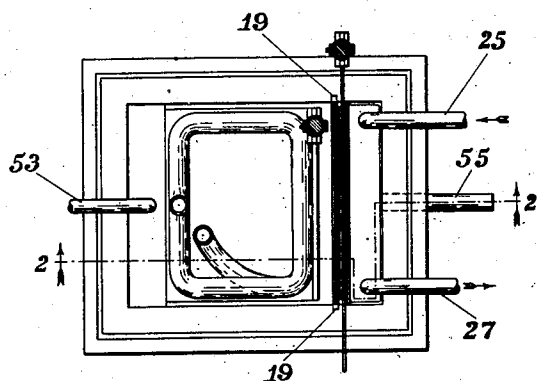


Fig. 2.

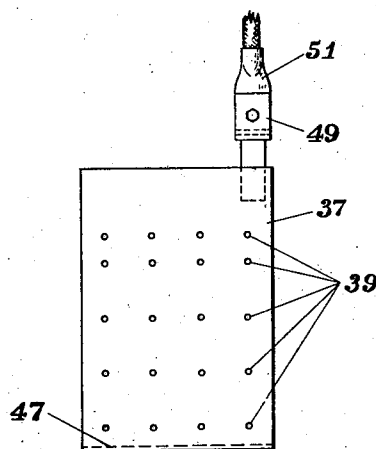


Fig. 4.

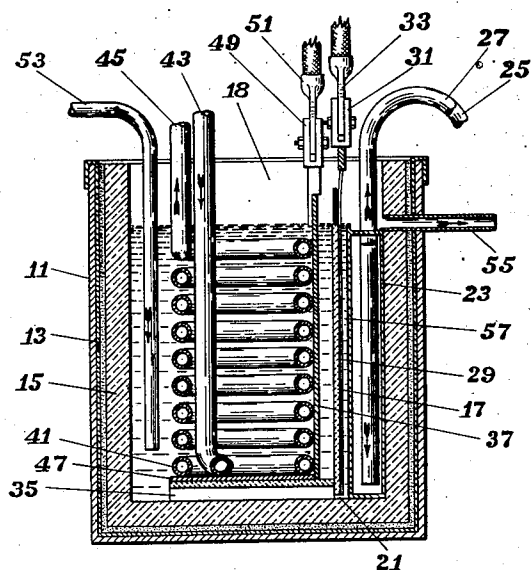


Fig. 1.

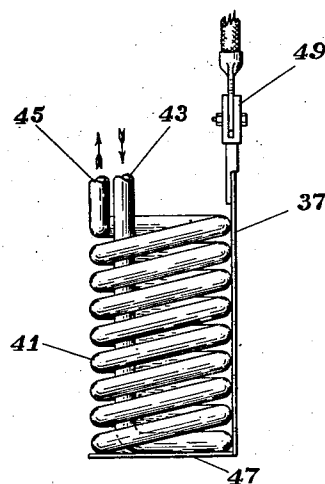


Fig. 3.

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2 Sheets-Sheet 2

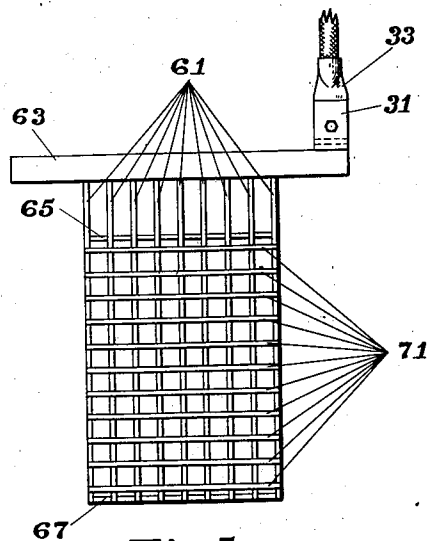


Fig. 5.

