Dewpoint Measurement in Ethylene Feed Gas

APPLICATION NOTE

SHAW MOISTURE METERS

Dewpoint measurement in ethylene feed gas protects the reactors that turn ethylene into polyethylene and other derivatives. Polymer grade ethylene reaches the plant by pipeline or from storage. Before it enters the reactor, it passes through feed treaters: beds that remove oxygen, carbon monoxide, water and other catalyst poisons. Water is usually taken out by 3A molecular sieve dryers, often installed as a lead lag pair.

Water is one of the most damaging contaminants in that feed. At parts per million levels it poisons polymerisation catalyst, consumes co-catalyst and cuts reactor yield. When a dryer bed saturates, nothing else in the process tells you.



Why moisture is a problem in ethylene feed gas

Water that gets past the feed treaters does damage in four ways.

Catalyst poisoning

Ziegler-Natta, chromium and metallocene catalysts all lose activity when water reaches their active sites. Water also reacts with the aluminium alkyl co-catalyst, such as triethylaluminium (TEAL), that scavenges feed impurities. The plant then burns more catalyst and co-catalyst for the same output.

Lost rate and off grade resin

When catalyst activity swings, production rate and polymer properties swing with it. Operators chase the upset with catalyst and hydrogen adjustments and resin made in the meantime can fall outside its grade targets.

Silent dryer breakthrough

A 3A molecular sieve bed holds water until its adsorption front reaches the outlet. From then on, water passes straight through. Nothing in the normal process readings announces it, so without moisture measurement the first sign is often the reactor itself.

Freezing after a wet event

Hydrotests and maintenance can leave free water in lines and vessels. Ethylene cools as its pressure drops, so that water can freeze in regulators and small bore instrument lines and block flow to analysers and controls.

Ethylene feed purification dryers and measurement points

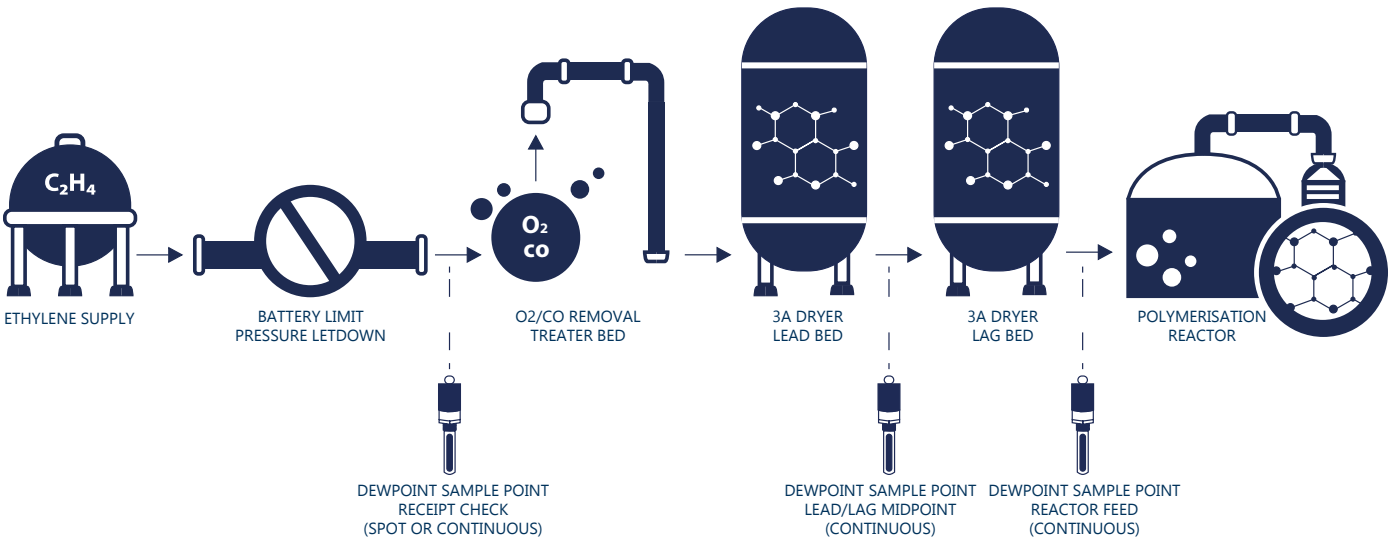


Figure 1. Ethylene feed purification train at a polyethylene plant, with typical dewpoint measurement points, receipt check, lead lag midpoint and reactor feed. The path is the treated feed. The order and number of oxygen and CO removal stages vary by plant; spot checks after dryer regeneration are covered in the text.

Measuring trace moisture in polymer grade ethylene

Measure between the lead and lag dryers. Sample in the vapour phase. Heat the pressure reduction.

That rule exists because a reading at the reactor inlet only tells you water has already arrived. A reading between the beds shows the lead bed breaking through while the lag bed still protects the reactor. Operators then have time to switch beds and start regeneration.

