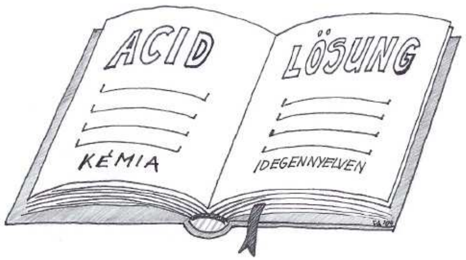
KÉMIA IDEGEN NYELVEN



Kémia angolul
Szerkesztő: MacLean Ildikó

Kedves Diákok!

A 2010/5. számban az előző lapszám témáját, a katalizátorokat folytatjuk tovább. A fordítandó feladat első része egy katalizált gyártási folyamathoz kapcsolódik, amelyet egy egyszerű, otthon is elvégezhető kísérlet leírása követ.

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A. / Haber process

The **Haber process**, also called the **Haber–Bosch process**, is the nitrogen fixation reaction of nitrogen gas and hydrogen gas, over an enriched iron or ruthenium catalyst, which is used to produce ammonia. The Haber process is important because ammonia is difficult to produce on an industrial scale, and the fertilizer generated from the ammonia is responsible for sustaining one-third of the Earth's population. Despite the fact that 78.1% of the air we breathe is nitrogen, the gas is relatively

unreactive because nitrogen molecules are held together by strong triple bonds. It was not until the early 20th century that this method was developed to harness the atmospheric abundance of nitrogen to create ammonia, which can then be oxidized to make the nitrates and nitrites essential for the production of nitrate fertilizer and explosives.

The process

By far the major source of the hydrogen required for the Haber-Bosch process is methane from natural gas, obtained through a heterogeneous catalytic process, which requires far less external energy than the process used initially by Bosch at BASF, the electrolysis of water. Far less commonly, in some countries, coal is used as source of hydrogen through a process called coal gasification.

Synthesis gas preparation

First, the methane is cleaned, mainly to remove sulfur impurities that would poison the catalysts.
The clean methane is then reacted with steam over a catalyst of nickel oxide. This is called steam reforming:

$$CH_4 + H_2O \rightarrow CO + 3\ H_2$$

Secondary reforming then takes place with the addition of air to convert the methane that did not react during steam reforming.

$$2\ CH_4 + O_2 \rightarrow 2\ CO + 4\ H_2$$
$$CH_4 + 2\ O_2 \rightarrow CO_2 + 2\ H_2O$$

Then the water gas shift reaction yields more hydrogen from CO and steam.

$$CO + H_2O \rightarrow CO_2 + H_2$$

The gas mixture is now passed into a methanator which converts most of the remaining CO into methane for recycling:

$$CO + 3\ H_2 \rightarrow CH_4 + H_2O$$

This last step is necessary as carbon monoxide poisons the catalyst. (Note, this reaction is the reverse of steam reforming). The overall reaction so far turns methane and steam into carbon dioxide, steam, and hydrogen.

Ammonia synthesis – Haber process

The final stage, which is the actual Haber process, is the synthesis of ammonia using a form of magnetite, iron oxide, as the catalyst:

$$N_2\ (g) + 3\ H_2\ (g)\ 2\ NH_3\ (g)\ (\Delta H = -92.22\ kJ\cdot mol^{-1})$$

This is done at 15–25 MPa (150–250 bar) and between 300 and 550 °C, passing the gases over four beds of catalyst, with cooling between each pass to maintain a reasonable equilibrium constant. On each pass only about 15% conversion occurs, but any unreacted gases are recycled, so that eventually an overall conversion of 98% can be achieved.

The steam reforming, shift conversion, carbon dioxide removal, and methanation steps each operate at absolute pressures of about 2.5–3.5 MPa (25–35 bar), and the ammonia synthesis loop operates at absolute pressures ranging from 6–18 MPa (60–180 bar), depending upon which proprietary design is used.

B. / Ammonia Ghosts

Description

Have you ever seen an ammonia ghost? You'll get a good look at one when you try this activity. They are pretty timid, though, for ghosts; in fact, a few drops of vinegar is all that it takes to scare them away! Ammonia diffuses through a paper towel into a large bottle of water containing phenolphthalein. Convection currents swirl the pink ghosts gently.

