

Hydrogen Energy and Environment

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Abstract

Energy consumption per capita is a kind of indication of the development for a society. Energy sources, today, are mainly fossil fuels (coal, oil and natural gas) which can cause severe environmental problems such as acid rains, global warming and climate changes. In addition to severe environmental problems, the sources of fossil fuels are finite. Because of increasing need of energy, researchers are forced to search for renewable energy sources such as hydro, biomass, wind, solar, geothermal, wave, tide and so on.

Hydrogen (H_2) seems to be more promising for a clean energy source. In fact, it is a clean energy carrier with a role to save environment. H_2 is universally accepted as a clean energy carrier because of its high energy density. It does also reduce the emission of greenhouse gases by using it as fuel in fuel cells or in combustion engines directly. For usage of H_2 as fuel, it is necessary either to compress or to liquefy it. Both processes are difficult and costly.

Metallic and nonmetallic hydrides have received considerable research interest in recent years. $NaBH_4$, is the one of the most prospective H_2 storage materials as it stores 10.8 w % hydrogen. H_2 is generated by hydrolysis reaction of $NaBH_4$ in the presence of a suitable catalyst. Another important fact with fuel cells is that one can bypass the 2nd Law of Thermodynamics.

In this paper, we will mainly review the negative effects of fossil fuels and the positive effects of fuel cells as far as environment is concerned.

Key Words: Fuel Cells, Carnot Cycle, Environmental Pollution

1. Introduction

Energy consumption per capita is a kind of indication of the development for a society. Energy sources, today, are mainly fossil fuels (coal, oil and natural gas) which can cause severe environmental problems such as acid rains, global warming and climate changes. In addition to severe environmental problems, the sources of fossil fuels are finite. Because of increasing need of energy, researchers are forced to search for renewable energy sources such as hydro, biomass, wind, solar, geothermal, wave, tide and so on.

Hydrogen (H_2) seems to be promising candidate for a clean energy source. In fact, it is a clean energy carrier with a role to save environment. H_2 is universally accepted as a clean energy carrier because of its high energy density. It does also reduce the emission of greenhouse gases by using it as fuel in fuel cells or in combustion engines directly.

Hydrogen energy is clean energy end no environmental problem. Fossil fuels, however, produce air pollutants and greenhouse gases. Therefore the usage of fossil fuel must be minimized.

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The main drawbacks of the fossil fuels are multi-fold:

- 1) They are in limited amount on the globe, and in the next 50 years they will, most likely, be depleted.
- 2) They also contain S- and N- heterocompounds which are eventually converted to SO₂ and NO_x acid gases upon burning. These gases are then converted SO₃ and NO₂ in the atmosphere. These gases react with H₂O vapor in the atmosphere and are converted to H₂SO₄ and HNO₃, respectively. At the end, these acids precipitate as so- called acid rains. Acid rains are not only disaster for human beings, animals and plants they are also disaster for environment.
- 3) Generation of CO₂ upon burning of fossil fuels. CO₂ is the main contributor of the greenhouse gases, which cause global warming, and climate changes [1, 2].

As can be seen from the above discussions that fossil fuels are not environmentally friendly due to SO₂, NO_x and CO₂ gas generations after burning.

Acid rain by itself is an important issue. Here we will be focusing on “*the effect of CO₂ on the global warming and climate change, and how to minimize CO₂ emission to atmosphere*” by means of chemical reactions and physical processes [3-5].

Greenhouse gases, global warming and climate change, and to meet the Kyoto Protocol what kind of actions to be taken should be considered at the very first step when dealing with energy

2. Remedy

Since all the fossil fuels eventually produce CO₂, the usage of them must be minimized if not totally eliminated. For this reason alternative energy sources must be sought.

Fossil fuels have been powering the industrial development. But these fossil fuels have undesirable side effects, namely pollution and global warming. The environmental pollution has reached such high levels that it became a serious threat to plant, wild life, and human health. For example, air pollution causes asthma and cancer as well as some other serious diseases.

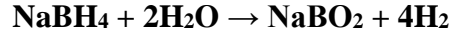
The technology of renewable energy must be improved so that the percentage of renewable energy in the total energy consumption is increased. Solar, wind, geothermal as well as biomass are becoming extremely promising. Especially H₂ energy is recently attracting more attention than ever before.

3. Hydrogen (H₂) Energy

Hydrogen is universally accepted as a clean energy because of its high energy density, and reduces the emission of greenhouse gases by using it as fuel in fuel cells or in engines directly.

Technically, using hydrogen as fuel, it is necessary either to compress the gas to a small volume or to liquefy it. Both processes are difficult and costly owing to the chemical and physical properties

of hydrogen. Compared with these traditional hydrogen storage processes, metallic and nonmetallic hydrides have also received considerable research interest in recent years. NaBH₄, is the one of the most prospective hydrogen storage materials as it stores 10.8 % hydrogen. In addition to its high hydrogen storage capability, it is also nonflammable, non-toxic in nature and stable in alkaline solution. Hydrogen is generated by the following hydrolysis reaction of NaBH₄ in the presence of a suitable catalyst:



As can be seen, half of the hydrogen produced comes from the water which is a great advantage and make it effective on-board hydrogen generation method for portable PEM fuel cells applications. The reaction product, borate, is environmentally clean and can be recycled for the further production of NaBH₄.

If we use H₂ in fuel cell, we can bypass the 2nd law of thermodynamics where the efficiency is limited by Sadi Carnot Cycle [6]. With that, not only we will have a clean environment, the efficiency is much higher as compared to conventional mode. That is in conventional mode

Chemical Energy → Heat energy → Mechanical Energy → Electrical Energy

There are, as can be seen, a few intermediate steps, hence lower efficiencies.

By using fuel cell, however, it is possible to convert the chemical energy directly into electrical energy

Chemical Energy → Electrical Energy

In this case, *Carnot Cycle Limitations* are by-passed. For this reason, the future of fuel cells is very bright and H₂-economy will probably dominate in near future.

4. Conclusions

- a. Use of more efficient fossil fuel cycles and cogeneration system in electricity production is inevitable. .
- b. We should understand that climate change is not local, but a global problem.
- c. Nowadays, intensive studies have been carried out on hydrogen energy. If some problems in hydrogen technology overcome, many things will change in our life. Hydrogen will replace petroleum. By using hydrogen in fuel cell, electric energy can be produced with high efficiency up to 60 % (with cogeneration, this goes to 80 %).

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