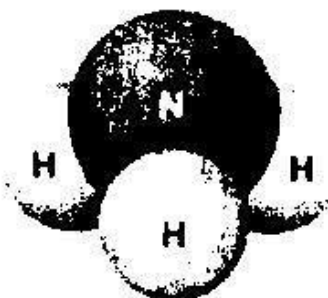


CHAPTER

4

The Making of Ammonia 30/30

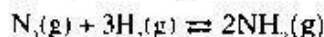
Ammonia Molecule

The pungent gas ammonia takes its name from the Ammonians. These ancient worshippers of the Egyptian god Amun used *sal volatile* (ammonium chloride) in their religious rites. During the Middle Ages, ammonia was used in the dyeing of woolen goods and in tanning. This colorless gas is generally thought of as nonflammable but will burn in air under some conditions. It dissolves readily in water because it interacts with water molecules. The fact that ammonia is extremely soluble in water is what makes its presence so obvious to your nose. It dissolves in the aqueous mucus that coats the olfactory tissue of the nose. Water might smell just as pungent if our nasal sensors were not constantly saturated with it!

At the beginning of the twentieth century, prominent scientists were warning of approaching world famine because of a scarcity of fertilizer containing nitrogen. The nitrogen is needed by plants to make proteins. Some types of bacteria "fix" nitrogen from the air, forming nitrates, which plants can use. But large-scale farming requires more abundant nitrates, which can be made from ammonia. However, because ammonia could not be produced in abundance, most nitrates had to be imported from mined deposits, mainly in Chile.

Nitrates are also used in the manufacture of explosives. In 1913, as World War I was approaching, Germany was under pressure to obtain ammonia needed to make such explosives. These factors led researchers to investigate methods of producing ammonia on an industrial scale. Fritz Haber, a

German chemist, learned that ammonia could be produced by the direct combination of nitrogen from the air and hydrogen through the following reaction:



To occur at a reasonable rate, the reaction requires the presence of a catalyst, high temperature, and high pressure. Because the reaction is reversible, the ammonia must be removed as it is produced to keep the reaction moving to the right, in favor of the product. Karl Bosch, an engineer from a German company interested in Haber's work, designed equipment that could operate at temperatures up to 550°C and up to 200 atmospheres, making the large-scale production of ammonia possible. The process developed to produce ammonia is known as the Haber-Bosch process.

Today, ammonia ranks as one of the most important industrial substances. Modern chemical plants that produce ammonia manufacture thousands of tons per day. The ammonia is then used in the manufacture of explosives, plastics, soap, and many other common products.

However, the greatest percentage of ammonia is used in the production of fertilizers. The nitrogen in fertilizers is supplied directly or indirectly by ammonia. Fertilizers replenish nitrogen and other substances, particularly potassium and phosphorus, that have been reduced or exhausted in soils.

Ammonia is used as a fertilizer in both gaseous and liquid forms. The gas is pumped directly into the soil. The liquid form, called anhydrous ammonia, is also added directly to the soil. Plants are able to absorb some of the ammonia, using it to make proteins. Bacteria in the soil convert much of the ammonia to nitrites (NO_2^-) and then to nitrates (NO_3^-). Plants absorb the nitrates and also utilize the source of nitrogen in making proteins.

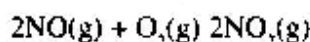
Many commercial fertilizers supply nitrogen in the form of nitrate salts that are manufactured from nitric acid, HNO_3 . Here again, ammonia plays a role because nitric acid is produced from ammonia from a method called the Ostwald process. In the Ostwald

CHAPTER 4

process, ammonia reacts with oxygen in the presence of a platinum-rhodium catalyst to yield nitrogen monoxide. The equation for the reaction is as follows:



The NO produced then reacts with oxygen to form nitrogen dioxide.



When NO_2 is combined with water, and the mixture is further processed, nearly pure nitric acid is produced. To produce high-nitrogen fertilizer, nitric acid can be reacted with ammonia to produce ammonium nitrate, NH_4NO_3 , an important fertilizer.

