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CRUDE OIL QUALITY – What Is Involved and Why Its Important
A PIPELINE PERSPECTIVE
Class # 5080

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Introduction:

Crude oil quality is important to all areas of the petroleum industry and for a variety of reasons that cross disciplines such as safety, enhanced production, pipeline hydraulics or pumpability, refinery operations and regulatory compliance. Pipelines are in the center of crude oil quality. Knowledge of crude oil quality is both important to pipeline operations and to ppipeline customers. Some knowledge of the aspects of crude oil quality all the way from well (production) to wheels (refinery finished products) is necessary to understand the importance of protecting crude oil quality in the transportation system. When we understand our needs as well as the needs of our suppliers and end users, we can begin to appreciate the importance of all of the testing and communications we must consider from our "middleman" position on pipelines.

Determining the quality of crude oil has always been a difficult task. Refiners generally rely on assays to determine if a crude oil will meet the needs of that refinery under its current operating parameters. A crude oil that is considered excellent quality for one refinery might be impossible to process for another.

In addition to the inherent characteristics of the crude oil in situ, which can usually be determined by the assay, there are many parameters that can vary from batch to batch depending on circumstances or events during production, storage and transportation. These events can have no effect, or can enhance or degrade the quality of the crude oil.

Begin at the Beginning:

There are thousands of chemicals used in the production of crude oil and new ones are placed on the market every year. Among other benefits to producers, these chemical additives allow faster, easier, more complete recovery of crude oil from formations. They prevent agglomeration of asphaltenes, control foam, prevent formation of hydrates, inhibit corrosion, discourage growth of bacteria, lower viscosity, etc.

Unfortunately, these chemicals that are so important to successful production of crude oil can also have a negative impact on crude oil quality.

In addition to the additives, other undesirable materials can get into crude oil such as used motor oil or other waste materials that are dumped into crude oil as a means of disposal.

What Can Happen In the Storage Terminals and on Pipeline?

The primary effects on crude oil quality that occur in storage terminals and on pipelines are related to degradation of one crude type with another crude type, however, chemical additives as well as waste disposal can also play a role in these facilities.

Degradation can occur at interfaces between batches in the pipelines, when one crude type is placed in a tank with the heel or bottoms of another crude type and by inclusion of a dissimilar crude type in a linefill. Intentional blending of crude types can also occur. This is sometimes a service provided at the request of an end-user. However, at times it is done without the knowledge of the end-user. This practice can result in delivery of material to a refinery that does not meet requirements.

Chemical additives used in crude oil storage and on pipeline are primarily pour point suppressants, anti-corrosives, anti-bacterials and drag reducing agents. In most cases,

these chemicals are used in very small quantities and do not cause downstream problems, however, there have been cases of overdosing due to equipment failure or improper procedures that have caused difficulties. Failure to use these chemicals when appropriate can result in severe problems in transportation, such as tank and pipeline corrosion, plugged pipelines due to high pour point crudes and loss of throughput resulting in inability to meet required rates.

What is the Refinery Impact of All These Changes to Crude Oil?

Some of the changes such as severe degradation and blending can result in unexpected and undesirable yields. Dumbbell blends, the practice of adding a very heavy crude oil or refinery residuals to a very light condensate or natural gasoline, have been made to achieve a certain density (API Gravity) specification, but they usually do not have the middle distillate value that a refinery is expecting.

Blending can also result in crudes that are harmful to the refinery metallurgy. An example is highly acidic crude oil blended into light, low acid, sweet crude oil and sent to a refinery designed to run light, sweet crude oil. These refineries do not have the same metallurgy as heavy, sour refiners and can suffer severe corrosion over time from these acids.

Chemical additives used improperly or whose use is not communicated and waste materials discarded into crude streams have probably caused the most unexplainable and perplexing problems in refineries. Organic halides found in cleaning solvents and dumped in crude oil can cause severe corrosion in refinery overhead piping. Olefinic materials can cause fouling in the crude furnaces and also result in off-spec jet fuel. High silicon production additives can cause catalyst poisoning and can also cause scaling, forcing more frequent turn-arounds for refineries. Heavy metals found in used motor oil can result in catalyst poisoning in any refinery and off-spec coke for refineries that produce anode grade coke. Many of these problems develop slowly over time and many of the chemicals are difficult to detect, so it is a huge and costly problem for refineries to troubleshoot.

What Can Pipeline Do?

The three areas of greatest importance on pipeline and at our terminals are effective communication, the use of best practices in operations to minimize degradation and contamination and knowledge of the additives and chemicals we use in our business.

We must communicate effectively with producers, chemical manufacturers, traders, shippers, connecting carriers and end-users. We are in an excellent position in the flow of crude oil to be able to tie the end-user back to the producer and to facilitate conversation and understanding between all of the players in the industry. One way to do this is to attend industry meetings where crude quality topics are discussed, such as, the American Petroleum Institute (API), the American Society of Testing and Materials (ASTM), the Crude Oil Quality Association (COQA) and the Canadian Crude Quality Technical Association (CCQTA).

We must minimize the degradation that will occur in transportation of crude oil. Using all of the technological advances available to us, we can make mid-point batch cuts at exactly the right time, we can design pipeline stations to minimize linefill contamination, we can sequence batches to move similar materials next to each other, and we can maintain turbulent flow to minimize degradation at the interface.

We should use additives only when necessary and as per manufacturer's recommendations. We must know the impact not only on our operations, such as the effect of drag reducing agents on turbine meters, but also additive impact on downstream carriers, such as the effect of using insufficient pour point suppressant. And as illustrated above, the effect of additives on the end-user refinery is critically important to understand.

Importance of Sampling and Testing

Pipeline samples are obtained for a variety of reasons. Measurement necessary for custody transfer is the primary reason we pull samples on pipeline. Aside from the determination of sediment, water and API Gravity, almost all other testing of pipeline samples is lumped into the category of quality testing. Other reasons for testing are determinations for safety monitoring, for operational concerns, for environmental monitoring and reporting and for our customers' use.

For example, Reid Vapor Pressure (RVP) testing is primarily done to comply with environmental emissions regulations. Hydrogen sulfide (H2S) testing is for safety concerns. The table below outlines some of the commonly requested analyses on pipeline samples and the reasons for the request.

Table 1. Analysis of Pipeline Samples

Analysis Requested	Primary Reasons
Sediment and Water	Custody Transfer and Quality
API Gravity	Custody Transfer and Quality
Sulfur	Quality and Safety
Hydrogen Sulfide	Safety and Reliability (corrosion control)
Wax	Pumpability and Quality
Viscosity	Pumpability and Quality
Pour Point	Pumpability and Quality
Total Acid Number	Quality and Reliability
Reid Vapor Pressure	Environmental Regulations and Safety
Light Ends and Residue	Quality
Organic Chlorides	Safety and Quality
Distillation	Quality
Metals	Quality

Conclusion:

Crude oil quality on our pipelines is intertwined with all areas of the petroleum industry. From well to wheels, we must work together to insure that we all understand the significance of quality on safety, enhanced production, pipeline hydraulics, refinery operations and regulatory compliance.