Manual Chilled-Mirror vs ZEGAZ Instruments' CEIRS™ Technology

KEY CONCEPTS

- CEIRS™ technology is essentially an advanced chilled-mirror.
- CEIRS™ Technology is a more advanced implementation of chilled-mirror concept.
- CEIRS™ Technology is far superior to other technologies for determination of dew points in natural gas.
- Chilled-mirror measurements are a first-principle technique.
- CEIRS™ Technology is immune to contaminants and corrosives in natural gas.
- CEIRS™ Technology does not need calibration as it is a *first-principle* measurement.

SUMMARY

ZEGAZ Instruments' CEIRS™ (Chilled-mirror Evanescent Infra-Red Spectroscopy) is an advanced implementation of the chilled-mirror concept. In principle, it is very similar to the manual chilled-mirrors, but much more accurate and repeatable.

Chilled-Mirror Concept

The chilled-mirror concept for measurement of hydrocarbon and/or water dewpoint is a fundamental first-principle measurement. If performed correctly, they are the most accurate measurement for determination of hydrocarbon and/or water dew point in the natural gas.

Manual chilled-mirrors have been around for many decades. In manual chilled-mirrors, the mirror is cooled using a refrigerant such as CO_2 or propane. There are few problems with the manual chilled-mirrors:

a- Detection of condensation is done by the human eye. This is somewhat subjective and depends on the operator. There is a lot of variance in the measurement depending on the operator.
b- The operator will not be able to reliably distinguish between water dew point, hydrocarbon dew point, or contaminants.
c- The measurement time is long.
d- The operator needs to carry a tank of refrigerant.

ZEGAZ Instruments' CEIRS™ Technology: Chilled-mirror Evanescent Infra-Red Spectroscopy

ZEGAZ Instruments Chilled-mirror Evanescent Infra-Red Spectroscopy (CEIRS™) is a **true dewpoint** measurement based on proprietary chilled-mirror technology combined with IR spectroscopy. It is a chilled-mirror technique and conforms to various standards that call for chilled-mirror measurements.

CEIRS™ technology is conceptually similar to a manual chilled-mirror, except that the refrigerant has been replaced with electronic coolers. More importantly, the human eye has been replaced with infrared sensing mechanism that can detect the dew point and whether it was water or hydrocarbon dew point. This eliminates the errors from the operator.

Accuracy of CEIRS™

ZEGAZ CEIRS™ Technology is a highly-accurate *first-principle* measurement of water dew point. This means that CEIRS™ actually measures the dew point directly. The accuracy in the short term and long-term is ±0.5 °C.

Long-Term Reliability

The only wetted part in CEIRS™ Technology is an extremely inert glass-like substance. It is immune to all contaminants, even strong acids and bases. No foreign substances can permanently bond to it, nor degrade it.

Measurement Under Pressure

ZEGAZ CEIRS™ Technology will perform the measurement at line pressure, up to 137 bars (2000 psi). **Therefore the dew point measured is the actual dew point at that pressure.**

Immunity to Contaminants in Gas Phase

Since the IR beam does not travel through the gas phase in CERIRS™, contaminants that may be present in the gas phase, will not affect the measurement.

Calculation of Water Content

ZEGAZ Instruments' products can calculate the water content from the measured dew point. Such a calculation is highly accurate since the core measurement of the dew point is performed at operational pressure. Most content measurement technologies (such as tunable-diode lasers, quartz crystal monitors, and aluminum oxide sensors) make the measurement at low pressures and as such are subject to pressure regulation errors.

