The Oil Drum
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Refinery Utilization Rates and Increase in Use of Heavy/Sour Crudes

Posted by Prof. Goose on June 30, 2007 - 9:30am
Topic: Supply/Production
Tags: api gravity, gas inventories, gasoline, oil, oil inventories, oil refineries, peak oil, refining, sulfur [list all tags]

This is a guest post by Smokey. Smokey has a background in sustainability in transportation, and has conducted research on responding to fuel supply disruptions.

To what degree is the decline in quality crude affecting domestic refinery utilization rates and therefore gasoline stocks?

In recent years some analysis has suggested that light sweet crude oil may have peaked, with the world left to increasingly rely on lower quality crudes. See for example this story on The Oil Drum and this story on Energy Bulletin. Although the data on global peaking of light sweet crude may not yet be conclusive, data on the production of many regions that produce primarily light sweet crudes conclusive show that many of these regions are past peak.

Recently, gasoline inventories have been well below the normal range for this time of year, while crude oil stocks have been above the 5-year average. At the same time, refinery utilization rates have been well below normal for this time of year. Refiners and the EIA are well-aware that the crude oil mix has become increasingly sour and heavy.

Figure 1 shows refinery utilization rates and the API gravity of crude imports from 1978 to 2007. Light crude oil is defined as having an API gravity higher than 31.1, medium oil has an API gravity between 22.3 and 31.1 and heavy oil is defined as having an API gravity below 22.3.

