EXAMINATIONS: NOVEMBER 2017

COURSE AND CODE: PETROLEUM & SYNTHETIC FUEL PROCESSING

DURATION: 2 HOURS

TOTAL MARKS: 100

INTERNAL EXAMINERS: PROF AH MOHAMMADI

INTERNAL MODERATOR: DR S MOODLEY

EXTERNAL MODERATOR: DR M CHETTY

INSTRUCTIONS:

1. **ALL** questions should be attempted.

2. Any programmable or non-programmable calculator may be used provided it has been cleared of any information that would subvert the purpose of the examination.

3. Calculations must be shown in sufficient detail to illustrate your understanding of the procedure.
QUESTION 1

a) Sketch a typical flow diagram for a natural gas refinery (Mention the feed, typical product, typical solvent/catalyst).

(8)

b) Which units are used in both natural gas processing and crude oil refinery?

(2)

TOTAL /10/

QUESTION 2

Define the following units with regard to the function, typical feed, typical product, and typical catalyst/solvent for the following processes:

- Hydrotreating Unit

(3)

- Merox Unit

(3)

- FCC Unit

(3)

- Visbreaking Unit

(3)

- Hydrocracking Unit

(3)

TOTAL /15/
QUESTION 3

a) Compare Isomerization and Alkylation processes for gasoline production (Compare their typical feed, typical catalysts and typical products). (3)

b) What is the main motivation of using Isomerisation and Alkylation units? (3)

c) Which one is more commonly used in crude oil refineries and why? (4)

TOTAL /10/

QUESTION 4

a) Define Synthetic Fuel and explain the different methods of its production. (9)

b) Which method(s) is(are) the most frequently used method(s) for producing synthetic fuels? (1)

TOTAL /10/
QUESTION 5

a) What is the main method for production of Synthetic Gas (Syngas)? (1)

b) Explain this method in terms of its typical feed, typical product, typical reactions and typical catalyst. (5)

c) Which other methods can be used for production of Synthetic Gas? (4)

TOTAL /10/

QUESTION 6

a) What is the main motivation of using a steam cracking process in a petrochemical complex? (2)

b) Which typical feeds are used in a steam cracker? (5)

c) Which typical fuels can be produced from a steam cracker and which one is most important? (3)

TOTAL /10/
QUESTION 7

List and explain two categories for coal liquefaction technologies and explain which method is commonly used in industry.

TOTAL /10/

QUESTION 8

a) What are the main roles of hydrogen in a crude oil refinery and in which units hydrogen is consumed?

(7)

b) Explain in which unit alkenes are produced as by-product and which unit uses alkenes as feed.

(3)

TOTAL /10/
QUESTION 9

Determine the amount of \( n \)-butane required to produce a gasoline blend with Reid Vapour Pressure (RVP) = 10 psi from the gasolines listed in the following table. The RVP of \( n \)-butane is 52 psi.

<table>
<thead>
<tr>
<th>Gasoline</th>
<th>Quantity/Volume (Barrel per day)</th>
<th>RVP (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isomerate</td>
<td>5000</td>
<td>5.12</td>
</tr>
<tr>
<td>Hydrocracking</td>
<td>3000</td>
<td>3.85</td>
</tr>
<tr>
<td>Alkylate</td>
<td>4000</td>
<td>5.52</td>
</tr>
<tr>
<td>Reformate</td>
<td>6000</td>
<td>4.33</td>
</tr>
</tbody>
</table>

Considering:

\[ BI_{RVP} = RVP_i^{1.25} \text{ and } BI_{RVP,\text{blend}} = \sum X_v \times BI_{RVP_i} \]

\( BI_{RVP_i} : \) RVP blending index for gasoline \( i \)
RVP\(_i\) : Reid vapour pressure (psi) for gasoline \( i \)
\( X_v \): volume fraction of gasoline \( i \)

TOTAL /15/