Nitric acid is also used to produce metallic salts, such as potassium nitrate (KNO_3). Such salts are important ingredients in many fertilizers.

Fertilizers can be used to tailor soils for specific crops, to enrich poor soils, and to increase crop yield. However, runoff is a problem with these fertilizers because they are highly soluble in water. Contamination of bodies of water by nitrogen fertilizers is a serious form of pollution. Increased plant growth in the affected body of water can lead to oxygen depletion and the "death" of the body of water. Controlled-release fertilizers are under development, but are currently used only in nonfarming applications, due to their cost.

1. What factors led to investigation of methods for producing ammonia on a large scale?

Ammonia could not be produced in abundance nitrates were imported from Chile. In WWI, Germany was under pressure to obtain ammonia needed to make bombs.

2. Describe the Haber-Bosch process for producing ammonia.

$\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$ Haber learned that ammonia could be produced by the direct combination of nitrogen from the air & hydrogen. The reaction requires a catalyst, high temp & high pressure. Bosch designed equipment that could regulate temps.

3. Explain why ammonia is important in large-scale farming for food production.

b/c Ammonia is used as a fertilizer & added to the soil. The plants absorb the ammonia to produce proteins. Ammonia helps enrich soil & increase crop yield.

4. Why is ammonia such an important chemical material?

It's the most industrial substance. Modern Chem. plants that produce ammonia manufacture 100's per day. Ammonia is used to manufacture explosives, plastics, soap, etc.

5. What effect does fertilizer runoff have on bodies of water?

b/c they're soluble water by contamination by nitrogen fertilizers that lead to serious pollution. Increased plant growth in the affected body of water can lead to oxygen depletion & the death of the body of water.

6. How does the concept of equilibrium relate to the fact that ammonia must be removed during the Haber-Bosch process if the reaction is to continue?

b/c the reaction is reversible, the ammonia must be removed to keep the reaction moving to the right. Also the ammonia has to be balanced in order to be sustainable.

NAME: NICOLE LATIELLA
DATE: 3/20/09 period 4
TEXT: _____
AUTHOR(S): _____

PURPOSE OF ARTICLE (answer after reading introduction):

The making of Ammonia

In this column, list and provide important information to explain the article's main ideas and points of view.

In this column, reflect on these ideas-questions, concerns, related ideas.

MAIN IDEA 1

Ammonia - pungent gas, ammonia was used in the dyeing of woolen goods & in tanning. Dissolves in water

Interesting - Ammonians worshiped Egyptian god "Amun"
Sal volatile - ammonium chloride

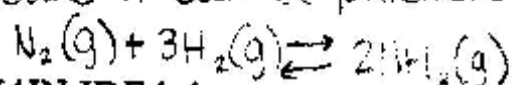
MAIN IDEA 2

Beginning of 20th century, famine warning b/c lack of fertilizers (nitrogen)
Plants + nitrogen = food for us.

Ammonia can be made from abundant + nitrogen
imported nitrates, mainly from Chile

MAIN IDEA 3

WWI - ammonia was used to obtain explosives. Fritz Haber found it can be produced by



MAIN IDEA 4

To occur, the reaction required a presence of a catalyst, high temp. & high pressure.

How did Haber come to this conclusion - the formula?

MAIN IDEA 5

Ammonia ranks as one of the most important industrial substances.

Does the chemical formula change drastically when producing different substances?

In this column, list and provide important information to explain the article's main ideas and points of view.

In this column, reflect on these ideas-questions, concerns, related ideas.

MAIN IDEA 6

The greatest percentage of ammonia is used in fertilizers (Nitrogen is supplied by ammonia)

How does fertilizers replenish potassium & phosphorus in the soil?

MAIN IDEA 7

Ammonia is used as a fertilizer in both gaseous and liquid forms.

Bacteria in soil converts ammonia into nitrates which make proteins.

Gas - pumped directly into the liquid - anhydrous ammonia is also directly added to the soil

MAIN IDEA 8

Ostwald Process - ammonia reacts w/ oxygen in the presence of a platinum-rhodium catalyst to yield nitrogen monoxide

Nitric acid is produced from ammonia. (Want to know more about the Ostwald process.)

