



Pros & Cons of Humidity Measurement Technologies

Helping you make a better measurement.

Webinar Presenters & Humidity Experts



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Agenda & Takeaways

Agenda

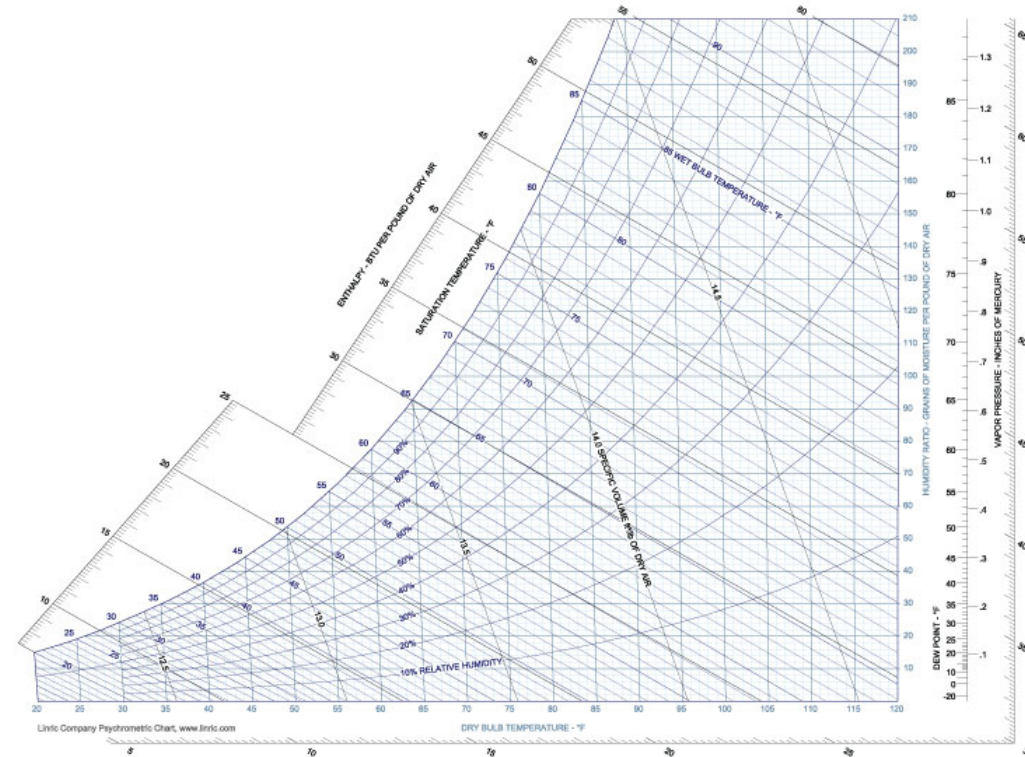
- Parameter review
- Mechanical
- Psychrometer (wet-bulb)
- Capacitive Sensors
- Resistive Sensors
- Chilled mirror
- Metal oxide

Takeaways

- Know which sensor makes sense for your application.

