Oil & Gas Process Analysis Terminology

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Optimizing Process and Product with Precision Measurement

Accurate measurement is nowhere more essential than in the oil & gas industry. Understanding the chemical composition of raw materials and the consistency of processed products can create an immense competitive advantage at every point in the process.

As part of our mission to make Raman spectroscopy accessible, we have curated a list of the essential process analytics terminology to help you get started.
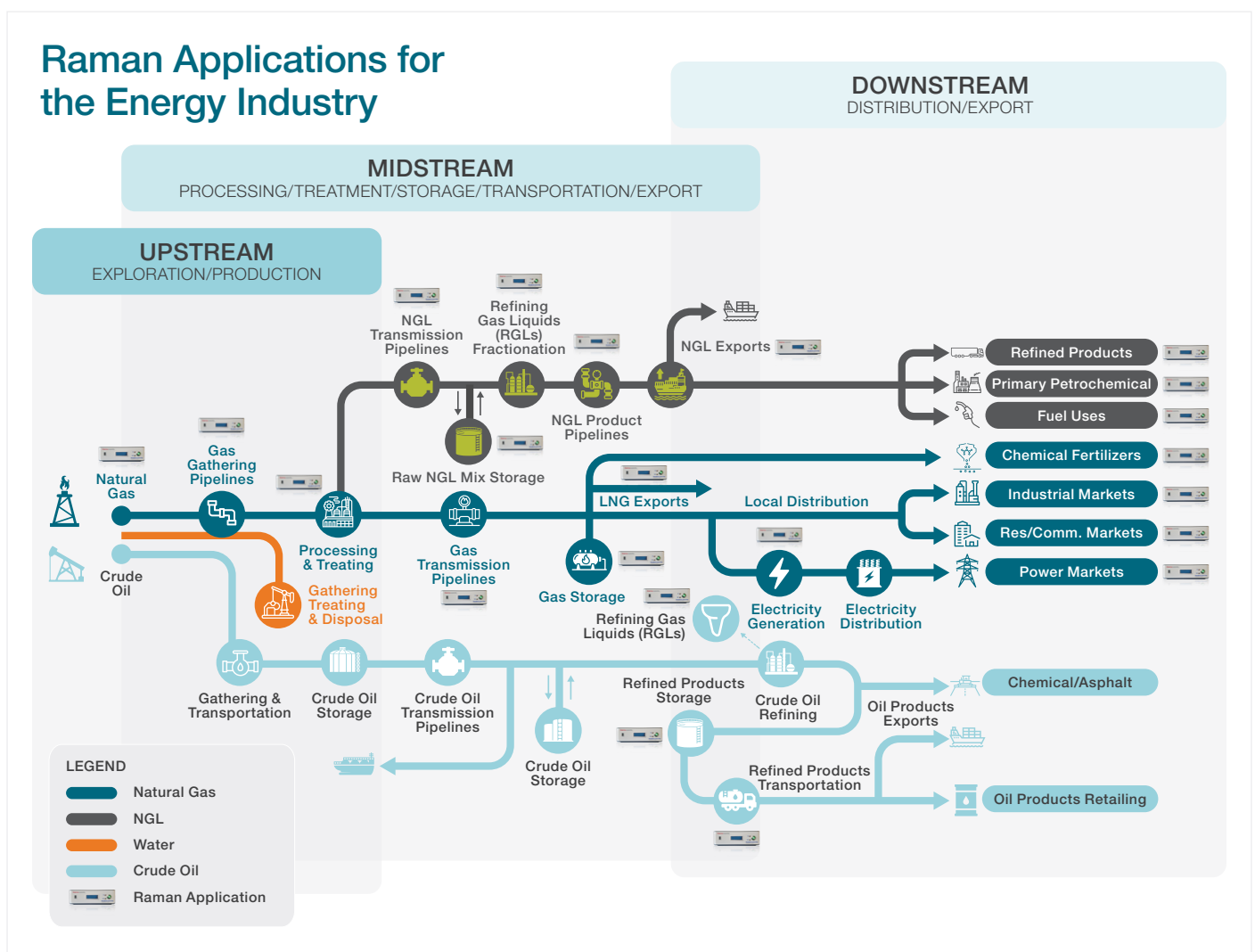
Raman Applications for the Energy Industry

