

Fossil Fuels And Their Effects On Environment, Global Warming And Climate Changes

Selahattin Gültekin

Üsküdar University, Faculty of Engineering and Natural Sciences
Department of Bioengineering, Istanbul-TURKEY (sgultekin@uskudar.edu.tr)

Abstract

Energy is the most important commodity in modern society. The development of a country is measured in terms of energy consumption per capita.

Today's energy is mostly obtained from fossil fuels. Only a small fraction is obtained from renewable energy sources which are fairly clean, environmentally friendly and sustainable. Efforts to increase the percentages of renewable energy in the total consumption are the main concern in the universities and energy research laboratories.

The main drawbacks of the fossil fuels are multi-fold: a) They are in limited amount on the globe. b) Contain S- and N- heterocompounds which are eventually converted to SO_2 and NO_x acid gases upon burning. c) Generation of CO_2 upon burning. CO_2 is the main contributor of the greenhouse gases causing global warming, and climate changes.

Here we are focusing on the effect of CO_2 on the global warming and climate changes . Hydrogen energy will also be emphasized.

Key words: Greenhouse gases, renewable energy, hydrogen energy, environment protection, acid rain

1. Introduction

Energy is fundamental demand of our lives. In other words, energy is the most important commodity in modern Society. The development of a country is measured in terms of energy consumption per capita.

Humanity is very dependent on an abundant supply of energy for living and working. Therefore, energy is a key ingredient in all sectors of modern economies, and it is a sign of power of a country.

The conversion of energy from one form to another often affects the environment and the air we breathe in many ways, and thus the study of energy is not complete without considering its impact on the environment [1]

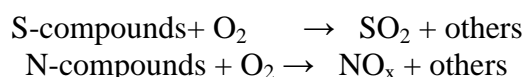
The environmental pollution has reached such high levels that it became a serious threat to plant, wild life, and human health. For example, air pollution causes asthma and cancer as well as some other serious diseases. The largest source of air pollution is the motor vehicles, which have a big part of our lives. Air pollution affects the ozone layer, the oxygen and carbon dioxide cycle. The other serious pollutant in air is carbon monoxide. It is more hazardous than carbon dioxide because it can bind with the red blood cells of the human and it affects human organs, especially the brain.

Today's energy is mostly obtained from fossil fuels (coal, crude oil, natural gas). Only a small fraction is obtained from renewable energy sources (solar, wind, hydro, geothermal, biomass,

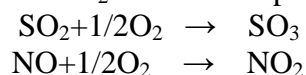
waves, tides, etc.). Renewable energy sources are fairly clean, environmentally friendly and sustainable. Therefore, the efforts to increase the percentages of renewable energy in the total consumption are the main concern in the universities and energy research laboratories in all over the world.

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 according to the following simple reactions:



These gases are then converted SO₃ and NO₂ in the atmosphere with the following reactions:



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 disaster for the whole 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 [2, 3].

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

Acid rain by itself is an important issue and to be tackled in another paper. 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 [4-6]. Hydrogen energy will also be emphasized too.

2. Fossil Fuels and Greenhouse Effects

Any carbon containing organic compound upon burning will generate CO₂. For example, natural gas (mainly CH₄) upon burning will generate CO₂ and H₂O according to the following reaction



This CO₂ in the atmosphere together with other greenhouse gases will form a blanket which will trap the low frequency (high wave length) rays close to the surface of earth, hence will increase the temperature of the earth. CO₂ increase in atmosphere in terms of ppm over the years is given in the **Figure 1**. As can be seen, CO₂ amount is increasing significantly. If no precaution is taken the temperature of atmosphere will rise to a point at which the ice in the poles will melt and most of the islands and seashores will be flooded with water. 78 island countries are under the danger of being submerged including Malta Island. It is certain that *Netherlands* will be submerged. The other coast countries would more or less face to this danger. Unfortunately, the beautiful city Istanbul is going to be one of them. At the same time climate changes will take place as well. In either case, the result is disaster.

Figure 2 represents this temperature increase very nicely.

Due to this global warming and climate changes, the emission of greenhouse gases must be minimized if we are going to leave a livable environment for the coming generations.

3. 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.

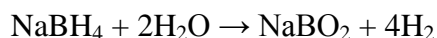
The technology of renewable energy must be improved so that the percentage of renewable energy in the total energy consumption is increased. Solar, wind, geothermal as well as biomass are becoming extremely promising not only in Turkey, but also in the whole world. Figure 3 shows the percentages of source of energy consumed.

