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ANTIMONY ELECTRODE ASSEMBLY

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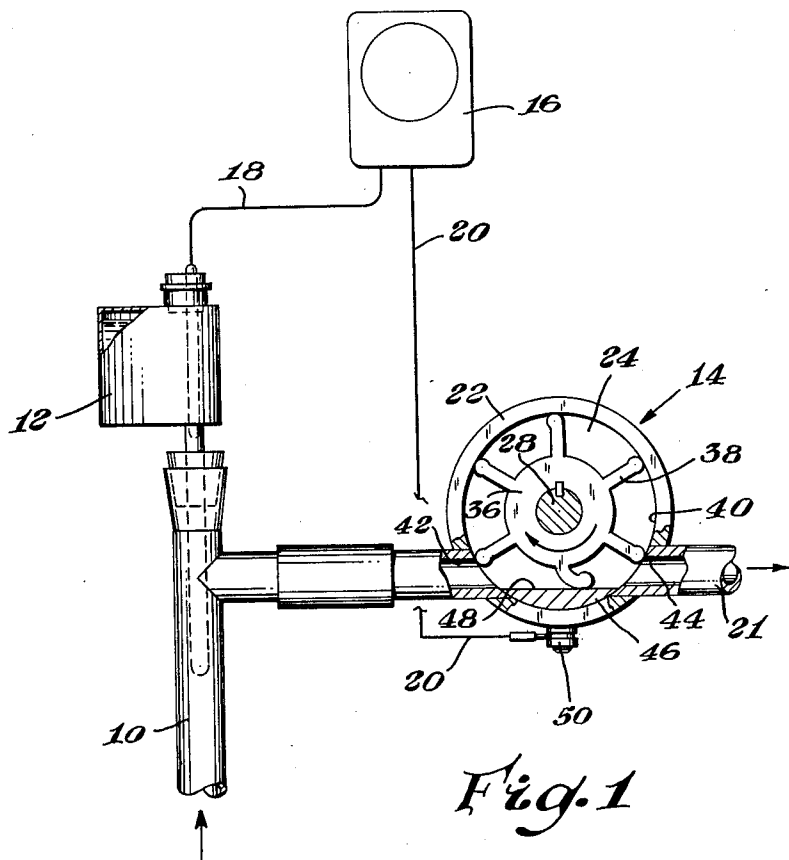


Fig. 1

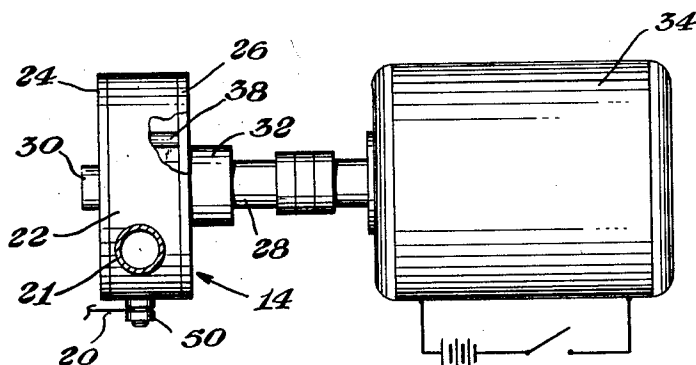


Fig. 2

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1

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ANTIMONY ELECTRODE ASSEMBLY

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This invention relates to an improved electrode assembly for use in process control applications, and particularly to a self-cleaning antimony electrode assembly.

Antimony electrodes have been used in the past, but they often have been unreliable because the surface of the electrode may react with the sample under test and in contact with the electrode or material may scale or settle out on the electrode.

Attempts have been made to make self-cleaning antimony electrodes which overcome the above-mentioned problems, but these arrangements have not been as satisfactory as desired.

Accordingly, a principal object of this invention is to provide an improved antimony electrode.

Another object of this invention is to provide an improved self-cleaning antimony electrode assembly.

A further object of this invention is to provide an improved self-cleaning anode assembly which also serves as a sample pump.

In accordance with this invention, there is provided an antimony electrode assembly comprising an enclosed electrically insulating housing having a substantially cylindrical hollow chamber. A coaxially disposed electrically insulated shaft which extends through the chamber and housing walls. An impeller made of electrically insulating material and having a plurality of flexible vanes which extend outwardly from a hub to contact the side wall of the chamber is disposed on said shaft. An antimony electrode element is disposed along part of the side wall of the chamber, the shaft to electrode surface distance being less than the shaft to chamber side wall surface distance. Electrode terminal means extends from the antimony electrode through the housing of the assembly. The width of the impeller is that it fits closely within the length of the housing. An inlet opening and an outlet opening extend through the side wall of the housing, one on each side of the antimony electrode. In operation, as the shaft rotates and the flexible impeller vanes contact the chamber side wall and electrode, keeping the electrode wiped clean, sample from the sample stream to which the input opening is coupled is drawn through the chamber and forced out the outlet opening.

The invention, as well as additional objects and advantages thereof, will best be understood when the following detailed description is read in connection with the accompanying drawing, in which:

FIG. 1 is a side elevational view, partly in section, of the electrode assembly of this invention as used in operation on a sample stream, and

FIG. 2 is an end view, partly broken away in section, of the electrode assembly shown in FIG. 1 and its driving means.

Referring to the drawing, there is shown apparatus for determining the pH in a liquid sample stream. The apparatus includes an inlet line 10 having a calomel reference electrode assembly 12 coupled thereto. An antimony electrode assembly, indicated generally by the numeral 14, is coupled to the sample inlet line 10, and a millivolt recorder 16 is coupled by leads 18, 20 to the calomel reference electrode and antimony electrode, respectively. A sample outlet line 21 extends from the out-

2

let of the assembly 14 to return the sample to a process stream or to waste disposed means.

