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Crude Quality-What Is Involved and Why It's Important
Class # 5080.1

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Introduction

Crude oil quality can mean different things to different people. A production facility may look at crude oil quality as anything that passes the field tests so the transporter will pick up the load or send it down their pipeline. A pipeline company or transporter may have a similar definition of crude quality, but from a different perspective. A crude oil marketer will also have a different idea of what crude quality is as will an end user, such as a refiner. I will touch on what each of these people think is crude oil quality, and why, and will discuss the testing procedures used to arrive at crude quality from their perspective.

Production/Transportation

A production company will have specifications from their crude oil purchaser/transporter which they will need to meet before they can sell their oil. Generally in the United States, there are specifications by crude oil purchasers for crude quality such as **Basic Sediment and Water (BS&W), API Gravity, Hydrogen Sulfide (H2S), Reid Vapor Pressure (RVP), total sulfur (S),** and **atmospherically stabilized crude.**

If you talk to a gauger out in the production field, their idea of crude oil quality is the maximum sediment and water content allowed by their transporter so it can be shipped. With some companies, it's what can they get by with shipping to their transporter. From my experience they may not be too concerned about how much BS&W is in the oil as long as the truck driver or pipeline operator will take it. Producers must, or at least should comply with tariffs from their transporters as a normal course of business. We've seen this go on for as many years as we've been in the business. On LACT units BS&W monitors are required to divert the oil flow back to the producer's tank if it is off-spec. On hand-worked leases the BS&W content is tested by a gauger or truck driver while the oil is in the lease tank. High BS&W content tanks should be turned down by the gauger until the producer chemically treats the tank to remove the entrained water from the oil.

Testing of BS&W involves obtaining a representative sample of the crude oil, usually from a tank or composite sampler. There are several tests available to measure the BS&W content of crude oil. **API Chapter 10.3- Standard Test Method for Water and Sediment in Crude Oil by the Centrifuge Method (Lab Procedure)** is meant for testing samples in a controlled environment such as a lab. This method is recommended for higher volume pipeline and marine movements rather than trucked or gathered oil**. API Chapter 10.4- Determination of Water and /or Sediment in Crude Oil by the Centrifuge Method (Field Procedure)** is meant to be used where a controlled environment is not practical. This is usually done by truck drivers and gaugers at remote lease sites.

An alternate method of measuring only the water content in crude oil is **API Chapter 10.9- Standard Test Method for Water in Crude Oils by Coulometric Karl Fischer Titration**. The Karl Fischer titrator measures only the water portion of BS&W. Another method, **API Chapter 10.1-Determination of Sediment in Crude Oils and Fuel Oils by the Extraction Method (Laboratory Procedure)** measures the sediment portion only.

The Karl Fischer titration is a very accurate and easy method to use, and in my experience as a chemist for 30 years, it is the most accurate method to measure water in crude oil. The main drawback is that if you have sediment in your crude you must use the sediment extraction method, or a filtration method to quantify the sediment portion of the BS&W. This makes the Karl Fischer testing, which is much simpler and straightforward compared to the centrifuge method, not as convenient.

The determination of **API gravity** at the lease site or on the pipeline is an important part of the quality process. The API gravity is used for several purposes in the measurement process as different densities of crude oil have different volume correction factors. Accounting and marketing groups may use API gravity as a qualifier for the value of the crude oil. Many marketing contracts will pay more for certain gravity ranges than others. There could actually be a deduction for gravities that are supposed to be within a given range but fall outside that range for

some reason. So, API gravity can affect the amount of dollars being paid to a producer or pipeline operator in both measurement corrections and quality specs.

The API Gravity, or density, can be determined in different ways at a lease site or pipeline connection. At hand-worked leases, the gravity is tested by the gauger or truck driver using API quality thermohydrometers. A representative sample is taken from the tank and tested right on site. With pipeline LACT units and other connections, a composite sample is taken of the batch and the API gravity is tested in the same manner. In the past 10 years or so, the measurement of crude oil has included online densitometers which read the gravity of the product real-time. This is my preferred method of determining gravity on a pipeline connection since you sample several times/second rather than once every 10 barrels or so. Composite sampling works very well as long as you sample proportional to flow and sample at a frequency that results in a good sample.

H2S is a serious problem in the oilfield. High H2S crude can be deadly if not treated with the utmost respect. A small amount of H2S can make a person ill, incapacitate them or even kill them as the concentrations increase. Producers are treating crude and condensate at the well site for H2S. Many of them treat the liquid down hole so that it does not come to the surface with high H2S content. I'm sure there are still many that treat the liquid at the surface through H2S treaters before going to storage and shipment to the transporter. Transporters and pipeline companies will have restrictions on the amount of H2S allowed in the oil they purchase. 10 PPM is a common amount in South Texas, but the number could be much higher in other areas of the world. Everyone who deals with high H2S crude must be aware of the potential risks and work accordingly.

Online H2S monitors for crude oil are being used in our area to gauge the amount of H2S in the oil. This will help the producer/transporter better understand when their product is on-spec and how to deal with it normally, and when an upset in treating might occur. There are also manual methods of testing that can be used, such as Draeger tubes, to measure H2S in tanks at leases. This is a common practice for trucking and pipeline companies to determine whether a lease has H2S or not.