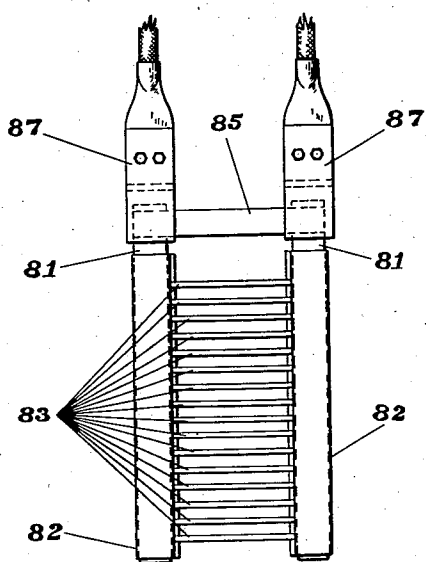


Fig. 6.

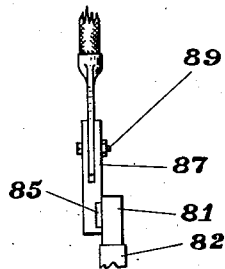


Fig. 7.

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2,224,831

ELECTROLYSIS CELL

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Application April 19, 1937, Serial No. 137,719

5 Claims. (Cl. 204—262)

This invention relates to an improved electrolysis cell and to a process employing that cell in the electrical synthesis of chemical compounds. Electrolysis cells are well known in the art and may be defined as electrolytic cells which are used for the synthesis of chemical compounds by utilizing the chemical effects of the electric current.

This invention relates more particularly to a new and improved electrolysis cell which is particularly adapted for the manufacture of persulphuric acid or persulphates by electrolytic synthesis, as well as the process of utilizing this novel cell for the manufacture of these chemical compounds. Cells for the preparation of persulphuric acid and persulphates by electrolytic synthesis are now used commercially in the manufacture of hydrogen peroxide. In processes of manufacturing hydrogen peroxide by the electrolytic route, it is usual to subject to anodic electrolysis a solution of sulphuric acid or an acid solution of ammonium sulphate. In present methods, the sulphuric acid or sulphate salt is converted into persulphuric acid or persulphate by electrolysis carried out successively in a series of electrolysis cells. After the persulphuric or persulphate content has been built up to a value sufficiently high to permit economical recovery of hydrogen peroxide therefrom, as a result of these successive electrolyses, the solution is subjected to hydrolysis and distillation in order to convert the per compound into hydrogen peroxide and to recover the evolved peroxide from the solution.

As the class of electrolysis cell for preparing persulphuric acid or persulphates by electrical synthesis is well-known in the art, it is to be understood that wherever hereinafter reference is made to persulphuric acid cells, it is my intention that cells for the manufacture of persulphates by electrolytic methods are to be also comprehended within the scope of that term.

It has been usual to utilize in electrolytic processes for the production of persulphuric acid an aqueous solution of sulphuric acid, the electrolysis being carried out in a cell having an anode of platinum and a cathode of lead or graphite. It has been usual to provide two liquids in these cells, the liquids being independently circulated from one cell to another throughout the series of cells in which the plurality of separate electrolytic synthesis is carried out. One of the liquids in the cells now known to the art is termed an anolyte and it ordinarily is positioned closely adjacent to the anode. The second liquid is the

catholyte, which catholyte is closely adjacent to the cathode. The chambers surrounding the cathode and anode, or the cathode and anode chambers, are usually separated in electrolysis cells of the type specified as now known in the art by a porous diaphragm. This porous diaphragm separates anolyte and catholyte liquids and permits only the passage of electrical ions therethrough. The diaphragm does not permit any appreciable diffusion of the two liquids from anode compartment to cathode compartment. A type of cell now known to the art and utilized commercially in the preparation of persulphuric acid and persulphates is shown in the Baum Patents 1,837,177 and 1,937,621. The anolyte, porous diaphragm, catholyte and cathode of this cell are all disposed concentrically within the cell container.

The group of cells in which the sulphuric acid starting material, or acidic solution of a sulphate, is converted by electrolytic synthesis into persulphuric acid or persulphates is arranged in present commercial installations in such a way that the individual cells constitute what is usually termed a "cascade." This means that the anolyte and catholyte liquids leaving one of the cells of the series flow to the next lower cell of the series, in an arrangement which is analogous to a cascade. The concentration of persulphuric acid (or persulphate) in the anolyte is built up to a certain extent by electrolysis in each cell. The anolyte liquid containing the persulphuric acid formed as the result of the electrolysis in one cell is carried over to the next cell of the cascade arrangement wherein the persulphuric acid content is built up by electrolysis to a further extent. The electrolytic process is repeated in plurality of cells until an anolyte having a sufficiently high percentage of persulphuric acid (or persulphate) to permit economical hydrolysis and distillation is obtained.