Parameter overview

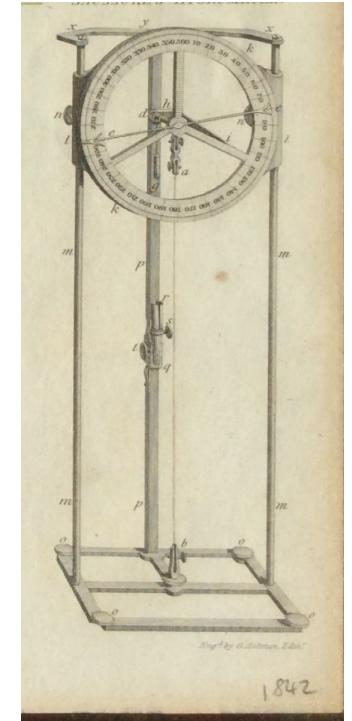
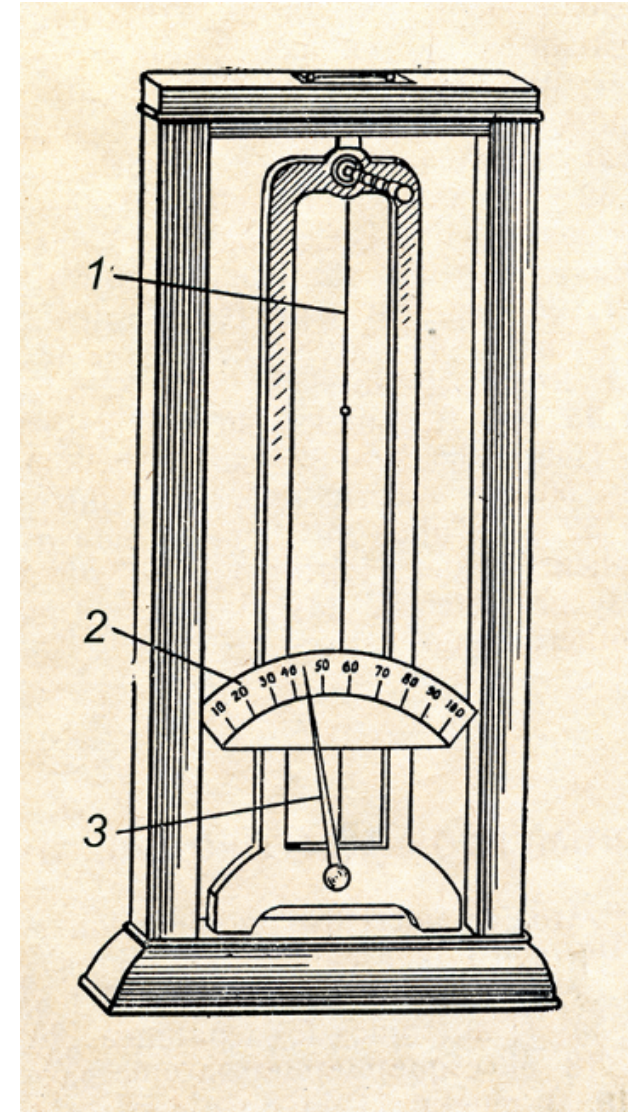
- Relative Humidity
- Water vapor pressure
 - aka partial pressure of water vapor
- Dew point temperature
- Wet bulb temperature



www.rotronic-usa.com/humidity-academy/humidity-measurement-tools/

Mechanical

- Uses organic materials that change in shape due to changes in relative humidity.
- Shape change is connected to mechanical levers, springs, etc. to output a reading
- Human hair, catgut, textile, goldbeater's skin



Mechanical

Pros	Cons
No electricity needed	Not reliable
Fun	Impossible to calibrate
	Only accurate mid range (30 to 80% RH)
	High in hysteresis
	Very slow response

Use a mechanical when:

- When you need a general idea
- If you don't have much money to spend on humidity measurement
- For fun if you're a humidity geek

