# OBJECTIVES

# for

# CHEMICAL PROCESSES

# and

# EQUIPMENT

CHM 203-4

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# CHEMICAL PROCESSES

## UNIT #1 - Unit Processes and Unit Operations

### General Objective

To present various chemical processes in a generalized form through correlation into flow sheets and descriptions of the following: Unit Processes
Unit Operations
Physical Chemistry

### Specific Objectives:

The student should be able to:

1) Define a unit process and a unit operation.
2) Distinguish a unit process from a unit operation.
3) List the characteristics of unit processes.
4) State the main differences between several of the basic unit operations.
5) Give an outline of the general areas of responsibility as found in most modern chemical manufacturing plants.

UNIT #2 - Electrochemistry

General Objectives:

The student should study the Electrochemical theory on galvanic and electrolytic cells as a prerequisite to the general understanding of the mechanism of corrosion.

Specific Objectives:

The student should be able to

1) Define the basic terms of electrochemistry such as: oxidation, reduction, anode, cathode.
2) Define the anode and cathode reactions in a simple electrochemical cell such as a Daniell cell.
3) Give the units and conditions used in Standard oxidation and reduction potential tables.
4) State the qualitative effects of concentration on the E.M.F. of a cell.
5) Use the nernst equation to determine quantitative effect of concentration on the e.m.f. of a cell.
6) Describe the two types of Polarization and their effect on the E.M.F. of a cell.
7) Define 'overvoltage' and list its cause and effect i.e. the factors contributing to overvoltage.
8) Describe the make-up of a common storage cell such as the lead-acid storage battery and give the equations for the anode and cathode reactions on charging and discharging.
9) Describe the make-up of the Edison cell and Nickel-Cadmium batteries.
10) Write equations for the anode and cathode reactions for the Edison cell and Nickel-Cadmium batteries on charging and discharging.
11) State the advantages and disadvantages of alkaline storage batteries as compared to lead-acid type.

UNIT #3 - Corrosion

Reference: "Corrosion" - reprint from Chemical Engineering - McGraw-Hill

General Objectives:

The student should study

1) The factors influencing corrosion such as:
   a) the factors associated with the metal
   b) the properties of the medium or environment.

2) The two general ways in which corrosion occurs.
3) The categories into which corrosion could be classified.
4) 'Design' as a factor in corrosion and corrosion control.
5) Corrosion test methods.
6) The common methods for evaluation of the effects of corrosion.

Specific Objectives:

The student should be able to:

1) Give a definition of terms used in corrosion theory such as (a) corrosion
   (b) passivity.
2) List some of the direct and indirect losses due to corrosion.
3) Explain how the two types (a) Oxidative and (b) non-oxidative corrosion occurs.
4) Write equations for the anode and cathode reactions that occur in the oxidative corrosion of iron.
5) List the seven categories which could be used to classify corrosion and give an explanation of each.
6) List the corrosion factors associated with a metal as outlined below and be able to explain how each affects the rate and extent of corrosion.
   a) oxidation potential
   b) presence of a cathodic metal or material
   c) purity of the metal
   d) relative areas of anode and cathode
   e) relative volume of the metal atoms and its oxide or corrosion product
   f) solubility of reaction products.
7) Explain how the properties of the environment listed below greatly influence corrosion.
   a) pH
   b) oxidizing agent content
   c) temperature
   d) velocity of the corroding medium
   e) presence or absence of an inhibitor
   f) conductivity of the solutions
   g) miscellaneous effects-biological, light, etc.

UNIT #3 (cont)

8) Draw a sketch and explain how an auxilary anode provides cathodic protection - a form of electrical inhibition.

9) List and explain six simple rules based on corrosion principles that should be observed in order to avoid corrosion.

10) Explain what are the aims of corrosion testing?

11) Give an outline of the physical measurements used to help evaluate corrosion effects.

12) Give an explanation of the requirements of a good corrosion test.

13) Briefly explain the various methods of corrosion testing as outlined by the American Society for Testing Materials.

14) Describe how a "Sacrificial Anode" may be employed as a means of controlling corrosion.

15) List the advantages and disadvantages of cathodic protection versus sacrificial electrodes.

UNIT #4 - Protective Coatings

Reference: Munro -"Chemistry in Engineering"
Prentice-Hall, Chapter 19, P.296

General Objectives:

The student should bear in mind that this topic area is presented from the point of view of the use of protective coatings to limit corrosion. The general headings to be studied are:

1) Metal Surface preparation
2) Principal application methods for metallic coatings
3) Inorganic coatings.
4) Organic coatings.

Specific Objectives: Metal Surface Preparation

The student should be able to:

1) List the various methods for degreasing metal surfaces and explain how they are accomplished.

2) Give some of the disadvantages of vapour degreasing.

3) Explain how descaling may be accomplished by (a) chemical means, and (b) physical means.

4) List the main requirements of a good coating.

Practical Metallic Coatings

5) List the six main practical application methods for metallic coatings.