DOWNSTREAM
DISTRIBUTION/EXPORT

MIDSTREAM
PROCESSING/TREATMENT/STORAGE/TRANSPORTATION/EXPORT

UPSTREAM
EXPLORATION/PRODUCTION

NGL Transmission Pipelines

Refining Gas Liquids (RGLs) Fractionation

NGL Exports

Natural Gas

Gas Gathering Pipelines

Raw NGL Mix Storage

NGL Product Pipelines

Refined Products

Primary Petrochemical

Fuel Uses

Crude Oil

Processing & Treating

Gathering Treating & Disposal

Gas Transmission Pipelines

LNG Exports

Local Distribution

Chemical Fertilizers

Industrial Markets

Res/Comm. Markets

Gas Storage

Power Markets

Refining Gas Liquids (RGLs)

Electricity Generation

Electricity Distribution

Gathering & Transportation

Crude Oil Storage

Crude Oil Transmission Pipelines

Refined Products Storage

Crude Oil Refining

Oil Products Exports

Chemical/Asphalt

Crude Oil Storage

Refined Products Transportation

Oil Products Retailing

LEGEND
- Natural Gas
- NGL
- Water
- Crude Oil
- Raman Application

Figure 1. Upstream, midstream, downstream segments and applications that benefit from real-time Raman benefit.

Alkylate – Gasoline blend stock made by the combination of olefins and paraffins to produce a higher octane rating.

American Society for Testing and Materials (ASTM) – An international standards organization that develops and publishes voluntary consensus technical standards for a wide range of materials, products, systems, and services.

API Gravity - A density measure of how heavy or light a petroleum liquid is compared to water.

Benzene – An organic chemical compound with the molecular formula C_6H_6. The benzene molecule is composed of six carbon atoms joined in a planar ring with one hydrogen atom attached to each. Benzene is a colorless and highly flammable liquid with a sweet smell and is partially responsible for the aroma of gasoline.

Carbon Dioxide (CO$_2$) - Carbon Dioxide CO_2 is an inert gas that is formed by the complete combustion of hydrocarbons. In the air, carbon dioxide is transparent to visible light but absorbs infrared radiation, acting as a greenhouse gas.

Carbon Monoxide (CO) – Carbon Monoxide CO is a colorless, poisonous, odorless, tasteless, flammable gas that is slightly less dense than air. The most common source of carbon monoxide is the partial combustion of carbon-containing compounds when insufficient oxygen or heat is present to produce carbon dioxide.

Cetane Number – An indicator of the combustion speed of diesel fuel and compression needed for ignition. It plays a similar role for diesel as octane rating does for gasoline.

Chemometrics – The chemical discipline that uses mathematical, statistical, and other methods employing formal logic to design or select optimal measurement procedures and experiments, and to provide maximum relevant chemical information by analyzing chemical data.

Cloud Point - The temperature below which a transparent solution undergoes either a liquid-liquid phase separation to form an emulsion or a liquid-solid phase transition to form either a stable solid or a suspension that settles a precipitate. The cloud point is analogous to the 'dew point' at which a gas-liquid phase transition called condensation occurs in water vapor (humid air) to form liquid water (dew or clouds).

Cross Validation - A resampling method that uses different portions of the data to test and train a model on different iterations. It is mainly used in settings where the goal is to estimate how accurately a predictive model will perform in practice.

Custody Transfer – The legal point in which a product is transferred between two operating parties.

Densitometer – Analytical equipment that measures the density of a fluid.

Diesel – Type of motor fuel designed for use in compression ignition engines, which relies on the compression ratio of the fuel/air mixture to ignite the fluid in the absence of a spark.

Distillation – The process of separating the components or substances from a liquid mixture by using selective boiling and condensation.

Downstream – Segment of the Oil & Gas industry responsible for refinement of unprocessed hydrocarbons into consumer products, chiefly gasoline, diesel, and jet fuels.

