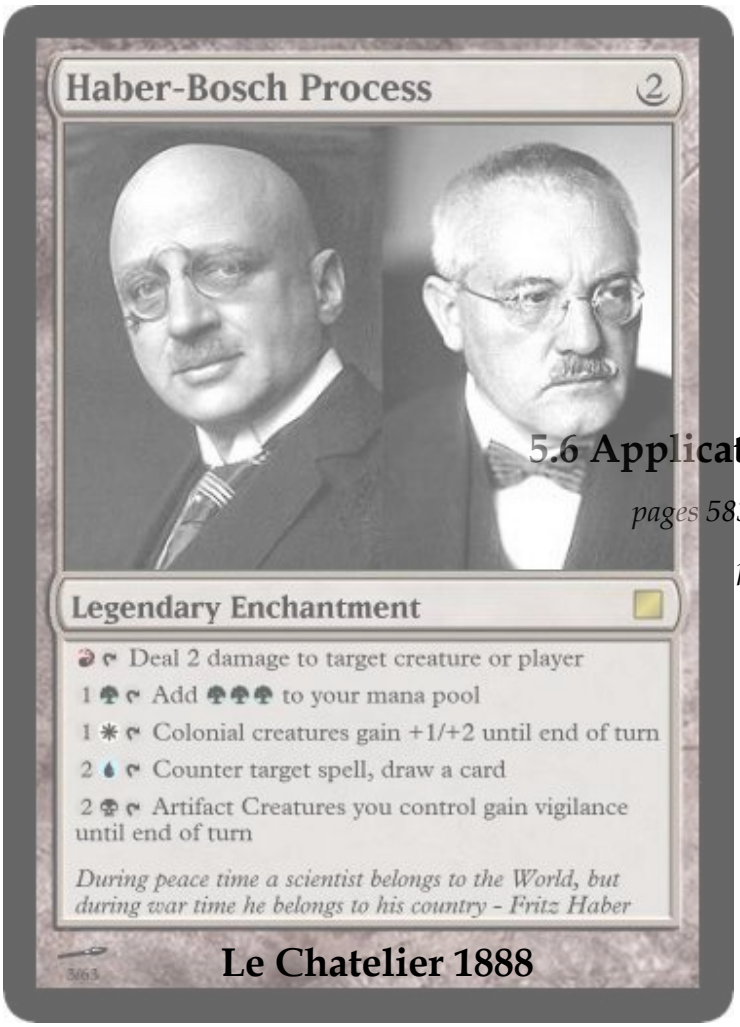

Le Chatelier 1888

5.6 Application of Le Chatelier's Principle

pages 583-584 and 588 in Matter and Change

pages 553 and 554 in Health

5.6 - Application of Le Chatelier's Principle

The Common Ion Effect

The **common ion effect** is an example of Le Chatelier's Principle.

It states that the *solubility of an ionic compound is decreased* (less is dissolved) by the addition of another ionic compound to the solution that contains one of the ions already in the solution.

For example, if $BaSO_{4(s)}$ was in equilibrium in a solution, then we would have the following system:

$$BaSO_{4(s)} \rightleftharpoons Ba^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)}$$

Note - it is dissociated because it is soluble.

If we added barium chloride, another soluble substance to this system, what would happen to the concentration of Ba^{2+}?

Le Chatelier's Principle more $BaSO_{4(s)}$ is being produced. If there is more solid than there initially was, and less ions in the solution, then the solubility of $BaSO_4$ has been decreased.

Note - only the addition of substances with common ions can affect the equilibrium of a soluble substance.

We also need to consider if adding a substance will create an additional precipitate.

This will cause ions from the original system to drop out, increasing the solubility of the solid…

Ex) Determine what would happen to the solubility of sodium sulfate if we added the following to a sodium sulfate solution in equilibrium:

a) NaCl

b) sulfuric acid

c) $Ca(OH)_2$

.

The Haber-Bosch Process

$$N_{2(g)} + H_{2(g)} \rightleftharpoons 2NH_{3(g)} + 46.1KJ$$

- diatomic nitrogen makes up about 79% of the Earth's atmosphere; only a few bacteria species can "fix" ammonia from atmospheric nitrogen
- ammonia can then be changed into nitrates and nitrites
- plants can use nitrates and nitrites (few can use ammonia) to meet their nitrogen needs

- In 1909, Fritz Haber first demonstrated how to synthesize ammonia from nitrogen and hydrogen gas to be used in fertilizer
  - > incorporated several operations that increased the yield of ammonia
    - cooled the reaction
    - pressurized reactant chambers
    - the use of a catalyst
    - the removal of ammonia gas (by liquefication)

- The above system was improved by Carl Bosch in 1913

- Using Le Chatelier's Principle, why did the Haber-Bosch process increase the yield of ammonia?

  > increased pressure:

  > lower temperatures:

  > use of catalyst:

  > removal of product:

5.6 Application of le Chatelier's Principle Assignment

1. Consider the following equilibrium system:

$PbCl_{2\,(s)} \rightleftharpoons Pb^{2+}_{(aq)} + 2Cl^{-}_{(aq)}$

Describe what happens to the solubility of $PbCl_2$ when the following substances are added to the solution. Why?

a) $Pb(NO_3)_2$

b) NaCl

c) H_2O

d) $AgNO_3$

e) NaBr

2. Consider the following equilibrium system:

$AgBr_{(s)} \rightleftharpoons Ag^{+}_{(aq)} + Br^{-}_{(aq)}$

Describe what happens to the solubility of $AgBr_{(s)}$ when the following substances are added to the solution. Why?

a) $Pb(NO_3)_2$

b) $AgNO_3$

c) NaCl

d) NaBr

3. Explain why more $Zn(OH)_2$ dissolves when 3 M HCl is added to a saturated solution of $Zn(OH)_2$. Start by writing the correct equilibrium equation.

4. Explain three ways in which the Haber-Bosch process utilizes Le Chatelier's principle to increase the yield of ammonia in industrial fertilizer production.