

Crude oil sourcing: price and opportunity

Sourcing crudes for the best refining margin needs to be supported by a detailed procurement strategy

MISHA GANGADHARAN, S D POHANEKAR and M D PAWDE
Hindustan Petroleum Corporation Limited

The world's crude oil market includes not only spot markets featuring physical transactions but also highly developed paper markets, notably futures and forward delivery, thus forming a very composite market structure in which all these transactions are interrelated and reciprocally influential. The variation in prices between two grades can influence refinery margins significantly if corrective action is not taken at the appropriate time. Therefore identifying and procuring crude oil that results in maximum margins are the industry's top priorities. In this article, various aspects relating to crude oil procurement for optimisation of refinery margins are outlined.

How the oil market works

The price of oil is set in the global marketplace. Oil is traded widely all around the world and can move from one market to another easily by ship, pipeline or barge. Therefore the market is worldwide and the supply/demand balance determines the price for crude oil all around the

world. If there is a shortage of oil in one part of the world, prices will rise in that market to attract supplies from other markets until supply and demand are in balance. If there is a surplus in a region and the price drops, buyers will soon be drawn to that market. This explains why crude oil prices are similar all around the world. Prices vary only to reflect the cost of transporting crude oil to that market and the quality differences between the various types of oil. The global nature of the market also explains why events anywhere in the world affect oil prices in every market. Several key factors influence the oil price, however the four major factors that help in determining the price of oil are supply, consumption, financial markets and government policies.

As per the basic principles of economics, prices will be low if supply exceeds demand, and the reverse applies: an increase in consumption over supply will lead to an increase in prices. However, crude oil pricing goes far beyond just supply and demand. The way oil is

traded on the financial markets has a massive influence on its price. Similar to the stock market, people also trade in crude oil as a commodity in financial markets. They purchase 'futures' – essentially bets on how much oil will cost at a later date – and this in turn affects how other people think oil should be priced. It also affects how much oil the petroleum companies will release to the market. Oil trading in financial markets has been growing bigger than ever in recent years. As a result, speculation has come to shape the price of crude oil more than ever before. Crude oil trading in financial markets has a surprising effect on crude oil prices – speculators who buy large amounts of futures can swing the price one way or another. Here is an example: a speculator who buys oil futures at a price higher than the current market price can cause oil producers to hoard their oil supply so they can sell it later at the new, higher 'future' price. This cuts the current supply of oil in the market and drives up both present and future prices.

Government regulation also

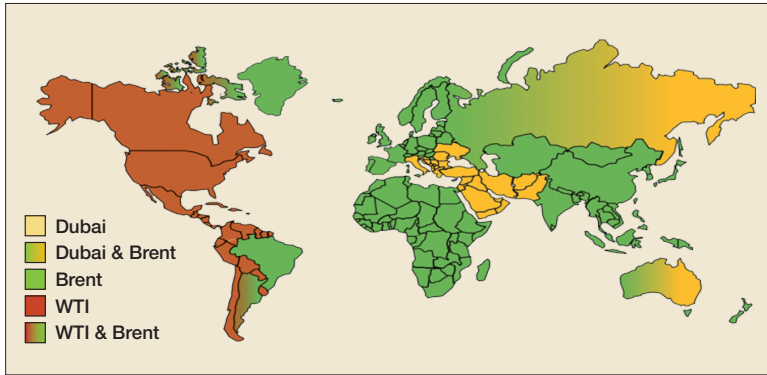


Figure 1 Marker crudes by area

has a big impact on oil prices. Rules and regulation on the sulphur content of fuel could raise demand for low sulphur crude oil. The incentive for fuel efficient cars, development of more efficient alternate modes of transport and so on will lead to demand for oil prices to go down, simply because the world will not need it as much. Thus selection

of crude oil for processing at a refinery is always dynamic and crude oil that was most desirable from a margin point of view can be less attractive after a few months.

Pricing and marker crude oil grades

The price payable for crude oil is calculated based on the marker crude oil price plus or

minus a price adjustment factor, which is set by the seller, or is mutually agreed between the buyer and the seller. While the marker crude oil price varies with events in international markets, including speculations, the adjustment factor is decided by the seller, taking various elements into account like quality difference with the marker crude, transportation cost difference with alternate grades, demand supply balance, competition from other suppliers/grades, and so on.

