TDLAS analyzers for natural gas processing

Accurate and reliable measurement of H_2O, H_2S, and CO_2

Endress+Hauser
People for Process Automation

Laser-based analyzers for natural gas processing

Laser spectroscopy – a better solution for challenging process conditions

The Endress+Hauser advantage Tunable diode laser absorption spectroscopy (TDLAS) analyzers from Endress+Hauser perform on-line, real-time measurements of impurities in natural gas streams from sub-ppm levels to low percentage levels. The unique design of our TDLAS analyzers, powered by SpectraSensors TDLAS technology, provide significant advantages over other technologies for monitoring H_2O, H_2S, and CO_2 in natural gas and natural gas liquids (NGLs).

Non-contact measurement The laser and solid state detector components of TDLAS analyzers are isolated and protected from the process gas and entrained contaminants flowing through the sample cell. This design avoids the fouling, corrosion, and memory effects associated with Al_2O_3 moisture sensors and quartz crystal microbalance analyzers, ensuring reliable long-term operation.

Fast response and analysis time TDLAS analyzers detect changes in analyte concentration much faster than other techniques. The wet-up and dry-down times associated with quartz crystal microbalances can result in a delayed response or failure to detect a sudden increase in H_2O concentration signaling breakthrough in a molecular sieve dehydration vessel.

Selective and specific analyte measurement TDLAS analyzers selectively measure the spectroscopic signature of H_2O, H_2S, and CO_2 in natural gas. Al_2O_3 sensors and Quartz Crystal Microbalances cannot distinguish between H_2O and methanol and give a false reading when methanol is present in natural gas as a hydrate inhibitor.

Low cost of ownership Unlike lead acetate tape analyzers or gas chromatographs (GCs), TDLAS analyzers have virtually no consumable components resulting in a lower cost of ownership and a lower service and maintenance burden on technicians.

TDLAS analyzers for natural gas processing

Monitoring contaminants throughout the gas treatment process

Selective and specific measurement of critical contaminants

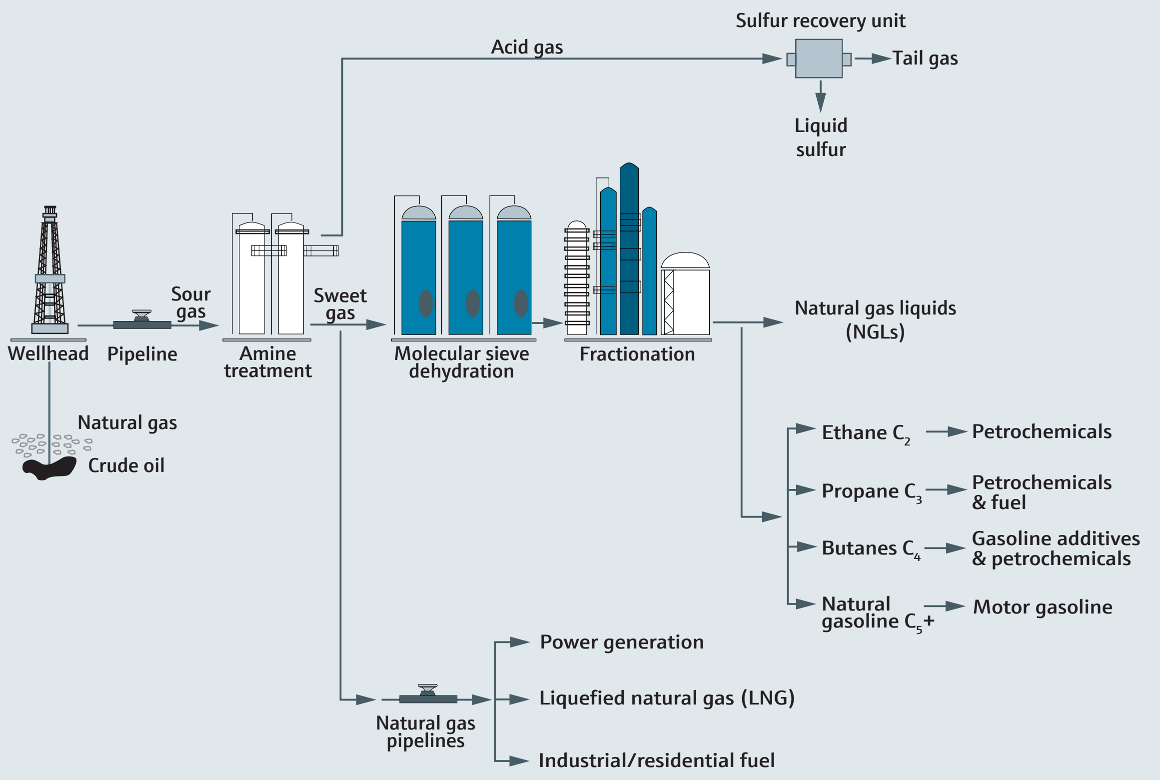
Natural gas processing involves separating methane (CH_4) from other hydrocarbons, fluids, and contaminants entrained in raw wellhead gas to produce pipeline-quality dry natural gas.

