

EXECUTIVE SUMMARY

This document compares the technology and products of ZEGAZ Instruments (US) to that of Michell Instruments (UK) in the field of hydrocarbon and water dewpoint measurement.

INTRODUCTION

ZEGAZ Instruments is the manufacturer of DewPoint Duo™, HCD5000™ and WDP5000™ and DewPort™. All of these instruments use the CEIRS™ (Chilled-Evanescant InfraRed Spectroscopy) for determination of hydrocarbon and/or water dewpoints.

Condumax™ and Condumax II™ are products of Michell Instruments (United Kingdom). They use dark-spot technology, which is really a light scattering approach for determination of hydrocarbon dewpoint. Condumax II (and PROMET) use an electrochemical water sensor for the determination of water content and then calculates the water dewpoint.

Below is a detailed discussion of the core technology used by both companies. The specifications are compared and the advantages and disadvantages of each are compared.

**Comparative analysis of DewPoint Duo™ (ZEGAZ Instruments, US)
And Condumax II (Michell Instruments, UK)**

Comparison of key specifications

	Condumax	DewPoint Duo
HC (temperature, accuracy), °C	-34 below ambient ± 0,5	-60 (60 deg. C below the ambient temperature) ± 0,5
H2O (temperature, accuracy), °C	-100 ... +20 ± 1; ± 2	
Operational Pressure, Bar	100 at HC channel, 206 at H ₂ O	Up to 103
Determination of both HC and H₂O DewPoint at the Same Time	+ (two separate analyzers) Housed in the Same Box	Both dewpoint are measured in the same cell at the same time using the same sensing mechanism. (for DewPoint Duo)
Sample Gas Flow Rate	1-5 SLM	1-3 SLM
Cycle Duration, min	30	12-20
Sample Preparation	Drip liquid Separation, Filtration 2 Micron	Drip Liquid Separation, Filtration
Measurement principle	H ₂ O – Electrical Impedance Metering; HC – Dark Central Spot (Light Scattering)	Chilled Evanescent IR Spectroscopy (CEIRS™) Is used for both HC and water dewpoint measurement.
Problems	<ul style="list-style-type: none"> • The instrument requires more careful preparation of sample gas. • Measurement of water is not dewpoint but content and is done separately. • Frequent cleaning/calibration is required. • Contamination causes false signals. • Problem with higher dewpoints is common. 	
Advantages		Many advantages, see below

Question: What is unique about the HCD5000™/DewPoint Duo™ cooling system?

Answer: The cooling system design in the DewPoint Duo™ is state-of-the-art technology. It was designed using the latest thermal simulation software. It is very efficient. Under most conditions, it uses less than 25W of power. This low power consumption results in reduced thermal stress on the whole system, particularly on the thermoelectric cooling modules. These modules have been running continuously for over 6 years without any degradation of performance.

Question: What is the temperature accuracy of HCD5000™/DewPoint Duo™?

Answer: The thermal sensor in HCD5000™/DewPoint Duo™ has an accuracy of better than $\pm 0.1\text{C}$. The detection mechanism, detects condensation in less than a second. Therefore the accuracy of the temperature determination of the dew point is very high. The pressure sensor used on the system has an accuracy of 1% of range. Therefore, when comparing the dewpoint of a known gas to its theoretical value, the uncertainty of the pressure sensor needs to be accounted for. However, the temperature determination by itself is highly accurate.

Operational Pressure for HCD5000™/DewPoint Duo™

The system gets tested to a pressure of 400 bar hydraulically. Each and every analytical gas-cell used in production of DewPoint Duo (as well as HCD5000 and WDP5000) undergoes this test for 15 minutes with no loss of pressure. Furthermore, every cell undergoes a 140 bar test, where it is filled with nitrogen at 140 bar, with no loss of pressure for over an hour.

Determination of both HC and H₂O simultaneously:

DewPoint Duo™ is unique in that it is making a spectroscopic determination of the dewpoint. It is not based on an ambiguous change in an optical signal.

