PRODUCTION OF ENVIRONMENTAL FRIENDLY FUEL IN INDONESIAN REFINERY

by

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1. INTRODUCTION

Worldwide crude supplies are experiencing a modest trend toward heavier and high sulfur content[4]. The average annual demand growth rate for light products (gasoline, kerosene and diesel oil) is higher than that for residual fuel oil[2]. Therefore, converting additional bottoms into light product by either thermal or catalytic processes will be needed.

Vehicles and fuels have been developed simultaneously and nowadays vehicles demand a very sophisticated fuel indeed. Environmental restriction, and efforts to minimize the pollutant problem by exhaust gases are causing design and changes in cars that in turn are having some effects on fuel quality.

To reduce exhaust emission by fuel combustion, the specification of gasoline and diesel oil is now stricter. Various term in the models address qualities of the reformulated gasoline, such as benzene, total aromatics and olefin content, RVP, the T_{90} of distillation range, sulfur content, and oxygenate contents (Table 1)[18,13,16]. Diesel oil specification is limited as follows: aromatics, polyaromatics, sulfur content, T_{90} and cetane number (Table 2) [19,23,26]

To improve the specification of commercial gasoline into the stricter specification of reformulated gasoline, refiners are forced in install new facilities to increase the production for high-octane mogas components. For the stricter diesel oil specification in the years 2000's,

Table 1
Specification of reformulated gasoline and commercial gasoline of Indonesia

Items	Unit	WWFC				California			Europe		Indonesia
		Cat. 1	Cat. 2	Cat. 3	Cat. 4	Phase 1	Phase 2	Phase 3	2000	2005	
RVP	kPa	60	60	60	60	7.8*	7.0*	7.0*	7.0	7.0	62
T50	oC	100	100	100	100	100	99	100.5	-	-	125
T90	oC	175	175	175	175	165	149	152	-	-	180
Benzene	vol.%	5	2.5	1	1	1.7	1	0.8	1	TBD	-
Aromatic	vol.%	50	40	35	35	32	25	25	42	35	-
Olefins	vol.%	-	20	10	10	15	6	6	18	TBD	-
Sulphur	ppm.w	1000	200	30	Sulfur free	300	40	20	150	50	2000
Oxygen	wt.%	2.7	2.7	2.7	27	-	1.8-2.0	-	2.7	TBD	2.0
Lead	g/l	0.013	-	-	-	-		-	-	-	0.3

Note : TBD = To be decided during 1999
(*) = in psi

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Table 2
Specification of clean diesel oil commercial diesel oil of Indonesia

Items	Unit	WWFC				CARB 1993	EU		Asia Pacific 2000	Indonesia
		Cat. 1	Cat. 2	Cat. 3	Cat. 4		2000	2005		
Cetane number		48	53	55	55	48	51	TBD	47.0	45
Density	kg/cm^3	860	850	840	840	-	845	TBD	-	-
T90	°C	-	340	320	320	290-320	-	-	357	-
T95	°C	-	-	-	-	-	370	360	-	-
Aromatics	vol.%	-	25	15	15	10	11*	TBD	-	-
Polyaromatics	vol.%	-	5	2	2	1.4	-	-	-	-
Sulphur	ppm.wt	500	300	300	Sulfur free	500	350	350	500	5000

Note : WWFC = World Wide Fuel Charter
CARB = California Air Source Board
EU = European Union
TBD = To be decided during 1999
(*) = % per mol of total aromatics

over 50% by volume of the total gas oil components (except hydrocracked gas oil) must undergo improvement by hydrotreating processes in order to achieve a suitable specification.

In Indonesia, there are seven refineries with total crude oil capacity of 1,063 MBCD to produce fuel oils, lube base stocks and petrochemical products. Processing units and fuel oil production in Indonesia's refineries are given in Table 3 and 4, respectively. The production of gasoline and diesel oil components is review in this paper. Influence of hydrocarbon composition of those fuel components on their performances is discussed. A brief discussion is offered on the impact of the changing specification of gasoline and diesel oil on the refinery configuration.