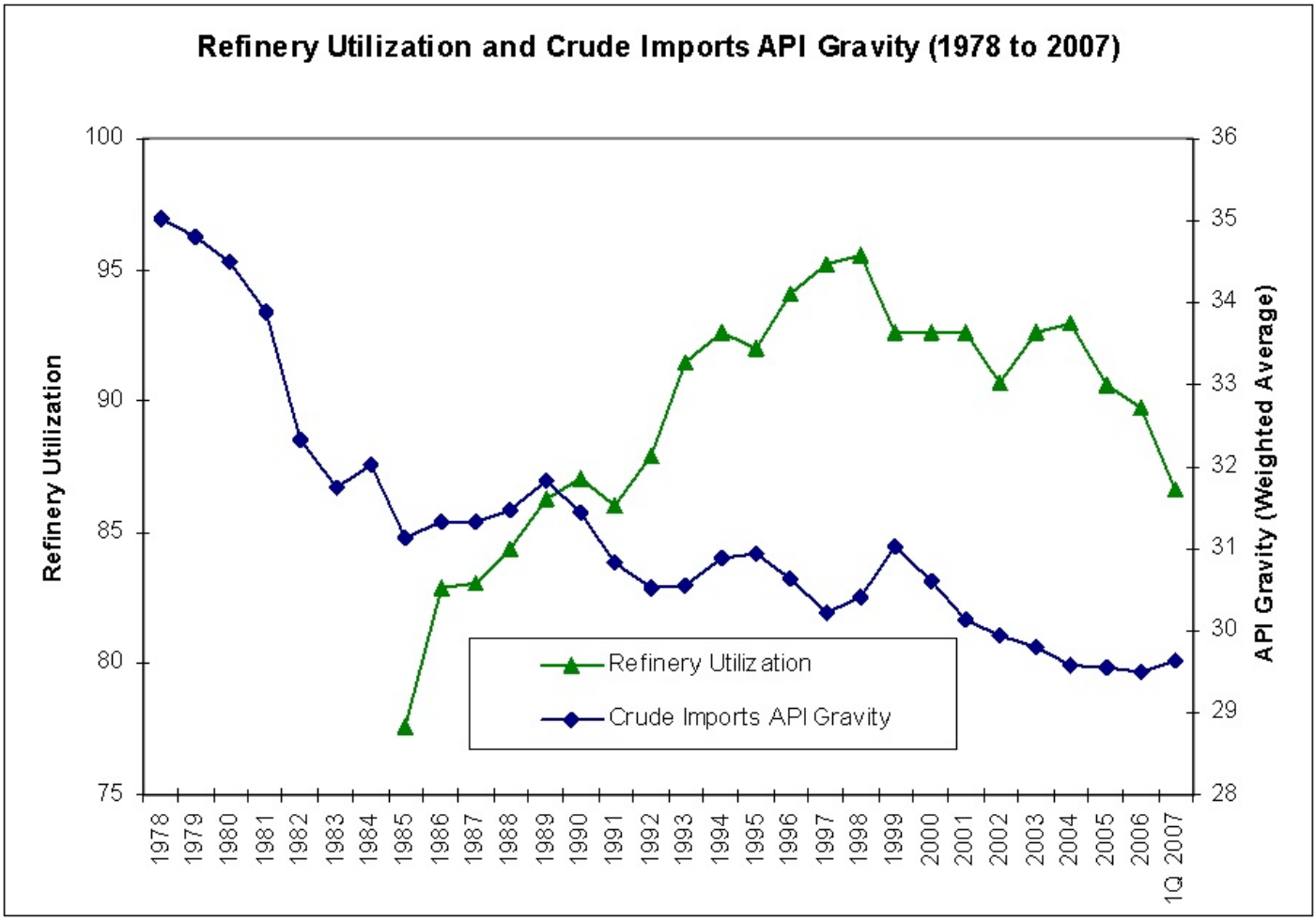


Figure 2 shows refinery utilization, the API gravity of refinery inputs, and the API gravity of crude imports from 1995 to 2005. As shown in Figure 2, API gravity of both imports and the crude used in refineries has been on the decline, while refinery utilization has also been on the decline.

