Interview with Mr. Zhigang Zou

Q1: Great progress has been made in terms of water photolysis, thanks to the joint effort of scientists like you. What problems do you think remain unsolved in basic scientific research? Is there any possibility that we can make some breakthroughs in some aspects?

Q2: Utilization of hydrogen energy hasn't been popularized worldwide yet, despite some small-scale attempts. What are the obstacles that prevent the large-scale application of hydrogen energy? What should scientists do to reverse the tide?

After the answer form Professor Yao Yingfang and Yu Zhentao, Professor Zou Zhigang made a wrap-up description explaining the above two question as well as the current development of hydrogen energy. The summary is recorded below:

First why do we pay attention to the development of hydrogen energy? Why do we choose hydrogen? This is in fact due to hydrogen's high heating value and it is a sort of green energy under low temperature. Currently our country is developing the 4^{th} generation of nuclear power. In this generator, nuclear power is first converted into electricity then electricity is used to split water into hydrogen. Eventually energy is transported in the form of hydrogen produced in electrolysis. Hydrogen is mainly consumed through fuel cells.

Why is hydrogen not utilized through combustion? This is because hydrogen can produce a large amount of heat in combustion and under a high temperature, hydrogen is likely to from compounds with sulfur and nitrogen in the air thus making it dirty. Then why is hydrogen not directly consumed in engines that employ hydrogen as fuels? This is because all heat engines rely on Carnot Circle, which will limit the efficiency of energy transformation. Nonetheless hydrogen fuel cells do not need high temperature, needless to say Carnot Circles. Therefore having a much higher efficiency, fuel cells are the real zero-emission machines and perfect device to utilize hydrogen.

As for the source of hydrogen, in an ultimate goal, certainly we hope that hydrogen can be produced from renewable energies, for instance, wind or solar power. However due to current restrictions, this is now impossible to achieve. Some time ago the U.S. department of energy has recognized three source of hydrogen, namely petroleum and natural gas, photolysis or electrolysis of water, and bio-hydrogen. Thus our laboratory hopes to do some work about biological hydrogen production.

Then what prevents hydrogen from large-scale applications? First we should understand what sections occur in hydrogen utilization. Hydrogen is produced, transported, stored and utilized; in each section some obstacles remain.

In the production section, cost levels are high. In California, the cost to produce 1 kilogram of hydrogen marks $10; however the most ideal cost we desire would be $2 per kilogram. Only at this price does hydrogen obtain the competence against fossil fuels. But in fact when environmental

cost is taken into account, $5 per kilogram would be enough for mass production. Thus cost is the limiting factor that prevents hydrogen from large-scale application. Currently Japan has been using left over lignite by Australian coal industry to produce hydrogen. Lignite, which has no actual value in use, is a companion mineral with coal in coalmines. Thus producing hydrogen from lignite would greatly reduce the cost.

Concerning the transportation section, Americans have built “hydrogen highways” to transport hydrogen through existing natural gas tubes. Japan has no domestic natural gas thus have abandoned this plan. Their hydrogen is carried in existing method that is used to transport liquefied petroleum gas (LPG). China plans to solve this problem through compressed hydrogen. However the problem in transportation remains to be solved.

Speaking of hydrogen storage, currently we tend to use hydrogen storage materials such as metals. The advantage of these materials is that they are relatively safe; nevertheless, the disadvantage is that none of these materials can achieve a satisfying high storage rate. That is, an overwhelming mass of storage material will be consumed to keep certain amount of hydrogen. It is known that gases like hydrogen are stored in metal cylinders according to traditional methods. However hydrogen molecule are quite small which can squeeze out metal lattices causing hydrogen embrittlement, which leads to leakage and possible danger. Carbon fiber materials do not have this problem. It is now under development.

As for the usage of hydrogen, that few hydrogen gas stations are built locks a main bottleneck. We hope that hydrogen can replace gasoline but if hydrogen changes our existing life style too much, also it is never conducive to its application. Therefore we need more hydrogen gas stations just like gasoline. Japan has produced a hydrogen-based car named 『the future』, priced at $70,000 and it will sell $50,000 with subsides from government. However you cannot run this car in China, as we do not have hydrogen gas stations. Meanwhile it required a great deal of time to fill fuel cells with hydrogen, which further restricted the application of hydrogen energy.

The human history is a history of the development of energy; and the development of energy is actually an increase in energy density. So hydrogen will suit the progress of eras and will eventually replace fossil fuels, as a current substitutive energy form with enough energy density. And this energy form will not be in use AFTER the drying up of fossil fuels; it will be in use BEFORE this drying up. Just as I have mentioned, “The stone age have gone however the stone still stands”. The application of hydrogen suits the progress of the time, and this is destined. But when taking a further view, hydrogen can only replace petroleum in fifty to one hundred years. It is not likely to happen in a short term owing to the problems mentioned above. Hydrogen can alternate the unstable power supply from sun and wind to a relatively more stable form in the chemical potential of hydrogen. This is the advantage for hydrogen as a more stable form of energy.

We teachers are like evangelists and ministers; we hope that there will be more young people joining our work. We are so glad to see young people like you doing our jobs. Only when we have young researchers joining our team does our work has hope and bright future.