

OIL QUALITY VARIABLES & THEIR IMPORTANCE

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The purpose of this document is to define and articulate the importance of 18 frequently measured properties of crude oil. These properties, or variables, dictate the quality of oil being tested, thus impacting financial transactions in the business.

Included for each variable is a visual, indicating risks, hazards, and considerations to keep in mind when testing for that particular variable is conducted incorrectly.

Human
Hazard



Environmental
Hazard



Equipment
Hazard













Financial
Risk









Quality Variable	Definition	Explanation	Risks/Hazards
Color (ASTM) ✓	Hydrocarbons range from a clear “water” color to a dark black color. An ASTM of 0.5 represents a color that is clearer than water. An ASTM of 8 is dark black and allows little light to penetrate the color.	Colour provides an indication of the concentration of heavy hydrocarbon, particulate, asphaltene, and contaminants that are in a product. Color is typically used to determine if additional testing of a product is required. Colour is more important when analyzing specification products (ie: downstream of a refinery). Colour is based off the ASTM color scale that consists of 9 colours, ranging from 0 to 9. Drinking water has an ASTM colour of 1, whereas black mud would be categorized as 9 ASTM. Condensate has a colour between 1.5-4 ASTM, while crude and sour crude have colours from 6-8 ASTM.	
Density (kg/m3) ✓	Mass per unit volume. Eg: the density of water is greater than the density of air.	Product density ranges are driven by commercial, refinery, and diluent use cases. The density of a product, coupled with total sulphur and viscosity will determine the product designation (Sweet, Sour, Condensate).	








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<p>Total Vapour Pressure — VP (kPaa @ 37°C)</p> 	<p>Pressure exerted by a vapour in thermodynamic equilibrium. Eg: Fill a jar halfway with oil. Close the jar and allow the oil to equalize (allow vapours to vapourize out of the oil liquid). While keeping the oil at 37°C, measure the pressure of the vapour space. It will settle at a pressure which is the vapour pressure. This is the force the oil is exerting on the jar at this specific temperature.</p>	<p>VP affects safety and emissions on atmospheric storage tanks. Having a high vapour pressure liquid will increase emissions and potentially cause over pressure events in storage tanks. High vapour pressure product in rail tanks that have low tolerances on maximum pressure are also risky.</p> <p>VP is a leading indicator of high light-end content (Methane, Ethane, Propane, and Butane). Commercially, products are expected to have low concentrations of these less valuable products. Additionally, downstream refineries and diluent customers consider products with high lights-ends to be less desirable for their businesses.</p>	   
<p>Total Filterable Solids (mg/L)</p> 	<p>Measure of solids that are left behind when filtered in milligrams within a liter of the solution that was filtered.</p>	<p>Filterable solids can be an indicator of how much heavy hydrocarbon is in a condensate. It also measures how well solids from down hole, such as fracking, are removed from products. Solids create issues with midstream assets including pump seals, instrumentation, pipelines, etc.</p>	
<p>Moisture (Vol %)</p> 	<p>The amount of water in a substance. Measured as a percent of the total volume of the substance. Ie: 5 liters of water in a cubic meter of crude oil represents 0.5% Vol H₂O.</p>	<p>Water content is important for several reasons: It's not valued and therefore, is subtracted from hydrocarbon payment volumes. Water freezes at 0 °C which creates issues with inline instrumentation, pipes, tanks, and pumps. Additionally, water can sit in low spots causing rust and can retain dissolved minerals that cause scaling.</p>	 






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Viscosity (cSt)	Measure of internal friction of a fluid. cSt represents centistokes, which is a measure of how much force it takes to move a liquid. Honey has a higher viscosity than water. Water has a higher viscosity than alcohol. Viscosity can be related to the ease of a liquid to flow.	<p>Condensate: Viscosity is important, as it is directly related to its effectiveness as a diluent for a heavy oil. Condensate typically has an acceptable viscosity of < 2.0-4.0 cSt.</p> <p>Crude & Sour: Acceptable viscosity is much higher for crude & sour products. Typical range is between 20-50 cSt. Viscosity specifications are set based on pipeline design requirements and downstream refinery requirements. Heavier and more viscous products demand more processing resources at refineries, and greater energy to transport the product to its final destination.</p>	 
Receipt Temperature (Celsius)	Degree of heat present in a substance or object. Typically, crude products are shipped between 0-45 °C.	<p>Temperature is specified to ensure the temperature doesn't exceed pipe, fitting, coating, and instrument design temperatures. Additionally, a maximum temperature is specified to help eliminate wax issues when product cools in downstream assets.</p>	
Organic Chlorides in Whole (wppm)	Organic chlorides are compounds with elemental chloride that have a carbon atom present. Organic chlorides can result in the creation of hydrochloric acid.	<p>Organic chlorides consist of a carbon-chloride bond. For example, Salt (NaCl) is not an organic chloride, as it does not have carbon molecules. Organic Chlorides can be hazardous as they lead to the creation of other molecules, such as HCl, that are highly corrosive to facilities. Sources of organic chlorides include: drilling/ frack fluids, contaminated products, and de-waxing chemicals. Organic chlorides can be seen in all produced products.</p>	  