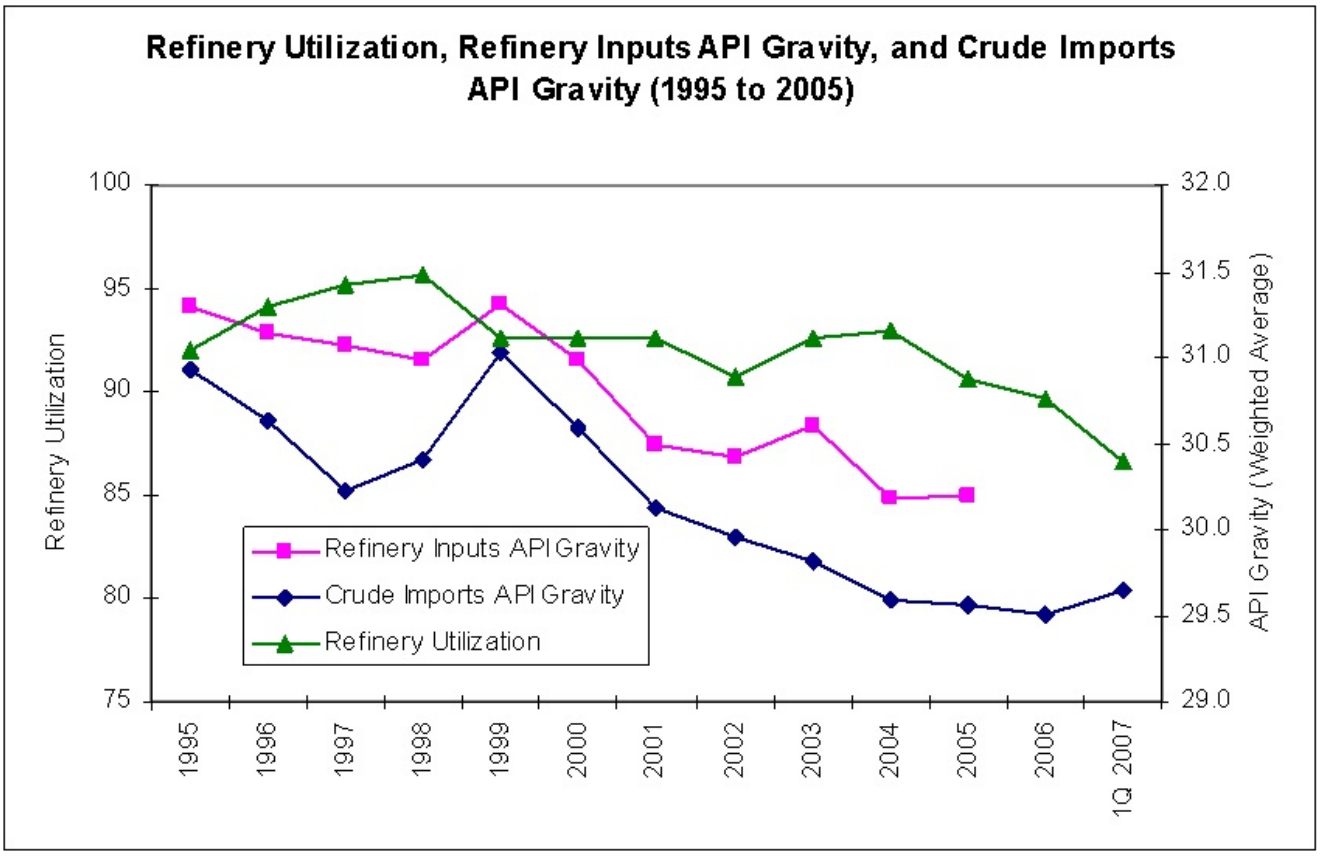


Figure 3 shows API gravity and sulfur content of US refinery inputs from 1985 to 2005. This figure shows that crudes used as feedstock to refineries are becoming increasingly heavy and sour.