II. FUEL PRODUCTION IN INDONESIA'S REFINERIES

A. *Production of Gasoline*

Gasoline blending components are essentially complex mixtures of hydrocarbons distilling between about 30°and 210°C which consist of compound generally in the rang C_4 and CA_{12}. These gasoline components can be produced by both the distillation of crude oil and the conversion crude oil fraction i,e. cracking, reforming, isomerization, alkylation and polymerization processes.

Low octane level of heavy naphtha of crude distillation, thermal cracking and hydrocracking processes must be improved by catalytic reforming process. Catalytic hydroisomerization process can increase the low octane level of light naphtha produced by those processing units. Unsaturated hydrocarbons (olefins and diolefins) of polymer gasoline, thermal reformate and thermal cracked gasoline are generally unstable and will undergo oxidation/polymerization reaction with dissolved air, forming what is known as gum.

Reformate has low-octane paraffin components in the lower boiling end and may comprise quite-octane aromatic components at higher boiling end. C_5 and C_6 isoparaffins of light isomerized gasoline can provide excellent high-octane components in the lower boiling end gasoline. They are useful to supplement those lower boiling-end reformates in producing high octane components of high branched structure of both paraffins and olefins at its lower boiling end, and contain also a high-octane aromatic components at higher boiling end of this gasoline. Alkylate contains nearly 100 percent of high-octane level, with high branched paraffins throughout its boiling range. Thus both catalytic cracked gasoline and alkylate would have a good octane distribution. Typical octane values for some process streams used in gasoline blending is given in Table 5[22].

Table 3
Processing units for producing gasoline and diesel oil components in Indonesia's refineries in MBCD

Items	UP I P. Brandan	UP II Dumai	UP III Plaju	UP IV Cilacap	UP V Balikpapan	UP VI Balongan	UP VII Kasim	Total
Crude distilling unit	5.0	170.0	135.0	348.0	270.0	125.0	10.0	1.063
High vacuum unit	-	92.6	40.7	36.6	94.0	-		263.9
Visbreaker	-	-	-	55.0	-	-		55.0
Delayed coker	-	35.0	-	-	-	-		35.0
Catalytic cracking	-	-	20.5	-	-	83.0		103.5
Hydrocracker	-	55.0	-	-	55.0			110.0
Reformer	-	18.1	-	49.0	15.7		2.0	84.8
Alkylation	-	1.6	-	-	-			1.6
Polymerisation	-	2.4	-	-	-	13.0		15.4
ARHDM	-	-	-	-	-	58.0		58.0
Hydrotreating								
- Naphtha	-	-	-	54.4	16.0		2.0	72.4
- Distilate	-	-	-	26.3		47.0		96.0

Note : UP = PERTAMINA refinery

Table 4
Fuel oil products of Indonesia refineries

Items	UP I P. Brandan	UP II Dumai	UP III Plaju	UP IV Cilacap	UP V Balikpapan	UP VI Balongan	UP VII Kasim	Total
Feedstock (crude)	5	170.0	135	348	270	125	10	1.063
Products								
LPG	-	2.38	3.03	4.78	4.34	12.03	-	26.56
Avigas	-	-	0.21	-	-	-	-	0.21
Avtur	-	9.36	1.68	3.40	7.91	-	-	22.35
Gasoline	-	15.59	20.01	59.55	41.90	51.84	-	188.89
Kerosene	0.85	21.89	18.15	62.03	40.35	16.49	1.46	161.02
Diesel oil	0.75	82.10	25.55	70.37	78.49	18.89	1.61	177.76
IDO	-	-	1.68	9.97	3.92	10.29	-	25.86
IFO	0.29	-	26.24	73.42	-	-	-	99.95
Others	1.81	38.88	27.15	64.48	83.09	15.46	3.93	234.80
Total	3.70	170.00	123.70	348.00	260.00	125.00	7.00	1.037.40

Note : UP = PERTAMINA refinery

Table 5
Typical octane values for some process stream in gasoline blending

Gasoline componrnts	RON	MON
Butane	93	92.0
Straight-run naphtha		
- Light naphtha	66	62
- Heavy naphtha	62	59.0
Coker naphtha	85	77
Cat. Cracked gasoline	92	97.00
Hydrocraked naphtha		
- Light naphtha	75	74
- Heavy naphtha	79	76
Reformate	94-100	84-88
Isomerate	88-89	81-87
Alkylate	97	96
MTBE*	115-123	98-105