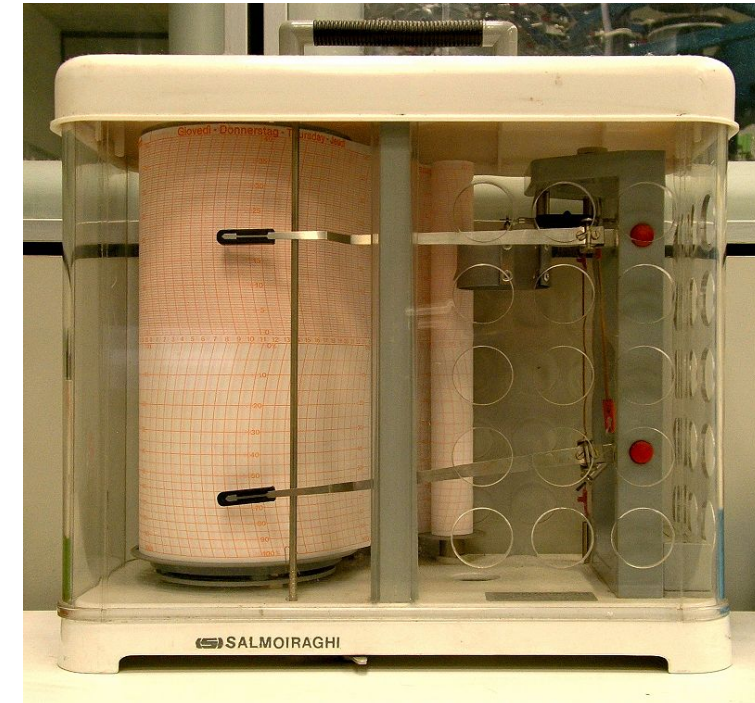


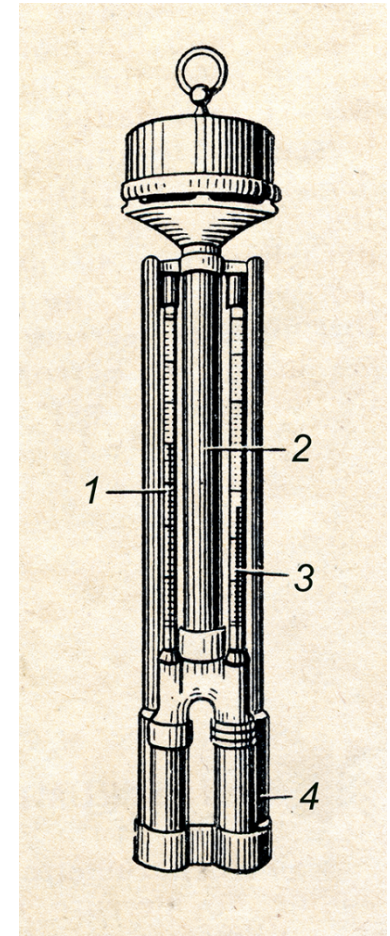
Image source - Wikipedia

Psychrometer (wet-bulb)

- Requires 2 temperature sensors.
- One is covered with wet sock.
- Air is drawn over the temperature sensor.
- The difference or depression between the two measurements indicates the amount of water vapor present.



Image source: Wikipedia



Psychrometer (wet-bulb)

Pros	Cons
Inexpensive (\$30 to \$90 on Amazon)	Requires skill and consistency to operate well
No problem with condensation	Not accurate in small spaces
Easy conversion with charts or graphs	Many variables = high uncertainty

Use a psychrometer when:

- Working with evaporative cooling installations
- Large air sample is available
- Able to control the variables
- Operators remain consistent
- No electricity is available (and don't want to rely on or carry batteries)

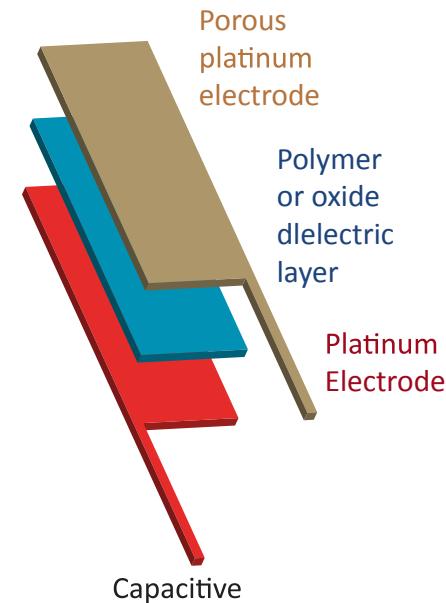


Image source: commons.Wikimedia.com

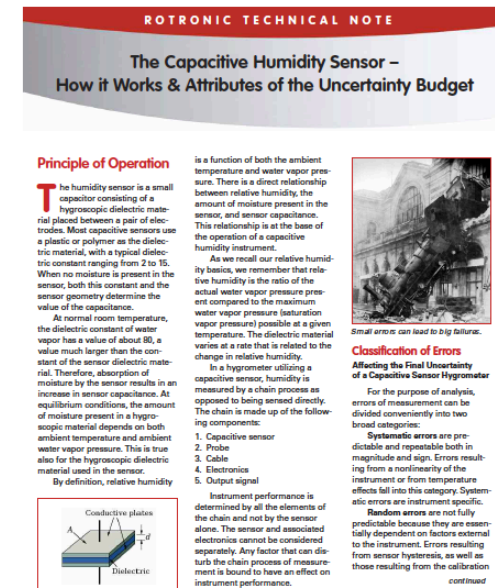
Capacitive Sensors

- As relative humidity changes, the amount of water molecules absorbed by the polymer changes the dielectric constant of the capacitor, varying the capacitance.
- As the relative humidity increases, the capacitance increases almost in a linear fashion.

