

Electrochemical half-element

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5 The invention relates to an electrochemical half-element having a gas diffusion electrode, in particular for the electrolysis of aqueous solutions of alkali metal chloride.

10 The use of gas diffusion electrodes in alkali metal chloride electrolysis as consumable oxygen cathodes advantageously involves pressure compensation between the height-dependent pressure of the sodium hydroxide solution in front of the gas diffusion electrode and the constant pressure of the oxygen behind the gas diffusion electrode, in the form of gas pockets, as shown in EP-A-0 717 130. In this context, it has proven advantageous for the gas to be routed in such a way that active venting of the gas pockets is ensured, as described in US-A 6,165,332.

15 A further development of pressure compensation by means of gas pockets is described in EP-A-0 946 791 and relates to removable gas pockets. However, technical tests have revealed a number of drawbacks, relating in particular to the following points:

20 The attachment of the oxygen supply at the rear by flanging flexible hoses onto connection stubs on the rear side of the gas pocket is highly laborious and difficult. The operation involves attaching the oxygen supply to the rear side, remote from the gas diffusion electrode, of the gas pocket. Furthermore, the presence of projecting connection stubs on the gas pockets, which in practice are over two meters long and
25 approx. 30 cm wide, is a nuisance and has in some cases led to mechanical damage. A further drawback is the need, for design reasons, to keep in stock two types of gas pockets, namely gas pockets whose gas inlet opening is arranged on the right-hand side of the gas pocket and whose gas outlet opening is arranged on the left-hand side of the gas pocket, and gas pockets in which, conversely, the gas inlet opening is
30 arranged on the left-hand side and the gas outlet opening is arranged on the right-hand side. Screwing on the gas pockets in the manner described above has also proven laborious and in need of improvement.



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It is an object of the invention to provide a gas pocket which is simple to exchange.

According to the invention, the object is achieved by the features of claim 1.

- 5 The present invention relates to an electrochemical half-cell with gas diffusion electrode as cathode or anode with pressure-compensated gas supply via gas pockets, in such a manner that the removable gas pockets, during all removal and installation operations, are designed such that they can be operated from the side of the gas diffusion electrode, and the mechanical and electrical connection of the gas pockets
10 to the frame-like supporting structure or the like of the half-shell, supporting the gas pockets, is preferably likewise effected by means of readily releasable connections.

In the context of the present invention, the term half-shell is to be understood as meaning the space which receives the electrode space for receiving the electrolyte,
15 the gas space, formed from the gas pockets, for receiving gas and the connecting passage which connects two gas pockets to one another in each case, and which allows electrical contact to be made with the gas diffusion electrodes. A frame-like supporting structure or the like is provided in the half-shell for the purpose of attaching the gas pockets.

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According to the invention, the electrochemical half-cell has a gas-feed connection which is arranged between a gas pocket and a gas-connecting passage which connects two gas pockets to one another, and can be detached from the side of the gas diffusion electrode. For this purpose, it is preferable for a fixed part or a
25 distributor plate with screw head and sealing system to be arranged as an element of the gas-feed connection at the gas-connecting passage, in particular at a front wall of the gas-connecting passage. The fixed part can be releasably connected to a mating piece which is connected to the gas pocket, in particular to the back wall of the gas pocket. The mating piece preferably has gas inlet openings leading into the gas
30 pocket, and the gas diffusion electrode has an aperture which is gastight with respect to the gas pocket. This forms a through-opening which extends from the back wall of the gas pocket to the gas diffusion electrode. The fixed part and the mating piece are designed in such a manner that the connecting elements of one or both parts are

accessible from the gas diffusion electrode, i.e. from the front. This, by simple release of the connection, allows the gas pocket to be exchanged and/or removed. It may also be necessary for connecting elements in the boundary region of the gas pocket, which are connected to a support structure or the like of the half-element, to
5 be released for this purpose.

One advantage of the half-cell according to the invention is that the gas pockets do not have any connection stubs. Instead, the gas pockets are flat, easy-to-handle units.

10 The gas supply is preferably fitted halfway up one end of the gas pocket. Gas outlet openings are provided at the other end of the gas pocket, both at the bottom and at the top. This has the advantage that only one type of gas pocket has to be constructed, since, depending on whether the gas supply into the gas pocket takes place to the right or to the left, the gas outlet openings at the top are closed off and
15 those at the bottom are opened or fitted. Therefore, the gas outlet from the gas pocket is always at the bottom, irrespective of how the gas pocket is fitted. The gas-connecting passages may in this case be installed in the half-shell as a fixed unit which is independent of the gas pocket.

20 It has proven advantageous for the back wall of the gas pocket to be provided with a dimension which projects on all sides and for this projection to be connected to the support structure, in order for the gas pockets to be installed in the half-cell, i.e. for the gas pockets to be connected to the support structure, which in EP-A-0 946 791 is effected releasably by screw connection or clamping strips. The projections of the
25 gas pockets on the longitudinal sides are preferably used for this purpose, while the projections on the narrow sides are bent up to the level of the sealing surface of the half-shell and are pushed under the seals.