It should be understood that during the process of electrolytic synthesis both catholyte and anolyte liquids are circulated through the plurality of cells forming the cascade arrangement. The catholyte and anolyte liquids are separated by means of a porous diaphragm. If the anolyte were permitted to come in contact with the cathode, persulphuric acid or persulphate present therein would be destroyed. The process of producing these per compounds electrolytically by the methods now known to the art involves building up the concentration of the desired product successively in small increments by car-

rying out successive electrolyses in a plurality of electrolysis cells.

This porous diaphragm in present cells is designed to prevent diffusion of one liquid into the other by fluid movement therethrough. However, it does not prevent the passage of electrical ions therethrough, which is, of course, essential in the electrolytic process. As the liquids are kept separate in the cells now known to the art during the entire period of successive electrolysis in a plurality of cells, both anolyte and catholyte liquids being circulated, the cells now utilized commercially for the manufacture of persulphuric acid and persulphates, such as those shown in the Baum patents, are known as double-electrolyte, double-flow cells. The electrical input of any one of these cells is relatively small and the amount of persulphuric acid or persulphate formed in any one cell is relatively small. By utilizing a plurality of cells and carrying out a plurality of electrolyses the content of desired products being thereby built up to a value high enough to permit the economical recovery, it is possible to secure a satisfactorily high final concentration in spite of the limited electrical capacity of each individual cell. As distinguished from the electrolysis cells now known to the prior art, my improved electrolysis cell is a single-pass, single-flow cell wherein but one electrolyte is employed. Instead of carefully segregating one portion of the electrolyte into an anolyte in a chamber surrounding the anode, and a second portion of the anolyte into a cathode in a chamber surrounding the cathode, and maintaining these liquids separate throughout the entire period of electrolysis, I provide but one electrolyte. This electrolyte is permitted to flow both through the chambers surrounding the cathode and through the chambers surrounding the anode. Instead of securing at the end of the electrolysis two liquids, one the anolyte containing the valuable constituent (persulphuric acid or persulphate), and the other a catholyte of no value insofar as desired chemical product is concerned, I secure but one liquid, an electrolyte of substantial persulphuric acid concentration which may be subjected to the usual hydrolysis and distillation steps in order to secure hydrogen peroxide. The improved cell with which this invention is concerned may be provided with a porous diaphragm but this porous diaphragm does not completely segregate the electrolyte into two portions as in the electrolysis cells now known to the art. There is an opening provided in this porous diaphragm which permits flow of electrolyte from the chamber adjacent to one electrode to the chamber adjacent to the other. In other words, the electrolyte flows from the cathode chamber through the opening in the porous diaphragm into the anode chamber, and from there is carried directly to the stills wherein the hydrolysis and distillation for the recovery of hydrogen peroxide is carried out. This single-pass feature of my improved cell is a marked departure from all electrolysis cells for the manufacture of persulphuric acid or persulphate now known or used for the commercial synthesis of these products.

As previously pointed out, it has been usual in the commercial manufacture of these per compounds to build up the content of per compounds successively by subjecting the anolyte (and catholyte) to successive electrolyses in a large number of individual cells. In an arrangement such as that disclosed in the Baum patents, some of these cells may be arranged at a level lower than other

cells so that both anolyte and catholyte liquids may flow by gravity from one group of cells to a lower cell in the so-called cascade arrangement. An important characteristic of my new and improved cell is that the persulphuric acid or persulphate content is built up to a much greater degree in one single individual cell than ever before attainable by single cell electrolysis. In other words, the improved cell with which this invention is concerned may be constructed of greater size than any now known to the art and of greater electrical capacity. My improved cell is designed primarily to build up the persulphuric acid content to a sufficiently high degree in a single cell, thus eliminating the objectionable cascade arrangement and successive electrolyses in a plurality of cells, previously considered essential in the manufacture of these compounds. The electrical current applied to any one cell constructed in accordance with my invention is ordinarily many times that supplied to any single cell of the type disclosed in the Baum patents.

