Electrochemical gaseous diffusion half cell

The use of gas diffusion electrodes in pressure-compensated electrochemical cells, given a greater overall height, requires the gas space to be subdivided into segments situated above one another, so-called gas pockets, which must each, in their border region, be brought into electrical contact with the electrode and be sealed in a gastight manner. A half cell of a basic design of this type is described, for example, in the German Offenlegungsschrift (German Published Specification) DE 44 44 114 A1. A drawback of the type of construction shown in DE 44 44 114 is the comparatively complicated way in which the gas diffusion electrode is contacted and sealed. Desirably, the space within which the electrode is brought into contact with the gas pocket and is sealed should be as confined as possible, to keep the electrode area that is inactive in terms of the electrode reaction as small as possible.

It is an object of the invention to provide an electrochemical gaseous diffusion half cell which allows the active electrode area to be utilized as extensive as possible, the electrode together with the gas pocket being designed, if required, to be removable as a module, thus enabling the electrode to be prefitted onto the gas pocket so as to provide a gas tight seal in the edge contacts, and making it simpler to make electrical contact for operating the gas diffusion electrode in the half cell.

A further object of the invention, in particular, is to design the half cell and the electrode module and gas pocket module in such a way that modules of the half cell can alternatively be replaced in a simple manner by a conventional electrode, for example a nickel electrode producing hydrogen.

The object is achieved according to the invention by the gas pockets fitted with gas diffusion electrodes being removable, individually if required, from the half cell and being of such design that they can be detached from their gas supply or pressure compensation means and from the terminals. This involves the gas pockets being fabricated as compact, flat elements whose front is sealed in such a way by the gas diffusion electrode that no electrolyte escapes into the gas space and no gas

escapes in the opposite direction from the gas pocket when the half cell is fitted with the electrode.

The present invention relates to an electrochemical half cell based on a gas diffusion electrode as the cathode or the anode, comprising a gas diffusion electrode gas space formed by one or more gas pockets and further comprising an ion exchange membrane, a retaining element for mounting the electrode, terminals for the electrode, a gas supply to the gas pocket and a pressure-compensating gas exhaust to the gas pocket, an electrolyte feeder and an electrolyte offtake, and a housing for accommodating the cell components, the half cell being characterized in that the gas diffusion electrode is connected to the gas pocket to form a module which is detachably secured to the retaining element, the gas supply and the gas exhaust forming a detachable connection to the gas pocket.

In a preferred embodiment, the gas space is partitioned into a plurality of gas pockets which, if required, can be fed with electrode gas independently of one another and which are pressure-compensated with respect to the electrolyte compartment located upstream of the gas diffusion electrode.

Particularly preferred is a half cell in which the, in the case of a plurality of gas pocket modules, the individual modules are detachably secured, independently of one another, to the retaining element.

Likewise particularly preferred are embodiments in which the gas diffusion electrodes are secured to the gas pocket so as to be readily detachable, to allow aged electrodes to be replaced.

Preferably, the gas supply and gas exhaust, respectively, are designed as a flexible hose connection to which the gas pocket is connected and which, after the ion exchange membrane has been loosened, allows the gas pockets to be taken off.

Alternatively it is also possible, in particular, for gas supplies fabricated as union seals over designed as bubble channels and correspondingly pressure-compensating

liquid seals to be used.

In a further preferred form of the half cell according to the invention, the gas pocket modules are, with the aid of structural elements, positioned in the half cell, electrically connected to the external power supply and, if required, sealed to the extent that electrolyte is not able to overflow in an uncontrolled manner from the perfused electrolyte gap into the rear pressure-compensated space of the gas pocket, the structural elements positioning the gas pocket modules in such a way that the gas diffusion electrodes at the same time are able to serve as an electrolyte gap for the passage of the electrolyte into the electrolyte compartment between the gas diffusion electrode and the ion exchange membrane.

The electrical contact of the gas pocket modules with an external electrical power supply, e.g. connected to the half cell housing, can be improved by the modules, in addition to the pressure contacts in the border region, being electrically contacted, with the aid of a substructure which e.g. is pressure bonded to the half cell housing, via their rear, the side facing away from the gas diffusion electrode, via resilient and electrically conductive contact elements (e.g. spring contacts).

The electrical contact in the border region and the electrode contact distributed over the area of the electrode permits a low-resistance electrical supply lead to the electrode.

In a further preferred variant of the half cell according to the invention, the gas diffusion electrode is electrically contacted over its area on its side facing the gas space of the gas pocket with the aid of a support grid, the support grid being in electrical contact with the gas pocket rear wall.

