論説 Commentary

Let's talk more about chemistry: the Haber and Bosch story

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Einstein's fame as one of the 20th century's greatest figures

Things are not always well known simply because they are important. There are many things that go left unknown, despite being interesting. Such things are especially abundant in the scientific field.

By any measure, the gap seems too large. That is how I keenly feel especially when I think about the Haber-Bosch process, which has saved human beings from hunger by fixing nitrogen in the air. The achievement does not need to be re-emphasized here. No one would deny that it is one of the 20th century's greatest achievements in the field of chemistry. Despite this, it remains almost unknown.

Albert Einstein is one of the 20th century's greatest physicists. TIME magazine selected him as one of the great lives of the 20th century. This U.S. magazine has also selected the Time 100: The Most Important People of the Century. If we look at the scientific field, other physicists such as Enrico Fermi and William Bradford Shockley, one bacteriologist, Alexander Fleming, two molecular biologists, James Dewey Watson and Francis Harry Compton Crick are included in the Top 100 list of the 20th century. In the chemical field, Leo Hendrik Baekeland known as "the father of plastics" is the only one included in the list. TIME's selection shows a visible bias for American greats, and some people might wonder why the inventor of nylon Wallace Hume Carothers is not included in the list.

For your reference, The Asahi Shimbun 100: The Most Important People of the 20th Century includes Wallace Hume Carothers as the only one chemist selected, while also including several physicists such as Albert Einstein, J. Robert Oppenheimer, and Hideki Yukawa.

It would be no surprise if Fritz Haber and/or Carl Bosch were supposed to be included in such a list.

I started to think about this when I was assigned to write a book review of Taiki wo Kaeru Renkin-jyutsu, Misuzu Shobo, May 2010 (The Japanese translation of *The Alchemy of Air: A Jewish Genius, a Doomed Tycoon, and the Scientific Discovery That Fed the World but Fueled the Rise of Hitler*, Crown, September 2008). As indicated by its Japanese subtitle "Haber, Bosch to Kagaku no Seiki" (which could be literally re-translated as "Haber, Bosch and the Century of Chemistry"), this book describes the two struggling chemists, with its focus on Bosch, who has been little known thus far. The author Thomas Hager received his master's degree in bacteriology and immunology, and has subsequently become a US-based science writer specializing in medical fields.

As several daily papers other than The Asahi Shimbun also included this book in their book review columns, a lot of people might take notice. It is an apparently unspectacular book but attracts a high level of interest.

Dr. Hideki Shirakawa offered a commentary on the text, beginning with the following comment: "Nitrogen is one of the indispensable elements that support life, but I am afraid that this fact is not well recognized." Needless to say, nitrogen is an essential element for life as it is indispensable to the formation of DNA, amino acids, and protein, just to name a few. However, we cannot help but recognize that nitrogen does not come up in our conversation in the context of life activities as frequently as either water or oxygen. It might be associated with suffocation rather than life.

This book characteristically focuses on nitrogen as an essential element for life and describes the achievements of Haber and Bosch in the context of an epic story like the history of the terrestrial civilization.

Half of the nitrogen within our bodies comes from factories

Although nitrogen is common and abundant, accounting for approximately 80% of the content of air, its existence is extremely intriguing if we look at it in a way that is described in the abovementioned book. It can be used as a raw material for gunpowder, while also nurturing life. History tells us that Western counties, with their survival at stake, had competed for a source of nitrogen, initially guano and then Chile saltpeter after guano was completely depleted.

The Haber-Bosch process quickly made Chile saltpeter unnecessary and thus substantially changed the fate of human beings. In the current era, fixed nitrogen is produced in factories with its annual production volume being almost the same as that of naturally-fixed nitrogen by means of root nodule bacteria and the like. It is surprising to know that half of our nitrogen, which is one component of our body, comes from factories. This means that half of the human population could not exist if it were not for artificially-fixed nitrogen.