Among the objects of this invention may therefore be enumerated the development of a single-pass, single-flow cell wherein but one electrolyte is subjected to electrolysis, this electrolyte being normally built up to a sufficiently high persulphuric acid or persulphate concentration in a single cell, without the necessity of carrying out a plurality of electrolysis in a series of cells as now necessary in the commercial production of these compounds. Another object of this invention includes the building of an electrolysis cell of the type specified, which cell may be constructed of various sizes, and which may be designed to take much larger electrical power inputs than those now known or used in this art. Closely allied with this latter object is the ancillary objective of reducing the number of cells necessary to secure a liquid having a concentration of persulphuric acid high enough to permit economical recovery of hydrogen peroxide from the great number now employed in plants utilizing electrolytic methods to a single large sized cell. This objective also involves a concomitant decrease in the operating expense incident to the manufacture of these per compounds by electrical synthesis.

Other objects of this invention involve the utilization in the construction of my single-pass, single-flow cell of certain features of construction which make possible for the first time in this art the use of a single-flow cell for the economical manufacture of persulphuric acid and persulphates. These features include a novel anode assembly, a novel diaphragm construction, a novel cathode assembly and novel means for cooling that portion of the electrolyte present in the chamber which contains the anode. The various features of my improved cell which permit the utilization of but one electrolyte in place of the two universally used in the prior art, these features including, among others, the provision of a space under the diaphragm and cathode assembly through which the electrolyte is permitted to flow from cathode chamber to anode chamber or, defined more broadly, the provision of means in the diaphragm through which the electrolyte is permitted to flow, also constitute novel elements contributing to the success of my improved construction.

It may be stated that all diaphragms now known or utilized in electrolysis cells for the manufacture of persulphuric acid or persulphates

definitely separate the electrolyte into two entirely separate portions. Present diaphragms do not permit positive passage of liquid therethrough, the only relative flow between anolyte and catholyte liquids being that relatively negligible amount which may occur as a result of the porosity of the diaphragm and the difference in level between the two liquids. As contrasted with present diaphragms, the diaphragm of my improved cell is not constructed imperforate, but is arranged so that a positive flow of liquid therethrough from one chamber of the cell to the other may constantly and continually take place.

My invention, which also involves other and subsidiary objectives which will become apparent during the ensuing description of my preferred cell and preferred mode of operation, may best be explained in conjunction with the annexed drawings wherein:

Fig. 1 is a vertical section of the entire cell assembly some parts being illustrated in elevation. This view is taken along the line 2—2 of Fig. 2.

Fig. 2 is a plan view of an improved cell constructed in accordance with my invention, the electrical lead-in wires being omitted from this view.

Fig. 3 is a detail view, in elevation, of the cathode assembly with the electrical lead-in connections shown in place thereon.

Fig. 4 is a detail of the perforated sheet lead cathode which is shown in Fig. 3 in end elevation.

Fig. 5 is a detail of one form of anode assembly. The clamping means and lead-in wires by which the electrical connection is made to the anode are also illustrated in this view.

Fig. 6 shows an alternative form of anode assembly. This view also illustrates the clamping means and electrical lead-in wire by which the anode is connected to a source of electrical current.

Fig. 7 is a detail of the clamping means by which the electrical lead-in wire may be secured to the anode of Fig. 6.

As will be more fully apparent from the sectional elevation, Fig. 1, my improved cell includes a cell container 11 which may be constructed of welded steel. This sheet steel box is lined with a lead lining 13. Secured to this lead lining by the use of acid-proof cement is an inner ceramic liner 15. This liner may be of porcelain or other ceramic material and should have sufficient thickness to insure adequate electrical insulation between the electrolyte and the sheet steel cell container.