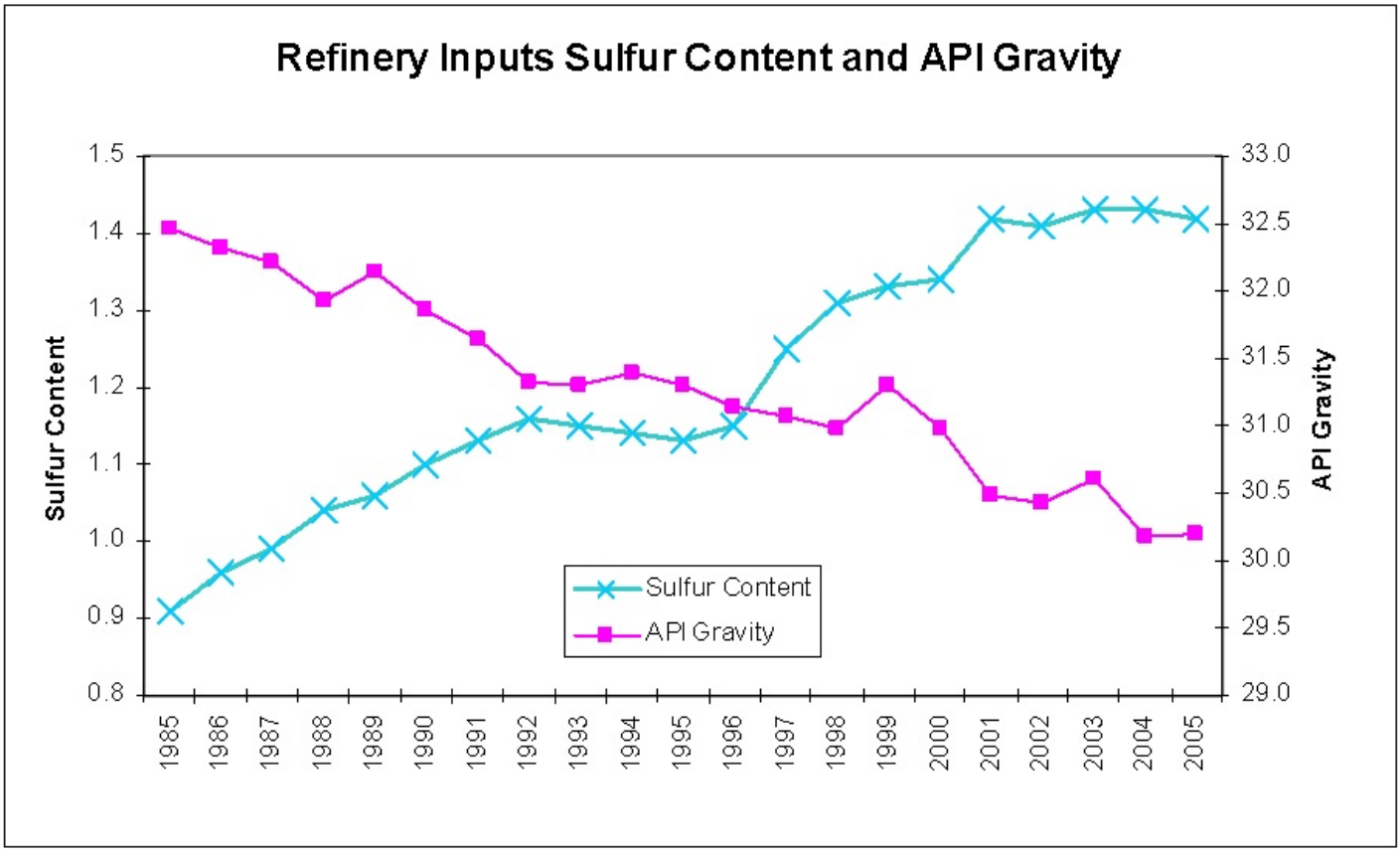
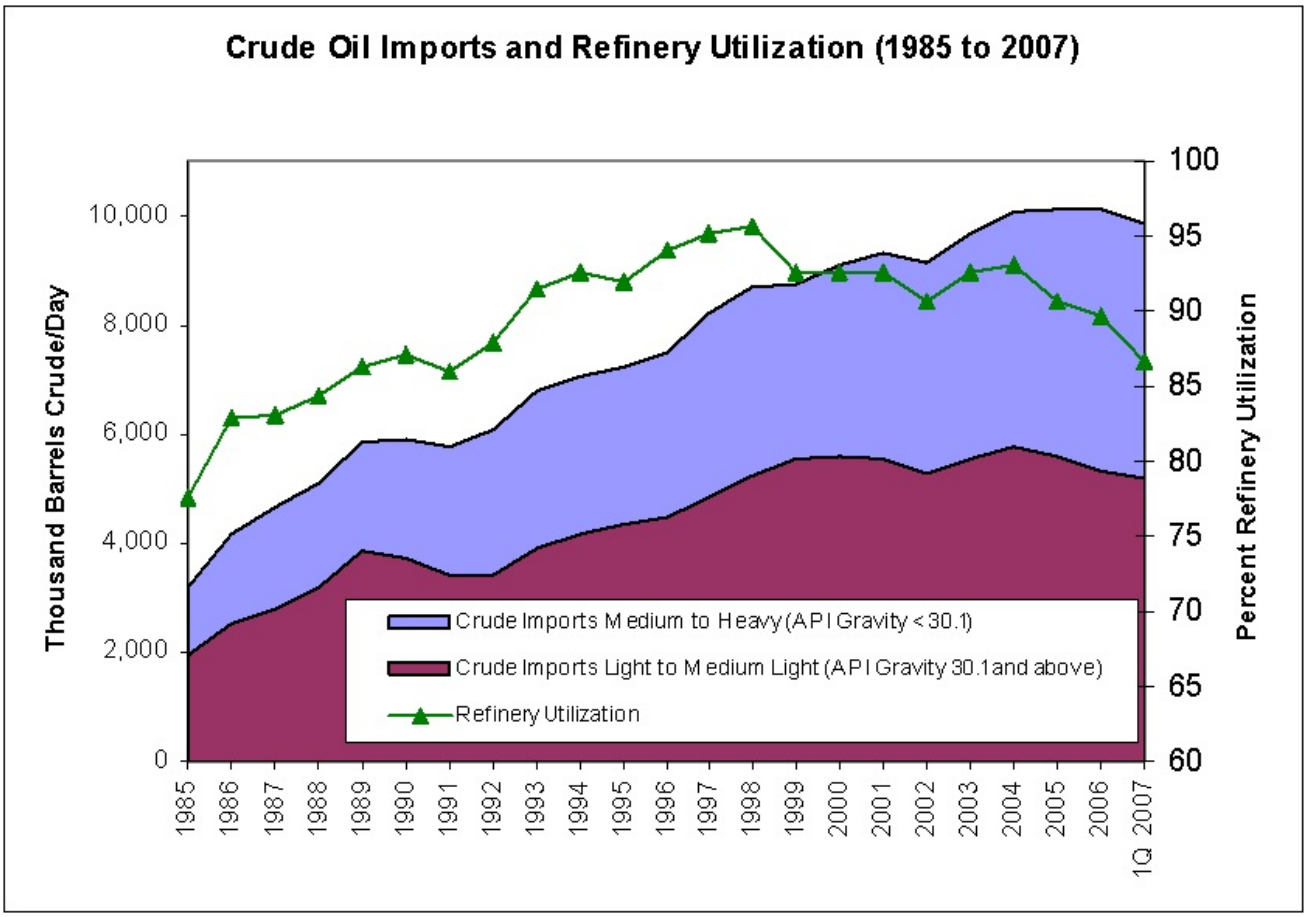
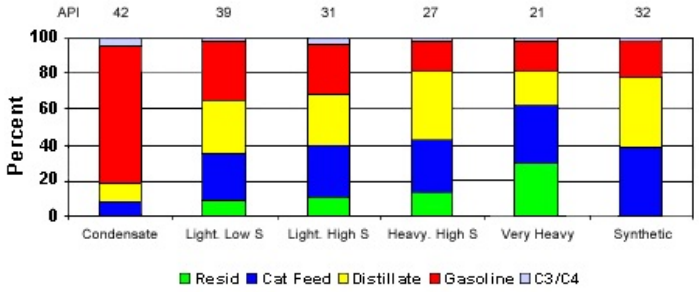