There are different crude oil markers, each one representing crude oil from a particular part of the globe. The marker crude oil is specific to the market and three major markers used in pricing of crude oil across the globe are WTI (Western Texas Intermediate) for the US market, Brent for the European/West African Market and Oman/Dubai for crude oil grades in the Persian Gulf for the Asian market. The applicability of marker crudes across the globe is shown in Figure 1. The details of each of the markers are:

Dubai/Oman: this Middle Eastern crude is a useful reference for oil of a slightly lower grade than WTI or Brent. It is heavier and has a higher sulphur content, putting it in the 'sour' category. Dubai/Oman is the main reference for Persian Gulf oil delivered to the Asian market.

Brent Blend: about two-thirds of all crude oil contracts around the world are marked to Brent Blend, making it the most widely used marker. 'Brent' actually refers to oil from four different fields in the North Sea: Brent, Forties, Oseberg

Characteristics of marker crude types

Key property	Brent	WTI	Dubai	Oman
API	37.5	39	31.4	30.4
Sulphur, wt%	0.45	0.3	1.54	1.45
Pour, °F	30	-0.4	-11	-33
Acid number, mg KOH/gm	0.01	0.09	0.05	0.61

Table 1

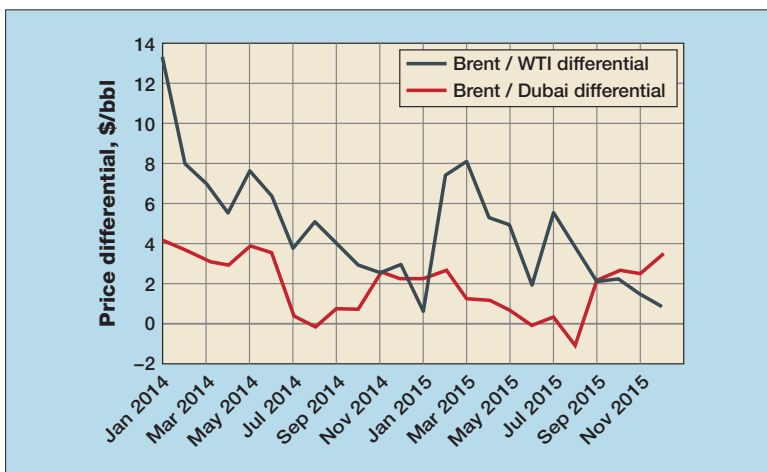


Figure 2 Price differential movements between marker crudes

and Ekofisk. Crude from this region is light and sweet, making it ideal for the refining of diesel fuel, gasoline and other high-demand products. The supply is waterborne and thus it is easy to transport to distant locations.

West Texas Intermediate (WTI): WTI refers to oil extracted from wells in the US and transported via pipelines. The crude is very light and very sweet, making it ideal for gasoline refining in particular. WTI continues to be the main benchmark for oil consumed in the US. The characteristics of these marker crude oil grades are shown in **Table 1**.

Figure 2 indicates how price differentials between marker crude oil move for various reasons, swinging sourcing decisions for a refinery.

Determination of marker crude oil price

The determination of a marker crude oil price varies between suppliers, and the various ways of determining marker crude oil price are: bill of lading (B/L) month average, five days around B/L, nominated month average, or as agreed between buyer and seller. Thus while finalising the sourcing of marker crude oil, determination of its price must also be kept in mind. **Table 2** indicates marker crude oil price determination methodologies followed by various national oil companies for supply to Asia, as well as the time of announcing the price adjustment factor.