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Acidity/Basicity of Water (pH)	pH is the measure of hydrogen ion concentration in a liquid. Low pH is an acidic product and high pH is an alkaline (basic) product. The pH scale runs from 0 to 14.	A pH of 0 and a pH of 14 can burn skin and erode equipment severely. Since pH is a measure of the acidic or basic water content of a product, it is important as it can corrode facility assets along the entire supply chain assets. Refineries will only accept specific ranges of pH levels to be processed in their facilities for the same reasoning.	 
Total BTEX (vol %)	Measured as volume percent of BTEX compounds within the solution.	BTEX is a measurement of benzene, toluene, ethylbenzene and xylene. These are also referred to as aromatics. These compounds are considered to be good diluent traits. They are naturally occurring in hydrocarbon formations. BTEX poses a safety concern as they are carcinogenic.	 
Mercury Hg (mg/L)	Measure of the element mercury in milligrams within a liter of the solution.	Mercury is not native to hydrocarbon production. It is introduced into products from treatment processes, chemical additives, and upstream blending. Mercury is highly corrosive to aluminum process equipment including heat exchangers.	
Vanadium and Nickel V, Ni (mg/L)	Measure of vanadium and nickel elements in milligrams within a liter of the solution.	Vanadium and nickel are heavy metals. They can be native to hydrocarbon formations. They cause operational issues with refineries, specifically with catalyst agents.	
Total Acid Number TAN (mg KOH/g)	This is a specific measure of acidity in a solution represented by the amount of potassium hydroxide required to neutralize the hydrocarbon solution.	Total acid number signifies how much KOH is required to neutralize the acidity of 1g of hydrocarbon. This is another characteristic that is associated with corrosion of facilities and processing assets.	

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Hydrogen Sulphide H ₂ S (wppm)	The measure of Hydrogen Sulphide molecules present in a solution.	H ₂ S is a safety concern if the concentration is high enough to cause a concentration of >5ppm in a breathing environment (vapor phase). Additionally, when mixed with water, H ₂ S creates sulphuric acid which will corrode assets. This can lead to failure of pumps, pipelines, and other midstream equipment. H ₂ S is native to some hydrocarbon formations. It is typically processed out at upstream facilities before transported on midstream assets. However, there are sour (H ₂ S) pipelines. Sour (crude, high sulphur) product doesn't necessary have high concentrations of H ₂ S, rather a total sulphur presence of greater than 0.5 wt%.	  
Micro Carbon Residue MCR (wt%)	Measures carbon residue formed after evaporation of petroleum products. This is measured as a percentage of the total weight of a product. MCR of 5g in a 100g sample equates to a 5% weight percent.	Micro carbon residue is a measure of extremely high carbon content in a product (C30+). First, for condensate, it is an indicator of how much crude or heavy oil has been mixed within it throughout the supply chain. Produced condensate from downhole typically has extremely low MCR content. Heavy sour products will have higher MCR content — up to ~10wt% is possible. Secondly, MCR levels must also meet specification on the back side of refineries for market products. High MCR can have negative effects on assets that consume fuels and oils (ex. high carbon deposits in combustion cylinders).	 

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Total Sulphur (wt %)	Sulphur is an element typically found in all natural resources. It combines with other elements to create hundreds of different sulphur compounds like Sulphur dioxide, hydrogen sulphide, COS, SO ₂ .	Total sulphur content is driven by refineries. Refineries must meet specifications for specification products such as diesel and gasoline. Removal of sulphur has an added cost for refineries as well, they are only designed to remove specific concentrations of sulphur.	
Phosphorous P (wppm)	Measure of the weighted parts per million of phosphorous in a solution.	Phosphorous is another element that is associated to refinery fouling. It is not native to hydrocarbon formations and is typically introduced to product streams through drilling additives.	
Olefins (wt %)	Can also be called alkene. They are a form of high bonded carbon atoms at the molecular level.	Olefins are hydrogen and carbon compounds which have a stronger double bond. They cause fouling and operational issues in refineries. They also create difficulties in producing on specification market products at the refinery.	