A Guide to the Fertiliser Industry

Teaching Approach

The Fertiliser Industry refers to all the industrial processes that take place during the preparation of typical commercial fertilisers. It is very important that learners understand the fertilisers industry and how it links to the agricultural industry and the associated environmental impact. Learners should be able to identify the nutrients needed by plants for them to be able to make their own food.

It is recommended that for this series, learners should watch the video *Fertilisers and Plants* first and follow through to watch the video *Processes in Fertiliser Industry*. The reason for this is to make learners build knowledge and relationships and hopefully conclude from the lessons why this industry is important after all.

It is also imperative that the teacher relates food consumption and human population increase as drivers of commercial agriculture. Bear in mind the factors that influence food production such as water and soil nutrients. For this series the educator must then highlight the need for nutrient replenishment in soils in order to achieve mass food production. This is where the fertiliser industry comes in whereby this industry enables farmers to supply nutrients to plants thus enabling them to grow and produce more food commercially.

What are the nutrients found in the bag of fertiliser? In lesson 1 the focus is on nutrients required by plants, the sources of these nutrients and the function of these nutrients are discussed. The concept of NPK ratio is also addressed in this lesson. Learners should be able to interpret the NPK ratio, use it to calculate the percentage of NPK. In lesson 2 the processes that place in the fertiliser industry are discussed and the impacts of fertiliser are discussed, the concept of eutrophication is highlighted and possible solutions to this problem. In this lesson the step by step processes to prepare various fertilisers are illustrated.

The use of flow charts and animation will make it easy for learners to understand the processes involved in the preparation of fertilisers and how plants get these nutrients. Finally, the videos can either be used independently for the learners to revise with after the content at school, or as part of the lessons. The use of multimedia to explain and reinforce concepts helps the learners understand and grasp new concepts better.

The task video has been prepared in such a way as it could be used as either an exercise or as a way for the students to test their knowledge independently.
Video Summaries

Some videos have a ‘PAUSE’ moment, at which point the teacher or learner can choose to pause the video and try to answer the question posed or calculate the answer to the problem under discussion. Once the video starts again, the answer to the question or the right answer to the calculation is given.

Mindset suggests a number of ways to use the video lessons. These include:

- Watch or show a lesson as an introduction to a lesson
- Watch or show a lesson after a lesson, as a summary or as a way of adding in some interesting real-life applications or practical aspects
- Design a worksheet or set of questions about one video lesson. Then ask learners to watch a video related to the lesson and to complete the worksheet or questions, either in groups or individually
- Worksheets and questions based on video lessons can be used as short assessments or exercises
- Ask learners to watch a particular video lesson for homework (in the school library or on the website, depending on how the material is available) as preparation for the next day’s lesson; if desired, learners can be given specific questions to answer in preparation for the next day’s lesson

1. Fertilisers and Plants
   In this lesson the focus is on the nutrients required by plants. This lesson shows the type of nutrients required by the plants and the sources of these nutrients. There is also an indication on how plants get these nutrients and the function of these nutrients. The N.P.K. ratio is also discussed.

2. Processes in the Fertiliser Industry
   In this lesson the processes involved in the preparation of fertilisers are discussed and illustrated. Animations are used to illustrate and explain each process. Eutrophication, its causes and solutions are also discussed.
# Resource Material

<table>
<thead>
<tr>
<th></th>
<th>Fertilizers and Plants</th>
<th>Processes in the Fertilizer Industry</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td><a href="http://home.howstuffworks.com/question181.htm">http://home.howstuffworks.com/question181.htm</a></td>
<td>This page explains what fertilizer is and why do plants need it.</td>
</tr>
<tr>
<td>2</td>
<td><a href="http://www.extension.umn.edu/agriculture/nutrient-management/phosphorus/understanding-phosphorus-fertilizers/">http://www.extension.umn.edu/agriculture/nutrient-management/phosphorus/understanding-phosphorus-fertilizers/</a></td>
<td>Phosphate based fertilisers are discussed</td>
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Task

Question 1

1.1 Supply two reasons why the world needs fertilisers
1.2 The following nutrient is found in fertilisers in a form of a nitrate compound
   a) Nitrogen
   b) Permanganate
   c) Oxygen
   d) Nitrogen
1.3 Explain why farmers use fertilisers.
1.4 What are the non-mineral nutrients that plants need to survive?
1.5 Magnesium is classified as a.....needed by plants
   a) Primary nutrient
   b) Micro nutrient
   c) Secondary nutrient
   d) Essential nutrient
1.6 Nitrogen, phosphorus and potassium are ingredients in fertilisers. They are primary nutrients needed for plant growth and have the following functions:
   • nitrogen – for rapid growth and green leaves
   • phosphorus – for strong roots, fruit and flower development
   • potassium – protects against cold and dry weather

