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WHAT SHALL WE DO WITH THE CARBON-DIOXIDE ?

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ABSTRACT. As a consequence of rising CO2 level in the atmosphere the temperature on the surface of the Earth is rising (Global warming). The CO2 level is around 385 ppm (v) nowadays and still increasing. The two main reasons are: power plants using coal, oil or gas, and the growing number of cars. The possibility of capture and storage of CO2 (CCS – Carbon Capture and Storage) has been studied. Scientists agree we have to stop the rising level of CO2 at around 450-500 ppm (v). We may use natural (photosynthesis) or industrial processes. We have the following industrial possibilities: new technologies using less energy, nuclear energy, renewable energy (solar, wind, power wood), CCS (deep ocean, depleted oil-gas reservoirs), methanol economy. In this presentation the selected methods of CCS will be discussed.

Keywords: global warming, CO2, greenhouse effect, carbon capture and storage, methanol economy

INTRODUCTION

One of the most important environmental problems of our age is the increasing level of Carbon-dioxide (CO2) in the atmosphere and the global warming.

The global warming is caused by several gases (namely: CH_4, CO2, NOX, O3). Scientists agree that the CO2 is responsible for the above mentioned greenhouse effect in two-thirds part. We are using fossil fuels nowadays causing the anthropogenic emission of CO2 in four-fifths part. A very interesting data: as much fossil fuel is burned in a year as it was formed earlier over a million year.

The water in the oceans (water 93%) and the solid surface of the Earth (land 5%) can absorb the CO2 so it remains only 2% increase in the air. Water and the soil become saturated so the CO2 increases in the air increasing the greenhouse effect.

The next figure e shows the CO2 emission of some countries between 1990 and 2005.

As the figure shows the average emission is increasing by more than 13 % - do not forget the Rio Conference was held in 1992 (Agenda 21) and the Kyoto Convention was done in 1973 (Revised Kyoto Convention, 1999) respectively. The situation is getting to be worse and worse. In the air the concentration of CO2 was 280 ppm (v/v) in 1800, today the same figure is 380-385 ppm (v/v). Scientists are agreed the level of carbon dioxide in the air should be stabilized at 450-500 ppm (v/v) by 2050.

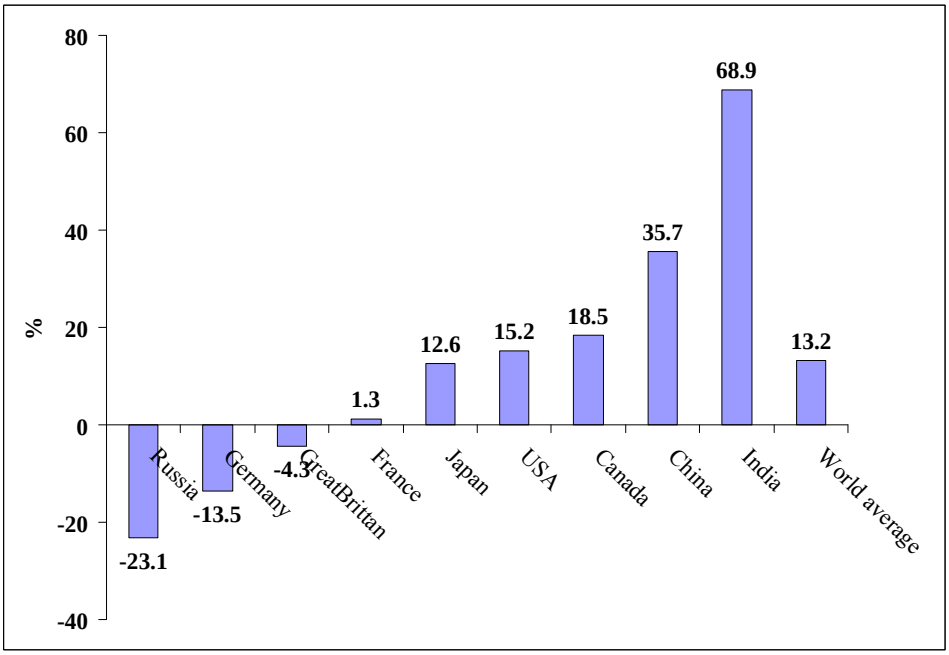

Fig. 1 Change of CO2 emission (1990-2005)

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RESULTS AND DISCUSSIONS

The possibilities of the reduction of carbon dioxide level are well-known:

- new technologies using less energy (modernization)
- non fossil-based energy production (nuclear energy, renewable sources)
- capture of CO_2 from exhaust gases
- storage of CO_2 (Carbon Capture and Storage CCS technology)
- usage of CO_2 (e.g.: methanol economy)
- power plants using CC technology

In this article we will discuss only several possibilities.