Chemical Concepts

1. Some compounds are different colors in the acid and basic forms. These compounds are called indicators.
2. Reactions of indicators are reversible.
3. Ammonia solutions are less dense than water.

Safety

Wear goggles at all times.

Procedure

1. Fill the large beaker with tap water to within 3-4 cm of the top, then stir in the 10-12 mL of 1.0% phenolphthalein solution. Place the beaker in position for the demonstration and allow 4-5 minutes for the solution to come to rest.
2. Prepare some dilute vinegar solution by mixing 1 mL of 5% vinegar with 9 mL of tap water.
3. Place the lead weights (or pebbles) in the baby food jar, then add the 20-25 mL of household ammonia.
4. Place two or three layers of paper towel over the mouth of the baby food jar, and secure them in place with a rubber band (this may require two sets of hands!). Cut away the extra paper towel fringe.
5. Wet the paper towel with a milliliter or two of the dilute vinegar. Then carefully lower the baby food jar into the beaker of water/phenolphthalein solution. (Avoid disturbing the water, and try to position the jar upright in the center.)
6. Wait and observe. Add dilute vinegar to disperse the ghosts, and watch formation of the ghosts again. The reaction is reversible for many cycles.
7. Watch surface of the towel where the gas is diffusing into the solution.
8. Also, to "scare the ghost away," a few drops of vinegar (undiluted) may be added and gently stirred in. The ghost quickly disappears, only to reappear later on.

Safety-

Wear goggles.

Materials-

- 20-25 mL of household ammonia {about 3 M $NH_3(aq)$}

        - or
    - 20-25 mL of 7.5 M NH_3 (Add 10 mL of conc. ammonia to 10 mL of water.) This more concentrated solution is faster than household ammonia.
    - 10-12 mL of prepared 1% phenolphthalein solution (Dissolve 1.0 g of phenolphthalein in 50 mL of 95% ethanol. Add 50 mL of water slowly with rapid stirring. Use a magnetic stirrer if it is available.)
        - or
    - 2-3 Exlax® tablets dissolved in 25 mL of rubbing alcohol
- 1 2-L clear plastic bottle
- scissors
- 1 baby food jar or similarly shaped small, clear container
- a paper towel
- a rubber band
- 80 - 100 g of lead fishing weights or small pebbles.
- stirring rod
- a disposable plastic pipet or eye dropper
- 5% vinegar
- water

Disposal-

Discard solutions at the sink. Store lead weights or pebbles for reuse.

Lab Hints-

1. Determine (mathematically or by trial and error in a bucket of water) how many lead weights it takes to make the empty baby food jar sink in water.

2. Use scissors to cut the top portion off of the 2-L plastic soda bottle to create a tall plastic beaker. Strip the label. Cut the sides of the bottom piece of plastic away leaving a saucer of plastic for support.
3. The dilute vinegar placed on the paper towels acts to provide a time delay for the basic ammonia must first neutralize the acidic vinegar before it can make the solution basic. This time delay allows the water to settle again after the jar has been added. The thickness of the paper towel also plays a role. If the ghost is taking too long to make its appearance, try using fewer layers of paper towel or a more dilute vinegar solution.
4. If local tap water is so basic that the phenolphthalein turns pink, add vinegar dropwise until the pink color disappears.

Observations-

Household ammonia is actually a solution of ammonia gas in water. The pungent odor one experiences when opening a bottle of ammonia is due to some of the ammonia gas coming out of solution. The same happens inside the baby food jar. The ammonia gas leaves the solution, diffuses up to the top of the jar, and there it re-dissolves into the water of the wet paper towel. As it does so, it turns the solution in and around the paper towel pink (ammonia acts as a base in water and the phenolphthalein indicator changes to pink in a basic environment). Ammonia not only produces a basic solution, it also does something that few other substances do; as it dissolves, the density of the solution decreases (Density of 17 M Ammonia -- 0.90 g/mL). And although this decrease is slight, it is enough to cause the pink solution to rise slowly upward through the beaker. The wispy, ephemeral appearance of this rising column of ammonia solution resembles (if you use your imagination) a pink ghost emerging from the jar. Furthermore, the shapes and movements generated seem to be different each time the demonstration is performed.

Források: http://dwb4.unl.edu/chemistry/beckerdemos/BD023.html

http://en.wikipedia.org/wiki/Haber_process