Electronic Humidity Sensor



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Capacitive Sensors

Pros	Cons
Accurate and reliable	Limited accuracy in very dry conditions
Resilient to water, dust and chemicals	Dependent on the manufacturer
Small size	Requires electronics to generate the signal
Fast response	High temp + high RH can affect calibration
Wide measurement range (0 to 100% RH)	More expensive than resistive
Wide temperature range (-70 to +200C)	

Use a capacitive sensor when:

- Condensation is possible
- >10% RH
- Dirty environment
- Need good performance (accuracy, repeatability, stability, etc.)

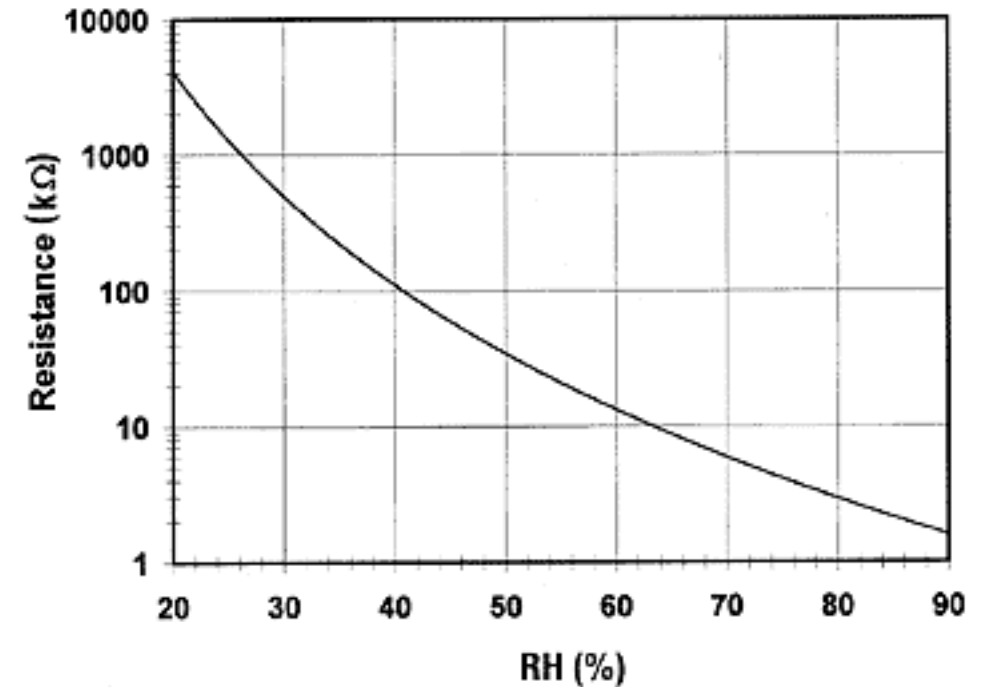


Resistive Sensors

- As relative humidity changes, the resistance changes.
- Increase in RH causes lower resistance.



Image source: Sensor Magazine



Resistive Sensors



Image source: Sensor Magazine

Pros	Cons
Field replaceable without calibration	Not suitable for extremes
Inexpensive	Not resistant to harsh conditions
Good for mid-range RH (20% to 90%)	Repeatability questionable
	Cannot tolerate condensation

Use a resistive sensor when:

- conditions are moderate
- 20% - 90% RH
- Condensation is not expected to occur
- Accuracy and repeatability are not critical

Chilled Mirror

- Fundamental measurement
- Dew point temperature is determined by the temperature of the mirror when dew or frost forms on the mirror.
- Be aware of dew point vs frost point.
- Know the pressure at the point of interest.