Price adjustment factor, official selling price

The price adjustment factor for a crude oil grade is adjustment over the marker crude oil

Price determination methodologies for marker crude oil			
Supplier	Marker crude	Marker price determination	Month of announcing OSP
Saudi Aramco	Oman Dubai avg.	B/L month average	M-1
Kuwait Petroleum Corporation (KPC)	Oman Dubai avg.	Nominated month average	M-1
National Iranian Oil Company (NIOC)	Oman Dubai avg.	Nominated month average	M-1
State Oil Marketing Organisation, Iraq (SOMO)	Oman Dubai avg.	Nominated month average	M-1
Abu Dhabi National Oil Company (ADNOC)	Outright Prices	Nominated month	M+1
Qatar General Petroleum Corporation (QGPC)	Outright Price	B/L month	M+1
Yemen Oil (YOG)	Brent	5 days after B/L date	M-2
Egyptian General Petroleum Corporation (EGPC)	Brent	B/L month	M
Nigerian National Oil Company (NNPC)	Brent	Five days avg. after B/L Five days avg. before B/L	M-1
Sonangol, Angola	Brent	Five days avg. after five days after B/L 5 days around B/L	M-1
Sonatrach, Algeria	Brent	5 days after B/L date	M-1
BPMigas, Indonesia	Minas	B/L month avg.	M+1
Petronas, Malaysia	Brent	B/L month average	M
Brunei Shell Petroleum (BSP)	Outright price	Nominated month	M+1
Oman's Oil Ministry (Oman)	DME Oman	B/L month average	M-2
National Oil Corporation, Libya	Brent	B/L month average	M-1

Table 2

price. The adjustment factor is declared before the beginning of the month by many national oil companies and is called the official selling price (OSP), whereas if crude oil is purchased on the spot market the adjustment factor is as agreed between buyer and seller.

The adjustment factor plays

an important role in crude selection as the relative economics (grade to be procured) changes based on the adjustment factors declared by the national oil company for their various grades. To be competitive, the national oil companies generally maintain the differentials of their grades with other,

