A New Method for the Measurement of Water Enhancement in Compressed Air

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Properties of humid air or humid gases at elevated pressures are needed for many modern technical processes such as, e.g., compressed air energy storage (CAES), humid air turbines (HAT), or steam injected turbines. One crucial thermophysical property of compressed humid air is the dew point, which can be expressed as the water enhancement of saturated humid air with pressure. The water enhancement factor is defined as $g_w = c_{w(p)}/c_{w0}$, a ratio of the water content of the compressed humid air, $c_{w(p)}$, at the pressure, p, to that at the ideal gas condition c_{w0}.

A new method was developed to measure the water content in saturated compressed air by Fourier transformed infrared (FTIR) spectroscopy. The absorption of IR light by humidity is directly related and very sensitive to the volumetric content c_w of water in the gas, which is in the path of the IR light beam. A high-pressure view cell with sapphire windows was constructed and placed in the sample compartment of the FTIR spectrometer. The complete path of the IR light beam outside the view cell (inside the spectrometer and inside bellows between the windows of the spectrometer compartment and the sapphire windows) is flushed by nitrogen and dried by a molecule sieve. Thus, humidity and carbon dioxide is removed from the IR light path. The apparatus is limited to temperatures between -20 and 200 ºC and pressures up to 25 MPa.

Measurements were performed with calibrated, artificial air at 20 to 140 ºC and pressures up to 25 MPa. The present data is very consistent along isotherms and isobars. There is only very little experimental data on compressed humid air in the literature, which compare only fairly well with the present data.