The other problem to human life is direct sunlight. The thickness of ozone layer gets thinner and thinner recently. The infrared radiation emitted back to atmosphere by the surface of earth is trapped in the atmosphere, which results in the global warming by means of greenhouse effect.

4. 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 [7]. 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.

5. Conclusions

- a. Humankind should focus on energy saving.
- b. Nevertheless use of more efficient fossil fuel cycles and cogeneration system in electricity production is inevitable.
- c. Besides the role of renewable and other alternative energy sources should be increased. Rearranging transportation and inner city traffic systems in order to minimize fuel consumption, giving importance to public railway transportation, intercity load and passenger transportation is a must.
- d. Looking after forests and admitting afforesting as a main responsibility by everyone.
- e. We should understand that climate change is not local, but a global problem.
- f. 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 %).

References

- [1] Hansen, J., Sato, M., Ruedy, R., Lacis, A. and Oinas, V., "Global warming in 21. Century: An Alternative scenario", *Proc. Natl. Acad. Sci.*, 1997, 9875-9880
- [2] Halmann, M.M. and Steinberg, M., "Greenhouse gas carbon dioxide mitigation: Science and Technology", Lewis, Publishers, Boca Raton, 1999
- [3] <http://www.hurr,yet.com.tr/dunya/13255327.asp?gid=200> (Access date: 19.12.2009)
- [4] Herzog, H. J. and Drake, E.M., Carbon dioxide recovery and disposal from large energy systems, *Annual Review of Energy and Environment*, 21, 1996 , 145-166,.
- [5] Bachu, S., Sequestration of CO₂ in geological media: criteria and approach for site selection in response to climate change energy *Con. Manna.*, 41, 2000, 953-970,.
- [6] Gentzis, T., Subsurface sequestration of carbon dioxide-an overview from an Alberta (Canada) perspective, *Int. J. Coa Geol.*, 43, 2000, 287-305,.
- [7] Çengel, Y., Boles, M.A., Thermodynamics: An Engineering Approach, 6E, McGraw-Hill, 2011

FIGURES and CAPTIONS (Selahattin Gültekin, Paper No. 127)

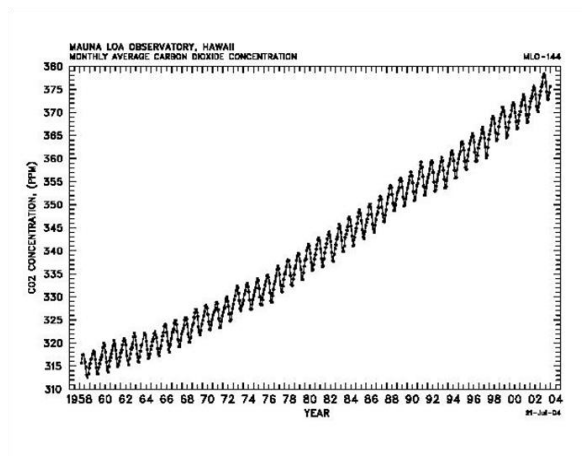


Figure 1. CO₂ Concentration in Atmosphere over The Years

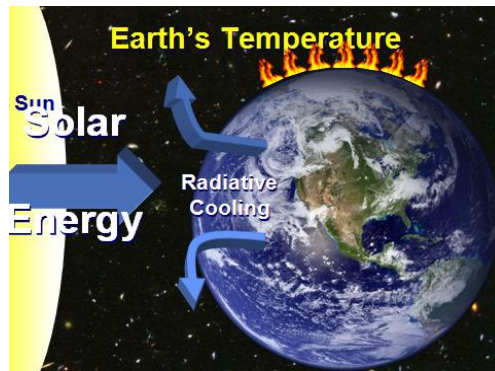


Figure 2. Representing Temperature Increase on Earth

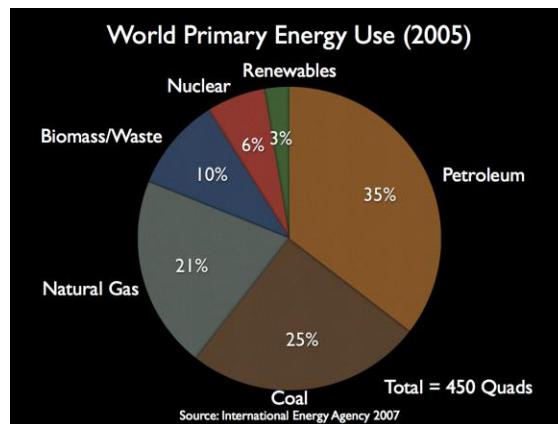


Figure 3. Percentages of Source of Energy Consumed