Note : (*) = MTBE = Oxygenates, as octane booster

Motor octane number (ON) is considered to be especially important for the absence of speed limits encourages a high proportion of high-speed driving. Road-ON under constant speed full throttles conditions, is as follows[22].

$$Road\text{-}ON = 0.25\ RON + 0.75\ MON$$

In general, MON will be the limiting factor for blending unleaded premium, which consists of reformate and cat cracked gasoline having high sensitivity (difference between RON and MON). Therefore, the low sensitivity gasoline components such as alkylate and isomerate must be added into unleaded premium blend to get the unleaded premium with low sensitivity of around 10. The components of the gasoline pool in a refinery vary for each specific case. An average composition in the refineries is shown in Table 6[1,5].

In indonesia is refineries about 1,063 MBCD crude oils are processed to produce about 189 MBCD of gasoline, which consists of the following gasoline components: straight-run naphtha, coker naphtha, cat-cracked gaso-

Table 6
Typical composition of blended gasoline

Gasoline components	1	2	3	4	5	6	7
Blending butane	5,5		7	-	-	-	-
Straight-run							
- Light naphtha	-	2,0	-	-	16,0	2,0	-
Coker gasoline	-	1,0	-	-	-	-	-
Cat. Cracked gasoline	34,5	40,0	68,4	-	-	39,0	38,0
Hydrocracked naphtha	1,5	-	-	-	-	-	-
Reformate	33,5	30,0	-	65,0	76,0	30,0	37,0
Isomerate	10,0	12,0	-	35,0	-	-	11,0
Alkylate	12,5	12,0	17,7	-	-	11,0	14,0
Dimate	-	-	-	-	-	11,0	-
Polygasoline	-	3,0	-	-	-	-	-
MTBE	2,5	-	6,7	-	8,0	7,0	-

Note : 1 = Potential U.S. Gasoline pool 1995
2 = Average U.S. Gasoline pool refinery
3 = Olefins mode FCC with MTBE
5 = Unleaded gasoline in Brunei revinery
6 = Unleaded gasoline in Singapore
6 = Reformulated gasoline

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line, hydrorocracked naphtha, reformate, alkylate and polygasoline. High-octane mogas components comprise about 50 vol. % of those total gasoline components, which consist of the following components : cat cracked gasoline 49.05 vol.% reformate 41.93 vol.%, alkylate 0.56 vol.% and polygasoline 8.46 vol.%. specification of commercial leaded premium 88 is shown in Table 1[8]. RVP, T_{50} and T_{90} and sulfur content specified for commercial gasoline Indonesia are higher than those for reformulated gasoline proposed in the USA or Europe . phasing out leaded gasoline is planned for Jakarta to be lead free by July 2001 and the whole country by January 2004. To compensate for eliminating of lead Indonesia has turned to oxygenate compounds, particularly MTBE at the level of 10-15 vol.%, as octane booster.

Indonesia's gasoline pool leans too much to reformate and catalytic cracked gasoline for its pool octane and lack in alkylate and isomerate. However, like many refiners in the world, Indonesia's refineries are in the process of upgrading many to its refineries base on the distribution of gasoline components in gasoline pool. About 50 vol.% of the total gasoline components in Indonesia's refineries has low octane naphtha components, which consists of straight-run naphtha, coker naphtha and hydrocracked naphtha, must be converted by isomerization and reformer processes to produce isomerate and reformate, respectively. Catalytic reforming process converts low octane number of heavy naphtha into the gasoline range with high octane number . The increase in the octane number of these low-octane naphtha reformer feed can therefore be regarded as the transformation of naphthenes and paraffins into aromatization and are quided by metal and acid sites of the bifunctional (bi-and/ or polymetallic) reforming catalyst (9,10) .

Isomerization of low octane light naphtha (C_5-C_6) can provide excellent hight octane isomerate component in the lower boiling end of gasoline. Paraffin isomerization is guided by bifunctional catalyst containing both metal and acid sites(11). Blending isomerate with reformate would produce blended gasoline with both high octane number and high- octane distribution .