Your lawn has a well developed root system. You need a fertiliser that will provide nutrients for rapid growth and green leaves, and to protect the lawn during extreme dry conditions.
Which ONE of the following fertiliser’s NPK ratio mixtures will you use on your lawn?
   a) 7:1:1
   b) 1:1:5
   c) 2:5:1
   d) 8:1:5
1.7 Briefly explain the difference between macronutrients and micronutrients.
1.8 What are the sources of essential nutrients?
1.9 Which of the following is the source of phosphorus?
   a) Potash
   b) Bone meal
   c) Guano
   d) Atmosphere
1.10 What are the functions of potassium in plants?
1.11 Which of the following is not the function of nitrogen?
   a) forms part of a chlorophyll
   b) Improve quality of leaves
   c) Involved in production of oils, sugars and starch.
   d) Form part of the living cell, needed in all proteins and enzymes

You are provided with the 10kg bag of fertiliser that carries the following information NPK 3:1:5 (26) as seen in the fertiliser bag
1.12 Name the primary nutrients given by the symbols NPK required by all plants to ensure healthy and sturdy growth.

1.13 What is the meaning of 26 in the bag?

1.14 Calculate the percentage of NPK fertiliser found in this bag.

**Question 2**

2.1 In which one of the following reactions is nitric acid a product?
   a) Ammonium chloride is heated  
   b) Catalytic oxidation of ammonia  
   c) Calcium hydroxide reacts with ammonium chloride  
   d) The final reaction that takes place in the Ostwald process

2.2 Write a balanced equation for the industrial preparation of ammonia.

2.3 Which catalyst is used during the reaction of preparation of ammonia?

2.4 Discuss, with reference to Le Chatelier's principle as well as reaction rates, the conditions of temperature and pressure that favour the formation of ammonia. Give reasons why industries use a temperature of 450°C and a pressure of 200 atmospheres.

2.5 Why is it necessary to liquefy the ammonia formed in a cooler during the Haber process?

The flow diagram below represents the processes used in the fertiliser industry

2.6 Write down the name of the industrial process X

2.7 Write down the name of the industrial process Z

2.8 Write down a balanced equation for the preparation of ammonia sulfate using acid R.

2.9 Give two examples of potash used in fertilizers

2.10 Eutrophication in water is caused by …
   a) algae bloom  
   b) A depletion of oxygen concentration  
   c) Bacterial nitrogen fixation  
   d) an increase in plant nutrients

2.11 State TWO effects of over-fertilizing on the environment.

2.12 State TWO precautions that can be put into place to prevent eutrophication
Task Answers

Question 1

1.1 The world population increases and more people must be supplied with food.
   More food must be produced at a faster rate.
   The available land decreases and the soil cannot replenish nutrients fast enough in a natural way.
   1.2 D
   1.3 Increase the amount of nutrients into the soil, and restore the soil so they are able to produce at a faster rate, in greater quantities, on less land
   1.4 Carbon, hydrogen and oxygen
   1.5 C
   1.6 D
   1.7 Macronutrients – nutrients that are required in large amounts.
   Micronutrients – nutrients that are required in small amounts.
   1.8 Hydrogen and oxygen, in water from the rain
   Oxygen and carbon from the atmosphere
   1.9 B
   1.10 Building of proteins Photosynthesis Ensures good quality of fruit.
   Decrease in plant diseases Apart from N, P is absorbed the most abundantly by plants
   1.11 C
   1.12 N – Nitrogen, P – Phosphorus, K – Potassium
   1.13 26 % of pure fertiliser (NPK)
   1.14 Nitrogen = \( \frac{3}{9} \times 26\% \)
   Nitrogen = 8,7\%
   Phosphorus = \( \frac{1}{9} \times 26\% \)
   Phosphorus = 2,9\%
   Potassium = \( \frac{5}{9} \times 26\% \)
   Potassium = 14,4\%

Question 2

2.1 D
2.2 \( N_2(g) + 3 H_2(g) \rightarrow 2NH_3(g) \)
2.3 Fe – iron
2.4 Temperature: The reaction is exothermic and the yield of ammonia increases with decrease in temperature. However, a too low temperature disadvantages the rate at which ammonia is formed. The temperature of 450°C gives an economical acceptable rate, although the yield is lower.
   Pressure: The yield of ammonia is favoured by a high pressure. Reaction containers that can withstand extreme high pressures are expensive and impractical. The pressure of twice atmospheric pressure gives sufficient ammonia and is economically the most advantageous.
2.5 To separate it from the hydrogen gas and nitrogen gas that has not reacted.
2.6 X - fractional distillation (of liquid air)
   Z – Contact process
2.7 \( H_2SO_4 + 2NH_3 \rightarrow (NH_4)_2SO_4 \)
2.8 KNO\(_3\), K\(_2\)SO\(_4\), KCl
2.9 D

2.10 Eutrophication in water bodies; oxygen depletion in water bodies therefore fish and aquatic plants die; algal blooms; over-growth of weeds on land.

2.11 Use fertilisers correct/wisely.
- Restrict inflow of sewage/pollutants/nitrogen and phosphate nutrients/factory wastes into streams, rivers.
- Treat sewerage. Stricter precautions against littering
- Manure from feedlots and milk stalls can be removed before it runs into surface water.
- Manure can be used as fertiliser – nutrients are recycled. The diet of stock animals can be adapted to their needs so decreasing the excretion of phosphates.
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