Raw natural gas is a complex mixture of methane, hydrocarbon condensates (natural gas liquids - NGLs), water, and contaminants: hydrogen sulfide (H_2S), carbon dioxide (CO_2), nitrogen, mercury, and other compounds. The composition of natural gas varies widely based on the geological formation it is extracted from.

Key processing steps include amine treatment to remove H_2S and CO_2 from sour gas, molecular sieve dehydration of the resulting sweet gas, and fractionation to separate and recover NGLs (ethane, propane, butane) from pipeline-quality natural gas.

Endress+Hauser TDLAS analyzers measure H_2S, CO_2, and H_2O at critical points in the gas treatment process. These measurements help plant operators improve process control, meet stringent product specifications, mitigate corrosion damage, and reduce operating costs.

Natural gas treatment process



Amine treatment and gas sweetening

H_2S and CO_2 measurements for process control and optimization

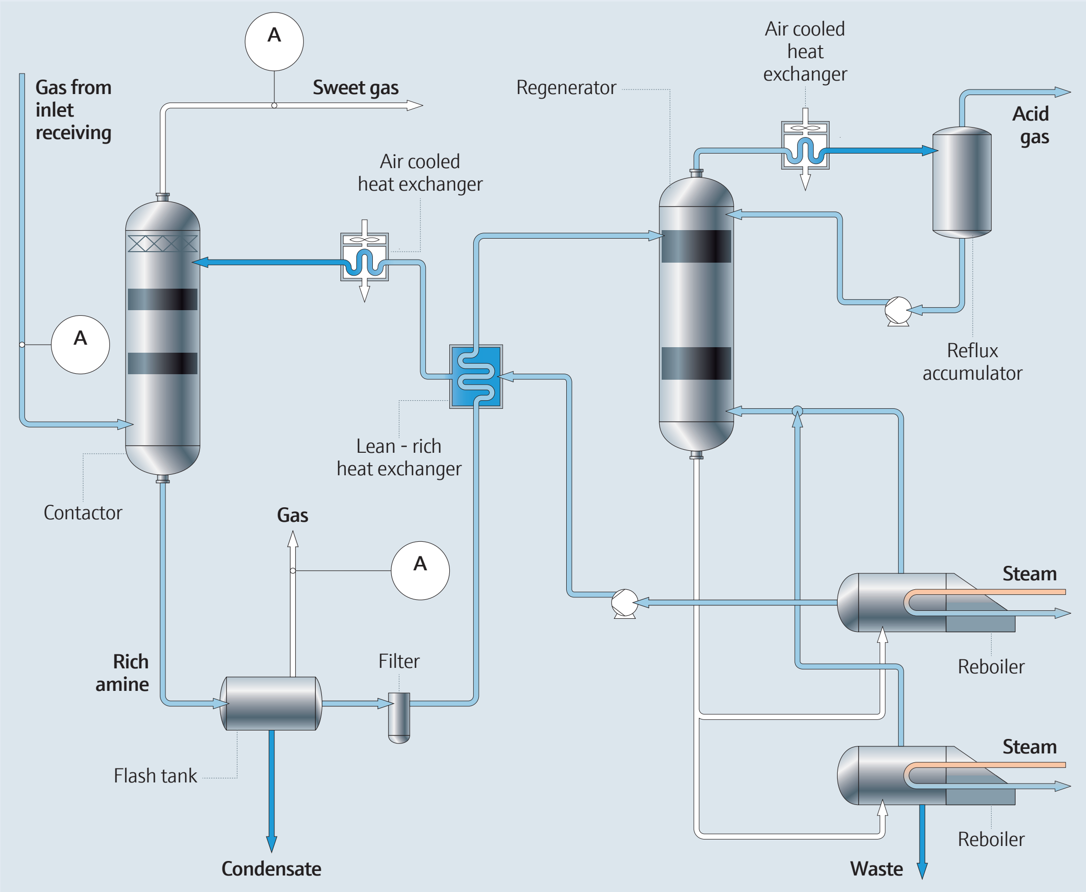
Raw natural gas from different geological formations contains varying amounts of acid gases (H_2S and CO_2). Natural gas that contains H_2S in excess of specifications for pipeline-quality gas is generally considered sour gas. Approximately 40% of the world's natural gas reserves are sour gas. Fields with sub-quality natural gas, containing > 2 % CO_2, 4 % N_2, and 4 ppmv H_2S are also widespread.

