

# Industrial Technologies in Ch. Eng.

**Chemical Engineering Department**  
**Level:** 5<sup>th</sup> level  
**Final term Exam**  
**Semester:** 2<sup>nd</sup> semester, (2017-2018).  
**Course title:** Industrial  
Technologies in Chemical  
Engineering  
**Course code:** CHE 503



Ministry of Higher Education  
The Higher Institute of Engineering and  
Technology  
In New Damietta

**Date:** 26 /5/2018  
**Day:** Saturday go  
**Time allowed:** 180 min. (3 hours)  
**Full marks:** 60 marks  
**Number of Pages:** 3

**Try to solve the following questions:**

## Model Answer

# Mid Term Exam

**Question (1):**(15 marks)

- #### 1. Distinguish between industrial and classical chemistry

We define industrial chemistry as the branch of chemistry which applies physical and chemical procedures towards the transformation of natural raw materials and their derivatives to products that are of benefit to humanity.

**Classical chemistry (organic, inorganic and physical chemistry) is very essential for advancing the science of chemistry by discovering and reporting new products, routes and techniques**

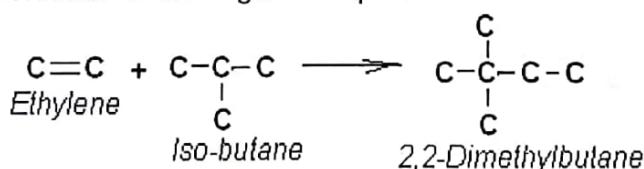
2. List down the various purposes for size reduction.

1. To reduce chunks of raw materials to workable sizes e.g. crushing of mineral ore.
  2. To increase the reactivity of materials by increasing the surface area.
  3. To release valuable substances so that they can be separated from unwanted material.
  4. To reduce the bulk of fibrous materials for easier handling.
  5. To meet standard specifications on size and shape.
  6. To increase particles in number for the purpose of selling.
  7. To improve blending efficiency of formulations, composites e.g. insecticides, dyes, paints

3. Write short notes including industrial applications of the following

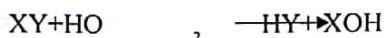
- ### i) alkylation

Alkylation is the introduction of an alkyl radical by substitution or addition into an organic compound



- ### (ii) hydrolysis

In the hydrolysis of either organic or inorganic compounds, water and another compound undergo double decomposition to form two products.



(iii) sulphonation

A chemical process that involves introduction of sulphonic acid group (SOOH)

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or its corresponding salt or sulphonyl halide ( $=SOCl_2$ ) into an organic molecule.

The sulphonating agents include sulphuric acid (98%), sulphur trioxide in water (oleum) and fuming sulphuric acid.

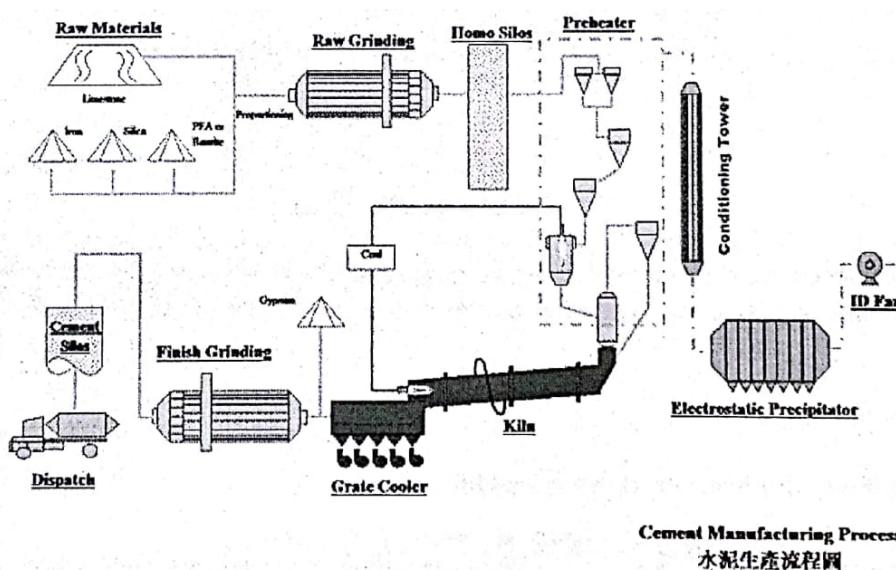
4. What unit operations are generally carried out during mineral ore dressing?

- **Size Reduction** to such a size as will release or expose all valuable minerals
- **Sorting** to separate particles of ore minerals from gangue (non-valuable) minerals or different ores from one another
- **Agglomeration** may be carried out sometimes before a roasting operation

5. Explain what sintering is.

Sintering involves diffusion of material between particles. It is applied to the consolidation of metallic and ceramic powder compacts which are heated to temperatures approaching their melting points to allow diffusion to take place at the points of contact of particles so that they grow together to form a rigid identity.