An optional additional channel, which forms at the bottom edge between gas diffusion electrode and gas pocket, may serve to receive any condensate produced. The condensate can be discharged, together with the excess gas, into the rear electrolyte compartment via the gas exhaust situated at the lowermost point.

Inhomogeneity in the supply of fresh electrolyte to the electrolyte compartment located upstream of the gas diffusion electrode can be avoided in a preferred variant by the half cell downstream of the electrolyte feeder having an additional electrolyte manifold which renders the electrolyte flow more uniform across the width of the half cell. The pressure-compensating rear space need not, in this embodiment, be perfused. The rear space communicates with the electrolyte stream only at the top end of the half cell.

A particular advantage of the construction of the half cell according to the invention is the option of the half cell, even if the gas pocket modules have been replaced, simply being operated using conventional electrodes, in particular using hydrogen-producing electrodes, e.g. nickel electrodes. In a preferred variant, the gas pocket modules are therefore designed to be replaceable by conventional electrodes, the gas feeder to the gas pocket being able to be shut off or dismantled.

The invention also relates to the use of the electrochemical half cell according to the invention in an electrochemical cell, in particular an electrolytic cell, for operation involving the optional use of gas pocket modules or of conventional electrodes, in particular hydrogen-producing electrodes, above all activated nickel electrodes.

The invention is explained below in more detail with reference to the figures, in which

Figure 1 shows a cross-section through a half cell according to the invention as seen from the ion exchange membrane towards the gas diffusion electrodes and the gas pocket mounts situated in between.

Figure 2 shows a broken longitudinal section for a closed half cell on A-A' in Figure 1.

Figure 3 shows a broken longitudinal section on A-A' in Figure 1 for an open half cell with the ion exchange membrane and gas pocket module loosened from the

cell housing.

Figure 4 shows a detail from Figure 2 to illustrate how electrical contact is made with the gas pocket.

Figure 5a shows a cross-section on B-B' as seen towards the gas supply 21 of the half cell.

Figure 5b shows a partial detail on C-C' in the upper part of the half cell according to Figure 1.

Figure 6 shows a partial cross-section on D-D' in Figure 1 through a half cell in which the gas pocket modules have been replaced by a conventional nickel electrode 30 with the supporting element 31.

Figure 7 shows a longitudinal section on A-A' according to Figure 1 pertaining to the variant of the half cell according to Figure 6 in operation using a nickel electrode 30.

Examples

Example 1

An electrochemical half cell is constructed as follows:
In a half-shell electrolyte-resistant housing 13 (see Figure 3) a frame element 11 and a substructure 12, which is connected to an external power supply (not shown), are firmly anchored. Run through into the housing are a gas line 21 (see Figure 1), an electrolyte feeder 20 and a combined electrolyte and gas discharge 22. On the retaining element 11, with the aid of vertical clamping bars 8 and horizontal clamping bars 9, the gas pocket unit 1 with the gas diffusion electrode 5 is secured in the housing 13. The half cell is sealed by the membrane 40 which fits against the circumferential rim of the housing 13 via a seal 41 (see Figure 2) and is pressed in an electrolyte-tight manner onto the circumferential rim of the housing 1, e.g. by a further half cell (not shown) being flange-mounted. The flexible lines 6a, 6b, 6c, 6d emanating from the gas manifold (see Figure 1) are connected to respective supports 6e on the gas pocket unit via flange connections.

The embodiment according to Figure 1 shows a partition into four gas pockets 2a, 2b, 2c, 2d with respective pressure compensation via gas transfer lines 7. The gas pocket 1 consists of the metallic housing 2 which, via current contacts, e.g. spring contacts 14, brush contacts 15 or direct contact, is connected to the current-carrying substructure 12 at convex structure sections 16 (see details in Figure 4). The further current supply takes place via the metallic process contacts between the clamping bars 8, 9 and the retaining element 11 via the rim regions of the housing 2. The contact resistance can be reduced by surface coating, e.g. gold coating. The gas pocket unit 1 further has supplies and exhausts 6e and 7 for the electrode gas, a supporting element 3 to support the gas diffusion electrode 5, and an electrode seating grid 4 on which the gas diffusion electrode 5 is seated over its entire area. Each of the four gas pockets 1a, 1b, 1c, 1d has a gas diffusion electrode 5 which is connected in a gas tight manner in the border region of the gas pocket module and which at the same time is electrically connected there. In the case of gas diffusion electrodes having conductive rear sides, electrical contact is established

entirely via the electrode seating grid.