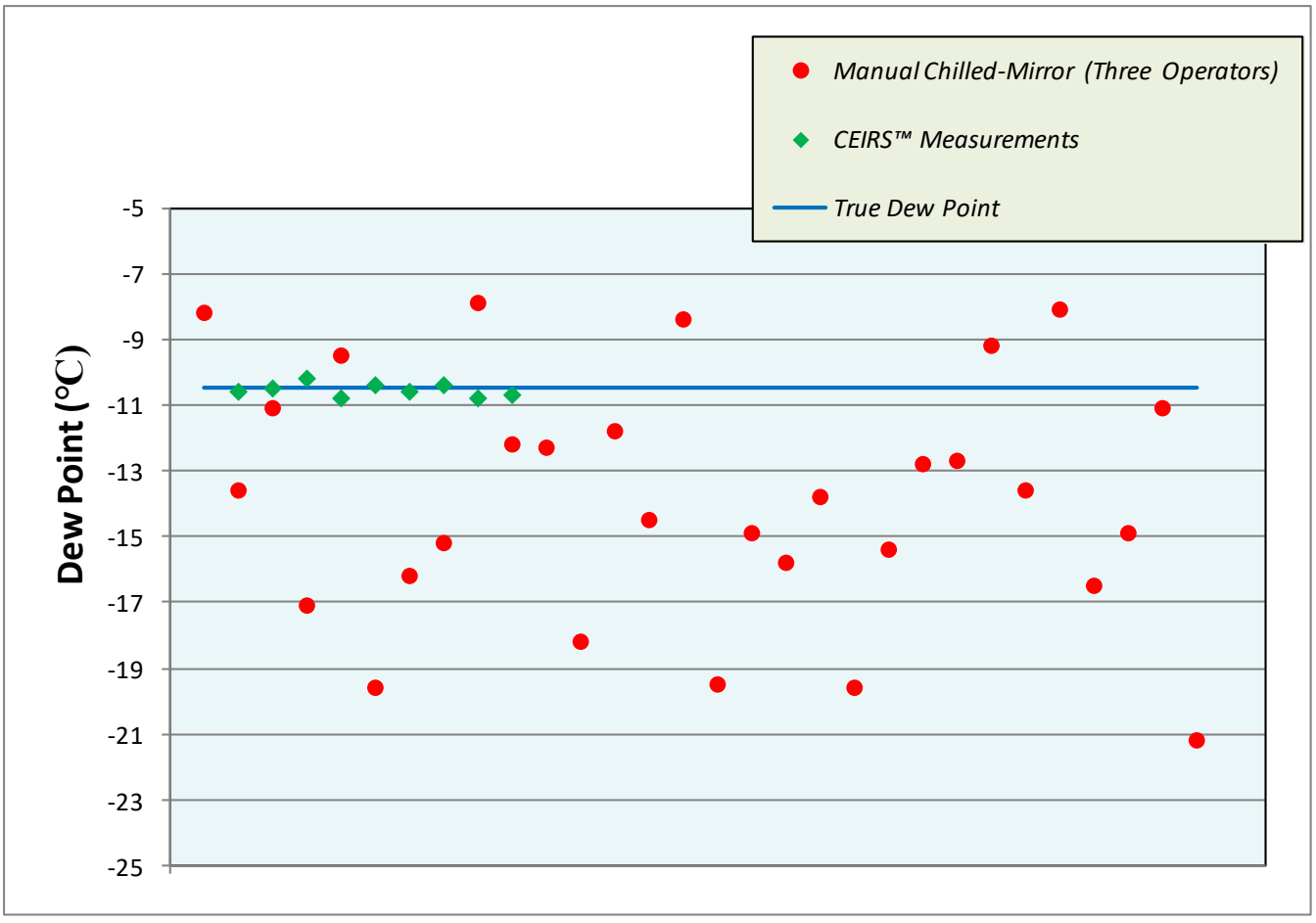
Since chilled-mirror measurements are a first principle measurement, they are still the reference standard for all other measurements.

Experimental Results Comparing CEIRS™ to manual chilled-mirror

ZEGAZ Instruments' products using CEIRS™ technology have been deployed at hundreds of locations. A series of experiments have been carried out to compare the performance of CEIRS™ technology to that of manual chilled-mirrors.

In one set of experiments, a gas with a known hydrocarbon dew point of -10.5°C was chosen. The water dew point for this gas was -5°C. The hydrocarbon dew point was measured with DewPort™, the portable water and hydrocarbon dew point analyzer by ZEGAZ Instruments which uses CEIRS™ technology. The same gas was also measured using a manual chilled mirror with three different skilled operators.

While DewPort™ provided repeatable and consistent results with very low variability; the results from manual chilled-mirror measurements showed significantly more scatter.



Comparison Table

The following table compares the ZEGAZ Instruments' CEIRS™ technology to manual chilled-mirrors.

Comparison of Manual Chilled-Mirror to ZEGAZ Instruments' CEIRS™ Technology		
	Manual-Chilled-Mirror	ZEGAZ Instruments CEIRS™
Core Principle	First Principle Chilled-Mirror	First Principle Chilled-Mirror
Cooling Method	Need a tank of refrigerant (Propane or CO_2)	Electronic Cooling
Temperature Sensor	Mercury thermometer or digital thermometer	High-accuracy Thermistor
Method of Detection of Dew Point	Human Eye, Subjective, Opertor Dependent	Infra Red Sensing, Objective
Repeatability	Low, operator dependent	Very high, opertor independent
Accuracy	Good, but operator dependent	Very high, opertor independent

Conclusions

ZEGAZ Instruments' CEIRS™ is essentially a chilled-mirror measurement where operator subjectivity has been eliminated. The results are much more accurate and repeatable, while still providing a first-principle chilled-mirror measurement.

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