

zero voltage conditions at 23° C. and 60° C. In other words, the electrolysis reaction of methanol in the presence of KOH occurs spontaneously in the absence of an applied voltage at both temperatures. The results further indicate that application of a voltage acts to accelerate the reaction. These results indicate that appreciable rates of hydrogen production occur in the electrolysis reaction of methanol and water in the presence of KOH conducted in the testing cell at voltage magnitudes at or above 0 V at both temperatures. A rapid increase in the rate of production of hydrogen is observed above about 0.1 V and 0.3 V at 60° C. and 23° C., respectively.

[0075] This example shows that hydrogen production from the electrolysis reaction of methanol and water in the presence of KOH occurs at substantially lower voltages than hydrogen production from the electrolysis reaction of water in the presence of KOH at 23° C. and 60° C. This example also shows that an increase in temperature promotes both hydrogen production reactions.

EXAMPLE 4

[0076] In this example, the production of hydrogen from methanol in the presence of KOH with no intentional inclusion of water is demonstrated. The reaction was completed in an electrochemical cell that included an anode, a cathode, and an electrolyte solution assembled within a 250 mL beaker. The anode included 20% Pt supported on a Toray paper substrate. The geometric area of the electrode was 4.1 cm². The cathode was identical in design to the anode. The anode and cathode were separated by 5.5 cm in the electrochemical cell. The electrolyte solution consisted of a 100 mL portion of a solution formed by combining 250 mL methanol and 90 g KOH in a separate beaker. The KOH dissolved in the solution to provide hydroxide ion. The concentration of KOH in the electrolyte, expressed in molarity, is 6.4 M. The KOH was used as received from the vendor and may include adsorbed or hydrated water. No water, other than any unintentional water accompanying the KOH, was intentionally included in the electrolyte solution.

[0077] Once assembled, the electrochemical cell was tested for electrochemical activity at 38° C. and 60° C. The test protocol consisted of applying a voltage from an external source and measuring the current produced by the electrochemical reaction. When no reaction occurs, no current flows through the electrochemical cell. If the voltage is sufficient to initiate a reaction, a current develops in the cell. The greater the magnitude of the current, the greater the rate of reaction and the greater the rate of hydrogen production.

[0078] The results obtained for the electrochemical cell is provided in FIG. 4 herein which shows a plot of the current that develops in the electrochemical cell as a function of the voltage applied by an external source. Curves are shown at 38° C. and 60° C. The results shown in FIG. 4 have been corrected for the Ohmic resistance of the testing cell and comparison cell. The results show that the production of hydrogen from methanol in the presence of a base without the intentional inclusion of water in the electrolyte solution occurs at a voltage of less than 0.1 V at both temperatures. As the voltage is increased above 0.1 V, the hydrogen production reaction accelerates. Especially pronounced increases in the hydrogen production rate occur above about 0.45 V and about 0.35 V at 38° C. and 60° C., respectively.

[0079] This example shows that hydrogen production occurs through the electrolysis of methanol in the presence of KOH without the intentional inclusion of water in the electrolyte solution.

[0080] The examples and disclosure set forth hereinabove show that production of hydrogen from organic substances occurs through electrochemical reactions of organic substances in the presence of water, acid and base. The examples and disclosure set forth hereinabove also shows that the production of hydrogen from water occurs through electrochemical reactions of water in the presence of base. Bases in reactions with water or organic substances may be present at concentrations ranging from zero (e.g. reaction of methanol with water in the presence of an acid) to intermediate (e.g. reaction of methanol with KOH where KOH is present at a concentration of 6.4 M) to high (e.g. reaction of methanol and water with KOH where KOH is present at a concentration of 9 M or reaction of water with KOH where KOH is present at a concentration of 12 M). It is to be appreciated by persons in the art that other concentrations of base such as, but not limited to, 1 M, 3 M, 6 M etc. are also operative within the scope of the instant invention. Electrolyte solutions including base concentrations ranging continuously from nearly zero up to the solubility limit of the base in the electrolyte solution are among the embodiments of the instant invention. As described hereinabove, the concentration of base included in the electrolyte solution may influence the number of equivalents of hydroxide ion that react with an organic substance as well as the by-products produced in a hydrogen production reaction of an organic substance with a base.

[0081] The disclosure and discussion set forth herein is illustrative and not intended to limit the practice of the instant invention. Numerous equivalents and variations thereof are envisioned to be within the scope of the instant invention. It is the following claims, including all equivalents, in combination with the foregoing disclosure, which define the scope of the instant invention.

We claim:

1. A method for producing hydrogen gas comprising the steps of:

providing an electrolyte solution, said electrolyte solution including an organic substance, said organic substance comprising carbon;

placing said electrolyte solution in an electrochemical cell, said electrochemical cell including an anode and a cathode; and

providing a voltage between said anode and said cathode, said voltage inducing an electrochemical reaction in said electrochemical cell,

wherein said electrochemical reaction produces hydrogen gas.

2. The method of claim 1, wherein said organic substance further comprises oxygen.

3. The method of claim 1, wherein said organic substance is an alcohol.

4. The method of claim 3, wherein said alcohol is methanol.

5. The method of claim 3, wherein said alcohol is ethanol.

6. The method of claim 1, wherein said organic substance is an aldehyde or a carboxylic acid.