Flash Point – The lowest liquid temperature at which, under certain standardized conditions, a liquid gives off vapors in a quantity such as to be capable of forming an ignitable vapor/air mixture.
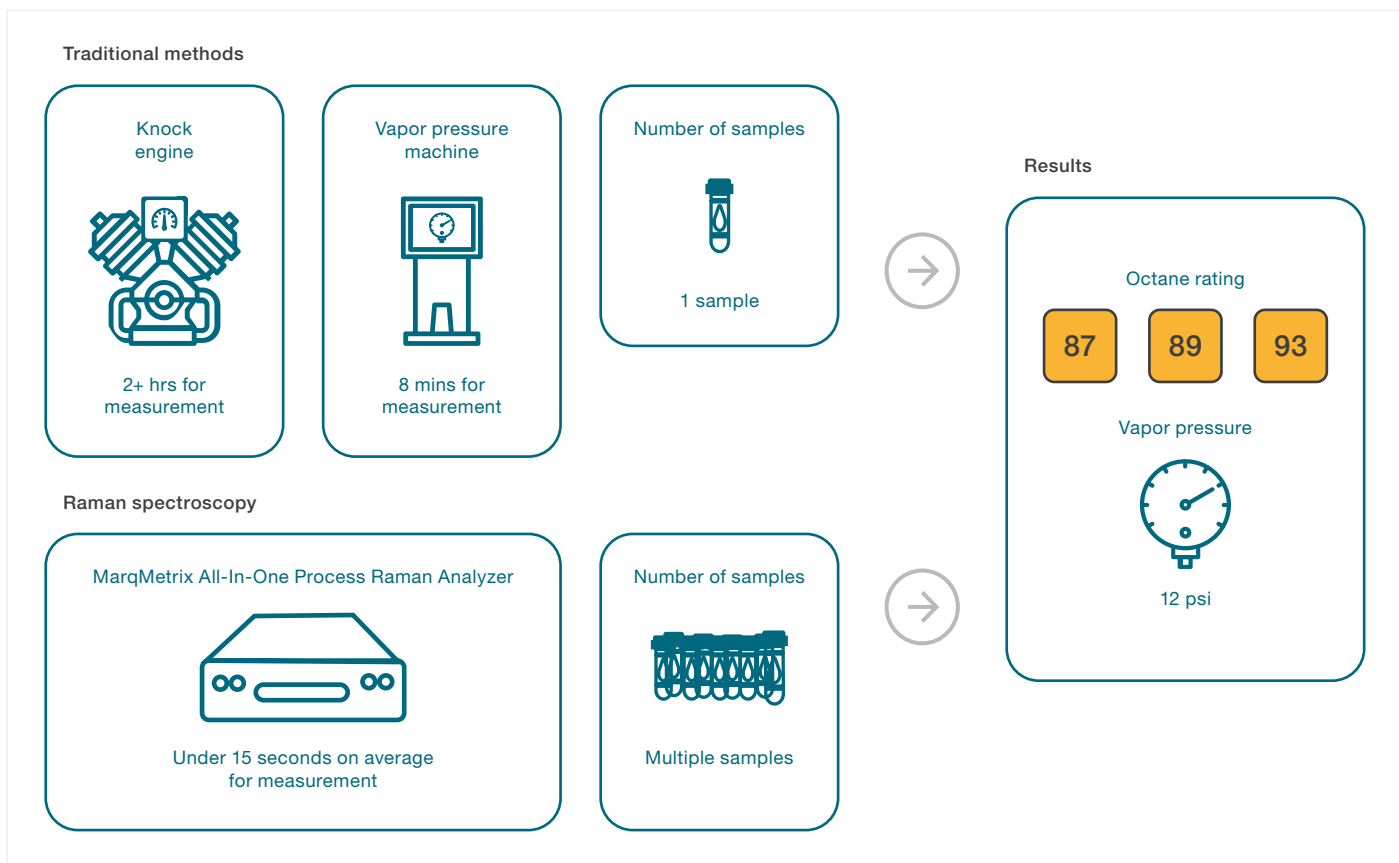
Figure 2. Measuring octane levels with traditional methods vs Raman spectroscopy.

Freeze Point – Temperature that the paraffin in diesel fuel begins to stiffen, leaving the product to appearformula C_6H_6. The benzene molecule is composed of six carbon atoms joined in a planar ring with one hydrogen atom attached to each. Benzene is a colorless and highly flammable liquid with a sweet smell and is partially responsible for the aroma of gasoline.

Gas Chromatograph – Analyzer that separates components of a substance through vaporization and measures the individual compounds to determine composition.

Gasoline – A transparent, petroleum-derived flammable liquid that is used primarily as a fuel in most spark-ignited internal combustion engine. It consists mostly of organic compounds obtained by the fractional distillation of petroleum.

Hydrocarbon – An organic compound that consists entirely of hydrogen and carbon. Hydrocarbons are generally flammable and have an odor exemplified by gasoline and lighter fluid.

Initial boiling point (IBP) – IBPis the temperature when a hydrocarbon mixture begins to vaporize as the temperature of the sample is increased.

Inline Analysis – An analysis method where an analyzer with a sensor is placed directly in the process piping or vessel.

Integration Time – The amount of time the Raman detector is collecting the Raman shift count.

Isomerate – Gasoline blend stock produced by the isomerization unit, converting light naphtha into a higher-value gasoline blendstock by changing its molecular shape and raising its octane.

Jet Fuel – Type of aviation fuel designed for use in aircraft powered by gas-turbine engines. It is colorless to straw-colored in appearance and is a mixture of hydrocarbons with carbon numbers 8 – 16.

Knock Engine – Standard four-stroke cycle engine that can run at a specified RPM to test the octane number of a given gasoline.