Polymer grade ethylene is typically supplied with water specified at around 1 ppm or below and molecular sieve dryers can further reduce this to under 0.1 ppm. At atmospheric pressure, 1 ppm(v) corresponds to a frost point of about -76 °C (-104.8 °F) and 0.1 ppm(v) to about -90 °C. Pressure moves those figures. At 30 bar, the same 1 ppm(v) reads near -52 °C (-61.6 °F). Always record the sample pressure with the dewpoint.

Shaw instruments use an aluminium oxide capacitance sensor. Water vapour adsorbs into the porous oxide and changes its capacitance, which tracks water vapour partial pressure. The measurement range reaches below -100 °C dewpoint with ±2 °C (±3.6 °F) dewpoint accuracy. Near -76 °C (-104.8 °F), ±2 °C spans approximately 0.75 to 1.4 ppm(v). Set alarm points below the feed limit with that band in mind and watch the trend. A steady rise at the midpoint is the earliest sign of breakthrough.

Heat the pressure reduction stage. Ethylene cools as it expands and its critical temperature is only 9.3 °C (48.7 °F). An unheated regulator on a high pressure line can chill the sample and partly condense it. Keep sample lines short and in stainless-steel. Route the vent to flare or another safe location. Expect slow settling at trace levels: below 1 ppm(v), water held on tubing walls and fittings desorbs for some time after a line is opened. Purge a new or disturbed sample line with process gas and wait for a flat trend before you trust the number.

Ethylene is a gas group IIB hazard and analyser locations are typically Zone 1 or Zone 2, therefore intrinsically safe instruments are a requirement.

All sensors require periodic recalibration and the instruments are built around that. Every Shaw sensor ships with a calibration certificate traceable to national and international humidity standards. The SDHmini-Ex handheld hygrometer runs an AutoCal check in the field between scheduled laboratory recalibration and our service and calibration team keeps the record traceable.



Typical locations for moisture measurement in ethylene feed

Battery limit (M1)

Check incoming ethylene against the supply specification before it loads the treaters. A wet delivery caught here protects dryer capacity. A continuous transmitter or a scheduled spot check measurement with a portable dewpoint meter both work.

Lead lag midpoint (M2)

This is the primary continuous measurement point. An intrinsically safe dewpoint transmitter sends a 4-20 mA signal to the DCS, which alarms on a rising trend and prompts the bed switch. Where beds switch on a fixed timer, the midpoint trend also shows how much capacity each cycle leaves unused, so the cycle can be set on evidence.

Reactor feed header (M3)

This point gives final assurance after the full treater train, alarmed at the feed limit. It confirms that nothing downstream of the lag bed is adding water.

After regeneration, change out or maintenance

A freshly regenerated bed can return to service wet if its cooling or purge step was cut short. Spot check the bed outlet with a portable intrinsically safe hygrometer before the bed goes back on line. The desiccant dry down assembly on the SDHmini-Ex keeps its sensor dry between checks, which shortens the wait for a stable reading at trace levels.

Accurate trace moisture measurement in ethylene feed gas protects polymerisation catalyst and keeps reactors at rate and on grade. It also turns dryer breakthrough from a reactor upset into a planned bed change.

References to applicable standards

ASTM D5234-92(2025)

Standard Guide for Analysis of Ethylene Product. Sets out the test methods, units of measure and typical concentration ranges for components of ethylene product.

ISO 7382:2023

Ethylene for industrial use: Sampling in the liquid and the gaseous phase. Covers procedures and precautions for drawing representative ethylene samples, including stainless-steel sample lines and purging.

ASTM D5454-11(2020)

Standard Test Method for Water Vapor Content of Gaseous Fuels Using Electronic Moisture Analyzers. Written for gaseous fuels, it describes aluminium oxide electronic analysers and their sampling practice, a useful reference for ethylene service.

IEC 60079-11:2023

Explosive atmospheres, Part 11: Equipment protection by intrinsic safety “i”. Governs the intrinsically safe instruments used in Zone 1 and Zone 2 ethylene areas.

Suitable Products



Dewpoint Transmitters

Intrinsically safe, continuous online monitoring for dehydration outlet and custody transfer points inside a classified hazardous area, wired into a control system on a 4-20 mA loop.



Handheld Hygrometers

Handheld spot check meters for commissioning, troubleshooting and periodic verification at remote or unmanned stations, using the same aluminium oxide sensing and AutoCal function as the fixed instruments.



Sample Systems

Sample conditioning built for line pressure natural gas, with a heated pressure reduction stage, filtration and hazardous area certification, matched to the transmitter or hygrometer in use.

Talk to our applications team

We design and manufacture dewpoint instruments for many different applications. Tell us about your application and we will help you choose the right product for your pressure, your hazardous area rating and your dewpoint range.

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