The porous diaphragm 17 divides the interior of the cell container into two portions. The larger portion, designated by the numeral 18, constitutes the cathode chamber. The smaller portion, designated by the numeral 57, constitutes the anode chamber or the chamber adjacent the anode 29. As shown at the portions designated by numeral 19, the diaphragm 17 is secured in grooves in the side wall of the inner ceramic liner. As shown more clearly in Fig. 1, the diaphragm does not extend all the way to the bottom of the cell thereby providing a passage of relatively small cross-sectional area, designated by the numeral 21, through which flow of electrolyte from cathode chamber to anode chamber may take place.

Positioned in the chamber in which the anode is suspended and securely cemented to the insulating inner liner 15 with acid-proof cement is a lead box 23 which serves as a cooling jacket

for the anode chamber 57. Water or some other cooling fluid is permitted to flow into this cooling jacket through the inlet pipe 25 and out through the exit pipe 27 (Fig. 2). In this way that portion of the electrolyte present in the anode compartment is subjected to cooling during the process of electrolysis. Although lead is specified as my preferred material of construction for this cooling jacket, as lead is resistant to the action of sulphuric acid, any other material which will serve to transmit heat and which will also stand up under the severe corrosive conditions encountered in such an electrolysis cell may be utilized with equal success. Among other suitable materials may be mentioned glass, tantalum and even in some installations platinum, although the latter is of course far too expensive to permit of commercial utilization.

The anode is designated in Fig. 1 by the numeral 29. As the drawing illustrates two possible forms of this anode, that shown in Fig. 5 and that shown in Figs. 6 and 7, a description of the exact construction of this anode may be deferred for the present. It may be stated, however, that in the embodiment disclosed in Fig. 1 the anode is closely positioned adjacent to the porous diaphragm, 17. It is provided at the upper end with a metal clamp 31 by which may be secured the electrical lead-in connection 33.

Insofar as this description is concerned, the porous diaphragm 17 may be considered simply as a porous plate through which ions bearing electrical charges can readily pass. It may be constructed of some porous ceramic material or of glass wool.

The cathode assembly is positioned on a grooved acid-proof, stoneware block 35 which rests on the insulating inner liner 15. This block is provided with longitudinal grooves which permit the liquid present in the cathode chamber to flow from this chamber through the grooves and through the passage under this porous diaphragm (designated by the numeral 21) into the anode chamber. This block may preferably be made of acid-proof stoneware but can also be made of any other material such as lead, tantalum, glass or other material which is resistant to the action of sulphuric acid. If constructed of material which electrically conducts electricity, it must of course be suitably insulated from the cathode assembly.

The cathode assembly consists of the cathode proper which comprises a perforated lead plate designated by the numeral 37. This plate is provided with a series of holes or apertures 39. It may be suitably secured, as by burning, to a lead cooling coil 41 provided with inlet and outlet conduits 43 and 45, through which water or some other cooling fluid may be permitted to flow for the purpose of cooling the liquid present in the cathode chamber. At the bottom of the cooling coil, and secured to and forming a part of the lead plate cathode, is a lead bottom plate 47 which abuts against and rests upon grooved block 35. Although lead is specified as the preferred material for my sheet cathode, it must be understood that other materials which possess electrodynamic properties, such as platinum or graphite, may also be utilized. Ordinarily platinum would not be used in view of its relatively great cost.

At the upper end the sheet lead cathode is provided a clamp 49 similar to that shown on anode 29. By means of this clamp the electrical connection between the cathode and the source of current is made. The clamp may be secured to

the cathode by welding or in any other suitable manner.

Positioned at one side of cathode compartment 18 is an inlet tube 53 which may be formed of glass, ceramic material, lead, tantalum, or any other suitable resistant material. This inlet tube serves to convey electrolyte to the cathode chamber of the cell. If desired, it may be omitted and a solution of sulphuric acid in water, or a solution of sulphate, which is to be electrolyzed, may be poured directly into the cathode chamber. Ordinarily, the use of an inlet tube 53 is desirable as it prevents splashing of acid.

Exit tube 55 is provided at the upper level of the cooling jacket 23 in order that the electrolyte containing the persulphuric acid or persulphate product may leave the electrolysis cell. As shown, exit tube 55 is brought out through an aperture especially formed for the outflow pipe 20 in the sheet steel case, lead liner, and inner ceramic insulating liner. The outflow tube 55, which may be formed of metal or ceramic material, must be insulated from the steel container and the lead liner.