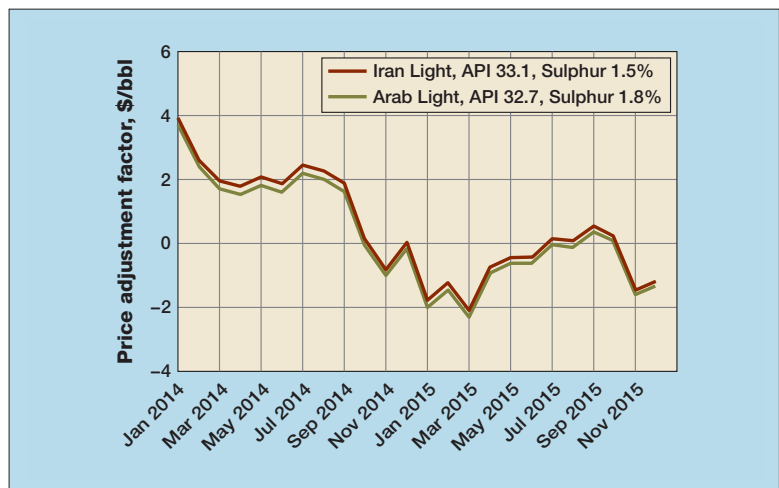


Figure 3 Price adjustment factor over Oman Dubai average

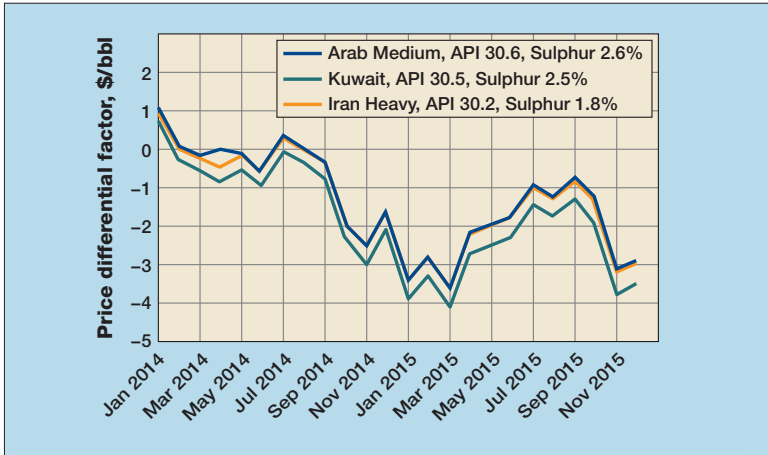


Figure 4 Price differential factor over Oman Dubai average

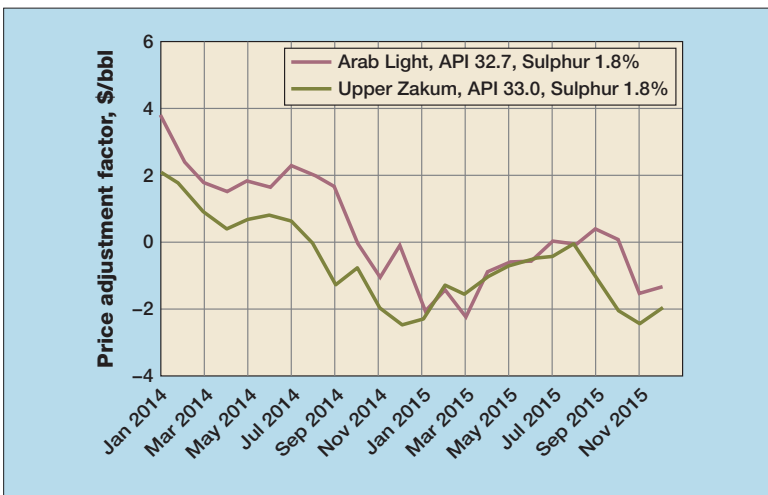


Figure 5 Price adjustment factor over Oman Dubai average

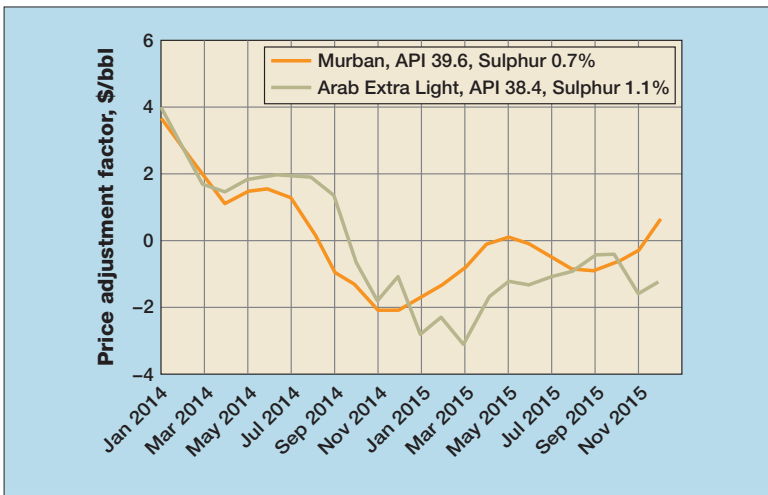


Figure 6 Price adjustment factors over Oman Dubai average

similar grades. Some national oil companies declare outright price for their grades after the completion of the month basis price is discovered under spot market conditions.

Figures 3 and 4 show how the price adjustment factors of grades similar to each other but from different suppliers closely track each other when the price adjustment factor is declared before the beginning of the month. However, the grades whose prices are declared after the end of the month (outright price) do not see any relationship with similar grades whose prices are declared before the beginning of the month (see Figures 5 and 6).

Thus, the economics of a grade whose price is declared after the end of the month vis à vis a similar, alternative grade whose price is declared before the beginning of the month keep changing from month to month as the differential price between two grades varies significantly.

Crude oil procurement strategy

The relative attractiveness of crude oil for refinery margin maximisation takes into account the differentials in crude price, freight, and product worth. If one scans the data over a period of years, there is no simple relationship on all three parameters and thus decisions on term contracting are required to be taken basis various scenarios on price variations and historical performance. In addition, if product demand and specifications are seasonal, the crude suitable for one season may not be suitable for another season. Gas oil rich crudes will be most suitable in

a high gas oil demand/price season whereas gasoline rich crudes will be suitable when gasoline demand/prices are high. **Figure 7** shows monthly variation in gasoil and gasoline prices in the Arabian Gulf market and indicates the suitability of gasoline rich crudes since March 2015 over gas oil rich crude oil grades.

The procurement strategy thus requires detailed insight into market variations, supply security considerations and attractiveness of grades traded on the spot market. The most important decision is how much to procure on term contracts, which are generally for a period of one year, to address concerns over supply security if the grades contracted are not optimum for the entire year.