Knocking - Occurs when combustion of some of the air/fuel mixture in the cylinder does not result from propagation of the flame front ignited by the spark plug, but one or more pockets of air/fuel mixture explode outside the envelope of the normal combustion front.

Laboratory Information Management System (LIMS) – Software program that manages the chain of custody of a sample in a laboratory.

Models – A statistical matrix that incorporates known parameters to make a prediction on a given signal to assign a quantitative or qualitative value.

Motor Octane Number (MON) - MON testing uses a similar test engine to that used in RON testing, but with a preheated fuel mixture, 900 rpm engine speed, and variable ignition timing to further stress the fuel's knock resistance.

Naphtha – A flammable liquid hydrocarbon mixture produced from natural gas condensates, petroleum distillates, and the distillation of coal tar and peat. Often used in the production of gasoline blending components.

Octane – The standard measure of a fuel's ability to withstand compression in an internal combustion engine without detonating.

Offline Analysis – An analysis method that utilizes an analyzer that does not interface with the process piping and is often located in a laboratory outside of the process area.

Online Analysis - An analysis method where the analyzer is placed next to the process piping and interfaces with the process fluid through a parallel speed loop.

Optics – The branch of physics that studies the behavior and properties of light, including its interactions with matter and the construction of instruments that use or detect it.

Partial Least Squares Discriminant Analysis (PLS-DA) - PLSDA is a method for the classification and identification of samples.

Partial Least Squares (PLS) Regression – A statistical method that finds a linear regression model by projecting the predicted variables and the observable variables to a new space. Once a sample is classified and identified, PLS defines how much of said sample is in something.

Product – The result of processing crude hydrocarbons into a usable good for consumption, which includes gasoline, distillates such as diesel fuel and heating oil, jet fuel, petrochemical feedstocks, waxes, lubricating oils, and asphalt.

Rack Tank – Storage tank that holds products prior to being loaded onto a truck, railcar, or ship.

Rack Batches – Term used for the product contained in the rack tank.

Raman Spectroscopy - A spectroscopic technique used to determine vibrational modes of molecules through inelastic scattering of photons from a light source.

Reformate – Gasoline blend stock that is produced by the catalytic reforming, a refining process in which mixed-catalysts and hydrogen promote the rearrangement of lower octane naphthenes into higher octane compounds.
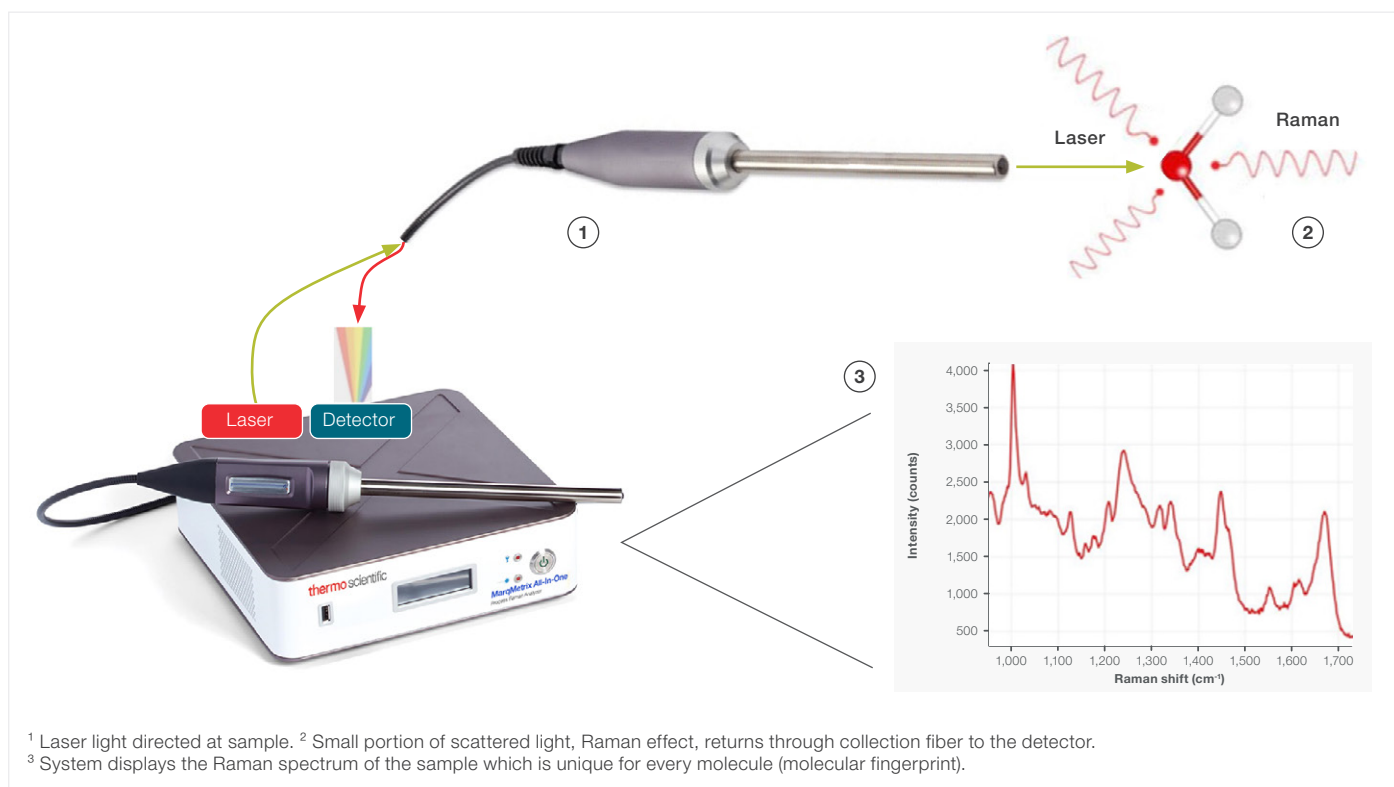

