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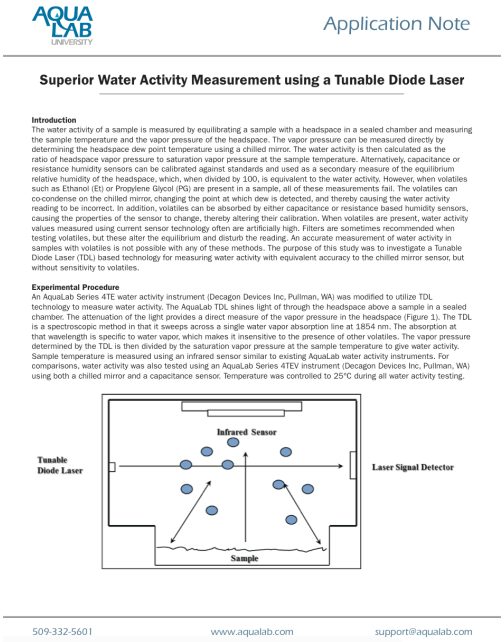

AQUALAB UNIVERSITY Application Note

Superior Water Activity Measurement using a Tunable Diode Laser

Introduction
The water activity of a sample is measured by equilibrating a sample with a headspace in a sealed chamber and measuring the sample temperature and the vapor pressure of the headspace. The vapor pressure can be measured directly by determining the headspace dew point temperature using a chilled mirror. The water activity is then calculated as the ratio of headspace vapor pressure to saturation vapor pressure at the sample temperature. Alternatively, capacitance or resistance humidity sensors can be calibrated against standards and used as a secondary measure of the equilibrium relative humidity of the headspace, which, when divided by 100, is equivalent to the water activity. However, when volatiles such as Ethanol (Et) or Propylene Glycol (PG) are present in a sample, all of these measurements fail. The volatiles can co-condense on the chilled mirror, changing the point at which dew is detected, and thereby causing the water activity reading to be incorrect. In addition, volatiles can be absorbed by either capacitance or resistance based humidity sensors, causing the properties of the sensor to change, thereby altering their calibration. When volatiles are present, water activity values measured using current sensor technology often are artificially high. Filters are sometimes recommended when testing volatiles, but these alter the equilibrium and disturb the reading. An accurate measurement of water activity in samples with volatiles is not possible with any of these methods. The purpose of this study was to investigate a Tunable Diode Laser (TDL) based technology for measuring water activity with equivalent accuracy to the chilled mirror sensor, but without sensitivity to volatiles.

Experimental Procedure
An AquaLab Series 4TE water activity instrument (Decagon Devices Inc, Pullman, WA) was modified to utilize TDL technology to measure water activity. The AquaLab TDL shines light of through the headspace above a sample in a sealed chamber. The attenuation of the light provides a direct measure of the vapor pressure in the headspace (Figure 1). The TDL is a spectroscopic method in that it sweeps across a single water vapor absorption line at 1854 nm. The absorption at that wavelength is specific to water vapor, which makes it insensitive to the presence of other volatiles. The vapor pressure determined by the TDL is then divided by the saturation vapor pressure at the sample temperature to give water activity. Sample temperature is measured using an infrared sensor similar to existing AquaLab water activity instruments. For comparisons, water activity was also tested using an AquaLab Series 4TEV instrument (Decagon Devices Inc, Pullman, WA) using both a chilled mirror and a capacitance sensor. Temperature was controlled to 25°C during all water activity testing.

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