6. In a simplified flow sheet diagram, explain the main steps of Portland cement manufacture.



**Question (2):(15 marks)**

1. Explain how the lithosphere is an important source of natural raw materials for the chemical industry

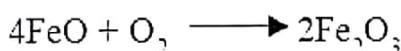
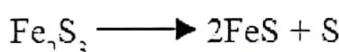
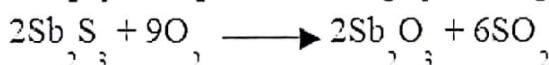
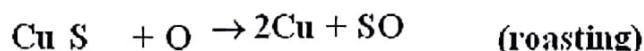
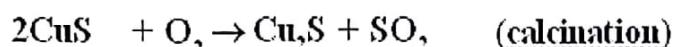
The vast majority of elements are obtained from the earth's crust in the form of mineral ores, carbon and hydrocarbons.

Coal, natural gas and crude petroleum besides being energy sources are also converted to thousands of chemicals

Vegetation and animals contribute raw materials to the so-called agro-based industries. Oils, fats, waxes, resins, sugar, natural fibres and leather are examples of thousands of natural products.

2. With respect to extractive metallurgy of copper, write equations for reactions that take place during:

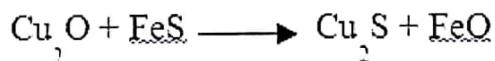
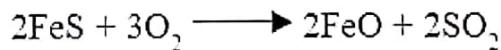
- a. roasting



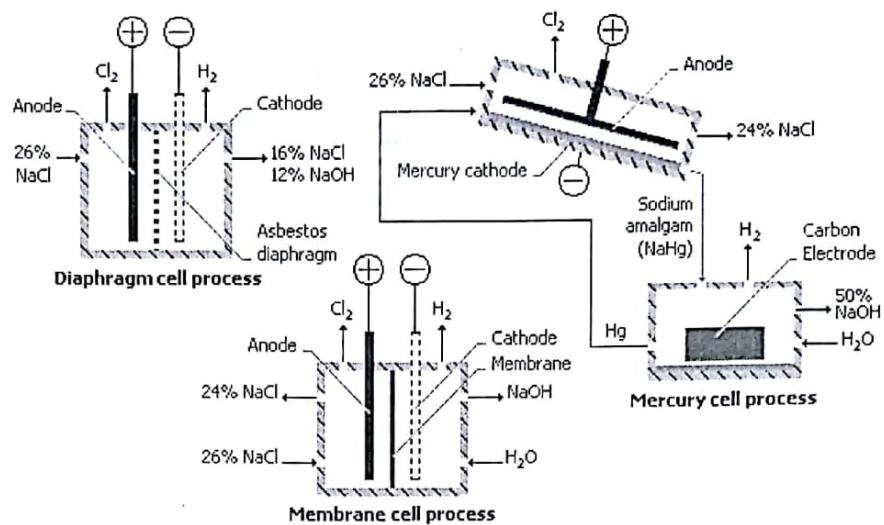
- b. matte smelting.

This is essentially a smelting process in which the components of the charge in the molten state separate into two or more layers which may be slag, matte, speiss or metal

- matte: heavy sulphide material
- slag: light oxide material
- speiss: iron oxide, insoluble in matte, slag or metal; it may contain elements



3. Draw a process flow diagram to show how sodium hydroxide and chlorine are produced using a membrane cell



4. What is the meaning of the following fertilizer analyses

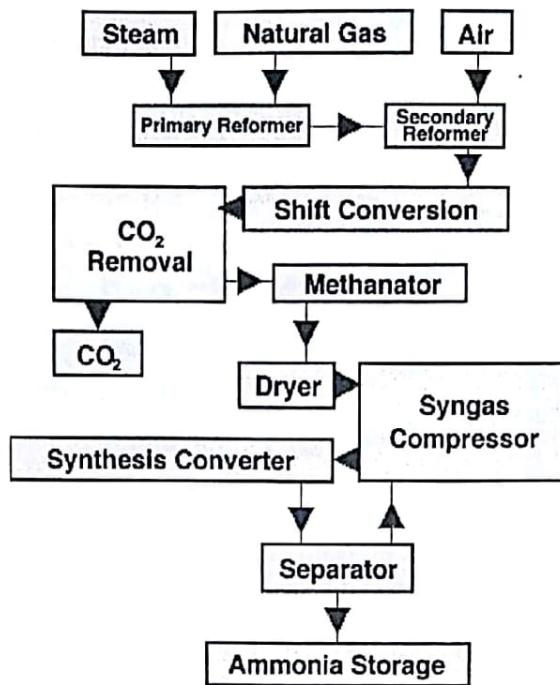
- (i) 0-46-0
- (ii) 46-0-0
- (iii) 5-10-5