ZEGAZ Instruments' DewPoint Duo™ measures both HC and water dewpoints based on the same detection principle.

HCD5000™ measures only hydrocarbon dewpoint; however, it is able to operate in the presence of other contaminants such as alcohol, glycols, or water.

Sample Preparation:

HCD5000™/DewPoint Duo™ have very high immunity against contamination. The reason for this is the material of the optical crystal used. It is highly inert and will not react with anything for up to 2000F. It is also highly polished and has a hydrophobic (water beads on its surface) surface. As such, it recovers to its "clean state" at the beginning of every cycle. At the beginning of every cycle, the system performs a self-check to make sure the surface is clean.

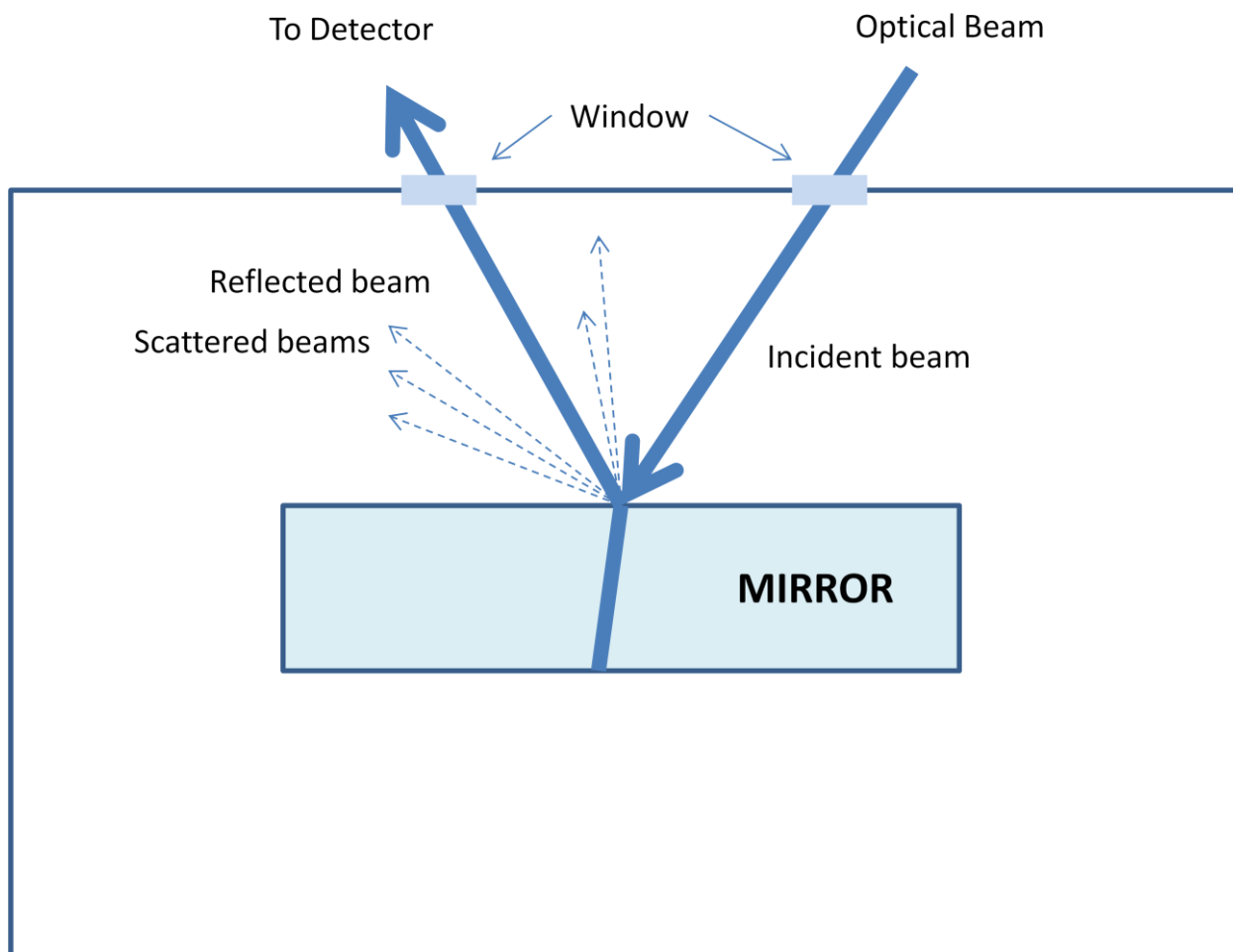
Therefore very little sample preparation is needed. Liquids must not be introduced into the system, and any large particulates should be removed.

