CRUDE OIL

Crude oil is usually thick and oily, but it can come in a huge range of compositions and colors, including black, green, red, or brown. Crude oil from Sudan is jet black and North Sea oil is dark brown. Oil from the US state of Utah is amber, while oil from parts of Texas is almost straw-colored. "Sweet" crudes are oils that are easy to refine because they contain little sulfur. "Sour" oils contain more sulfur, and consequently need more processing.

One of the first indications of quality is color. The variations in oil color can be dramatic, and very indicative of the quality of that crude. Not all crude oil is black - higher quality oils can be a golden or amber in color.

- Viscosity is the resistance to flow. Do not use the term "Thickness" which is a length measurement. The higher the viscosity the slower the liquid will flow and the lower the quality.

- The viscosity process is a measure of quality, because the chemical structure of the crude influences its flow ability.

OIL MIXTURE

Oil mainly contains the elements hydrogen (14 percent by weight) and carbon (84 percent). These are combined in oil as chemical compounds called hydrocarbons. There are three main types of oil hydrocarbon, called alkanes, aromatics, and naphthenes. This diagram shows the approximate proportions of these substances in "Saudi heavy" crude oil,which is higher in alkanes than many crude oils.

HYDROCARBON CHEMICALS

The hydrocarbons in crude oil have either ring- or chain-shaped molecules. Alkanes, including methane and octane, have chainlike molecules. Aromatics, such as benzene, have ring molecules, while naphthenes are heavy-ring hydrocarbons. Oil also contains tiny amounts of non-hydrogen compounds called NSOs, which are mostly nitrogen, sulfur, and oxygen.

Crude Oil Types	Characteristics	Inherent Yields
Light Sweet (e.g. WTI, LLS, Brent)	> 34 API Gravity < 0.7 % Sulfur 35% Demand Most Expensive	3% 32% 30% 35%
Medium Sour (e.g. Mars, Arab Light, Arab Medium, Urals)	24 to 34 API Gravity > 0.7 % Sulfur 50% Demand Less Expensive	2% 24% 26% 48%
Heavy Sour e.g. Maya, Cerro Negro, Cold Lake, Western Canadian Select)	< 24 API Gravity > 0.7 % Sulfur 15% Demand Least Expensive	1% 15% 21% 63%

2013 U.S. Refinery Production

6%	Refinery Gases
45%	Gasoline RBOB CBOB Conventional CARB Premium
39%	Distillate Jet Fuel Diesel Heating Oil
10%	Heavy Fuel Oil & Other