The major source of benzene in the gasoline pool is the reformate, only minor contributions of benzene come from light straight- run naphtha, light hydrrocracked, and light cat cracked gasoline. Cat cracked gasoline and coker naphtha are

Table 7
Contribution of RVP, T90, benzene, total aromatic, olefin and sulfur contents in gasoline pool

Gasoline components	RVP	T90 over 330°F	Benzene	Total aromatic	Sulfur
Butane	13	-	-	-	-
Coker Naphtha	-	-	-	-	2
Cat. Cracked gasoline					
- Light gasoline	32	-	-	12	12
- Heavy gasoline	2	63	-	20	86
Hydrocracked naphtha	-	-	11	-	-
Reformate	24	33	78	68.0	-
Isomerate	16	-	-	-	-
Alkylate	7	4	-	-	-
Others	-	-	1.0	-	-

Table 8
Typical aromatics distribution of straight-run and light cycle gas oil

Aromatics distribution	Straight-run gas oil vol.%	Light cycle gas oil vol.%
Total aromatic	20-35	50-70
Mono aromatic	15-30	15-May
Di-aromatic	25-May	40-50
Tri-aromatic	0-5	38482.0
Typical cetane index	>50	>28

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the major sources of olefins in the gasoline pool. Most of the olefins in the cat cracked and coker naphtha are light olefins that are in the C_5, to C_6 range. More than 90% of the total sulfur in the gasoline pool comes from catalytic cracked gasoline, and about half of wich is in the least 10 vol % of this cat. cracked gasoline. Heavy cat. cracked naphtha and reformate are the major sources of T90 in the gasoline pool. The major sources of RVP in the gasoline pool are light cat. cracked naphtha, reformate , isomerate and butane. (Table 7[25].

For preparation of reformats and cat. cracked gasoline components the meet the stringent specification of reformulated gasoline, deep prefractionater column and hydrotreating process will be needed.

Table 9
Cetane number and specific gravity of diesel oil components

Diesel oil components	Specific gravity 60/60°F	Cetane number
Butane	93	92.0
Straight diesel oil		
- Paraffinic	0.812	62.0
	0.823	57.0
	0.839	54.0
	0.845	50.5
- Inter mediate	0.869	41.0
- Naphatenic	0.889	32.5
Thermal cracked diesel oil	0.878	45.0
Catalytic cracked diesel oil	0.847	47.0
	0.851	39.0
	0.872	35.5
Hydro cracked diesel oil	0.823	62.0

B. *Production of Diesel Oil*

Diesel oil is middle distillate used as fuel for compression (diesel) engine. The normal boiling rang for the middle distillate or gas oil . is 250°C to 370°C. High speed diesel may use oils with initial boiling point as low as 140°C. The 50% distillation point should not exceed 300°C.

Diesel oil produced in the refineries generally consists of predominantly straight- run gas oil, obtained from the fractional distillation of crude oil; howefer, compounds such as thermally and catalytically cracked diesel oils are sometimes included.

Table 10
Sulfur content of diesel oil components and their used feedstock

Diesel oil components	Sulfur content, wt%	
	Feedstock	Gas oil product
Straight-run diesel oil	1.15	1.05
	2.01	0.90
	3.10	1.45
	3.15	1.85
Thermal cracked diesel oil	2.35	1.05
	3.35	2.85
Catalytic cracked diesel oil	1.50	0.75
	1.85	1.55

The quality of straight-run gas oil, such as hydrocarbon types, sulfur or paraffin content, will in general reflect the nature of crude oil. Sulfur content of straight-run gas oil increase with sulfur content of the crude oil. Cetane number of straight-run gas oil, depended by the type of used crude oils, i,e. paraffinic crude oil > intermediate crude oil > naphthenic crude oil.

Cracked stock, either thermal or catalytically cracked gas oil, contain higher percentage of aromatic and olefin hydrocarbons than those the straight-run gas oil. Sulfur content of those cracked gas oil increase with boiling ranges. Naphthenic straight-run gas oil and or catalytic cracked gas oil, contain higher percentage of the aromatic hydrocarbons than those the paraffinic straight-run and hydrocracked gas oil. Total aromatic content and its aromatic distribution of various gas oil components are given in Table 8[24].

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The high diesel index of hydrocracked gas oils due to the conversion of undesirable polycondansed nepthenes and aromatic component of feedstock into the preferred diesel oil molecules structures. Saturation of polycondensed aromatics, opening of some of the naphthenes rings and cracking of paraffins are guided by bifunctional hydrocracking catalyst[12,13]. Cetane number and sulfur contents of various types of diesel oil components are presented in Tables 9 and 10[14,15].

