

UNIVERSITY OF RUHUNA

BACHELOR OF SCIENCE SPECIAL DEGREE LEVEL II EXAMINATIONS
DECEMBER 2017

SUBJECT: **Selected Topics in Industrial Chemistry**

COURSE UNIT: **CHE4482**

TIME: **Two (02) hours**

Answer **all** questions.

1. Answer **all** parts.

(a) "Use of safer solvents/auxiliaries" is one of the 12 principles of green chemistry. The use of super critical fluids such as supercritical carbon dioxide ($scCO_2$) is one of the approaches for safer solvents.

(i) Giving an example for each, name three other greener approaches for safer solvents.

(ii) Discuss advantages and disadvantages of using $scCO_2$ as a solvent in industry.

(30 marks)

(b) Consider the reaction scheme and the detailed procedure given below.

A stirred solution of allylamine (12 mL, 0.158 mol.) and Et_3N (22 mL, 0.158 mol.) in CH_2Cl_2 (200 mL) was cooled to $-78.^\circ C$ followed by the dropwise addition of acryloyl chloride (13 mL, 0.158 mol.). The reaction mixture was allowed to reach room temperature and after resting it for 24 hours, the precipitated salt was removed by filtration. The filtrate was then washed with aqueous solution of 0.1M HCl (100 mL) followed by extraction of the aqueous layer with CH_2Cl_2 (200 mL). The combined organic layers was dried over $MgSO_4$ (0.2 g) and concentrated *in vacuo* to give the desired compound (13.8 g) as slightly yellow oil.

Note: Density of CH_2Cl_2 = 1.33 g/mL, molecular weight of Et_3N = 101.19 g/mol, and assume that CH_2Cl_2 and Et_3N as non-benign materials.

By using above information, calculate the following;

- (i) Yield
- (ii) Atom economy
- (iii) E-factor
- (iv) PMI
- (v) EMY (ignoring water used)

(40 marks)

- (c).
- (i) Briefly discuss three cleaner production options that can be implemented by an existing industry.
 - (ii) Name three possible barriers that might be faced by an industry for cleaner production options

(30 marks)

2. Answer **all** parts.

(a) Briefly explain the following terms pertaining to rubber industry.

- (i) Vulcanizing process
- (ii) Synthetic rubber

(N.B. Draw structures where appropriate.)

(12 marks)

(b) Briefly comment on the statement “chain segment pattern exist in *natural rubber* is very different than that of polyethylene”.

(N.B. Draw structures where appropriate.)

(12 marks)

(c) List *typical varieties of additives* those are *essentially* included during the *industrial processing* to obtain the *desired characteristics* of the *finished rubber products*.

(16 marks)

(d) Identify the features of fillers those are typically added to rubber to meet *material property targets*.

(20 marks)

(e) Sketch a typical *process flow diagram* to illustrate “a *dry rubber processing methodology*”.

(20 marks)

(f) Sketch three (03) different *typical cure curve(s)* observe during *rheometer testing* of *master rubber batches* as a *quality control criterion* before the *vulcanization process*.

(i) In one of the diagrams mark the following areas;

- (I) Scorch time
- (II) Cure time
- (III) Post cure time

(ii) Briefly explain the significance of “*scorch time*”.

(20 marks)

3. Answer **all** parts.

(a) List the expected functions by application of paints.

(10 marks)

(b) Identify physical and chemical properties of pigments

(10 marks)

(c) Discuss *the following pertaining to paint industry.*

(i) Drying mechanisms

(ii) Criteria for the selection of different drier combinations in a paint formulation.

(30 marks)

(d) Compare and contrast the *dry cleaning process* with that of *conventional cleaning*.

(12 marks)

(e) (i) Write the IUPAC name of the solvent abbreviated as PERC, which is most commonly used for *dry cleaning process*.

(ii) Draw the *chemical structure* of the molecule (PERC) and briefly discuss the *cleansing action* in dry cleaning.

(12 marks)

(f) What are the main environmental impacts caused by using PERC in dry cleaning?

(13 marks)

(g) Write a short account on use of *dry ice* as a replacement for PERC.

(13 marks)

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