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Description

- The invention relates to a gas-generating metal electrode for electrochemical processes, in particular to a coated titanium anode for amalgam cells, consisting of rods arranged in one horizontal plane in spaced and parallel relationship to each other, the surfaces of which rods form the working face of the electrode and have a cross-section whose dimension at right angles to the plane is greater than that parallel thereto.
- Gas-generating, horizontally arranged metal electrodes, normally the anode, opposite which is placed a generally horizontally arranged counter-electrode, normally the cathode, must fulfill various criteria.
- The first criterion consists in the requirement of removing the gas evolved at the anode as quickly as possible. For this purpose, the anode must have a free surface located in the horizontal plane of the arrangement, i.e. it must have interruptions or the like, through which the gas evolved on the lower side of the anode can escape upwardly. This free surface of the anode should be as large as possible. According to values found from experience, this free surface should be greater than or equal to about 33% of the projected area of the anode which is formed by multiplying the length by the breadth of the area occupied by the anode in the horizontal plane. Having regard to the fact that the open areas which can be formed with apertured plates, expanded metal grids or the like, and which form the free surface through which the gas can be removed, are insufficient for the purpose, the trend has been to changeover to mutually parallel rods spaced from one

another whose surfaces form the working surface of the electrode.

5 With rods having profiles with edges, such as for
example rectangular or triangular profiles, it was found
that increased abrasion of the coating of the rods
occurred on these edges. A second criterion is
therefore taken to be the use of a rod profile which has
no sharp edges. Having regard also to this condition,
10 rods having a circular cross-section have been employed.

In addition to these two essential criteria, further
conditions must also be satisfied.

15 One of these further conditions consists in that the
working surface of the anode must lie as close as
possible to the cathode. The further the working
surface of the anode is spaced from the cathode, the
larger is the cell voltage and thus the energy
20 requirement for production of the desired products.
Since chlorine alkali electrolysis according to the
amalgam process operates with a mercury cathode which as
a result of this material cannot have a completely
stable shape and in the event of a possible short
25 circuit occurring as a result of deformation of the
cathode resulting in contact with the anode, great
damage is caused to the anode as a result of the high
current densities used in this method, operation is
carried out substantially with an anode-cathode spacing
30 of 3 mm in dependence upon the current density and
various factors such as the ability to monitor the
process. Since the proportion of the surface of the
anode which extends parallel to the cathode should be as
small as possible, so that the free surface for escape
35 of the gas is as large as possible, a proportion of the

working surface must extend at right angles to the plane of the anode. According to values found from experience, the difference between the closest and furthest point of the working surface with reference to the cathode should be no greater than 2.0 mm. Coating onto the carrier, i.e. the rods or the like, must therefore be mainly carried out in this region.

A further criterion consists in that the proportion of the working surface of the anode which lies in the current shadow as seen from the cathode should be as small as possible. From this it results that for the proportion of the working surface which extends at right angles to the plane of the anode, in addition to the above-explained limit value of 2.0 mm, the radius of the round rods must be taken into account as a further limit value.

Furthermore, it should be taken into account that abrasion of the layer for the coating is also very strongly dependent upon the true current density. It is therefore necessary to maintain a working anode surface which is as large as possible for a cathod surface predetermined by the cell dimensions. The so-called projected anode surface is given by the anode length and breadth. It is in most cases predetermined by the user and therefore only slightly adjustable. The projected surface however gives very little information concerning the size of the working surface of the anode and thus concerning the true current density. It should however always be attempted to maintain a ratio of working surface F_A to the projected surface $F \geq 1$.

The known metal electrodes or anodes of the discussed type only partially fulfill the criteria set forth.

5 With the known anodes with round rods, it is true that premature abrasion of the coating can be prevented in contrast to rods with profiles having edges, but however the round rods have the disadvantages that the portion of the working surface of the anode which lies substantially perpendicular to the anode plane or 10 parallel to the main flow direction of the electric current is relatively small, in contrast the proportion of the working surface of the anode which lies in the current shadow as seen from the cathode and thus is unused or incompletely used is relatively large, and 15 moreover the ratio between the free and projected surface of the anode is unfavourable with the consequence of insufficient escape of the evolved gas.

20 The known electrodes or anodes of the described type in which the rods have a rectangular cross-section whose height extending perpendicular to the plane of the arrangement of rods is larger than the width parallel to this plane, have primarily the disadvantage that abrasion occurs rapidly on the edges of the coating and 25 thus the lifetime of such electrodes is small.

30 GB-A-1 068 992, Figure 4b, shows a relevant anode of U-shaped plates. It is true that this anode has the object of improving the escape of gas by using a free surface which is as large as possible, however it is necessary in order to achieve high current density to arrange the profiled plates relatively close together because the cross-section of the individual profiled plates is relatively small as a result of the desired 35 small width, whereby the escape of gas is again adversely affected.

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In contrast to the above, it is the object of the invention so to develop an electrode of the stated type that it fulfills the described conditions better than the known arrangements and nevertheless is simple and inexpensive to manufacture.

