Ammonia combustion for a decarbonized society

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Global warming is one of the most serious problems in the world as of the 21st century. Climate changes caused by global warming can affect people all over the world. Rising atmospheric temperatures increase the amount of water evaporation from the sea, which results in heavy rainfall and forming powerful typhoons. Floods caused by such typhoons can damage human life and societies. For example, Typhoon Hagibis, which hit Eastern Japan in October 2019, resulting in 107 deaths and causing more than one trillion yen in damage, even led to the cancellation of several matches in the Rugby World Cup. Recovering from these damages cost a huge amount of money and time.

In order to stop global warming, we must turn our society into carbon-free society or a society without net carbon dioxide (CO_2) emissions. This transition is necessary because the main cause of global warming is excess CO_2 produced by human activities. We get a lot of energy by combusting fossil fuels, such as oil or coal, which emits a huge amount of CO_2. The amount of CO_2 has been increasing since the Industrial Revolution. CO_2 and other greenhouse gases trap some of the heat that may have escaped from the earth otherwise. As a result, increasing the concentration of atmospheric CO_2 raises the atmospheric temperature. In fact, the 40% of CO_2 in the atmosphere has been emitted by human beings for the past 200 years, and the atmospheric temperature had risen by 0.8 degrees Celsius during the 20th century. Thus, we must reduce CO_2 emissions by finding alternatives to fossil fuels to prevent global warming.

Currently, there are a few candidates for alternative sources of energy. Renewable energy is one of the most important ones because it does not emit CO_2 or pollutants. However, one disadvantage is that renewable energy sources such as wind, wave or sunlight are not stable. Solar power plants, for example, cannot generate electricity efficiently without sunlight. Their efficiency therefore depends on the weather. We have to develop a reliable system to store the generated energy to conquer this weakness. Hydrogen is one substance can possibly store such energy. We can produce hydrogen from renewable energy via the electrolysis of water and get energy by burning hydrogen. This process does not emit CO_2. However, since the boiling temperature of hydrogen is -253°C, storage and transport of hydrogen requires very low temperatures or very high pressures. Achieving these conditions would cost a lot of money and energy. It is thus difficult to use only hydrogen itself instead of fossil fuels.

Recent studies have showed that ammonia may be able to be the most promising alternative fuel. A lot of merits come from using ammonia instead of fossil fuels. Combusting ammonia does not create CO_2 because there is no carbon in ammonia. Ammonia also has an advantage, in that it is easier to treat than hydrogen, since ammonia has a higher boiling point of -33°C. This property means ammonia can be carried or stored easier in its liquid form than in its gaseous form. As opposed to renewable energy, combusting ammonia has the potential to provide stable electricity. Nevertheless, stabilizing ammonia combustion is difficult because of ammonia's low flammability. Recently, however, some studies have proven that ammonia air flame can be stabilized, and a research group succeeded in the stable combustion of liquid ammonia spray (Okafor, et al. 2021). This achievement may allow us to generate

electricity using ammonia with minimal changes to the existing gas turbines. That would ultimately contribute to the realization of an electricity generation system using ammonia.

It is important to acknowledge that using ammonia may not be the best solution for global warming. There are some challenges in using ammonia as a fuel. For example, combusting ammonia also emits harmful pollutants such as nitrogen oxides (NOx). Recent studies have proposed and tested some ways to reduce the pollutants and have got positive results. Producing ammonia is also a big problem. In the current methods, ammonia is produced by combining hydrogen from natural gas or lignite and nitrogen from air. A substantial amount of CO_2 is emitted during this process. Of course, we can decrease CO_2 emissions by producing hydrogen using renewable energy. However, the conventional way to synthesize ammonia requires a steady supply of hydrogen. Renewable energy cannot produce hydrogen constantly because of the fluctuations in energy production. Some researchers have tested a new catalyst, which may enable us to synthesize ammonia efficiently even when the hydrogen supply fluctuates.

Despite these challenges, I think the idea of combusting ammonia to generate energy is worth considering and researching on because of its above-mentioned benefits. Of course, a more cost-effective strategy might be proposed in the future. However, if another viable way to accomplish a carbon-free society arises, we can combine these methods or choose better approach for our society. We should continue making efforts to develop methods to create energy without emitting CO_2. If such technology were to be developed and applied, we could live more comfortable lives consuming energy without worrying about the CO_2 emissions.

References

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