Figure 4 shows total crude oil imports by API Gravity and Refinery Utilization. Total imports declined in both 2006 and first quarter 2007, while imports with an API gravity of 30.1 or higher also declined in 2005.



More gasoline can be derived from a barrel of light sweet than heavy sour crude, as shown in this figure from Natural Resources Canada.



Source

From NRCAN: "Refinery yields by crude type: Figure 3 illustrates the product yield for six typical types of crude oil processed in Canada. It includes both light and heavy as well as sweet and sour crude oils. A very light condensate (62 API) and a synthetic crude oil are also included. The chart compares the different output when each crude type is processed in a simple distillation refinery. The output is broken down into five main product groups: gasoline, propane and butane (C3/C4), Cat feed (a partially processed material that requires further refining to make usable products), distillate (which includes diesel oil and furnace oil) and residual fuel (the heaviest and lowest-valued part of the product output, used to make heavy fuel oil and asphalt)."

Regarding differentials, an EIA presentation from March 2005 2004: Sign of the Future for Refiners? for the NPRA annual meeting suggested a couple of theories on light/heavy crude differentials.

"Theories on How Capacity Constraints Drove Light-Heavy Differentials:
1. Overall world refining capacity limit
2. Constraints on conversion capacity"

See the EIA presentation for a full analysis, which include potential indicators of one or the other theory above, such as:

- Light product stocks drop sharply
- Price for light products rise sharply
- Product price pulls crude prices up and pulls light crude up more than heavy
- Additional heavy crude oil won't be used
- Demand for light crude oil increases
- Added heavy crude oil run without benefit of conversion
- Residual fuel oil yield increases
- Over-supply of residual fuel oil

In the end, their analysis concluded that crude oil price was primary factor in 2004 differential increase, and that refiners made an economic choice to use more heavy crude oil as product values shifted.

Questions

A few questions that come to mind that readers of the Oil Drum may be able to offer thoughts on:

1. To what degree might low refinery utilization rates be a function of the inability of some refineries to process the heavier/sour crudes? Likewise, to what degree might refinery outages/unplanned maintenance be a function of the increasing use of heavy sour grades of crude? Finally, to what degree might low gasoline production rates also be a function of increasingly sour/heavy crude oil used as refinery inputs due to lower gasoline yields for the lower quality crudes?

2. Do trends in the quality of oil imports provide any evidence to support the theory that light sweet crude may have already peaked?

3. How long does it take to upgrade or expand a refinery to handle these lower quality crudes, and what kind of progress on this front has been made over the last several years?

I'm hoping there may be some insiders in the refining industry who could help answer these questions.