6) Give a brief explanation of how each of the six practical metallic coatings are applied.

7) List two metals that may be applied by each of the six methods for applying metallic coatings.

Inorganic Coatings

8) Define or explain the difference between an inorganic coating and a metallic coating.

9) Explain how certain oxide films provide corrosion protection.

10) Give a brief explanation of how vitreous enamels are applied and act as a protective coating.

11) State the functions of phosphate coatings.

12) List the three types of phosphate coatings used for treating metal surfaces prior to painting.

13) Give some of the characteristics desired of phosphate coatings.

14) Give an example of a typical operating cycle for production of a phosphate coating.

Organic Finishes

15) List the primary raw materials used in the manufacture of paints, lacquers and varnishes.

16) Give a brief description of the purpose of each of the primary materials in the previous objective.

17) List and explain the purpose of some of the secondary constituents used in paints, etc.

18) Define the requirements of a good pigment.

19) Define the terms vehicle and fixed vehicle.

20) Explain the difference between 'raw', 'blown' and 'boiled' oil.

21) List several resins commonly used as binders today.

22) Give three factors which should be considered in selecting a solvent for use in paints etc.

23) List the four groups in which the major portion of solvents in current use may be categorized.

24) List two solvents that belong in each of the categories in objective 23.

25) Explain why enamels and lacquers should never be mixed.

26) Give a brief explanation of the function of a wetting agent.

UNIT #5 - Oils (Animal and Vegetable)

General Objective:

The study of oils is of importance due to their use in the manufacture of organic finsihes.

We shall confine our study to:
1) the composition and chemical nature of oils
2) oil test methods and oil properties
3) methods of extraction and refining
4) classification.

Specific Objectives:

The student should be able to:

1) Give a definition of an oil.

2) Write a general equation showing the formation of an oil.

3) Give a brief explanation together with equations showing the drying mechanism of oils.

4) Classify the oils as either normal or abnormal, using tables showing the composition of the oils.

5) Define the terms acid value, iodine value and saponification number of an oil.

6) List the sources where oils are obtained.

7) Give a brief explanation of how oil is obtained from seeds by pressure extraction.

8) Outline the method of solvent extraction for obtaining oil from seeds.

9) Define the terms raw oil, non-break raw oil, and stainless raw oil.

10) List the three methods commonly employed in the refining of oils.

11) Give a brief explanation of the method of alkali refining of oils.

12) Outline the process of refining oils by mechanical means.

UNIT #5 (cont.)

13) Explain briefly how oils are purified by acid refining.

14) Classify oils as drying, semi-drying or non-drying based on the composition of the oil and test data obtained from tables.

15) List in point form the factors used to determine the choice of oils for use in paint.

UNIT #6 - Plastics

Plastics, because of their abundant uses and increasing applications are an ideal topic for this program.

They are important because many synthetic resins used for making plastics are also used in the manufacture of protective coatings.

General Objective:

The student should study this topic under the following general headings.

1) Plastics are divided into two main groups Thermoplastics and Thermosetting.

2) The properties of plastics in each group.

3) Methods of manufacture.

4) Formulas of the common plastics.

5) Reactions (equations) involved in their manufacture.

Specific Objectives:

1) Define the terms Thermoplastic and Thermosetting.

2) List the outstanding properties of each of the plastics mentioned in the text.

3) Write an equation for the reaction involved in the manufacture of the plastics shown in text.

4) Write a formula for each of the common type plastics in the text.

5) Name the formulas of the plastics using both common names and chemical names.

6) Show formation of a methylene bridge in a three dimensional lattice as produced by reactions such as phenol with formaldehyde.

7) Show the formation of methylol groups by further addition of formaldehyde to product in #6.

8) Choose the best plastic for particular application using information provided in tables such as table 17-1, P. 274&275.

9) State the properties of Silicones which make them useful in lubricants and protective coatings.

# Petroleum

## UNIT #7 - Crude Oil

Ref: Munro - "Chemistry in Engineering" - Prentice-Hall
Chapter 6, p. 59

### General Objectives:

The student should read and study this chapter to learn the following:
a) the different types of crude oil
b) the history of the oil industry
c) the preparation of petroleum fractions by distillation.

### Specific Objectives:

The student should be able to:

1) Classify crude oil into the three types.

2) Explain the difference in make-up of the three types of crude oil.

3) Give a description of crude oil types according to locality.

4) State the differences in crude oil from different localities.

5) List the petroleum fractions obtained from the atmospheric distillation tower.

6) Give an outline of the fractions obtained from the vacuum distillation tower.

7) Describe the interior make-up of a fractionating column consisting of risers, trays and caps etc.

8) Give a brief explanation of each of the two types of processes found in a modern oil refinery a) Physical methods
b) Chemical or conversion processes.

9) List the substances found in crude oil.

10) Classify the hydrocarbons into gases, liquids and solids according to molecular size (i.e. the number of carbon atoms per molecule).