Total sulfur content in crude oil is an important quality issue with pipeline companies and refiners due to several reasons. High sulfur content can be corrosive to pipelines causing extra cost to ensure the integrity of their pipelines. Marketing will pay less for higher sulfur crudes as they are less valuable to refiners. Refineries have to deal with high sulfur as a waste product and contaminant in their facility. In today's market with the low sulfur and ultra-low sulfur diesel mandated by the EPA, it is very expensive for refiners to process high sulfur crude.

Ried Vapor Pressure is a new problem in our area of production, mainly due to some of the very light crude and condensates emerging in the shale oil areas. The infrastructure to strip light hydrocarbons from condensate does not exist in some locations, so the "crude oil" that is being sold has an unusual amount of gaseous hydrocarbons. API recommends that oil be purchased that is **atmospherically stable**. Imagine a 2 liter bottle of soda that you remove the cap on. You get a pretty good charge of CO2 being expelled from the liquid. This is the same thing going on with these very light crude oils. You shouldn't transport the oil until it goes flat, like the soda eventually will. We used to not purchase crude until it had weathered 24-48 hours. This doesn't seem to be happening in today's environment, so producers, transporters and refiners have to deal with all the problems associated with higher RVP product. It is difficult to accurately measure crude and condensate that is boiling when you are trying to meter it. Shake up the 2 liter bottle of soda and see if you can fill a glass with the foam and see how much liquid you have really put in there. The same thing is happening with the meters and high RVP condensate.

High RVP product causes fits for everyone involved. Not only can it be difficult to measure and transport, but it is difficult to contain in atmospheric tanks. Most of the traditional tanks either had no process to contain hydrocarbon emissions, or some had floating roofs to keep the emissions down to acceptable levels. With the shale oil activity and the lack of stabilizing the crude, companies have to install nitrogen blankets, flare systems and other items to deal with the high RVP. The EPA is cracking down on companies that do not do enough to comply with hydrocarbon emissions, and they are making the requirements tougher every year. So not only do our companies have a vested interested in quality, the federal government is making sure everyone complies with the emissions standards.

Marketing/Refineries

Marketing and refiners look at the same crude quality issues as do the producers and the pipeline companies, but in addition to the items above, they are also interested in the assay, or composition of the crude oil they are

purchasing. A refinery, with the help of their marketing group, will run different analyses on crude oil in areas where they are interested in purchasing the crude. Depending on the design of the refinery, they will target oil that theoretically produces yields favorable to their plant.
In our area there are refineries that purchase light sweet crude to produce jet fuel, diesel, gasoline and chemicals that are typically found in these crudes. There are other refineries in our area that only run foreign, high sulfur, heavy crude as they are targeting a different product slate for their plant.

Refiners also purchase crude oil via bulk purchases from other sources as well as production from the lease site. Refiners that purchase bulk crude oil may not always get what they think they are getting. A crude oil with a 40 API gravity crude, which is in its natural state, will yield certain products that refiners may be looking for. One problem that can happen to a refiner when purchasing bulk crude oil is that someone might blend a heavier crude with a lighter crude to produce a 40 gravity that looks to be what they are looking for. But after running the crude or doing an assay on the crude, they find out that the middle fraction they are hoping to capitalize on is missing. When a heavy and light crude are mixed, the resulting gravity looks like it should, but doesn't contain the components that would normally be in a pristine naturally occurring crude oil. So, refiners can get duped by suppliers who blend to a gravity spec. This can cost the refiner a great deal of money when they aren't getting what they pay for and their yields are less than they expected. There is an opportunity cost to the refiner since they are not producing the yield they should be with the right crude slate.
Refiners can also have the same problem with blending of sulfur content of crude. Blending a high sulfur crude with a low sulfur crude can enhance the profit to the blender, but the refinery pays for it in added costs to process and an increase in maintenance costs of the plant.

Non-Naturally Occurring Contaminants

Occasionally non-naturally occurring contaminants wind up in the crude oil streams and can play havoc with pipelines and refineries. Non-naturally occurring contaminants may be products that are added to the crude in various places to enhance recovery, increase flow capability, reduce corrosion properties etc. Many producers and pipeline companies add additives to crude to accomplish a certain goal that enhances their ability to produce and transport crude oil. Unfortunately this may be at the detriment of the refinery. Some refineries are very susceptible to these contaminants, which may poison the catalyst bed that is used in the cracking process. A catalyst bed is an expensive and consumable part of the refining process. Certain contaminants will poison the catalyst making it useless to the refinery much sooner than it would have been without the contamination.

Another problem that has occurred in the past is someone deliberately blending waste hydrocarbon chemicals into a crude oil stream in an effort to make money. Some chemical wastes that have been blended with the crude oil are used motor oil and dry cleaning chemicals. These chemicals contain a significant amount of organic chlorides which poison the catalyst beds. Organic chlorides are not generally found in nature except in very small quantities. Organic chlorides are man-made through the refining process, so an increase in the concentration in a crude stream could be a sign that someone is willfully injecting these chemicals into the crude stream. Refiners get very angry when this happens, and they can usually trace the crude stream back to a source of the contaminants. They may not catch the actual offender, but they will definitely put the supplier on notice.

Conclusion

Crude oil quality is much more than just BS&W and sulfur content. Each group that touches the crude oil has a different perspective on what crude oil quality is and why it's important to each of them. If each group would understand the other group's needs and wants with respect to quality then everything would work out to everyone's benefit. Unfortunately these groups may not understand the needs of the others, or are not concerned with meeting those needs. Millions of dollars can be lost in the buying, selling, transporting and refining of crude oil if each group doesn't do their part to add value to their customers and society.