Overview of the Haber-Bosch Process

Some Consider the Haber-Bosch Process Reponsibile for World Population Growth

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The Haber-Bosch process is a process that fixes nitrogen with hydrogen to produce ammonia - a critical part in the manufacture of plant fertilizers. The process was developed in the early 1900s by Fritz Haber and was later modified to become an industrial process to make fertilizers by Carl Bosch. The Haber-Bosch process is considered by many scientists and scholars as one of the most important technological advances of the 20th century.

The Haber-Bosch process is extremely important because it was the first processes developed that allowed people to mass-produce plant fertilizers due to the production of ammonia. It was also one of the first industrial processes developed to use high pressure to create a chemical reaction (Rae-Dupree, 2011). This made it possible for farmers to grow more food, which in turn made it possible for agriculture to support a larger population. Many consider the Haber-Bosch process to be responsible for the Earth's current population explosion as "approximately half of the protein in today's humans originated with nitrogen fixed through the Haber-Bosch process" (Rae-Dupree, 2011).

History and Development of the Haber-Bosch Process

By the period of industrialization the human population had grown considerably and as a result there was a need to increase grain production and agriculture started in new areas like Russia, the Americas and Australia (Morrison, 2001). In order to make crops more productive in these and other areas farmers began to look for ways to add nitrogen to the soil and the use of manure and later guano and fossil nitrate grew.

In the late 1800's and early 1900's scientists, mainly chemists, began looking for ways to develop fertilizers by artificially fixing nitrogen the way legumes do in their roots. On July 2, 1909 Fritz Haber produced a continuous flow of liquid ammonia from hydrogen and nitrogen gases that were fed into a hot, pressurized iron tube over an osmium metal catalyst (Morrison, 2001). It was the first time anyone was able to develop ammonia in this manner.

Later Carl Bosch, a metallurgist and engineer, worked to perfect this process of ammonia synthesis so that it could be used on a world-wide scale. In 1912 construction of a plant with a commercial production capacity began at Oppau, Germany. The plant was capable of producing a ton of liquid ammonia in five hours and by 1914 the plant was producing 20 tons of usable nitrogen per day (Morrison, 2001).

With the start of World War I production of nitrogen for fertilizers at the plant stopped and manufacturing switched to that of explosives for trench warfare. A second plant later opened in Saxony, Germany to support the war effort. At the end of the war both plants went back to producing fertilizers.

How the Haber-Bosch Process Works

The process works today much like it originally did by using extremely high pressure to force a chemical reaction. It works by fixing nitrogen from the air with hydrogen from natural gas to produce ammonia (diagram). The process must use high pressure because nitrogen molecules are held together with strong triple bonds. The Haber-Bosch process uses a catalyst or container made of iron or ruthenium with an inside temperature of over 800°F (426°C) and a pressure of around 200 atmospheres to force nitrogen and hydrogen together (Rae-Dupree, 2011). The elements then move out of the catalyst and into industrial reactors where the elements are eventually converted into fluid ammonia (Rae-Dupree, 2011). The fluid ammonia is then used to create fertilizers.

Today chemical fertilizers contribute to about half of the nitrogen put into global agriculture and this number is higher in developed countries.

Population Growth and the Haber-Bosch Process

world's population

Today the places with the most demand for these fertilizers are also the places where the world's population is growing the fastest. Some studies show that about "80 percent of the global increase in consumption of nitrogen fertilizers between 2000 and 2009 came from India and China" (Mingle, 2013).

Despite the growth in the world's biggest countries, the large population growth globally since the development of the Haber-Bosch process shows how important it has been to changes in global population.

Other Impacts and the Future of the Haber-Bosch Process

The current process of nitrogen fixation is also not completely efficient and a large amount is lost after it is applied to fields due to runoff when it rains and a natural gassing off as it sits in fields. Its creation is

also extremely energy-intensive due to the high temperature pressure needed to break nitrogen's molecular bonds. Scientists are currently working to develop more efficient ways to complete the process and to create more environmentally-friendly ways support the world's agriculture and growing population.