If what are known as dimensionally stable gas diffusion electrodes in accordance
30 with DE-A 100 27 339 are used, their rigid edge region which is not coated with catalyst material can be bent downward in a Z shape onto the level of the gas pocket back wall and at this level can be connected to the back wall of the gas pocket. Accordingly, in this case the projection of the back wall with the rigid edge region of

the gas diffusion electrode resting on it can be connected to the support structure for the purpose of securing the gas pockets in the half-cell.

5 The gas pockets can in each case be connected to the support structure of the half-shell using special self-centering screws or using tensile rivets. The projections of adjacent gas pockets in this case overlap one another. The seal with respect to the electrolyte behind the gas pockets, which is required in order to avoid bypass flows out of the electrolyte gap through which flow is forced into the back space, can be achieved by an elastic seal and a prestressed metal section, both with mating holes,
10 being introduced. This prestress allows continuous linear electrical contact with the holding structure. Furthermore, the resistive losses can be minimized here by the contact regions being coated with applications of precious metal, e.g. of silver or gold.

15 Alternatively, the gas pocket could also be secured in the half-shell by welding or soldering. A releasable connection which offers the option of installing and removing an individual gas pocket directly on site, i.e. in the chlorine factory, is preferably selected, however. A gas pocket which can be handled individually has the advantage, for example, that it is considerably easier to fit a gas diffusion electrode,
20 for example when the gas diffusion electrode is being changed on account of wear or damage or for quality assurance checking for any incorrect penetration of gas through the gas diffusion electrode.

Nickel is preferably selected as the material for constructing the gas pockets and the
25 gas-connecting passage. Alternatively, it would also be possible to use alkali-resistant, eluate-free special steel compounds, such as for example Hastalloy. The gas diffusion electrodes are substantially an electrochemically active coating which contains a catalyst metal and/or a nonmetallic compound of a metal which forms the catalyst, e.g. silver(I) oxide, and a binder, e.g. a polymer, such as
30 polytetrafluoroethylene (PTFE), on an electrically conductive support, for example a metal mesh, nonwoven or woven fabric. Furthermore, the support may be a carbon mesh, a carbon nonwoven or a carbon woven fabric or a corresponding mesh etc. made from other electrically conductive materials.

The invention is explained in more detail below on the basis of preferred embodiments and with reference to the appended drawings, in which:

Fig. 1 shows a diagrammatic longitudinal section through a gas pocket according to the invention,

Fig. 2 shows an excerpt from a diagrammatic cross section through the gas pocket on line A-A' in Fig. 1,

Fig. 3 shows an excerpt from a diagrammatic cross section through a further embodiment of the gas pocket,

Fig. 4 shows an enlarged view of the gas-feed connection as illustrated in Fig. 2, and

Fig. 5 shows a diagrammatic cross section, corresponding to Fig. 4, through a further embodiment of the gas-feed connection.

The gas pocket according to the invention described below is used in a cathode half-element during the electrolysis of an aqueous solution of alkali metal chloride. The gas diffusion electrode is in this case operated as an oxygen consumption cathode.

A gas pocket 2 is provided with a detachable gas-feed connection 3 which is arranged on one side of the gas pocket symmetrically or centrally between the longitudinal sides 37, 38 (Fig. 1). Of the outlet openings 30 and 30', only those which lie at the bottom are open. Gas pockets with a gas-feed connection located on the left are thus of the same design as those with a gas-feed connection located on the right. There is therefore only one basic type of gas pockets, which are arranged above one another with the gas-feed connection on the left or the right alternately.

The gas-feed connection 3 comprises a fixed part 6 (Figs 2 and 4), which is connected to the front wall 4 of the gas-connecting passage 1, and the mating piece 7, which is part of the removable gas pocket 2. The gas-connecting passage 1 is used to

connect two gas pockets 2 located above one another. The gas which emerges from the lower gas pocket flows through the gas-connecting passage into the gas pocket above. For the gas supply, the bottom gas pocket has a gas-feed connection stub, and a further connection is provided for the gas discharge, and the gas can be discharged
5 together with the electrolyte via the gas discharge connection stub. The gas pocket 2 is connected to the gas-connecting passage 1 via a screw connection between fixed part 6 and mating piece 7 through the through-opening 19 in the mating piece 7 via a securing pin, such as for example a threaded pin 15 and the nut 16 with washer 17. The through-opening 19 extends from the back wall 5 to the gas diffusion electrode
10 22 and is therefore accessible from the front, i.e. from the side on which the gas diffusion electrode 22 is arranged. Simply loosening the nut 16 allows the gas-feed connection 3 to be released and the gas pocket 2 can be removed after the connection to a support structure 33, which in the exemplary embodiment illustrated is configured as a riveted connection 34 (Fig. 2), has been released. Gas is in this case
15 transported via the mating channels or gas passages 8 and 10 in the fixed part 6 and in the mating piece 7, respectively, with a compensation passage 9 serving to improve the gas transport in the event of poorly aligned, for example offset, gas passages 8, 10. Seals 13 and 14 outside and inside the through-openings in corresponding seal seats 11 and 12 are responsible, in the screwed-together state, for
20 providing a seal with respect to the electrolyte and therefore for avoiding uncontrolled loss of gas.