Gas sweetening processes are designed to remove acid gases from sour gas to meet specifications for gas transmission pipelines. Amine treatment units are commonly used in gas processing plants to scrub H_2S and CO_2 from natural gas.

In operation, sour gas is contacted with an aqueous amine solution which removes H_2S and CO_2 by chemical reaction and absorption. Measuring the H_2S and CO_2 concentrations in sour gas at the inlet and the sweet gas at the outlet of the amine treatment unit is important for control and optimization of the treatment process.

Acid gas containing elevated levels of H_2S and CO_2 is a byproduct of the process. Many gas processing plants have a sulfur recovery unit (SRU) on site to convert and recover elemental sulfur from H_2S in acid gas. Measuring the H_2S concentration in the acid gas stream is critical for optimization of the oxidation process occurring inside the SRU.

Amine treatment / gas sweetening



Molecular sieve dehydration

Trace level H_2O measurements for process control and optimization

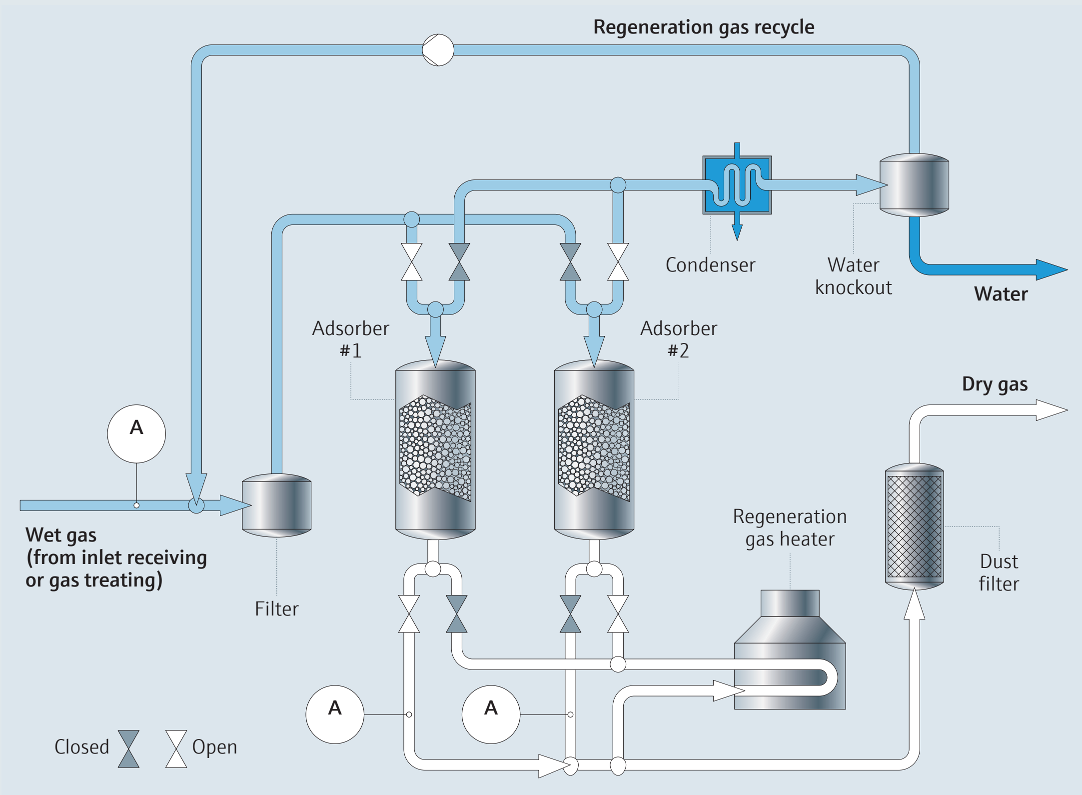
Sweet natural gas exiting an amine treatment unit is saturated with water vapor. Some water can be removed from wet gas by passing it through a knock-out drum, compression and cooling.

Molecular sieve dehydration must be used to obtain the very low H_2O concentration (< 0.1 ppm) required in low temperature and cryogenic processes for NGL extraction and liquefied natural gas (LNG) production.