Source: EIA refinery yield through November 2013

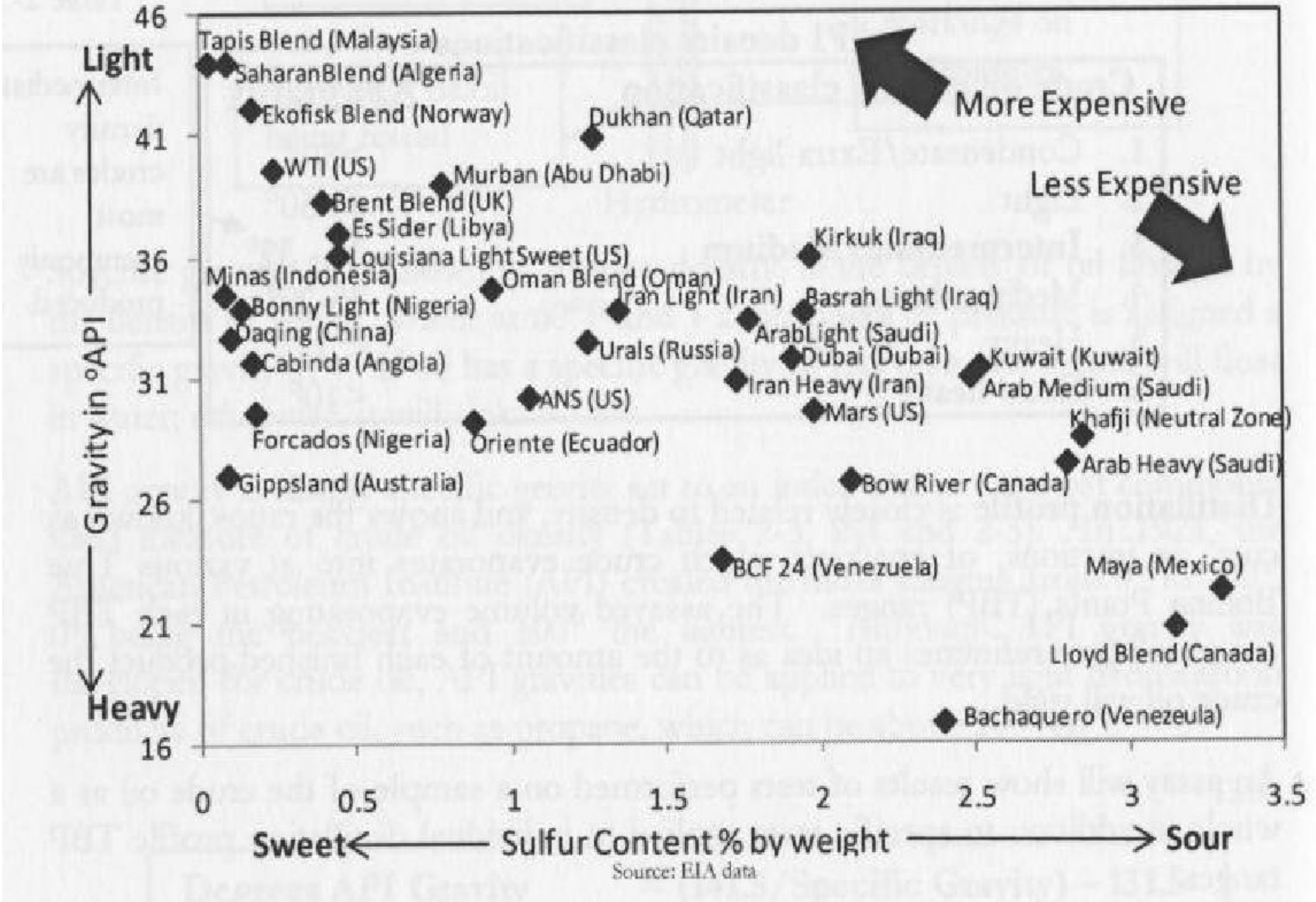
Refineries upgrade crude oil into higher value gasoline and distillates

Crude oil sulfur content (% by weight)

Sour	> 1.5
Medium sour	0.5-1.5
Sweet	< 0.5

Crude Oil Density and Sulfur

Fig. 2-3



Source: EIA data

Density is defined as the mass of unit volume of a material at a specific temperature.
A more useful unit used by the petroleum industry is specific gravity, which is the ratio of the weight of a given volume of a material to the weight of the same volume of water measured at the same temperature.
Specific gravity is used to calculate the mass of crude oils and its products.
Usually, crude oils and their liquid products are first measured on a volume basis, then changed to the corresponding masses using the specific gravity.

The API (American Petroleum Institute) gravity is another way to express the relative masses of crude oils. The API gravity could be calculated mathematically using the following equation:

$$^{\circ}\text{API} = \frac{141.5}{\text{Sp.gr. } 60/60^{\circ}} - 131.5$$

A low API gravity indicates a heavier crude oil or a petroleum product, while a higher API gravity means a lighter crude or product.
Specific gravities of crude oils roughly range from 0.82 for lighter crudes to over 1.0 for heavier crudes (41 - 10 °API scale).