Reducing the specific gravity and viscosity of gas oil by hydrotreating process gives a fine atomatiozation of injected fuel, wich induces a high ability of the fuel to find oxygen in the combustion chamber. Stability is also important particularly for long period storage of gas oil, an this related to its olefin component which is prone undergo oxidation/polymerization reacting, forming what is knows as gum.

In Indonesia's refineries, over 1,063 MBCD crude oils are processed to produce about 277 MBCD of diesel oil wich consists of the following gas oil components: straight-run gas oil, visbroken gas oil, coker gas oil, cat cracked gas oil and hydrocracked gas oil. Specification of commercial gas oil shown in Table 2[8]. Commercial diesel oil in Indonesia is specified low cetane number and light sulfur content than those for clean diesel oil proposed in the USA and Europe.

To meet the more stringent specification of reformulated diesel oil, upgrading treatment for low performance gas oil components: i,e non-paraffinic straight-run gas oil, visbroken gas oil, coker gas oil and cat cracked gas oil must be carried out in Indonesia's refineries.

By hydrogenation of the refractory dinuclear aromatics to tetraline than it converts into components that crack readly to monocyclic aromatics. The most refractory substituted heterocyclic compounds are usually associated with aromatic, which have higher density. A cracked gas oil component is more difficuklt than those straight-run gas oil to hydrotreat because of its higher thiophenic sulfur and the multi-ring organic sulfur contents[16,17].

Process technology currently being selected to meet the more stringent specification of reformulation diesel oil included hydrocracking, hydrotreating, and aromatic saturation. Refiners with hydrocrackers are in the best position to produce low aromatic and sulfur diesel oil that reduce the aromatic and sulfur level in the overall diesel pool. Deep hydrodesulfurization of straight-run diesel or cuts from other converision units such as thermal and catalytic cracking processes can produce 0,05 wt. % sulfur products.

C. *Fuel Specification for Environmental Need*

Indonesian government takes a serious concern for environmental friendly fuel to meet the globalization specification i.e. the restrictive environment consideration. The government is planning to issue the regulation that implementing the *World Wide Fuel Charter Category 2 (Euro-2)* specifications for gasoline and diesel fuel (Table 11 and 12). Issued in year order to reduce the air pollution due to the fuel combustion in vehicles' engine. Therefore, the refineries take an important role in production of such fuel specification.

Table 11
World wide fuel charter specification of category 2 (Euro-2) for gasoline that published in December 2002

Gasoline	Category 2
RON, min	95
MON, min	85
(MON+RON)/2	-
Lead, g/l, max	0
Sulphur, ppm, max	200
Manganese, g/l, max	0
Phosphorus, g/l, max	2.5
Aromatics, vol%, max	40
Olefins, vol%, max	20
Oxygen content, wt%, max	2.7
RVP @ 37.8°C, kPA, min-max	45 - 105
Density @ 15°C, kg/m^3	715 - 770
Distilation, °C	
- IBP, min-max	-
- T10, min-max	45 - 65
- T50, min-max	77 - 100
- T90, min-max	130 - 175
- FBP, max	195
Distilation, vol%	
- E70, min-max	15 - 47
- E 100, min-max	50 - 70
- E150, min-max	-
- E180, min-max	90 min
- Residue, vol%, max	-

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III. CONFIGURATION OF REFINERY FOR PRODUCTION OF REFORMULATED FUELS

A. *Production of Reformulated Gasoline*

Production of reformulated gasoline can be realized by increasing the performances of prefractionation, fractionation of reformate and cat, cracked gasoline, and FCC units[20,21].

Prefractionation

In some refineries 1.0 vol. % maximum benzene specification can be met simply by diverting the benzene in the crude, along with benzene precursors such as methyl cyclopentane and cyclohexane, around the catalytic reformer (Figure 1).

In those plants, the benzene in gasoline from the fluid catalytic cracking (FCC) unit, plus the benzene formed in the reformer from components heavier than those normally identified as benzene precursors, will produce less than 1% benzene in any of the gasoline blends and in the average gasoline pool. The prefractionator overhead is combined with light straight run gasoline and feed to the isomerization unit, where the benzene is converted to other compounds. Prefractionation also can reduce T_{90}, if required. Preaparing a heart cut to the reformer has an advantage over cutting the T_{90} of the reformate.

