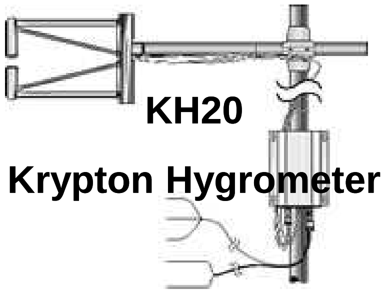


KH20

Krypton Hygrometer

KH20 Krypton Hygrometer

- Measures water vapor fluctuations only
  - Signal offset drift precludes use for absolute water vapor measurements

KH20 Specifications

- Frequency response
  →100 Hz
- Voltage output range
  →0 to 5 Vdc
- Current consumption
  →20 mA max at 12Vdc unregulated power supply

KH20 Measurement Theory

- Uses krypton lamp
  - Emits two absorption lines
    - Major line at 123.58 *n*m
    - Minor line at 116.49 *n*m
- Both of these lines are absorbed by water vapor, and minor line by oxygen (small)

KH20 Measurement Theory

•Voltage output V of KH20
- **Without** the response of oxygen

$$V = V_0 e^{-k_w x \rho_w}$$

$$\rho_w = \frac{1}{-k_w x}\left(\ln V - \ln V_0\right)$$

- V_0 output with no absorption
- k_w effective water vapor absorption coefficient
- X path length between source and detector tubes
- ρ_w water vapor density

KH20 Measurement Theory

•Vapor flux E can be calculated

$$E = \overline{w' \rho'_w}$$

- w vertical wind speed
- overbar time average
- prime fluctuations about the mean

where,

$$\rho'_w = \rho_w - \overline{\rho_w}$$

$$\rho'_w = \frac{1}{-k_w x}\left(\ln V - \overline{\ln V}\right)$$

KH20 Measurement Theory

•Voltage Output V of KH20
- **With** the Response of Oxygen

$$V = V_0 e^{-k_w x \rho_w} e^{-k_o x \rho o}$$

Oxygen (O_2) correction term

$$\rho'_w = \frac{1}{-k_w x}\left(\ln V - \overline{\ln V}\right) - \frac{k_o}{k_w}\rho'_o$$

- k_o effective oxygen (O_2) absorption coefficient

KH20 Measurement Theory

•Oxygen fluctuations are caused by pressure and temperature changes

•Using ideal gas law we obtain oxygen density

$$\rho_o = \frac{C_o M_o P}{RT}$$

KH20 Measurement Theory

- Differentiating the oxygen density we obtain the density fluctuations

$$\rho_o = \frac{C_o M_o P}{RT}$$

$$\rho'_o = \left[\frac{C_o M_o}{RT}\right] P' - \left[\frac{C_o M_o P}{RT^2}\right] T'$$

KH20 Measurement Theory

- Effect of pressure change in oxygen density change is negligible

$$\rho'_o = \left[\frac{C_o M_o}{RT}\right] P' - \left[\frac{C_o M_o P}{RT^2}\right] T'$$

0

KH20 Measurement Theory

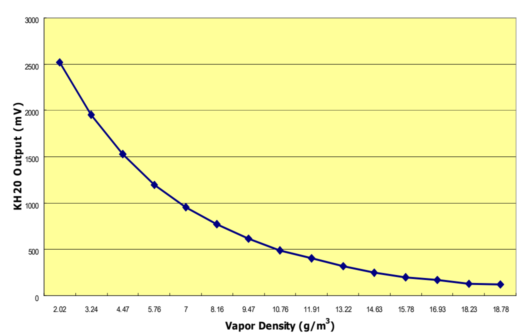
- Recall vapor flux E

$$E = \overline{w' \rho'_w}$$

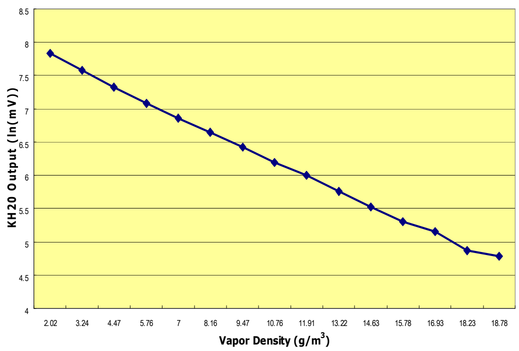
- With the oxygen correction term, we obtain

$$LE = L_v \frac{\overline{w'(\ln V)'}}{k_w x} + L_v \left[\frac{C_o M_o P}{RT^2}\right]\left[\frac{k_o}{k_w}\right]\overline{w'T'}$$

KH20 mV Signal Output vs. Vapor Density



KH20 ln(mV) Output vs. Vapor Density



Regression Report for

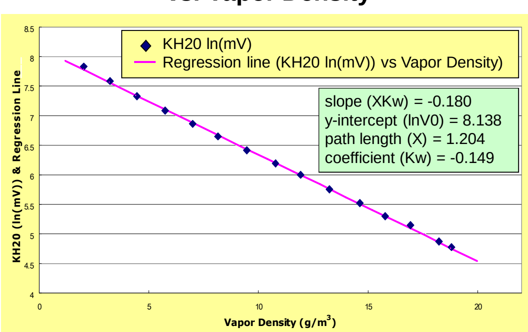
KH20 ln(mV) vs. Vapor Density

	Value	Stand. Error
y- intercept (ln(V_0))	8.138	0.015
slope (XK_w)	- 0.179	0.001

Regressed Output (ln(mV))	Residuals	Standardized Residuals
7.775	0.055	2.207
7.557	0.023	0.939
7.336	- 0.006	- 0.256
7.105	- 0.025	- 1.016
6.883	- 0.023	- 0.925
6.675	- 0.025	- 1.009
6.440	- 0.020	- 0.814
6.209	- 0.019	- 0.765
6.003	- 0.003	- 0.112
5.768	- 0.008	- 0.323
5.515	0.005	0.192
5.309	- 0.009	- 0.369
5.103	0.047	1.902
4.870	0.000	0.001
4.771	0.009	0.348

KH20 ln(mV) & Regression Line

vs. Vapor Density



Final Calibration Values

	Vapor Range (g/m^3)	Slope XK_w	Y-Intercept ln(V_0)	Coefficient K_w	% difference
Full Range	2.02 ~18.78	-0.179	8.138	-0.149	0
Dry Range	2.02 ~ 9.47	-0.189	8.193	-0.157	5.280
Wet Range	8.16 ~ 18.78	-0.176	8.084	-0.146	-2.042

Diagnosing KH20

- **Visual Inspection**
  - Make sure the optical window is clean
  - Make sure the UV light is emitted from the source tube (the longer of the two tubes and on top)
    - → *Note: Minimize exposure*
    - If you see faint or flickering blue light
      - → check the current drain
        - → current drain of around 5 mA indicates the source lamp problem
        - → Typical current drain for KH20 is 15~20 mA

KH20 Maintenance

- **Old KH20 used to suffer permanent damage when exposed to water**
  - corrosion; loss of vacuum

- **Managing the Scaling of KH20**
  - Clean when the window scaling is detected (low output signal)
    - → Use distilled water and cotton swab to clean
  - Use the scaled calibration coefficient when scaled