The course of flow of electrolyte through the cell will now be evident. The electrolyte which, in the manufacture of persulphuric acid, will constitute an aqueous solution of sulphuric acid, with or without various addition agents, is fed into the cell or, more particularly, into the cathode chamber through inlet pipe 53. This electrolyte then passes from the chamber surrounding the cathode through the groove in the porous stoneware block 35 and through the opening 21 provided under porous diaphragm 17. From here, flow occurs through the narrow passageway designated by the numeral 57, this passageway constituting the anode chamber. In the anode chamber the electrolyte comes into contact with anode 29 and is thus subjected to anodic electrolysis. Persulphuric acid (or persulphate) is produced in the electrolyte as the result of the electrolytic synthesis carried out in anode chamber 57. With its persulphuric acid content built up to a sufficiently high concentration, the electrolyte flows out through exit tube 55 to the stills where it is subjected to hydrolysis and distillation to recover hydrogen peroxide therefrom.

As previously specified, a cooling fluid such as water should continuously flow through the cooling coils 37. This cooling fluid is introduced through inlet 43 and flows out through outflow pipe 45. As a result of this cooling, the electrolyte is maintained at a temperature below about 20° C. during its passage through the cathode chamber. The electrolyte in the anode chamber 57 is cooled by flowing cooling fluid through the lead box 23. In this way the electrolyte is, at all times, maintained at a temperature of 20° C. or less.

The anode assemblies disclosed in Figs. 5, 6 and 7 may now be described in further detail. The anode construction shown in Fig. 5 is alternative to the construction shown in Figs. 6 and 7, and either one may be utilized in my improved electrolysis cell. It should be understood, of course, that the size of the anode chamber must be designed to accommodate whichever anode assembly is selected.

In the construction shown in Fig. 5 a plurality of vertical tantalum strips designated by the numeral 61 are supported from a lead cross-bar or cross-strip 63. These tantalum strips, which may be of relatively narrow width and slight depth, may be secured to the lead cross-bar by

welding. The strips 61 hang vertically in the cell. Toward the upper portion of the anode assembly is positioned, cross-wise to the vertical tantalum strips 61, a horizontal tantalum strip 65. Similarly, there is positioned at the lower portion of the cell another horizontal tantalum strip 67. The vertical tantalum strips and the two horizontal cross-strips constitute a frame which supports the actual electrode members. Tantalum is the material which is most suitable for the supporting frame, as it is relatively strong, inert to acid, readily secured to both lead and platinum by welding, and is a good conductor of electricity without itself acting as the electrode.

The actual anode members in the construction disclosed in Fig. 5 are the platinum strips designated by the numeral 71. These strips are arranged cross-wise of the tantalum vertical supporting strips 61, to which they are secured by welding. As shown, a number of these vertical platinum electrode elements are supported, one above the other, and extend throughout the entire width of the anode supporting frame. Sufficient platinum is required to give the required current density at the anode, but the strips need be only of relatively narrow width and slight depth.

Lead-in wire 33 is secured by clamp 31 which in turn is attached to lead cross-bar 63 in any suitable manner as by welding. As the lead-in wire, and the means of securing this wire to the lead cross-bar by clamping means, are now well-known in the art, further description thereof is unnecessary. Any standard and well-known manner of making contact between the cross-bar 63 and the source of current may be utilized and the particular means illustrated forms no essential part of my invention. It may be stated that the method of securing the lead-in connections to the electrodes, involving the use of a clamp, is the same in all constructions shown in the drawing.

The alternative form of anode assembly disclosed in Figs. 6 and 7 comprises a pair of lead posts 81, which are covered with tantalum indicated by numeral 82. To the tantalum covered posts is attached, in some suitable manner, as by welding, a plurality of tantalum cross-strips 83. The lead posts covered with tantalum, 81, may rest on the bottom of the cell, there being provided an insulating block, usually of porcelain (not shown) in order to provide proper insulation. To the cross-strips 83 there are secured narrow strips of platinum (designated by the same numeral 83) which constitute the actual electrode. The vertical posts 81 are tied together by means of a lead cross-bar 85 to which is secured, by welding, a lead clamp 87. This lead clamp is shown in greater detail in Fig. 7. By means of this clamp a bolt 89 may serve to secure the electrical lead-in connection to the anode assembly. It is obvious that the relatively more massive anode construction disclosed in Figs. 6 and 7 is capable of carrying a heavier electrical current than the anode disclosed in Fig. 5. As in the former construction, however, the area of platinum used must be sufficient to give the desired current density.