During operation, as shown in Figure 5a, the electrolyte passes from the electrolyte supply 20 through the electrolyte manifold 23 via holes 24 and further holes 10 in the horizontal clamping bars into the electrolyte compartment 27 upstream of the gas diffusion electrode 5. The electrolyte perfuses the electrolyte compartment 27 along the four gas pocket modules 1a to 1d and, through holes in the topmost horizontal clamping bar 9, flows into the electrolyte header 26. From there the electrolyte drains via holes 25 into the rear compartment downstream of the gas diffusion electrode and, together with excess electrode gas, is discharged from the half cell via a down pipe 22 (see Figure 5b). When operated as an electrolytic cell, the half cell is sealed at the front by an ion exchange membrane 40 which provides for passage of the ions, depending on the respective electrolysis reaction, from the half cell according to the invention to a further connected half cell or possibly in the opposite direction.

At the feeder 21 the electrode gas enters the half cell and is distributed via a gas manifold 19 over the feeders 6a, 6b, 6c and 6d to the four gas pocket modules 1a, 1b, 1c, 1d (see Figure 1), said feeders being partially throttled to achieve improved gas distribution to the individual gas pocket modules. The electrode gas perfuses the gas pockets in a longitudinal direction, and the unused excess and any condensate produced escape from the gas pockets at the opposite end through gas transfer nozzles 7 towards the electrolyte in the electrolyte gap, pressure compensation being achieved as a result. From the gas transfer lines 7 the gas bubbles upwards through the compartment downstream of the gas pocket modules and collects in the compartment above the end of the connection 22. From there the gas is discharged from the half cell via the down pipe 22.

Example 2

For operation using a conventional electrode, the gas pocket modules 1a to 1d, together with the clamping bars 8 and 9, can be dismantled as indicated in Figure 3 and be replaced by a nickel cathode 30 having a substructure 31 which serves as

a current lead and support. The gas supplies 6a to 6d are usefully closed. The conventional electrode, e.g. an activated nickel cathode, is secured to the frame element 11 of the half cell by means of screws 32 (see Figures 6 and 7). The discharge of the hydrogen formed in the electrode reaction can take place via the down pipe 22, together with electrolyte being drained.

Claims



1. Electrochemical half cell based on a gas diffusion electrode (5) as the cathode or the anode, comprising a gas diffusion electrode gas space formed by one or more gas pockets (2a, 2b, 2c, 2d) and further comprising an ion exchange membrane (40), a retaining element (11), a gas supply (21) and a gas exhaust (22), an electrolyte feeder (20), an electrolyte offtake (22) and a housing (13), characterized in that the gas diffusion electrode (5) is connected to the gas pocket(s) (1a, 1b, 1c, 1d) to form a module or a plurality of modules (1a, 1b, 1c, 1d), which is detachably secured to the retaining element (11), the gas supply (21) and the gas exhaust (22) forming a detachable link to the gas pocket (2a, 2b, 2c, 2d).

2. Half cell according to Claim 1, characterized in that the gas space is partitioned into a plurality of gas pocket modules (1a, 1b, 1c, 1d) which, if required, can be fed with gas independently of one another and which are pressure-compensated with respect to the electrolyte compartment (27).

3. Half cell according to Claim 2, characterized in that the gas pocket modules (1a, 1b, 1c, 1d) are detachably secured, independently of one another, to the retaining element (11).

4. Half cell according to Claims 1 to 3, characterized in that the gas supplies (6a, 6b, 6c, 6d) are designed as flexible hose connections to the gas pocket (2a, 2b, 2c, 2d).

5. Half cell according to Claims 1 to 4, characterized in that the gas pocket modules (1a, 1b, 1c, 1d) are, with the aid of structural elements (9), positioned in the half cell, electrically contacted therein and, if required, sealed in terms of flow, the structural elements at the same time, if required, forming an actively perfused electrolyte gap.

6. Half cell according to Claims 1 to 5, characterized in that the gas pocket

modules (1a, 1b, 1c, 1d) are in electrical contact with the substructure (12) via contact elements (14, 15, 16).

7. Half cell according to Claims 1 to 6, characterized in that the gas diffusion electrode (5) is electrically contacted over its area at a support grid (4) in the interior of the gas pocket (2a, 2b, 2c, 2d).

8. Half cell according to Claims 1 to 7, characterized in that the cell includes an electrolyte manifold (23) for homogeneously supplying electrolyte to the electrolyte compartment (27).

9. Half cell according to Claims 1 to 8, characterized in that the gas pocket modules (1a, 1b, 1c, 1d) can be replaced by conventional electrodes (30).

10. Half cell according to Claims 1 to 9, characterized in that the gas diffusion electrode (5) is detachably connected to the modules 1a to 1d.

11. Use of the half cell according to any one of Claims 1 to 10 in an electrochemical cell for operation involving the optional use of gas pocket modules (1a, 1b, 1c, 1d) or of conventional electrodes (30).

* C L M S *