

NATIONAL EXAMS May 2005

98-CHEM-B6: PETROLEUM REFINING AND PETROCHEMICALS

3 hours duration

Notes:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper a clear statement of any assumptions made.
2. Candidates may use one of two calculators, the Casio or Sharp approved models. This is a Closed Book exam, however candidates are permitted to bring in one (1) aid sheet, 8.5x11" (both sides) which can contain notes and formulae.
3. Any five questions constitute a complete paper. Only the first five questions as they appear in your answer book will be marked.
4. All questions are of equal value (as indicated).

Question 1 (20 marks):

- (a) Sketch the layout of a typical Fluidized Catalytic Cracking Unit (FCCU), indicating the major pieces of process equipment and their function.
7
- (b) What is the typical catalyst used in FCCU operation?
2
- (c) What is usually produced with the extra heat obtained from the “full burn” operating mode in catalytic cracker operation?
2
- (d) Briefly describe the effect of catalyst/oil ratio and reactor temperature on FCCU operation.
3
- (e) What are the two standard catalysts for alkylation units?
4
- (e) Where does the thermal cracking occur in a delayed coker? How is this accomplished?
2

Question 2 (20 marks):

- (a) Why is hydrogen added to the Naphtha Reformer feed?
2
- (b) There are typically three beneficial types of reactions occurring in a Naphtha Reformer: saturation, isomerization, and dehydrocyclization. Briefly describe what chemical change each reaction causes, and the type of component (olefin, naphthene, paraffin) typically involved.

Now identify two types of undesirable reactions that decrease gasoline blending properties.
5
- (c) Identify three types of Naphtha Reformer processes.
3
- (d) Sketch a typical flowsheet for the Naphtha Reformer. Indicate the essential reaction, heating, and separation equipment.
6
- (e) Sketch the relationship between gasoline yield and octane number in a Naphtha Reformer.
3
- (f) What is the typical feedstock to the Naphtha Reformer?
1

Question 3 (20 marks):

- (a) What is the difference between an Equilibrium Flash Vapourization curve and a True Boiling Point curve?
2
- (b) Sketch a typical True Boiling Point curve for crude oil, and indicate the relative locations on the curve of the following fractions: naphtha, heavy vacuum gas oil, light atmospheric gas oil, heavy atmospheric gas oil, light vacuum gas oil, diesel. Identify which fractions are drawn from the Atmospheric distillation column, and which are drawn from the Vacuum distillation column.
4
- (c) Why do overlaps occur between two adjacent petroleum fractions? What does the overlap represent physically?
3
- (d) What is a PONA analysis?
2
- (e) Why is a vacuum distillation column used in the primary fractionation of crude oil?
2
- (f) Sketch the flowsheet of a typical refinery containing an atmospheric and vacuum distillation unit, fluid catalytic cracking unit, naphtha reformer, alkylation unit, light ends separation unit, and delayed coker. It isn't necessary to sketch the details of the individual units; rather, provide a sketch that shows the typical material pathways and sequence of the various units
7

Question 4 (20 marks):

- (a) The naphtha cracking process is frequently used to produce light olefins (e.g., ethylene, propylene, butylene) which represent major petrochemical feedstocks.
- (i) Briefly describe the separation sequence required to retrieve the individual light olefins from the cracker product.
5
- (ii) How is coking in the tubes of the naphtha cracker reduced?
2
- (b) Identify a feedstock other than naphtha that is used in cracking furnaces to produce ethylene.
2
- (c) What role does benzene play in the formation of Nylon 6/6?
2
- (b) How is styrene obtained from ethylene?). Identify any additional feedstock(s) required, and the general reaction conditions (e.g., liquid vs. gas-phase).
3

- (c) Briefly describe how vinyl acetate can be produced using ethylene. Identify any additional feedstock(s) required, and the general reaction conditions (e.g., liquid vs. gas-phase).
3
- (d) How is ethylene glycol obtained from ethylene using the oxidation route? Identify any feedstock(s) required, and the general reaction conditions required (e.g., liquid vs. gas-phase).
3

Question 5 (20 marks):

- (a) What is the MEROX process, and what streams does it usually treat?
2
- (b) How does hydrogen sulphide arise in refinery operation? Using a sketch, briefly describe the amine treating unit for a refinery gas stream. How does the refinery dispose of the hydrogen sulphide?
5
- (c) What is an API skimmer, and in which refinery unit is it found?
2
- (d) What is the primary function of the Visbreaker?
2
- (e) Which refinery unit produces a product stream rich in benzene, toluene and xylene (BTX)? How are these components typically extracted from this product stream, for separate sale?
4
- (f) Identify three sources of process water streams requiring treatment.
3
- (g) What is the desalter, and where is it usually found in a petroleum refinery?
2

Question 6 (20 marks):

- (a) What is the Reid Vapour Pressure? Which product usually has a Reid Vapour Pressure specification?
3
- (b) What are the definitions of Motor Octane Number and Research Octane Number?
3
- (c) Which product usually undergoes solvent dewaxing?
2
- (d) Name one property that is important for jet fuel, and provide a brief description of how this property is defined.
3
- (e) A regular gasoline is to be blended using the components listed in the table below. The target RON specification is 90. Using the information provided, determine the volume of Reformate required to meet the blending specification.
4

Blending Indices and Volumes

Component	Volume (barrels)	RON	MON
Hydrocrackate	3000	82.8	82.4
Alkylate	1000	89.7	89
Reformate	To be determined	98	91
Straight run naphtha	1000	79	78

- (f) What is the pour point of a petroleum product? Provide an example of a product for which pour point is measured.
2
- (g) The Isomerization Unit produces enhanced blendstock for a petroleum product. Please identify the product, and briefly describe how the Isomerization Unit enhances the blending properties. Please note that I am not asking you to describe the Isomerization Unit in detail.
3

TOTAL MARKS: 100

---- END OF EXAMINATION ----