I visited the Atacama Desert in Chile this summer. The purpose of my visit was to tour the Atacama Large Millimeter/submillimeter Array (ALMA), an international astronomy facility under construction through a partnership of the National Astronomical Observatory of Japan and its counterparts in the U.S. and Europe. The construction site is located at a high altitude of about 5,000 meters above sea level and about 300 km south of a Chile saltpeter locality near the national border with Peru. In the early 20th century, the Atacama Desert faded from the world's limelight with the advent of the Haber-Bosch process. Now, a century later, the desert is about to take center stage again, but this time as a cutting-edge astronomical observation station. I sensed a mysterious link, and asked my local guide about Chile saltpeter. She said, "Nowadays, there are very few saltpeter factories. Most of them vanished due to the Germans."

Back then, the achievements of the two Germans must have

caused considerable hardship for Chileans. I wonder whether Chileans at the time also keenly felt any big influence of chemistry.

The nitrogen cycle will be a challenge over the coming years

At the end of the above-mentioned book, the author tells a story about nitrogen, drawing attention to an emerging challenge to which people have started to pay long-awaited attention, and the challenge is the nitrogen cycle in the Earth's environment. He points out the possibility of distorted ecosystems caused by the nitrogen cycle: First, fixed nitrogen is scattered over fields as a fertilizer. Then the nitrogen flows into rivers and seas in the form of nitrate salt, which could eventually distort ecosystems. As a matter of fact, studies on how nitrogen moves, or its cycle in the environment, have just started.

The 2010 Japan Prize was awarded to Prof. Peter Vitousek, a pioneer researcher on the nitrogen cycle and Professor of Biology at Stanford University. Still fresh in my mind, Prof. Vitousek emphasized the importance of this new challenge that has been of not much interest to anyone thus far in his acceptance speech.

According to the publisher, Misuzu Shobo, the above-mentioned book has been read by a wide range of readers whose interests are not confined to the life of scientists but vary from environmental issues to innovation, etc. This suggests that even the general public can be interested in science or chemistry if it is well presented as an interesting story.

Chemists should be more sensitively aware of the fact that the two chemists Haber and Bosch are little known despite the substantial impacts of their achievements on human beings.

Knowledge of significant contributions is the first step

Why is the Haber-Bosch process so unknown despite being described in a half page of chemistry textbooks for senior high school students?

Fritz Haber, as a German Jew, was aware that he had to show his loyalty to the country to such an extreme that he was also involved in the development of chlorine-based poisonous gas weapons, which made him also known as the "father of chemical warfare." For this reason, the international community opposed his winning the Nobel Prize. In spite of his tycoon status as head of his own company, Carl Bosch was also continuously struck with remorse because his achievements eventually helped the German war effort.

It was a speech by the President of the Royal Society (based in the UK) in the late 19th century that first inspired scientists to achieve the fixing of nitrogen. And yet for each of the two achievers, later life brought little happiness, partly because the Haber-Bosch process was haunted by memories of the war due to its historical background. This could be one reason why Haber and Bosch have hardly been recognized as heroes in the chemistry community.

In addition, people are generally unfamiliar with the field of chemistry itself and have difficulty in understanding it. We could also point out that the larger the achievement, the more common it becomes as a part of daily life, and consequently ordinary people become less aware of its existence. The Haber-Bosch process is a typical case of this cause and effect. In the meantime, many chemists might have given up their hopes or become introspected as they tend to be accused of being the villain of pollution and other problems.

Nevertheless, it is extremely important to know about the benefits and impacts of chemical achievements such as the fixing of nitrogen. Such knowledge is essential for us human beings when considering the population problem and the future of the Earth as our own problems and to select our future course. Besides, expectations for chemistry in the future will be raised only after the significant contributions of chemistry are understood. We should not resign ourselves to the current situation where chemistry is not understood.

I consider it essential to educate people more and more about chemistry in the same way that stories about physics, including the merits and demerits, are told.

The commentary shown here is written by a commentator invited by the Commentary Committee of the Society, and the author is basically responsible for the contents. The Society acknowledges that this is important and worth publishing. Opinions and comments of the readers are highly appreciated.
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