Reformate fractionation

The additional precautions that may be required involve reformate fractionation. Some refineries producing reformulated gasoline will extract benzene as a means of reducing gasoline benzene content. Others will feed reformate light front-end (LF) to a benzene, as opposed to extracting it or simply prefractioning "deeply" to avoid producing benzene (Figure 2).

Catalytic Cracked Gasoline Fractionation

Refiners are designing and building catalytic cracked gasoline fractionators for a variety of reasons.

Fractionation is required to prepare feed for MTBE and TAME units and to comply with the reduced T_{90} specification (Figure 3). In at least one plant, peantanes will be hydrotreated for sulfur and olefin reduction before being blended into gasoline.

The most flexible approach for compliance with blend and pool maximal for olefins, sulfur, and T_{90} specifications appears to be hydrotreated a carefully selected portion of heart cut from full-range cat. cracked gasoline. With this scheme, all there specification can be met

Table 12
World wide fuel charter specification of category 2 (Euro-2) for diesel that published in December 2002

Diesel	Category 2
Cetane number, min	53
Cetane index, min	50
Sulfur, ppm, max	300
Density @ 15°C, kg/m^3 min-max	820 - 850
Viscosity @ 37.8°C, csT, min-max	-
Distilation, °C	
- T50, min-max	
- T85, min-max	340 max
- T90, min-max	355 max
- T95, min-max	365 max
- End point, max	-
Total aromatics, vol%, min-max	25
Palyaromatics, wt%, min-max	5
Flash point, °C, min	55
CCR, 10%, wt%, max	0.3
Pour point, °C, max	≤ the lowest ambient temperature
Could point, °C, max	≤ the lowest ambient temperature
Water and sediment, vol%, max	-
Water, vol, max	0.02
Ash, wt%, max	0.01
Total acid No., mg KOH/g, max	0.08

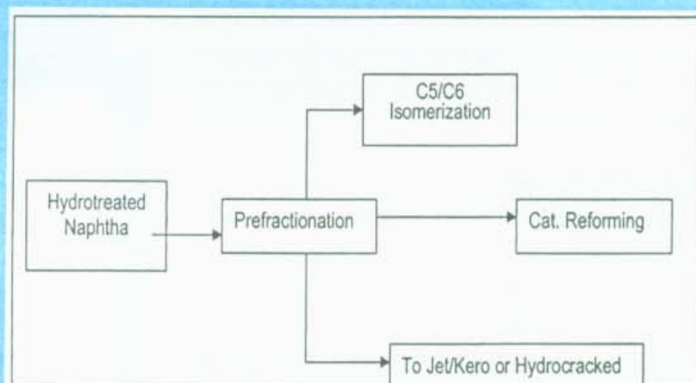

Figure 1
Prefractionation tower for production of reformulated gasoline

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by controlling the fractionators, assuming there is also a cat feed hydrotreated to meet the 40 ppm maximum sulfur cpecification for reformulated gasoline.

The heart cut is fashioned to match the process units employed. For example, the front end could be cut to send amylenes to alkylation or TAME, and the back end to meet the T_{90} requirement. The bottoms form the FCC gasoline fractionators (the T_{90} + cut) will be blended into jet/kerosene or diesel. As with the bottoms from reformate fractionation, these bottoms might require dearomatization.

High-Olefin Catalyst of FCC Unit

New catalysts are capable or producing more olefins without increasing dry gas production. The obovious advantage of these catalysts is increased production of alkylate, MTBE, or tertiary amyl methyl ether (TAME), increasing alkylate production replaces and dilutes aromatics in the blends.

The shift in cat cracked yield distribution can be at the which is normally detrimental to overall economics. Consequently, refiners are carefully to evaluate dehydrogenation unit to increase available isobutylene for MTBE production. Catalytic feed hydrotreates have been justified most often on the basis of improved cat cracked gasoline yield and to meet the gasoline sulfur specification.