The antimony electrode assembly 14 has a housing of electrically insulating material such as phenol formaldehyde, for example. The housing includes a tubular body part 22 and end plates 24, 26 which, when assembled, define an inner chamber which is generally cylindrical in configuration. A shaft 28, electrically insulated or made of electrically insulating material, such as glass, for example, disposed concentrically with respect to the inner chamber, is journaled in suitable bearing assemblies 30, 32 in the end plates 24, 26, respectively. The shaft extends through the end plate 26 whose bearing assembly 32 includes a suitable seal, and is coupled to suitable rotating drive means, such as a variable speed motor 34.

An impeller which includes a hub 36 and a plurality of more or less radially extending flexible vanes 38 is coupled to the shaft 28 within the chamber. The width of the hub and vanes is such that the impeller fits closely but slidably between the end plates 24, 26 and the length of the vanes 38 is such that they extend from the hub and bear against the wall 40 of the chamber.

The inlet line 10 and outlet line 21 are coupled through the chamber wall 40 by means of the bores 42, 44, respectively, the bores 42, 44 being spaced apart radially around the circumference of the chamber.

An antimony electrode 46 is disposed along the wall 40 of the chamber between the two bores 42, 44. The electrode 46 is, usually but not necessarily, a casting of metallic antimony which extends between the end plates 24, 26, conforms to the configuration of the wall 40 on one side and is usually flat or slightly concave on its surface which faces the shaft 28. Thus, any point on the surface 48 of the electrode 46 is closer to the shaft 28 than is the wall surface 40 of the chamber.

The vanes 38 of the impeller are flexible and may be made of any suitable material which does not chemically affect the sample stream. Neoprene is commonly used as a material from which the vanes are fabricated.

In operation, the shaft 28 is rotated by means of the variable speed motor 34, causing the impeller to rotate and the vanes 38 to sweep along the chamber wall 40 and surface 48 of the antimony electrode 46. The vanes 38, in wiping contact with the wall surface 40, are bent as they contact the antimony electrode surface 48 due to the shorter distance between the shaft and that surface. Thus, while the surface 48 is being wiped and cleaned by the moving vanes 38, the assembly 14 acts as a pump, drawing sample through the inlet line 10 and expelling it through the outlet 21.

The electrode 46 will have enough antimony oxide (Sb_2O_3) on its surface 48 to function as an oxide electrode for the measurement of the pH in the sample stream. The electrode 46 is secured in position against the wall surface 38 and electrical terminal means 50 extends through the wall of the cylindrical housing section 22.

Thus, with the lead 18 connected between the calomel reference electrode which is coupled to the sample stream and a millivolt recorder (or other suitable signal sensing means) 16 and the lead 20 connected between the terminal 50 of the cleaned antimony electrode 46 and the recorder 16, a reliable apparatus for continuously measuring the pH of a sample stream is provided.

It has been found, for example, in one test assembly, that the antimony electrode assembly produces excellent results when the impeller rotation is at a rate of 50 to 500 revolutions per minute.

In one specific example in which an electrode assembly was used, the pump rate of the assembly is 4 gallons

3

per hour of a stream having an average composition of 1.3 to 3.9 percent magnesium hydroxide and 1.13 to 0.39 percent calcium hydroxide in water. The rotation rate of the shaft which is required to achieve a 4 gallon per hour pumping rate is 72 revolutions per minute. On a three month test of operation, a pH range of 11 to 13 was recorded.

Thus, the present invention provides an improved self-cleaning antimony electrode assembly which additionally serves to pump a sample stream through the assembly. The assembly is economical to make, can be operated in any position, is rugged enough for plant usage yet has the reliability needed for laboratory work.

I claim:

1. An antimony electrode assembly adapted to be used in conjunction with a reference electrode to measure an electrolytic function of a stream which contacts both electrodes, comprising a housing having a hollow inner chamber which has cylindrical side walls and flat end walls, said walls being composed of electrically non-conductive material, a drive shaft being coaxially disposed in said housing with respect to said side walls, an impeller made of electrically nonconductive material and having a hub and an array of flexible vanes, said hub being coupled to said shaft within said chamber, said vanes extending outwardly from said hub to said side walls between said end walls, said vanes extending towards and being close spaced with respect to said end walls, an inlet means and an outlet means, said inlet means and outlet means communicating with said chamber at spaced apart locations, and an antimony electrode, said antimony electrode being disposed along and secured to said side wall between said inlet means and outlet means, said antimony electrode presenting a smooth continuous surface towards said shaft, a terminal member, said terminal member being disposed externally of said chamber, means coupled to said antimony electrode and

4

extending through said side wall for making electrical contact with said terminal, and means to rotate said shaft.

2. An assembly in accordance with claim 1, wherein said shaft extends through one of said end walls.

3. An assembly in accordance with claim 1, wherein said inlet means and outlet means communicate with the said chamber through said side walls.

4. An assembly in accordance with claim 1, wherein said impeller is made of neoprene.

5. An assembly in accordance with claim 1, wherein said shaft is made of electrically non-conductive material.

6. An assembly in accordance with claim 1, wherein said shaft is made of glass.

7. An assembly in accordance with claim 1, wherein said shaft is made of electrically conducting material and is electrically insulated from the measuring circuit.

8. An assembly in accordance with claim 1, wherein said shaft is made of metal and is electrically insulated from the measuring circuit.

9. An assembly in accordance with claim 1, wherein said antimony electrode extends along substantially the entire length distance between said cylindrical side walls and the maximum thickness dimension of said electrode is a substantial fraction of the distance between said hub and said side walls.

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