The operation of my improved electrolysis cell and the process of electrolysis carried out therein will now be apparent. An electrolyte, which in the persulphuric acid process may consist of a solution of persulphuric acid in water, with or without addition agents, and which in the am-

monium persulphate process consists of an acid solution of ammonium sulphate, flows into the cell through the inlet pipe 53. If desired, this pipe may be eliminated, but is preferably included as it prevents splashing of acid solutions. The electrolyte builds up in the cathode compartment 18 and flows through the perforations 39 in lead sheet cathode 37 so that it fills up the entire space comprising the cathode compartment between the diaphragm 17 and the insulating lining 15.

From the cathode chamber the electrolyte flows through the grooves in the grooved bottom plate 35 and through the opening 21 below diaphragm 17. If desired, the opening 21 may be positioned elsewhere in the diaphragm, but I have found it very much more advantageous to position it at the bottom of the cell.

After flowing through aperture 21, the electrolyte flows upwardly through anode chamber 57 where it comes into contact with electrode 29 and is subjected to anodic electrolysis. After the electrolysis is complete, the persulphuric acid or persulphate content being built up to a concentration sufficiently high to permit economical hydrolysis and distillation by treatment in the single cell, the electrolyte flows out through outlet 55 where it is delivered to stills for the subsequent treatment usual in this art. During the entire electrolysis the liquid in the cathode chamber is cooled by means of cooling coil 44 and the electrolyte in the anode chamber is cooled by means of lead box 23.

The acid recovered after hydrolysis of the persulphuric acid and the recovery of hydrogen peroxide by hydrolysis and distillation may be used as electrolyte in a successive electrolysis operation. Its specific gravity may be adjusted by the addition of fresh acid or distilled water so that gravity of preferably 1.3 is attained. Acid concentrations other than that equivalent to a gravity of 1.3 may of course also be used.

As noted above, the current density is an important factor in the electrolysis. I have found that a cathode current density of about 0.06 ampere per square centimeter of cathode surface and an anode current density of 0.6 ampere per square centimeter of anode surface will give very satisfactory results. I do not wish to be limited to this current density, however, as other densities may be selected which will also give satisfactory operation.

It has been found that the electrolyte may be circulated through the cell at the rate of about one-half liter (500 cc.) of electrolyte per minute. Under these conditions, a current of 1000 amperes is supplied to the cell and the temperature of the electrolyte is maintained at about 14 to 17° C., preferably below 20° C. The voltage drop across the cell will be approximately 5 volts. I have obtained current efficiencies of from 70 to 75% and the persulphuric acid content of the effluent electrolyte in the persulphuric acid process has usually been from 8 to 9%. It should be understood, of course, that these numerical data are merely given as illustrative, as my invention also involves the use of currents, current densities, voltage drops, and rates of electrolyte flow other than those specified.

Solutions of sulphates can also be employed in my improved process. Thus, I may electrolyze, for example, a solution containing 220 grams of ammonium bi-sulphate and 280 grams of sulphuric acid per liter of aqueous solution, the temperature being maintained below 20° C., in the

above apparatus. Current efficiencies obtained under these conditions are high, 80% or over.

My invention is not to be restricted to the foregoing details of my process as these conditions may be considerably modified, nevertheless obtaining satisfactory results from my novel and improved electrolysis cell. Therefore, I do not wish to be limited to exact rates, temperatures, or compositions given, nor to exact construction of the various elements or members forming my novel persulphuric or persulphate cell. Various changes might be made in the construction described as illustrative and preferred, which would nevertheless still be within the purview of my invention.

It may be stated, moreover, that a great variety of solutions may be treated in my improved cell and these solutions will, in general, contain other materials in addition to sulphuric acid or various sulfates, such, for example, as addition agents and other substances present as media to improve the efficiency of the process.