MAIN IDEA 9

Nitric acid can react w/ water, ammonia, & other substances to produce fertilizer, ammonium nitrate, metallic salts etc.

Why are these salts produced so important in the fertilizer?

MAIN IDEA 10

Fertilizers are great when they're used correctly, some problems are still being solved to slow/stop pollution.

How bad is the pollution? What happens when the nitrogen fertilizers end up in water?

SUMMARY:

One may think ammonia is just a compound from science, however this article has taught me that ammonia is used in one way to make fertilizers which make food/crops to feed us. Ammonia is also used in war to make explosives. It's used in soaps and cleaning products. A few people (Haber/Bosch) were involved.

NAME: Danielle Fala Period 4

DATE: 3/20/09

TEXT: _____

AUTHOR(S): _____

PURPOSE OF ARTICLE (answer after reading introduction): The purpose of the article is to show what ammonia is and where it comes from, how it forms.

In this column, list and provide important information to explain the article's main ideas and points of view.

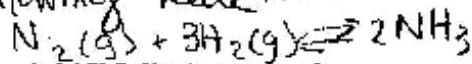
In this column, reflect on these ideas-questions, concerns, related ideas.

MAIN IDEA 1 - The main idea is that ammonia is a colorless gas that is nonflammable, but will burn in some conditions. It interacts w/ water molecule, ammonia is extremely soluble. Dissolves in the aqueous mucus that coats the olfactory tissue of the nose.

MAIN IDEA 2

- Warning of approaching world famine due to a scarcity of fertilizer containing Nitrogen. Large scale of farming requires more abundant nitrates, which are from ammonia. Nitrates had to be imported from Chile.

MAIN IDEA 3 Fritz Haber - learned that ammonia could be produced by the direct combination of nitrogen from the air + hydrogen through the Haber reaction



MAIN IDEA 4 - The reaction requires the presence of a catalyst, high temp, + high pressure. The process to produce ammonia is the Haber Bosch process, Karl Bosch helped produce ammonia

MAIN IDEA 5 Ammonia ranks as 1 of the most important industrial substances.

- I found interesting that the pungent gas ammonia takes its name from the Ammonians.

- Some types of bacteria "fix" nitrogen from the air, forming nitrates which plants can use
*Interesting

- Interesting is Nitrates are also used in the manufacture of explosives

- What is a catalyst?

- Ammonia is used in the manufacture of explosives, plastics, soap, + etc.
*Interesting

In this column, list and provide important information to explain the article's main ideas and points of view.

In this column, reflect on these ideas-questions, concerns, related ideas.

MAIN IDEA 6. The greatest % of ammonia is used in the production of fertilizers. The nitrogen in fertilizers is supplied directly or indirectly by ammonia.

MAIN IDEA 7 Ammonia is used as a fertilizer in both gaseous & liquid forms. Gas pumped into the soil, the liquid form is added to the soil. Bacteria in the soil converts ammonia into nitrates.

MAIN IDEA 8 Commercialized fertilizers supply Nitrogen in the form of nitrate salts that are manufactured from nitric acid HNO_3 . Nitric acid is produced from ammonia called the Ostwald process.

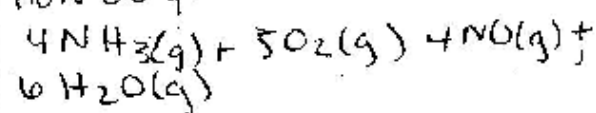
MAIN IDEA 9 When NO_2 is combined w/ water and the mixture is further processed, nearly pure nitric acid is produced.

MAIN IDEA 10 Fertilizers can be used to tailor soils for specific crops, to enrich poor soils & to increase crop yield.

How much is the percentage of ammonia?

- What is anhydrous ammonia?

How do you do this equation.



Interesting - Nitric acid is also used to produce metallic salts, such as potassium nitrate.

- Contamination of bodies of water by nitrogen fertilizers are under developed.