Discussion of the Michell Condumax System

Principle of Operation for Michell Condumax (and Ametek 241 and Vympel)

The Michell Condumax unit is based on light scattering. Units made by Ametek and Vympel also use light scattering and are only packaged differently.

These systems depend on the detection of different scattering profile when a light beam hits a surface that is covered with a liquid.



Michell Condumax (as well as Ametek 241 and Vympel) Principle of Operation

The problems with this technology are several:

- 1- If any type of debris (metal chips, glycol droplets, etc) falls on the mirror, or the light entrance and exit windows, the unit will have a false signal.
- 2- The detection is not spectroscopic and thus cannot distinguish between a hydrocarbon dewpoint or something else.
- 3- The mirror is metallic and will change over time, being corroded by trace amounts of H_2S as well as CO_2 and H_2O .

Question: Can Condumax detect both water AND hydrocarbon dewpoints simultaneously?

Answer: The short answer is NO. CONDUMAX uses two different sensors for detection of HC and water dewpoint. The water dewpoint detection is not really a dewpoint detection, but a calculation based on water content.

Question: What are other problems with Michell Condumax units?

Interference from Contaminants: Contaminants such as glycol and methanol can lead to erroneous results.

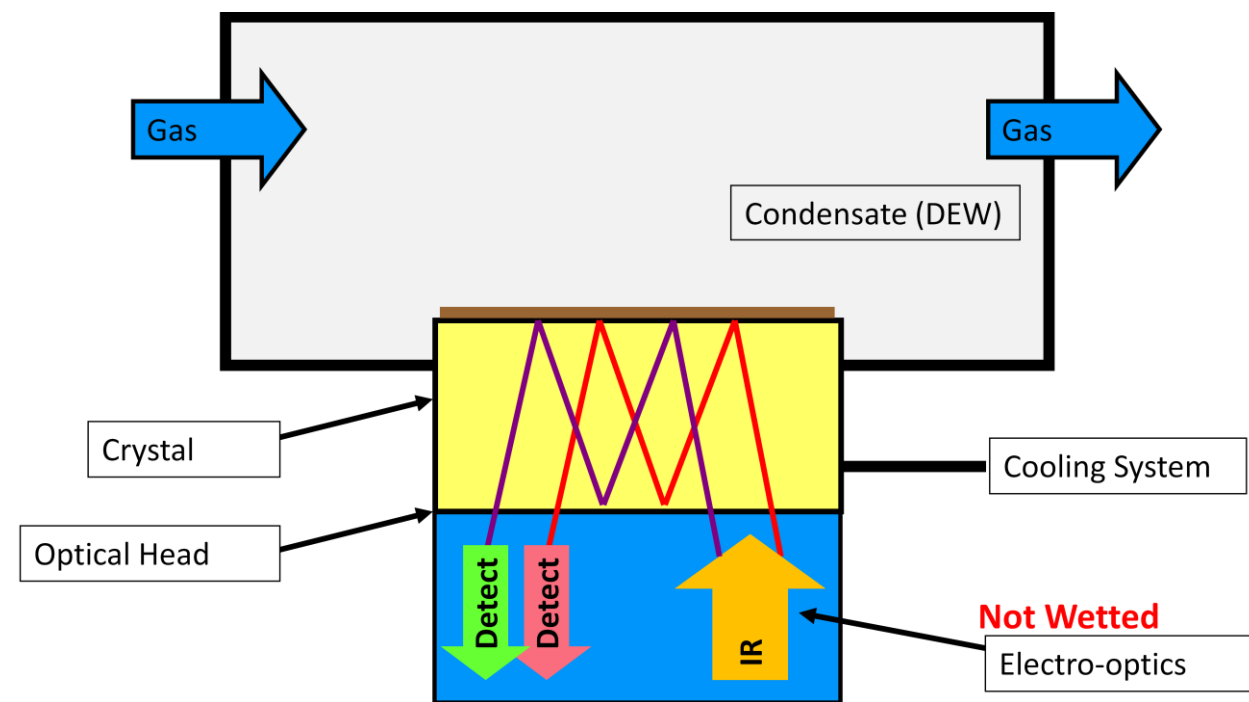
Degradation of the Metallic Mirror: The metallic mirror gets degraded over time because of reaction with corrosive contents such as H₂S and CO₂.