It is therefore my intention that the scope of the invention is to be restricted only as necessitated by the prior art and appended claims. In the claims the term persulphuric acid is intended also to include persulphates such as ammonium persulphate and potassium persulphate.

I claim:

1. An electrolysis cell for the manufacture of persulfuric acid which comprises, in combination, a cell container, a porous diaphragm separating said cell container into two compartments, which compartments are adapted to contain an electrolyte, said porous diaphragm being provided with an opening permitting communication between said compartments, a cathode positioned within one of said compartments, an anode positioned within the other of said compartments, and cooling means positioned within each of said compartments for cooling the electrolyte during its flow through the cell, said cooling means in said compartment in which said anode is positioned being so arranged adjacent said anode as to provide a relatively narrow path of travel for said electrolyte through said compartment between said anode and said cooling means.

2. An electrolysis cell for the manufacture of persulfuric acid which comprises, in combination, a cell container, a longitudinally extending porous diaphragm positioned within said cell container and separating said cell container into two compartments, which compartments are adapted to retain an electrolyte, said porous diaphragm being provided with an opening permitting communication between said compartments, a cathode positioned within one of said compartments, an anode positioned within the other of said compartments, cooling means positioned in said compartment containing said cathode in such a manner as to cool the electrolyte in said compartment, said cooling means being secured to and forming a part of said cathode, and cooling means positioned within said compartment in which said anode is positioned, said last-named cooling means being supported in said cell container closely adjacent to said anode, so that a relatively narrow path of travel for the electrolyte through said anode compartment in electrical contact with said anode is provided.

3. An electrolysis cell for preparing persulfuric acid which comprises, in combination, a cell container, a porous diaphragm separating said cell container into a pair of compartments, which compartments are adapted to contain an

electrolyte, said porous diaphragm being provided with an opening permitting communication between said compartments, an anode positioned within one of said compartments, a cathode positioned within the other of said compartments, electrical lead-in wires for supplying electrical current to said anode and said cathode, cooling means positioned within said compartments for cooling the electrolyte, said cooling means positioned in said compartment containing the cathode being rigidly secured to said cathode in such a manner that the effective area of said cathode is thereby increased, said cooling means positioned in said compartment containing said anode being positioned closely adjacent to said anode in such a manner that a relatively narrow path of travel is provided for the electrolyte through said compartment in the space between said cooling means and said anode, means for introducing fresh electrolyte into the compartment in which said cathode is positioned, and means for removing electrolyte which has been subjected to electrolysis from said compartment in which said anode is positioned and thence out of the cell.

4. An electrolysis cell for preparing persulfuric acid which comprises, in combination, a cell container, a porous diaphragm separating said cell container into a pair of compartments adapted to retain an electrolyte, said porous diaphragm being provided with an opening permitting communication between said compartments, an anode positioned within one of said compartments, a cathode positioned within the other of said compartments, electrical lead-in

wires for supplying electrical current to said anode and said cathode, and a box-like member positioned in said anode compartment adjacent said anode and in such a manner as to provide a relatively narrow space for travel of the electrolyte between said box-like member and said anode, said box-like member serving to retain a cooling liquid which cools said electrolyte as it passes in contact with said anode.

5. An electrolysis cell for preparing persulfuric acid which comprises, in combination, a cell container, a longitudinally extending porous diaphragm separating said cell container into a pair of compartments, which compartments are adapted to retain an electrolyte, said porous diaphragm being provided with an opening permitting communication between said compartments, an electrolyte positioned within said compartments, an anode positioned within one of said compartments, a cathode positioned within the other of said compartments, electrical lead-in wires for supplying electrical currents to said anode and said cathode, means for introducing fresh electrolyte into the compartment in which said cathode is positioned, means for removing electrolyte which has been subjected to electrolysis from said compartment in which said anode is positioned, and a cooling coil positioned in said compartment containing said cathode, said cooling coil being integrally secured to said cathode, whereby the effective area of said cathode is increased while said cathode and the electrolyte in said cathode compartment are subjected to cooling during the electrolysis.

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