Widening of the crude oil basket

The quality of crude oil varies widely in terms of its properties: API, sulphur, nitrogen, metals and so on. The crude and vacuum distillation unit in a refinery is designed to operate within the limits of the hydraulics of streams separated from crude oil. However, secondary units may be limited by the quality and quantity of streams generated from crude oil. The crude unit can handle crude oil with certain API variations. If the crude is very light (high API), the column overhead section as well as naphtha stabilisers will be limiting. Alternatively, if the crude is heavy (low API), the bottom circuit and vacuum unit may become limiting. Certain crude oil properties like viscosity and metals content can limit the preheat train/desalter operation in a crude unit. Crude oil

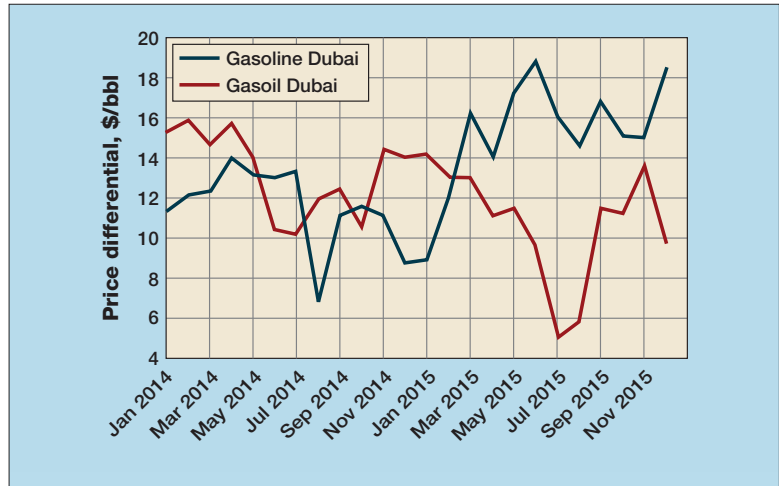


Figure 7 Crude and product price differentials

with an acid number beyond an acceptable limit cannot be accepted in the absence of crude oil blending facilities or a chemical programme to mitigate corrosion.

The properties of product from processed crude can limit the secondary processing units as well as the final product specification. Sulphur recovery units may be limited for high sulphur crude, while a hydrocracker may be limited due to high nitrogen in vacuum gas oil, and a diesel hydrotreater

may be limited for processing high diesel yield crudes. Generally, linear programming (LP) models are used for evaluation of crude oil grades. However, there are limitations in a LP model as processing in the model is for a group of crudes together and not for a single grade. Thus widening of the crude oil basket depends on the capability of the refinery to process crude oil on a standalone basis in the absence of crude oil blending facilities. Alternatively, if blend-

Crude blend properties					
	Arab Extra Light	Soroosh	Blend	Arab Light	
Blend 1	A	B	A+B		
API	39.1	18.7	32.8	32.7	
Sulphur	1.1	3.6	1.7	1.8	
% wt in blend	71	29			
	Arab Super Light	Khafji	Blend	Kuwait	
Blend 2	A	B	A+B		
API	50.6	28.5	30.5	30.5	
Sulphur	0.04	2.8	2.5	2.5	
% wt in blend	10	90			
	Arab Super Light	Maya	Arab Heavy	Blend	Arab Medium
Blend 3	A	B	C	A+B+C	
API	50.6	21.8	27.8	30.65	30.6
Sulphur	0.04	3.3	2.7	2.27	2.6
% wt in blend	30	38	32		