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This object is achieved with a metal electrode of the type set forth in the preamble of claim 1 in that the rods each have a solid cross-section of oval shape which consists of a rectangle whose long side extends parallel to the plane, and of two segments, the length of whose cord corresponds to the long side of the rectangle, the cord of each segment adjoining the long side of the rectangle.

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The construction according to the invention of the rods with a cross-section in the form of an oval ensures increase of the spacing between the individual rods and thus increase of the free surface of the anode with the result of improved withdrawal of the gas evolved on the anode during operation. The anode according to the invention is for this reason specially suitable for amalgam cells operating with relatively high currents and thus high current densities since with increased current densities similarly increased gas evolution occurs.

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With the arrangement according to the invention, in contrast to round rods, in addition the proportion of the working surface perpendicular to the plane of the rods is increased and furthermore the proportion of the working surface lying in the current shadow as seen from the cathode is reduced.

In contrast to the electrodes having rods with rectangular cross-section, the construction of rods according to the invention has the advantage that the rods have no such edges which cause increased abrasion of the coating.

The cross-section according to the invention can be easily produced from a round material for example by a drawing or rolling process.

Expedient further developments of the subject matter of the invention may be seen from the remaining claims.

Particularly simple manufacture of the profile according to the invention may be achieved if the segment of the cross-section of the rod is a segment of a circle. Thus, in this case the round material need only be flattened on two oppositely lying sides.

Experience has shown that for the oval profile according to the invention the following ranges of dimension are of advantage:

- Height h_R of the rectangle of the cross-section $\geq 1,0$ mm

- Width s of the rod such that $3.00 \text{ mm} \leq s \leq 5.55 \text{ mm}$

- Radius r of the circular segment such that $1.62 \text{ mm} \leq r \leq 5.55 \text{ mm}$.

A particularly clear comparison of the dimensional rules between round rods and rods having the profile according to the invention appears from the following table:

	Round Material	"Oval" Profile
Rod radius [mm]	$1.314 \leq r \leq 2.1525$	$1.625 \leq r \leq 5.55$
5 Rod width [mm]	$2.628 \leq s \leq 4.305$	$3.0 \leq s \leq 5.55$
Rod spacing [mm]	$1.5 \leq sp \leq 2.283$	$1.5 \leq sp \leq 3.34$
10 Free surface [%]	$33.33 \leq F_{\text{free}} \leq 36.34$	$33.33 \leq F_{\text{free}} \leq 52.68$
Surface fac- tor [1]	$1.0 \leq F_{A/P} \leq 1.047$	$1.0 \leq F_{A/P} \leq 1.408$

As may be seen from the above comparison, the profile according to the invention offers considerable advantages as compared with the known electrode arrangements, in particular having round rods, having regard to the criteria which are decisive for electrolysis operation relating to the surface factor, the free surface and the rod spacing.

An exemplary embodiment of the profile according to the invention is illustrated in the drawing. In the drawing:

Figure 1 shows a perspective representation of the anode according to the invention, and

Figure 2 shows the detail X according to Figure 1.

As may be seen from Figure 1, the metal electrode according to the invention consists of rods 1 arranged

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in a horizontal plane at a distance from one another and parallel to one another. These rods 1 are both mechanically and electrically connected to current feed rails 2 which are arranged at a mutual spacing and parallel to one another and perpendicularly to the rods on their upper side. The current feed rails 2 are either directly or via cross rails 3 electrically and if necessary also mechanically connected to a current feed bolt 4.

The cross-section of the rods 1 and their arrangement in the horizontal plane may be best seen from Figure 2. In this Figure, the cross-section of the rods 1 consists of a rectangle 1a whose height h_R extends perpendicularly to the plane of the arrangement and two segments 1b whose cords correspond to the length of the rectangle and which adjoin with their cords the respective long sides of the rectangle 1a. The segments 1b are preferably circular segments having a radius r .

As may be further seen from Figure 2, the rods 1 have a rod width s and are arranged at a spacing from one another to produce a rod spacing sp .



Claims:

1. A gas-generating metal electrode for electrochemical processes, in particular a coated titanium anode for amalgam cells, consisting of rods arranged in one horizontal plane in spaced and parallel relationship to each other, the surfaces of which rods form the working face of the electrode and have a cross-section whose dimension at right angles to the plane is greater than than that parallel thereto, characterized in that the rods (1) each have a solid cross-section of oval shape, which consists of a rectangle (1a), whose long side extends parallel to the plane, and of two segments (1b), the length of whose chord corresponds to the long side of the rectangle (1a), the chord of each segment adjoining a long side of the rectangle (1a).
2. An electrode according to Claim 1, characterized in that the segment (1b) is a segment of a circle.
3. An electrode according to Claim 1 or 2, characterized in that the vertical dimension (h_R) of the rectangle at right angles to the plane is at least 1.0 mm.
4. An electrode according to any one of the preceding Claims, characterized in that the long side s of the rod satisfies $3.00 \text{ mm} \leq s \leq 5.55 \text{ mm}$.
5. An electrode according to any one of Claims 2 to 4, characterized in that the radius r of the segment of a circle satisfies $1.62 \text{ mm} \leq r \leq 5.55 \text{ mm}$.