[1] Laser light directed at sample. [2] Small portion of scattered light, Raman effect, returns through collection fiber to the detector.
[3] System displays the Raman spectrum of the sample which is unique for every molecule (molecular fingerprint).

Figure 3. Graphical representation of how Raman works.

Figure 4. Octane ratings at a gas pump.

Reid Vapor Pressure (RVP) – RVP is a common measure of the volatility of gasoline and other petroleum products. It is defined as the absolute vapor pressure exerted by the vapor of the liquid and any dissolved gases/moisture at 37.8 °C (100 °F).

Research Octane Number (RON) –RON is determined by running the fuel in a knock engine at 600 rpm with a variable compression ratio under controlled conditions and comparing the results with those for mixtures of iso-octane and n-heptane.

Scintillation Vial – Laboratory apparatus that a sample is held in, commonly sized as 20 mL.

Signal to Noise Ratio (SNR) – SNR measures the strength of the desired signal relative to background noise.

Spectra – Dataset that shows the Raman count at a given signal frequency. Spectra are run against models to produce a quantitative or qualitative value.

Spectroscopy – The field of study that measures and interprets the electromagnetic spectra that result from the interaction between electromagnetic radiation and matter as a function of the wavelength or frequency of the radiation.

Solid-state – An electronic system that is comprised of semiconductors and has no moving parts.

Transmix – Fluid interface between two purity products that are being transported.

Vapor Pressure – Defined as the pressure exerted by a vapor in thermodynamic equilibrium with its condensed phases (solid or liquid) at a given temperature in a closed system. The equilibrium vapor pressure is an indication of a liquid's thermodynamic tendency to evaporate.

Vapor to Liquid (V/L) Ratio – Measure that describes a fuel's tendency of forming a vapor lock when used in an Internal Combustion Engine.

Volatile – Material quality which describes how readily a substance vaporizes. At a given temperature and pressure, a substance with high volatility is more likely to exist as a vapor, while a substance with low volatility is more likely to be a liquid or solid.

Refined Measurement for Raw Materials

The Thermo Scientific™ MarqMetrix™ All-In-One Process Raman Analyzer and Thermo Scientific™ MarqMetrix™ BallProbes™ are the perfect tools for online process characterization, quality measurement, and control.

MarqMetrix BallProbes, utilizing our patented TouchRaman™ technology, end optics have been successfully deployed to assess composition during exploration, characterize crude and distillates, determine the composition of natural gas, and perform environmental assessments.

MarqMetrix All-In-One Process Raman Analyzer Benefits

- Small footprint: move in the analyzer without moving other equipment out

- Complementary analysis to your existing technology: knock engine, vapor pressure tester and gas chromatographer

- Data you can use: analyzer measurements are correlated to the relevant ASTM standard

With a small footprint and no moving parts, the MarqMetrix All-In-One Process Raman Analyzer makes Raman analysis portable and puts decision-makers at the point of measurement.

The Thermo Scientific™ AutoFLEX offers a flexible platform allowing operators from wellhead to consumer increase their ability to monitor instrument performance, flow throughput, and other metrics via increased processing power. This helps users to avoid costly unplanned downtime, make better maintenance decisions based on collected data.

Learn more at **thermofisher.com/marqmetrixAIO**

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