Table 3

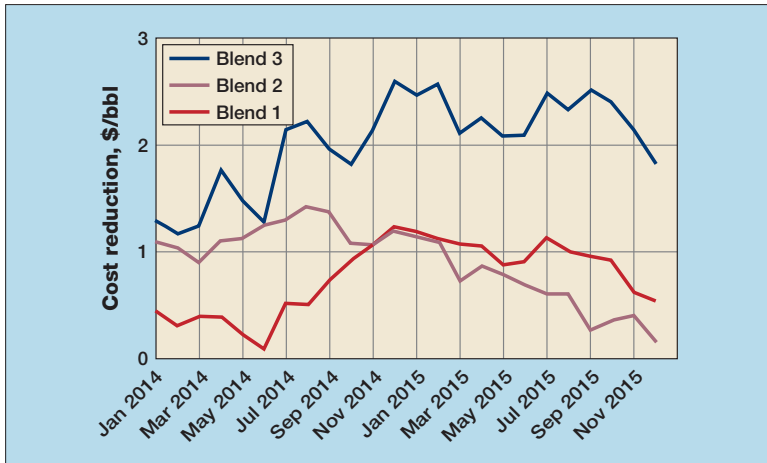


Figure 8 Reduction in crude cost through blending

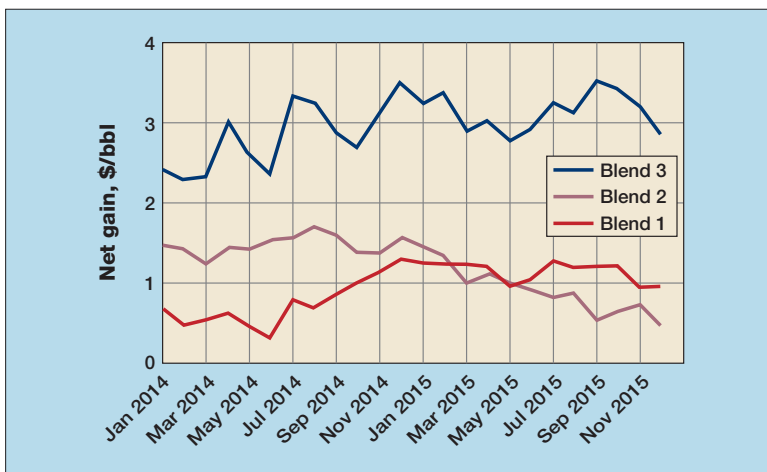


Figure 9 Net gain through blended crude

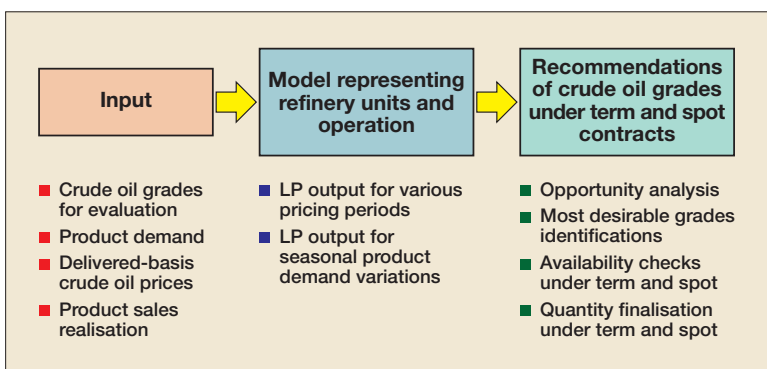


Figure 10 Steps followed during crude oil evaluation

ing facilities are available, the widening of the basket is not a challenge as difficult to process crude oil grades can be blended with other crudes so as to have a composite crude oil suitable for refinery configuration. The challenge then shifts to

scheduling and blending. As the economic benefit of widening of the crude oil basket is expected to be high, it is essential for every refiner to explore options that can give flexibility to procure any crude oil grade that will maximise margin. Examples in Table 3 indicate how grades that cannot be processed neat, if blended and processed can reduce the crude cost over procuring a single grade similar to the blended crude oil grade.

Thus widening of the crude oil basket and blending is essential to increase options and capture opportunities for maximisation of margins. Figure 8 shows the price difference between blended crude and neat crude and indicates an opportunity to reduce crude cost by widening the crude oil basket with blending. The net realisation of processing blended crude over neat crude basis five-cut (LPG, naphtha, kerosene, gasoil and fuel oil) is shown in Figure 9. The blended crude processing margins are directionally higher than for neat crude of similar quality. The crude oil grades considered for blending need to be evaluated for compatibility as well as evaluated in detail by means of LP model runs before a decision on procurement is taken.

Formulation of crude oil purchase plans

Sourcing of crude oil can be carried out under term or spot contracts with national oil companies, oil majors and traders. Sourcing on term conditions ensures security of supply, whereas sourcing on the spot market can capture opportunities for margin max-

imisation by sourcing the most suitable grade under the prevalent monthly market conditions. Most refiners use a LP model (a true reflection of the refinery configuration) for evaluation of crude oil. The product sales plan, sales net realisation, refinery processing units' capacities/constraints, processing cost (fuel and power consumption, chemical and catalyst consumption), crude oil availability, and crude oil landed cost are input to the LP model for evaluating the various options.