B. *Production Of Clean Diesel Oil*

Process technologies currently being selected to meet clean diesel oil include: hydrocracking to produce low sulfur diesel oil and hydrotreating to reduce sulfur and unsaturated hydrocarbons (olefins and aromatic)[7,22].

Hydrocracked Unit

Hydrocracking process is a combination of desulphurization and conversion developed primary to process feed having a high content of unsaturated hydrocarbons (olefins and polyromatics) and non-hydrocarbons compound (sulfur and nitrogen compounds) with bifunctional Ni-Mo/Al_2O_3-SiO_2 or Ni-Mo/Al_2O_3-SiO_2 catalysts. A variety of bifunctional catalysts and processing designs may be used commercially depending on the feedstock used and the desired products (Figure 4).

Hydrocracked gas oil is in the least position to produce < 0,05 wt% sulfur diesel oil. The production light cycle oil will require and added aromatic saturation step to meet the 10 vol. % maximum aromatic in diesel specifications. The heavy gas oil form coking, and catalytic cycle oil are more difficult to hydrocracked than the same fraction derived from crude, because of their higher content of polycyclic aromatic hydrocarbons (Figure 3). Thus, the production of diesel from those cracked feeds, will require an added aromatic saturation step. Hydtrocracking of heavy distillate

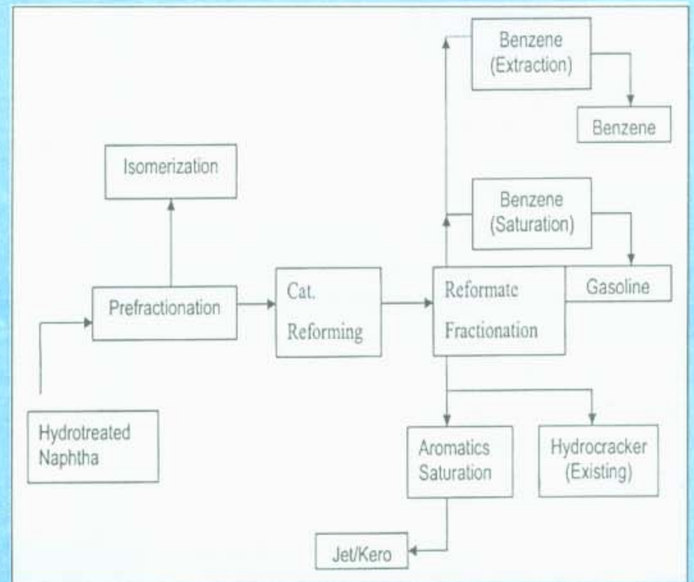

Figure 2
Reformate fractionation of reformulated gasoline

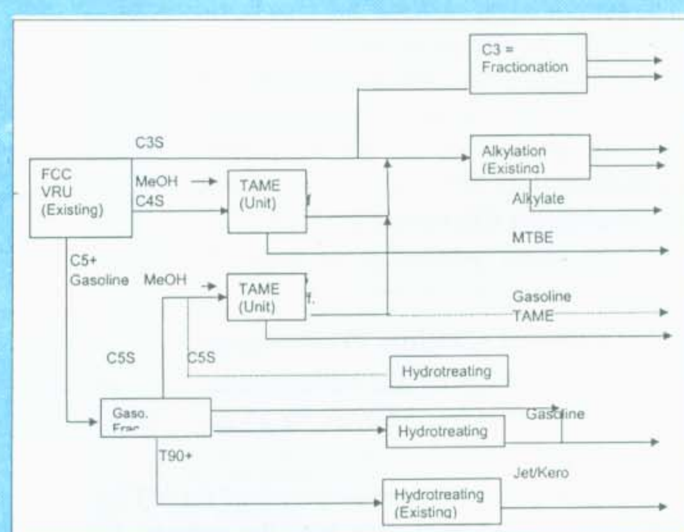

Figure 3
Cat. cracked gasoline fractionation for production of reformulated gasoline