5. It is required to produce ( 3- 6- 10 ) fertilizer from:

- 1- Sodium nitrate ( $\text{NaNO}_3$ )
- 2- Mono calcium phosphate  $\text{CaH}_4(\text{PO}_4)\text{H}_2\text{O}$
- 3- Potassium Chloride  $\text{KCl}$

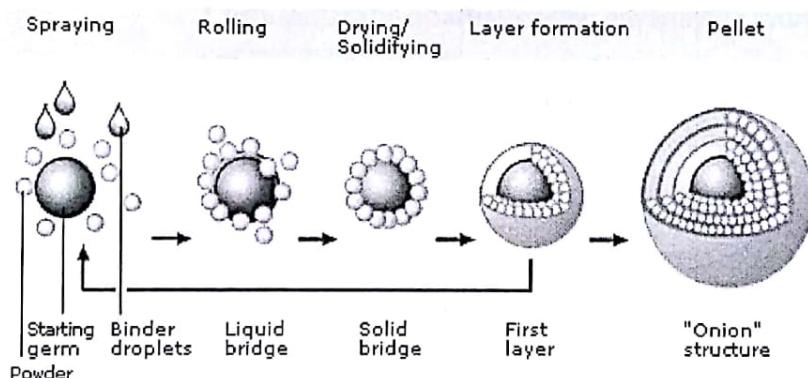
Calculate the quantity of each needed to produce one tone of fertilizer.

6. Describe briefly with the help of a diagram and equations, the Haber process for manufacture of ammonia.



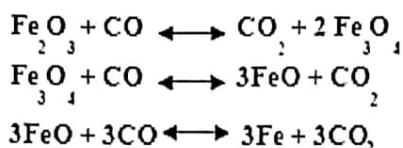
**Question (3): (15 marks)**

1. Describe how agglomerates are made by the layering process

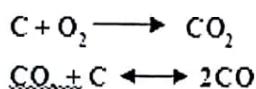


2. Write blast furnace equations for:
  - a. Iron ore reduction
  - b. Fuel reactions
  - c. Slag formation

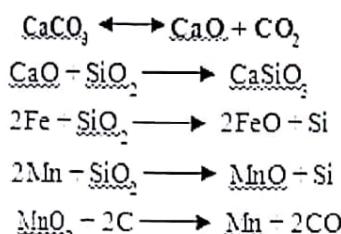
Iron ore reduction:



Fuel reactions



Slag formation reactions



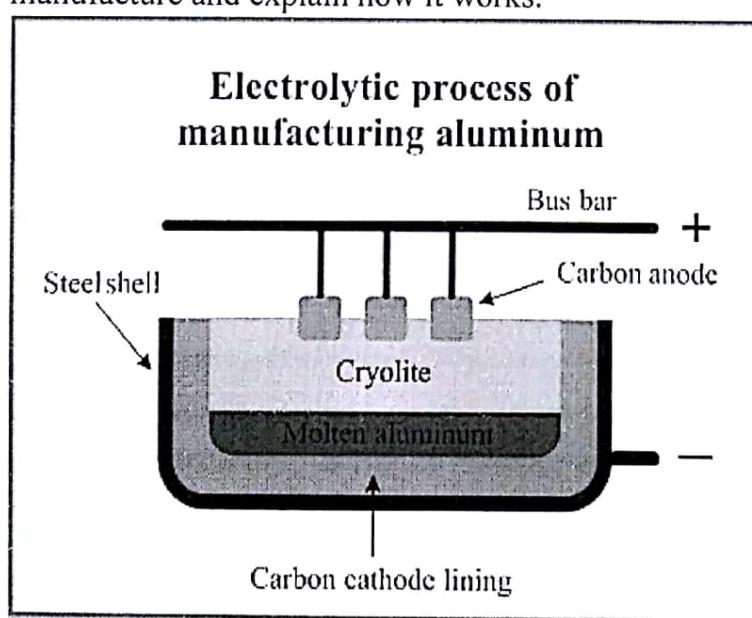
3. Describe the process of extracting alumina from bauxite.

*Extraction of aluminium from bauxite is carried out in three stages:*

- **Oredressing:** cleaning ore by means of separation of the metal containing mineral from the waste (gangue).
- **Chemical treatment of bauxite:** for converting the hydrated aluminium oxide to pure aluminium oxide.
- **Reduction of aluminium from aluminium oxide by the electrolytic process.**

Oredressing may involve washing the ore, size classification and leaching.

4. Draw a schematic diagram of a Hall-Heroult electrolytic cell for aluminium manufacture and explain how it works.



5. Comment on the location of the Egyptian aluminum production plant at Naga Hammadi
6. What are the major industrial and domestic uses of ammonia?