Comparison of density measurements (at 60°F and 1atm)

API Gravity °API	Specific Gravity (relative density)	Metric Density Kg/M³	Barrels per Metric Tonne
0	1.076	1076	5.93
10	1.000	1000	6.35
20	0.934	934	6.77
30	0.876	876	7.19
40	0.825	825	7.64
50	0.780	780	8.06
60	0.739	739	8.48
70	0.702	702	8.90
80	0.669	669	9.32
90	0.639	639	9.74
100	0.611	611	10.16
110	0.586	586	10.58
120	0.563	563	11.00
130	0.541	541	11.42
140	0.521	521	11.84
150	0.503	503	12.26
160	0.485	485	12.68

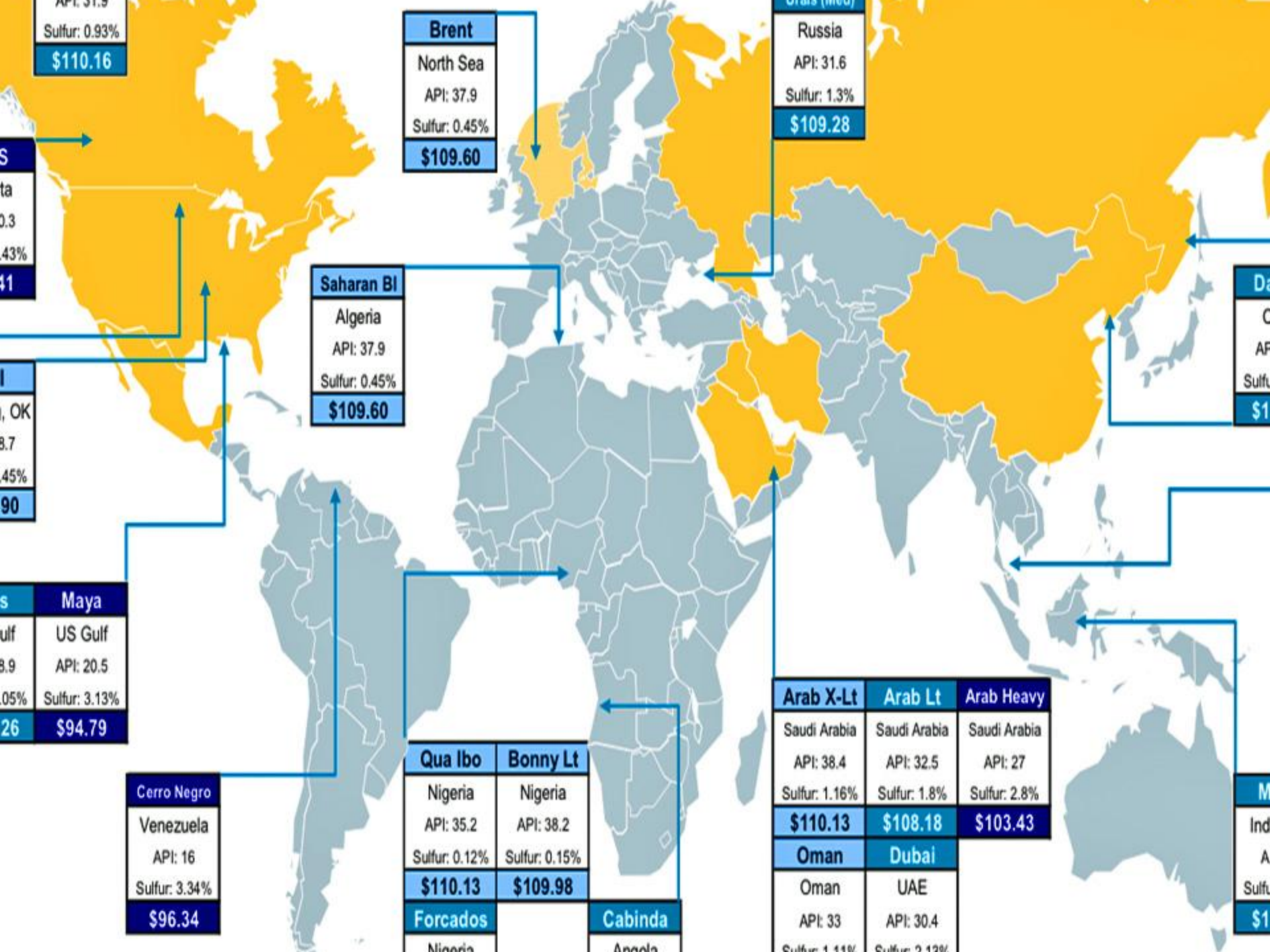
Density of water.