The Combined Cycle Power Plants use oxygen instead of air to burn the fossil fuels. In this case the exhaust gas contains 95 % of CO_2 and we can recycle it to the power plant as an oxygen resource. We have to capture the extra CO_2 from the exhaust gas. Unfortunately when using this technology the efficiency decreases, the quantity of the fossil fuel increases and the price of the electricity produced using this method increases as well, but at the same time the quantity of CO_2 decreases.

It seems to us the most of all elaborated technique is the capture of CO_2 from exhaust gases (for example at power plants) and the storage of it underground. First we may apply an absorption technique using mono-ethanol-amine (MEA) and water. We will get the CO_2 in an amine-carbonate. In the second step we can recover the CO_2 at elevated temperature using steam. Unfortunately the efficiency of the power plant decrease by 6-8 % and the price of the electricity will be increased by 30%.

The recovered CO_2 can be stored in depleted oil and gas reservoirs but we have to do it very carefully (for example the reservoir should be able to store surely and it should be earthquake-proof).

If we would use this solution at every power plant in the world the decrease of the CO_2 level would be 40-50% in the air.

Nowadays we are planning this technology in Hungary as well. According to the plan the CO_2 of the Gyöngyös Power Plant will be transferred to Tiszafüred and Kunmadaras and then it will be stored in depleted gas reservoirs.

There is a similar possibility to store the liquefied CO2 in deep sea. The surface of the oceans and seas are saturated with CO2 but the deeper layers are not. According to experts we have to press the liquidities CO2 at least 3000 m under the surface because it can't get to the surface too fast. There is another problem as well. Nowadays the pH in the oceans and seas is 7.6-8 unfortunately gradually decreases because of the CO_2. If we put CO_2 to the depth as a gigantic liquid drop the surrounding water will be acidified and the pH may drop to pH=5, which will be harmful to the living creatures of the oceans. According to the opinion of scientists the food chain will break off and at the end the quantity of the fishes will decrease. Of course the technique to pump CO_2 to the depth is very difficult and expensive as well.

Perhaps a better solution, if we add limestone chips to the carbon dioxide. CO_2 will be fixed and the pH will be stable as well.

There are under water depleted oil and gas reservoirs. It seems a safer solution if we press the CO_2 to this layer, but there are only a few possibilities to do this.

Another interesting solution is the use of peridotite. Peridotite is a basic mineral and it can capture the CO_2. If we drill holes into the peridotite and CO_2 will be pumped together with warm water, limestone will be formed from the peridotite and CO_2. This mineral is frequent enough in the world especially in Oman and the Balkans. It should be a remarkable solution because the 1/8th of whole CO_2 production can be captured via this way.

At the end there is one more good possibility so called methanol economy by György Oláh (he was awarded Nobel Prize in chemistry). He and his group suggest forming the CO_2 to methanol as a storing form. The technique isn't simple but well worked up. At first we have to capture the CO_2 form exhaust gases of the power plants following the catalytic hydrogenation of the CO_2 producing methanol.

Methanol economy gives another possibility using the Olah's methanol fuel cell in reverse mode. In this case we use CO_2-water mixture and we can reduce the CO_2 to methanol on electro-catalytic way. We can store the methanol easily. The methanol can be used as a fuel in electric cells and in regular engines too. This can be able to replace the fossil fuels (oil and gas) and we can use to synthesize organic compounds. In this way we can get a good energy resource, meanwhile we are able to regulate the CO_2 level in the air. Unfortunately the procedure is energy consuming. Olah suggests using nuclear energy but solar energy seems to be a better solution of the future. If we can increase the efficiency of the solar cells over 10% it will be economical to build a solar cell power plant in the Sahara and it can supply electricity for the all world.

CONCLUSIONS

We have several possibilities to regulate CO_2 level in the atmosphere but all of them are expensive. The developed countries are not ready to pay the price because they don't want to give up their standard of living. We have to find the solution very soon because the global warming can cause a lot of problems in the world.

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