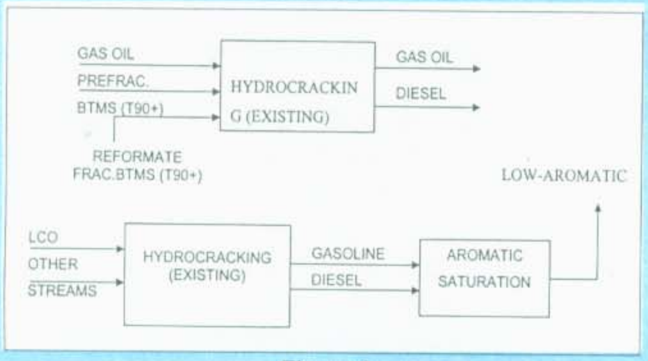

Figure 4
Hydrotreating process for production of reformulated diesel oil

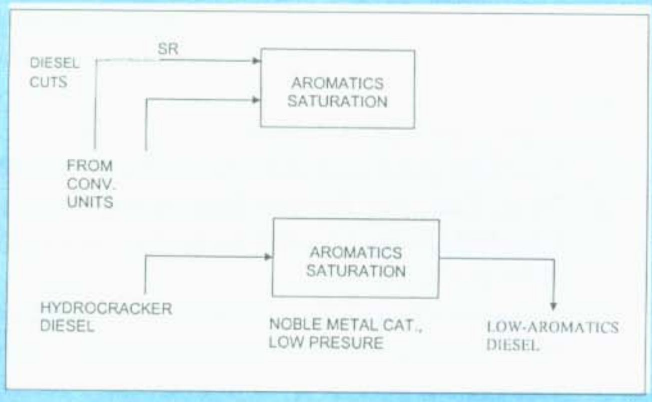

Figure 5
Hydrotreating process for production of reformulated diesel oil

feedstock may produce clean diesel oil products containing sulfur impurity of up to 0,005 wt.% and undesired aromatic hydrocarbons of single-ring aromatics up to 12,5 wt. % and multi-ring aromatics up to 4,5 wt.%.

Hydrotreating Unit

Catalytic hydrotreating process reduces both sulfur and unsaturated hydrocarbons (olefins and aromatics), and improves color and stability, as well as burning characteristic so that they meet the stringent specification required for high performance gas oil and automotive diesel oil (Figure 5).

Cracked gas oil is more difficult than those straight-run gas oil to hydrotreat because of its higher thiophenic sulfur and the multi-ring organic sulfur content. Cracked gas oil has a higher improvement of both cetane number and specific gravity than those straight-run gas oil because most of its higher heavy aromatics are saturated.

With the increasing both crecked stock portion in the diesel oil pool and the stringent diesel oil specification, i.e. sulfur content < 0.05wt.%; total aromatics from 10 to 20 vol.% with polycyclic aromatic d•1,4wt.% and cetane number e" 48, the gas oil, hydrotreating process will play a more important role.

Deep hydrodesulfurization process of straight-run diesel, or cuts from other conversion units such as thermal and catalytic cracking processes; can produce 0,05 wt.% sulfur products. The traditional hydrotreating processes is still dependent on a single-stage reactor system that combines severe operating conditions with hydrogenation using a single catalyst type such as Co-Mo/Al_2O_3. the other process is duel-stage reactor in which the hydrodesulfurizing step with Co-Mo/Al_2O_3 catalyst, is followed by hydrocarbon saturation step using Ni-Mo/Al_2O_3 or Ni-W/Al_2O_3 catalyst[3]. The pressure of this duel-stage system is much lower at around 50 kg/cm^2 as compared to above 80 kg/cm^{2}for the single-stage system. Details of this option are outlined in the diesel from hydrocracking and low-aromatics diesel flow schemes and presented in Figure 4[6].

IV. CONCLUSION

A total 1,063 MBCD of crude oil is currently processed in Indonesia's refineries to produce about 188 MBCD of gasoline and 227 MBCD of diesel oil.

With the more stringent specification of reformulated fuels in Asia-Pacific region in the year 2000's, Indonesia's refineries must be developed to increase the performance of low octane naphtha to high octane mogas components, and to improve the performance of diesel oil components in order to be further capable of producing reformulated gasoline and diesel oils.

Production of reformulated gasoline can be realized by increasing the performances of prefractionation, fractionation of reformate an cat. cracked gasoline, and by increasing the capacities of catalytic cracking, isomerization and alkylation units.

Process technologies currently being selected to meet clean diesel oil include: hydrocracking to produce low sulfur diesel oil, hydrotreating to produce sulfur and unsaturated hydrocarbons (olefins and aromatics).

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