UNIT #8 - Gaseous Fuels

Reference: Munro - "Chemistry in Engineering" - Prentice-Hall, Chapter 10

General Objectives:

The study of gaseous fuels should be undertaken with the following in mind:

a) History, sources and use of natural gas.
b) Purification of natural gas.
c) Removal of sulfur from natural gas.
d) L.P.G. gases.
e) Manufactured fuel gases such as:

i) coal gas
ii) producer gas
iii) water gas
iv) carburetted water gas
v) blast furnace gas
vi) sewage gas.

f) Compare the heating values of the above fuels.

Specific Objectives:

The student should be able to:

1) Define or explain what is meant by the terms "lean" gas and "wet" gas.

2) Outline the various methods employed to recover the vapours of liquid hydrocarbons from "wet" natural gas.

3) Give a brief explanation of three methods for removal of hydrogen sulfide from natural gas together with equations.

4) Write equations and describe how elemental sulfur may be obtained from hydrogen sulfide.

5) List the main constituents of the manufactured gases:
   a) coal gas
   b) producer gas
   c) natural gas
   d) water gas
   e) blast furnace gas
   f) sewage gas

6) Write equations showing how each of the fuels in #5 are obtained.

UNIT #9 - Fuel to Match the Engine

Reference: Chapter 7 - Munro

General Objectives:

The student should study the terms related to engines and the reasons why it is necessary to produce more efficient fuels. A system of rating fuels is described together with a brief outline of how these ratings are related to molecular structure.

Specific Objectives:

The student should be able to

1) Define such terms as compression ratio, critical compression ratio, IMEP, RON, MON and sensitivity.

2) Describe a method for determining the octane rating of a gasoline.

3) Explain the how or why knock is produced in an engine.

4) State or describe the difference between RON and MON.

5) Explain what is meant by sensitivity of a gasoline.

6) Determine which of several hydrocarbons would have the highest or lowest octane number.

7) Describe a method by which fuels with ratings over 100 octane can be graded.

8) Know the proper I.U.P.A.C. name for isooctane.

9) Explain the various tests performed on gasoline and other fuels. Tests such as distillation range and gum content.

UNIT #10 - Diesel and Other Fuels

Ref: Munro -"Chemistry in Engineering"

General Objectives:

Continuing your study of petroleum fractions the fuels are next in interest.

The student should study the different grades of diesel fuels, the method of rating, other fuels such as kerosene and some of the tests performed on fuel oils.

Specific Objectives:

The student should be able to:

1) List the three grades of diesel fuel and define the differences in each.

2) Explain what is meant by cetane number.

3) Give an explanation of "Diesel Index", and what is its significance.

4) Distinguish between flash point, fire point and ignition temperature.

5) Name three improvers for diesel fuel.

6) Define smoke point.

7) Determine which of the following would show the greatest tendency to smoke.

8) Name the two grades of kerosine used as turbo fuels.

9) Describe the difference between the two different grades of turbo fuels.

10) Explain what petroleum fraction is heating oil obtained.

11) Explain from what petroleum fraction fuel oils such as Bunk 'C' fuel are obtained.

General Objectives:

In this section the student should study and understand the following:

f) gels and greases
g) synthetic lubricants
h) solid lubricants.

Specific Objectives:

The student should be able to:

1) Give four functions of lubricants.

2) Briefly explain the theory of lubrication.

3) Define coefficient of friction.

5) List the various categories into which lubricants are divided by the SAE grading system.

6) Explain what is meant by a multigrade oil.

7) Define absolute viscosity, S.U.S., centistokes and viscosity index.

8) Give an explanation of the three processes used in the preparation of a lubricating oil.

9) Explain the role of phenol in the manufacture of a lubricating

10) List four solvents used to extract asphalts or aromatic compounds.

11) Write the formulas of three wax solvents.

UNIT #12 - Manufacture of Modern Gasolines

Ref: Munro - "Chemistry in Engineering" Prentice-Hall Chp. 8

General Objectives:

Modern gasoline contains many tailor made hydrocarbons not found in crude oil. A number of different processes may be involved such as:

a) cracking
b) debutanization
c) stabilization
d) alkylation
e) polymerization
f) isomerization
g) treating
h) reforming and related procedures.

Specific Objectives:

The student should be able to:

1) Give a brief description explaining each of the above processes mentioned in the general objectives.

2) Name the products used as feedstock for the catalytic cracker.

3) Explain the difference between reformed gasoline and alkylate.

4) Define polymer gasoline.

5) Write the reaction between two molecules of Isopentene. Name the product.

6) Show how Isobutene reacts with n-propene.

7) Briefly explain what is casinghead gasoline.

8) Explain why inhibitors are added to gasoline.

9) Describe how thioalcohols (mercaptans) may be removed from gasoline and show equations.

10) Explain how hydrogen sulfide may be removed from oil and give equations.

11) Write the formula for butyl mercaptan.

12) Define what are Naphthas.