Inherent Shortcoming of the Technology: The changes to the intensity of the three light segments (reflected, absorbed or scattered) is very unpredictable and depends on too many unknown variables. One of the many variables is the temperature of the HC film on the surface. The higher this temperature is, more of the water “dissolves” in the HC film and will not form ice crystals, at least initially. The lower this temperature is, the higher the likelihood that water will form hydrates with the HC film. The hydrates will have unpredictable shape and may or may not scatter light the same way as water crystals. They may also absorb light.

The above problem is further compounded if there are any other condensable components in the gas. For example, condensation of glycols and alcohols will fundamentally behave differently than water. Alcohols will dissolve easier in the HC film and will in general freeze at a lower temperature than water. So even if changes in the scattered light are observed, it will be very difficult to unambiguously determine whether it was water or something else.

Water Dewpoint Determination: **The CONDUMAX II unit does not measure water dewpoint.** It uses an electrochemical sensor to measure water content. It then calculates water dewpoint. Electrochemical sensors are known to have severe problems in repeatability, stability, and drift. They require frequent calibration. **PROMET** is another product from Michell instruments that uses the same electrochemical sensor to measure water dewpoint only.

Discussion of ZEGAZ Instruments CEIRS™ Technology



ZEGAZ Instruments CEIRS™ Principle of Operations

ZEGAZ Instruments CEIRS™ technology has many advantages. They include:

- 1- The “mirror” (which is an optical crystal) is completely inert. It will not react with anything up to 1000C.
- 2- The light beam does not pass through the gas phase and is confined to the crystal. It cannot be scattered by particulates in the gas phase leading to false signals.
- 3- CEIRS™ uses infrared signals to detect the onset of condensation as well as the nature of condensate. It can distinguish between water and hydrocarbon dewpoints.
- 4- Because of the thermal design and the nature of the crystal, CEIRS™ uses minimal power, leading to a more robust cooling system, and broader cooling range.
- 5- It is highly accurate.
- 6- It does not require routine maintenance. It has no consumables.
- 7- It does not need auxiliary cooling. It is also low power.
- 8- It performs a self-check at the beginning of every single cycle to make sure the crystal is clean and all systems function properly.

CONCLUSIONS:

- 1- The ZEGAZ Instruments' HCD5000™ and DewPoint Duo™ are the only systems in the world that use CEIRS™ technology. Because it is a spectroscopic detection technology, it is the only system in the world that can unambiguously distinguish between a water dewpoint and a hydrocarbon dewpoint.
- 2- The ZEGAZ Instrument systems are the only ones in the world that can detect both water and hydrocarbon dewpoints simultaneously based on the same sensors and the same technology.
- 3- The ZEGAZ Instruments systems are the only ones in the world that use an inert optical crystal rather than a metallic mirror.
- 4- ZEGAZ Instruments' systems are, by far, the most advanced units for detection of HC and water dewpoints in the world.