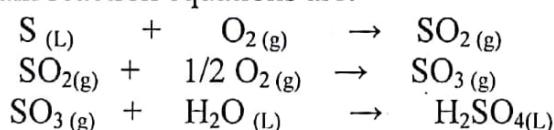
The main uses of ammonia include the manufacture of:

- Fertilizers ((ammonium sulfate, diammonium phosphate, urea))
- Nitric acid
- Explosives
- Fibres, synthetic rubber, plastics such as nylon and other polyamides
- Refrigeration for making ice, large scale refrigeration plants, air-conditioning units in buildings and plants
- Pharmaceuticals (sulfonamide, vitamins, etc.)
- Pulp and paper
- Extractive metallurgy
- Cleaning solutions

Question (4): (15 marks)

Starting with element sulphur, a plant is designed to produce 2000 Ton of 100% sulphuric acid together with 3000 ton of 20% oleum per year.

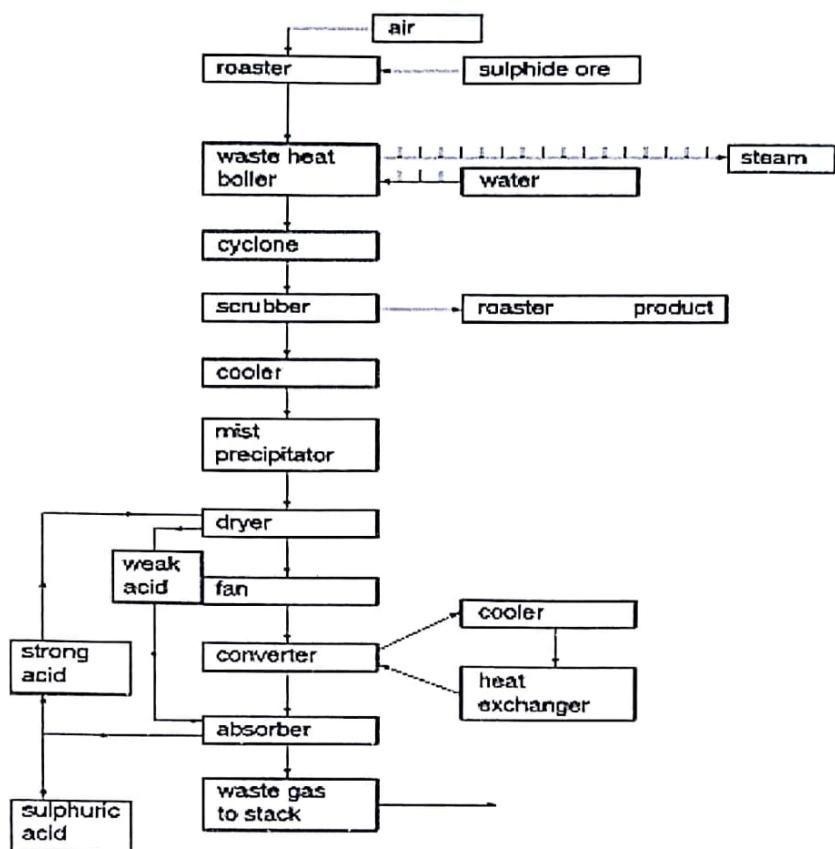
Main reaction equations are:



It is required to :

- 1- Construct a block flow diagram and qualitative flow diagram, for the sulphuric acid plant showing all pieces of equipments.

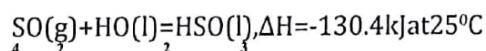
A block diagram for a sulphuric acid plant



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- 4- Suggest material transfer equipments for sulphur dioxide and sulphuric acid.
- 5- What are the other industries that can be started depending on the use of the existing sulphuric acid plants?
- 6- Converting sulphur trioxide into sulphuric acid cannot be done by simply adding water to sulphur trioxide. Why?

$\text{SO}_3$  will react with water to form sulphuric acid. However, converting the sulphur trioxide to sulphuric acid cannot be done by simply adding water to the sulphur trioxide. Direct mixing of sulphur trioxide with water by the following reaction is uncontrollable. The exothermic nature of the reaction means it generates a fog or mist of sulphuric acid, which is more difficult to work with than a liquid.



- 7- Suggest 2 industrial uses, in the same plant for steam produced in the waste heat boiler.
- 8- How to avoid probable future pollution problems from the early stages of a plant design project?

Sulphuric acid is a constituent of acid rain, formed by atmospheric oxidation of sulphur dioxide in the presence of water. Sulphur dioxide is released when fuels containing sulphur such as oil and coal are burned. The gas escapes into the atmosphere forming sulphuric acid. Sulphuric acid is also formed naturally by oxidation of sulphide ores.

*With my best wishes*

*Dr. Sohier Abo Bakr*