In developing a strategy for crude oil procurement, the crude oil basket to be considered for evaluation plays a very important role. Once evaluation under different pricing scenarios has yielded appropriate crude oil grades, a strategy for sourcing under term and spot conditions needs to be developed. **Figure 10** shows the details of various steps followed during crude oil evaluation. With various options generated, a decision must be taken on how much crude to term up and how much to keep for procurement under spot.

The salient features of procurement under term or spot are shown in **Table 4**.

If one reviews the features of securing crude oil under term or spot contract, the premium/discount applicable and date range for loading a cargo secured under term conditions is not known at the time of confirming the contract, whereas for crude oil procured under spot conditions there is an agreement on premium/discount to the marker crude and also on a date range for loading. Under term contract, the

The salient features of procurement under term or spot	
Procurement under term	Procurement under spot
1 Available mainly from national oil companies or equity producers. Some of the traders can also supply subject to them having a contract with oil major/equity producers.	Available mainly from oil majors and traders.
2. The contract can be for a particular grade or for all the grades available from the national oil company	The contract is for a specific grade of crude oil.
3 The contract is finalised either through negotiation or through participation in a tender enquiry by the national oil company.	The contract is finalised either negotiation or through participation by a supplier in a tender raised by the buyer.
4 Period of contract is generally for 12 months starting from April or from January.	The period of contract is specific to the cargo procured.
5 Price as per official selling price (OSP) as declared by a national oil company or at a differential to OSP as agreed between buyer and seller. Grades that do not have an OSP are priced as per the price declared by the seller according to actual trading during the month.	Price at premium/discount to marker crude or to OSP as agreed between buyer and seller.
6 Terms and conditions as per general terms and conditions of a national oil company or an oil major holding equity. Few specific conditions of the contract like payment terms and credit limit will be as agreed between buyer and seller.	Terms and conditions as per general terms and conditions of national oil company or oil major holding the equity. Few specific conditions of the contract like payment terms and credit limit will be as agreed between buyer and seller.
7 The grade and quantity is finalised on a barrels per day basis to be supplied during the year. Nominations for loading month and cargo size are to be indicated well in advance.	The grade, quantity and loading month/date range for loading is finalised at the time of contract.
8 The supply is mostly assured.	The most desired grade may not be available if all the cargoes are tied up.
9 The grade offered by the supplier may not be suitable for a particular pricing scenario and thus becomes sub-optimum.	The contract is finalised only if the grade appears suitable.
10 There are possibilities to surrender the cargo back to the supplier with adequate notice, in the event of any issues with refinery operations.	The cargo contracted is generally required to be lifted unless agreed by the seller. However, the option of resale is available.

Table 4

Grades available only from national oil companies and only through term contracts			
Country	Crude oil grade	Key properties	
		API	S%
Iran	Forozan	31.7	2.1
	Iranian Heavy	30.2	1.8
	Iranian Light	33.5	1.5
	Lavan	35.2	1.7
	Nowruz	20.5	3.5
	Sirri	33.2	2.0
	Soroush	18.7	3.6
Kuwait	Kuwait	30.5	2.5
	Neutral Zone	Hout	32.8
Saudi Arabia	Khafji	28.5	2.8
	Arab Extra Light	39.1	1.1
	Arab Heavy	27.8	2.7
	Arab Light	32.7	1.8
	Arab Medium	30.6	2.6
	Arab Super Light	49.1	0.1