Three or four dryer vessels containing molecular sieves are typically operated in parallel with a piping system that allows a saturated adsorbent bed to be taken off line for regeneration with heated gas. Measuring the moisture level in the outlet gas from each dryer vessel enables the operator to rapidly detect moisture breakthrough in the adsorbent bed and switch gas flow to a vessel with a freshly regenerated adsorbent bed.

Endress+Hauser TDLAS analyzers monitor trace levels of H_2O at the outlet of molecular sieve dryer vessels to ensure the gas meets specifications and to control the dehydration process.

Molecular sieve dehydration



Fractionation and recovery of NGLs

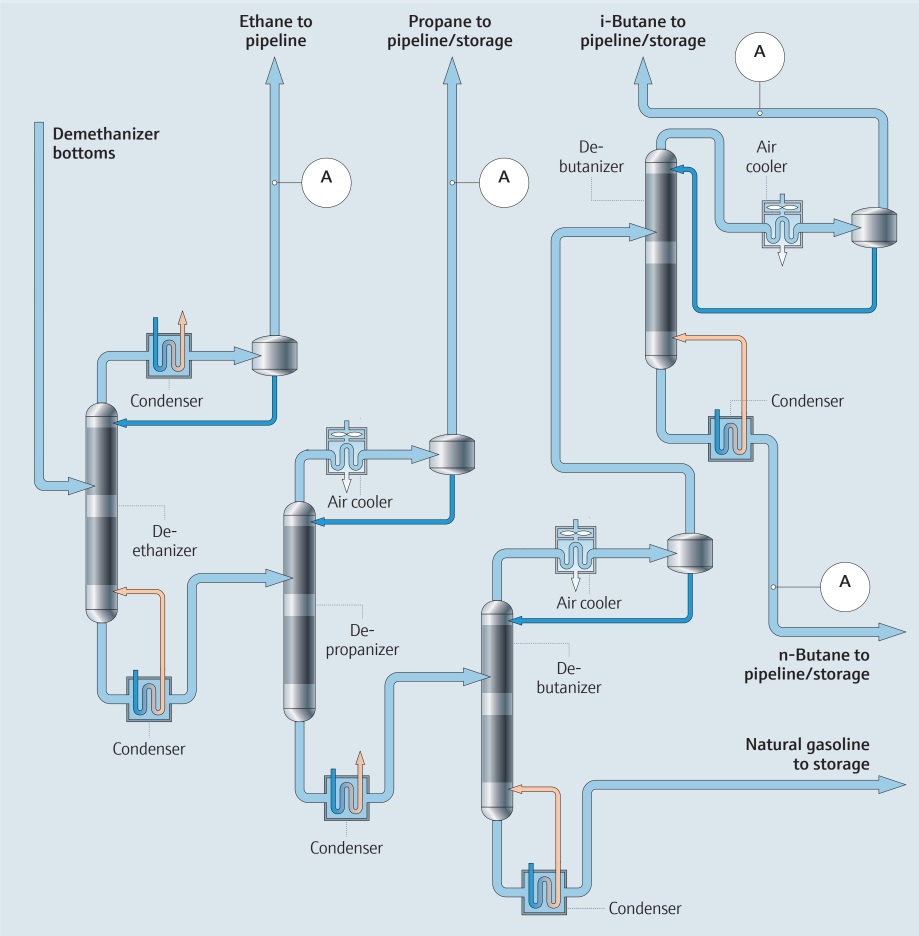
Measuring contaminants in NGL fractionation products

Unprocessed wellhead natural gas contains NGLs: ethane (C_2H_6), propane (C_3H_8), butane (C_4H_{10}), and a mix of C_5+ liquid condensates termed natural gasoline. These NGL compounds are commercially valuable as feedstocks for production of petrochemicals, octane-boosting gasoline additives, and for use as fuels. Raw natural gas containing low levels of NGLs is referred to as lean gas, while gas with elevated levels of NGLs is rich gas. The gas found in many shale formations is rich gas and plants processing shale gas will often include a fractionation unit to recover individual NGLs or a mixture of them.

Cryogenic processing is used to extract NGLs from natural gas. The extracted NGL mix is fed to a fractionation unit and processed through a series of fractionation columns: a deethanizer, a depropanizer, and a debutanizer to separate and recover ethane, propane, butane, and a residual C_5+ natural gasoline mix.

Purity specifications for NGL fractionation products are based on their intended use and downstream processing. Endress+Hauser TDLAS analyzers measure H_2O, H_2S, and CO_2 in NGL fractionation products to ensure applicable specifications are met.

NGL fractionation process

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