A baffle plate, in particular a metal baffle sheet, 20 fitted to the edge 18 of the mating piece 7 associated with the gas pocket 2 diverts the incoming gas into a direction of
25 flow parallel to the gas diffusion electrode 22 and thereby avoids unacceptably high gas velocities at the rear side of the gas diffusion electrode 22.

The connection of the gas diffusion electrode 22 to the edge 18 can be effected either by means of a suitable weld (ultrasonic or laser welding) or by soldering.
30 Alternatively, it is possible to select a screw connection 16' (Fig. 5) with a seal 25, which is designed in such a way that the mating piece 7 and the fixed part 6, on the one hand, and the gas diffusion electrode 22 and the edge 18, on the other hand, are connected to one another fixedly, i.e. in a gastight manner.

The gas pocket 2 itself is provided with a rim 21, the height of which defines the distance between back wall 5 and gas diffusion electrode 22. Back wall 5, rim 21 and gas diffusion electrode 22 are preferably connected by ultrasonic or laser welding, welding advantageously being carried out using an angle plate 24 designed as an edge protector. This constitutes a gas pocket electrode unit.

Alternatively, the gas pocket may also be formed from a dimensionally stable gas diffusion electrode 36 (Fig. 3), whose region 35 which is not coated with catalyst material in the edge region is bent down in a Z shape onto the level of the gas pocket back wall 5 and is connected to the back wall 5 of the gas pocket 2 at this level, for example by welding or soldering. If the flank of the Z is selected to be less than 90°, the outlet openings 30 at the bottom are in any event at a lower level than the bottom edge of the active zone of the gas diffusion electrode and thereby ensure good removal of condensate without wetting the active zone. In both cases, the way in which the releasable gas-feed connection 3 is fitted to the gas pocket electrode unit is identical.

The gas pockets are likewise secured to the securing rail 33 belonging to the cathode half-cell (Fig. 2) releasably by means of a screw connection or riveted connection 34. To achieve particularly good electrical contact between the two components and at the same time to avoid a leaking flow of electrolyte between the front side and the rear side of the gas pocket, a prestressed metal profiled strip 31, which is perforated so as to match the perforations in the gas pocket and securing rail, and a permanently elastic seal 32 beneath it are pressed on via the screw connection/riveted connection, thereby producing linear contact between the securing points of the gas pocket electrode unit.

An advantage of all these variants is that the gas pocket electrode units can be exchanged using components which have been tested for leaktightness, the gas pocket electrode units forming flat structures without projecting parts which are therefore easy to handle. If the releasable connection of the gas pocket electrode units is also selected, they can be exchanged in situ in the installation.

Patent Claims

1. An electrochemical half-element, in particular for the electrolysis of aqueous solutions of alkali metal chloride, comprising at least
- 5 an electrode space for receiving electrolyte having an electrolyte feed and an electrolyte discharge,
- a gas space formed from a plurality of gas pockets (2) for receiving gas, each gas
- 10 pocket having a back wall (5) and a gas diffusion electrode (22) as cathode or anode which separates the gas space from the electrode space,
- a connecting passage (1) which connects two gas pockets to one another and through which the gas which emerges from a lower gas pocket (2) via an outlet opening (30;
- 15 30') flows via a gas-feed connection (3) into a gas pocket (2) above, characterized
- in that the gas-feed connection (3) can be detached from the side of the gas diffusion electrode (22).
- 20 2. The electrochemical half-element as claimed in claim 1, characterized in that the gas-feed connection (3) has a fixed part (6), which is connected to the connecting passage (1), in particular the front wall (4) of the connecting passage (1), and a mating piece (7), which is connected to the gas pocket (2), in particular the back wall
- 25 (5) of the gas pocket (2), the fixed part (6) and the mating piece (7) being releasably connected to one another.
3. The electrochemical half-element as claimed in claim 2, characterized in that the mating piece (7) has a through-opening (19) extending from the back wall (5) to the gas diffusion electrode (22).
- 30 4. The electrochemical half-element as claimed in claim 3, characterized in that the through-opening (19) serves to receive a securing pin (15) which is connected to the fixed part.

5. The electrochemical half-element as claimed in one of claims 2 - 4, characterized in that the fixed part (6) and the mating piece (7) have gas passages (8, 10) which are in communication with one another.
- 5 6. The electrochemical half-element as claimed in claim 5, characterized in that the fixed part (6) and/or the mating piece (7) has a compensation passage (9) for compensating for any offset between the gas passages (8, 10).
7. The electrochemical half-element as claimed in one of claims 2 - 6,
10 characterized in that a baffle plate (20) is arranged between the gas passages (10) provided in the mating piece (7) and the gas diffusion electrode (22).
8. The electrochemical half-element as claimed in one of claims 1 - 7,
15 characterized in that the gas-feed connection (3) is arranged centrally between two longitudinal sides (37, 38) of the gas pocket (2), and outlet openings (30; 30'), which can be opened or closed depending on the arrangement, are provided in each case on the longitudinal sides (37, 38).