API gravity is the density measurement used most often for oil.

API density classifications

Crude oil density classification	API gravity
1. Condensate/Extra-light	>50°
2. Light	40-50°
3. Intermediate/Medium	**30 - 39°**
4. Medium-heavy	25-29°
5. Heavy	< 25°
6. Extra-heavy	<10°

Intermediate density crudes are most commonly produced.


Sulfur: 0.93%
$110.16
Brent
North Sea
API: 37.9
Sulfur: 0.45%
$109.60
Russia
API: 31.6
Sulfur: 1.3%
$109.28
Saharan Bl
Algeria
API: 37.9
Sulfur: 0.45%
$109.60
Maya
US Gulf
API: 20.5
Sulfur: 3.13%
$94.79
Cerro Negro
Venezuela
API: 16
Sulfur: 3.34%
$96.34
Qua Ibo
Nigeria
API: 35.2
Sulfur: 0.12%
$110.13
Bonny Lt
Nigeria
API: 38.2
Sulfur: 0.15%
$109.98
Forcados
Cabinda
Arab X-Lt
Saudi Arabia
API: 38.4
Sulfur: 1.16%
$110.13
Arab Lt
Saudi Arabia
API: 32.5
Sulfur: 1.8%
$108.18
Arab Heavy
Saudi Arabia
API: 27
Sulfur: 2.8%
$103.43
Oman
Oman
API: 33
Dubai
UAE
API: 30.4

Global oilfield statistics

		Reserves*	Number of fields
Elephant Fields	Super Giant	> 5 billion barrels	54
	Giant	0.5-5 billion barrels	263
	Large	50-500 million barrels	481
	Others	< 50 million barrels	70,000+

Source: IEA World Energy Outlook 2008 at pages 224-226; *2P reserves.

There are dozens of different oil **benchmarks**, with each one representing crude oil from a particular part of the globe. Benchmarks are used because there are many different varieties and grades of crude oil. Using benchmarks makes referencing types of oil easier for sellers and buyers.

There is always a spread between WTI, Brent and other blends due to the relative volatility (high API gravity is more valuable), sweetness/sourness (low sulfur is more valuable) and transportation cost. This is the price that controls world oil market price. However, the price of most of them is pegged to one of three primary benchmarks:

- **Brent Blend** – Roughly two-thirds of all crude contracts around the world reference Brent Blend, making it the most widely used marker of all. These days, "Brent" actually refers to oil from four different fields in the North Sea: Brent, Forties, Oseberg and Ekofisk. Crude from this region is light and sweet, making them ideal for the refining of diesel fuel, gasoline and other high-demand products. And because the supply is water-borne, it's easy to transport to distant locations.
- **West Texas Intermediate (WTI)** – WTI refers to oil extracted from wells in the U.S. and sent via pipelines to Cushing, Oklahoma. The fact that supplies are land-locked is one of the drawbacks to West Texas crude – it's relatively expensive to ship to certain parts of the globe. The product itself 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 United States.
- **Dubai/Oman** – This Middle Eastern crude is a useful reference for oil of a slightly lower grade than WTI or Brent. A "basket" product consisting of crude from Dubai, Oman or Abu Dhabi, it's somewhat heavier and has higher sulfur content, putting it in the "sour" category. Dubai/Oman is the main reference for Persian Gulf oil delivered to the Asian market.