Table 5

Grades actively traded on the spot market¹

Country	Crude oil grade	Key properties	
		API	S% S
Dubai	Dubai	31.4	1.5
Iraq	Basrah	28.8	3.1
	Basrah Heavy	23.7	4.1
Neutral Zone	Kirkuk	34.2	2.2
	Eocene	18.3	4.6
	Ratawi	24.2	4.1
Oman	Oman	30.4	1.4
Qatar	Al Shaheen	30	2.4
	Qatar Land	40.7	1.2
UAE	Qatar Marine	32.7	1.8
	Das Blend	38.3	1.1
	Lower Zakum	39.9	1.0
Yemen	Murban	39.6	0.8
	Upper Zakum	33.0	1.8
	Marib Light	45.1	0.1
Egypt	Masila	34.6	0.5
	Ras Charib	20.9	3.8
	Belyam	23.6	2.7
Nigeria	Suez Mix	30.8	1.5
	Various Grades	29-47	0.05-0.3
Angola	Various Grades	22-39	0.1-0.8
Algeria	Saharan Blend	45.7	0.1
Malaysia	Miri	29.7	0.1
	Tapis	42.1	0.04
	Labuan	30.2	0.1
	Kikhe	36.7	0.07
Indonesia	Various grades	20-48	0.02-0.2
Other WAF countries:	Various grades like		
Cameroon, Chad, Congo,	Kole, Doba, Djeno,		
Gabon, E. Guinea, Ghana,	Nkossa, Rabi Lt, Ceiba,		
Sudan	Zafiro, Jubilee, Dar, Nile Blend	21-40	0.1-0.4
Mexico	Isthmus	33.2	1.2
	Maya	21.8	3.3
	Olmeca	38.8	0.9
Venezuela	Various grades	11 -39	0.1-5.2
Brazil	Various grades	17-29	0.3-0.8
Colombia	Cano Limon	30.2	0.5
	Castilla	18.2	1.5
	Cusiana	43.2	0.1
Ecuador	Napo	18.6	2.0
	Oriente	24.7	1.4
Azerbaijan	Azeri Light,	36	0.1
Libya	Various grades	37-42	0.1-0.4
Brunei	SLEB	38.5	0.1
	Champion	33.1	0.1
	ESPO	36	0.6
Russia	Sokol	36.1	0.3
	Urals,	32.7	1.0
	Vityaz	34.4	0.2
Kazakhstan	CPC Blend	45.4	0.6
	Kumkol	41.4	0.1
North Sea	Various grades	30-47	0.2-0.8

Note 1: There are many more grades over and above those mentioned above

Table 6

supply of agreed quantity is assured. As regards grade of crude oil to be procured, there is no issue if the contract is for a single grade; however, if the contract is for multiple grades

the allotment of desired grades is subject to availability. The date of loading is subject to acceptance by the seller.

Some national oil companies market their crude oil grades

only through term contracts and also with end user restriction. However, the equity crude oil of some national oil companies is available under spot as well as under term conditions without any end user restriction. **Table 5** details major crude oil grades available only through term contracts, whereas **Table 6** details availability of major crude oil grades actively traded on the spot market from countries of interest to India.

As can be seen from **Table 6**, there are many alternatives for grades that are supplied only under term contracts. If security of supply is not a concern for a refiner, there is very little reason why one should seek procurement under term contract unless the grades available under term conditions are robust under all pricing scenarios.

Conclusion

The crude oil market is complex and procurement of the right crude can maximise refinery margins. The procurement of a crude oil grade under term conditions depends on its attractiveness under various pricing scenarios and any need to address concerns over security of supply. The opportunity exists to source crude oil through spot market and maximise margins, as terming up of grades for a longer period may not be attractive under all pricing scenarios and may not be required if there are no issues on supply security. Widening of the crude oil basket through state of the art blending facilities can increase the options for crude sourcing for a refinery and will also contribute to margin maximisation.

Misha Gangadharan is a Senior Engineer with Hindustan Petroleum Corporation Limited India (HPCL) with experience in crude oil evaluations, production planning and optimisation. She holds a BTech degree in chemical engineering from Institute of Chemical Technology (ICT) Mumbai, India.

Email: mishagangadharan@hpcl.in

S D Pohanekar is a Senior Engineer with Hindustan Petroleum Corporation Limited (HPCL) India with experience in refinery production planning and optimisation. She holds a BTech degree in chemical engineering from Laxminarayan Institute of Technology, Nagpur, India.

Email: sdpohanekar@hpcl.in

MD Pawde is Head of Economic Planning and Optimisation with Hindustan Petroleum Corporation Limited (HPCL) India with over 30 years of experience covering refinery operations, crude oil evaluation and procurement, production planning and optimisation. He holds a BTech degree in chemical engineering from Nagpur University, India. *Email: mdpawde@hpcl.in.*