SUMMARY:

It's about fertilizers and what they do & produce

NAME: BJ Gwin

DATE: 3-12-09

TEXT: _____

AUTHOR(S): _____

PURPOSE OF ARTICLE (answer after reading introduction): the purpose of this article is to make you realize how fertilizer plays such a major role in our world today.

In this column, list and provide important information to explain the article's main ideas and points of view.

In this column, reflect on these ideas-questions, concerns, related ideas.

MAIN IDEA 1 It is about the affect of ammonia on water and in the air.

Does ammonia smell only when you put it in water or only in air?

MAIN IDEA 2 This paragraph is the affect of ammonia and how important it is for farmers to have it for their plants to be successful.

If you use all this ammonia doesn't that have a health factor soon come into play?

MAIN IDEA 3

The affects ammonia have when it comes to highly explosives.

what does ammonia have to do with bombs?

MAIN IDEA 4 This paragraph is about Karl Bosch and his way he created to be able to ~~produce~~ be able for large scale of ammonia possible

what steps did he take to create this machine?

MAIN IDEA 5

This is how important ammonia is to the world and all its products that come from it.

If ammonia is a liquid how can you use it for soap?

In this column, list and provide important information to explain the article's main ideas and points of view.

In this column, reflect on these ideas-questions, concerns, related ideas.

MAIN IDEA 6 this is the use of how farmers use it for their plants

What do plants use ammonia for?

MAIN IDEA 7 This is the creation of ammonia entering into the soil how they use it in both gas & liquid.

How do you get ammonia mixture in a gas for?

MAIN IDEA 8 This is how ammonia plays a big role in Nitric acid, HNO_3 which plays another part in filtration.

How do you create nitric acid from ammonia?

MAIN IDEA 9 this is about the important form of Nitric acid and how a pure form of it is produced.

What results in Nitric acid for the plants?

MAIN IDEA 10 This is how pollution is a major problem from the runoff into the water

How does it take the oxygen out of the water?

SUMMARY: Fertilizer plays a major part in our world today. This also has major pollution affects. I think we need to ~~learn~~ learn how to control our fertilizer better so we can have a greener world.

NAME: Marybel Uscala

DATE: 3/12/24 8

TEXT: Chemistry Enrichment Ch. 4

AUTHOR(S): ?

PURPOSE OF ARTICLE (answer after reading introduction):

To show how Ammonia is made.

In this column, list and provide important information to explain the article's main ideas and points of view.

In this column, reflect on these ideas-questions, concerns, related ideas.

MAIN IDEA 1

Where and why and when ammonia got its name.

Why ammonia extremely soluble in water?

MAIN IDEA 2

How ammonia is used in explosives, like for WWI.

Why is nitrogen needed by plants to make proteins?

MAIN IDEA 3

How Fritz Haber, the German scientist learned that ammonia could be produced

Why is reaction reversible?

MAIN IDEA 4 by nitrogen + hydrogen

How Karl Bosch designed equipment that could operate at temperatures up to 550°C making the large-scale of ammonia possible.

Why is the greatest percentage of ammonia used in the production of fertilizers?

MAIN IDEA 5

How ammonia is used in many different things. For ex. explosives, plastics, soap

Why is ammonia ^{liquid} used called anhydrous ammonia? Other common products.

In this column, list and provide important information to explain the article's main ideas and points of view.

In this column, reflect on these ideas-questions, concerns, related ideas.

MAIN IDEA 6

That ammonia is used as a fertilizer in both gas and liquid forms.

MAIN IDEA 7

Plants need ammonia because it is made into fertilizer that provides protein.

MAIN IDEA 8

When NO_2 is combined with water, nearly pure nitric acid is produced.

MAIN IDEA 9

These fertilizers are highly soluble in water. It can lead to the "death"

MAIN IDEA 10

of the body of ammonia has to be removed if the reaction continues.

~~(Why is nitric acid)~~
Why ^{can} nitric acid be reacted w/ ammonia to produce ammonium nitrate?

Why is nitric acid used to produce metallic salts?

Why is runoff a problem with fertilizers?

SUMMARY:

Ammonia plays a very important role in our world today, and without it we wouldn't be able to have so many foods or products.