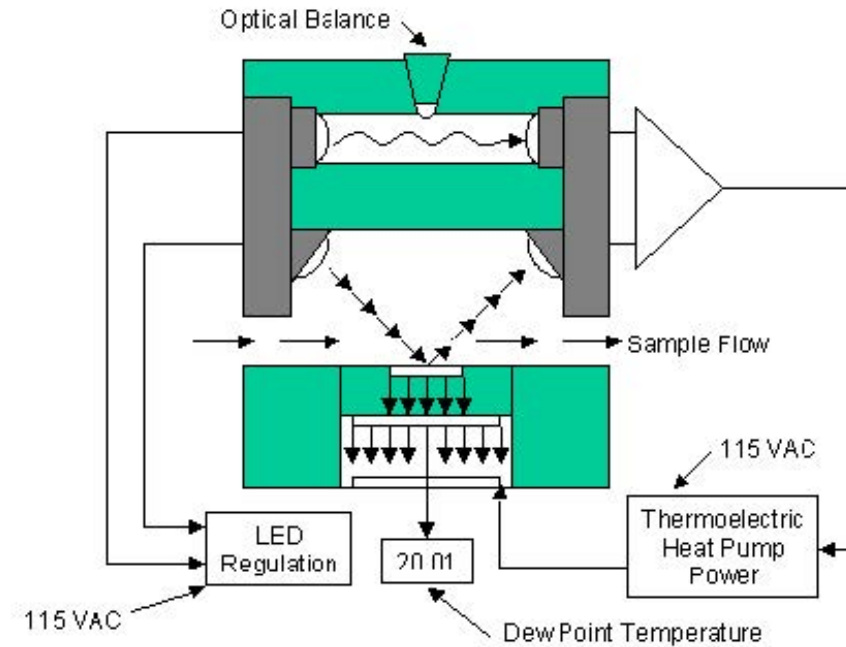


Image source: Thunder Scientific

Chilled Mirror or Condensation Hygrometer

Pros	Cons
Low uncertainties; (+/- .1C k=2)	Expensive compared to other technologies
Highly stable	Requires very clean environment
Broad range (-100C to +100C)	High level of maintenance
Fundamental measurement	Requires a skilled, trained operator
	Airflow through sensing head



Use a chilled mirror when:

- Low uncertainty and high stability are a requirement (Lab, R&D)
- Measurement environment is clean and controlled
- You have a lot of money and you don't know what to do with it.
- Not recommended for inline or field applications.

Metal Oxide

- Aluminum Oxide (Al_2O_3) most common
- Water vapor adsorbs to oxide
- Conductivity varies with amount of water vapor molecules
- Gives an absolute measure
- Need pressure and temperature for conversions

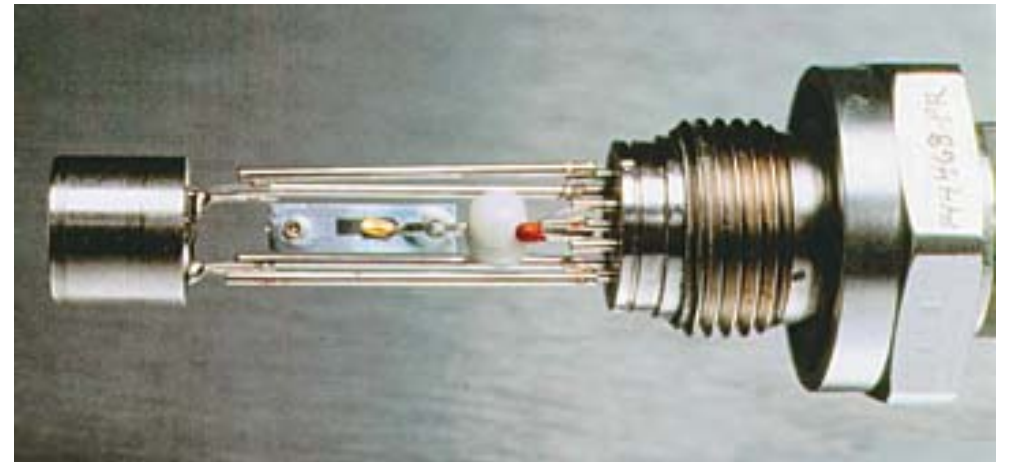


Image source: Sensor Magazine

Metal Oxide

Pros	Cons
Excellent for very dry conditions (as low as -100C)	Slow response to changes
Very small footprint	Large calibration shifts from wet air
	Requires numerous calibrations
	Calibration is usually very expensive
	Not stable over time

Use a metal oxide when:

- Very dry, very clean air/gas
- For dew point temperature < -70C
- Stable, uneventful air streams
- Measuring trace moisture in absolute terms (ppm, mixing ratio, p)

Summary of Technologies

1. Mechanical
2. Psychrometer (wet-bulb)
3. Capacitive Sensors
4. Resistive Sensors
5. Chilled mirror
6. Metal oxide

Other technologies:

- Spectroscopy
- Color changing chemicals
- Saturated lithium chloride
- Electrolytic
- Acoustic
- Adiabatic expansion
- Gravimetric
- And more

Comments & Questions



Please type your questions into the chat box at the lower left portion of your screen.

Takeaways for a Better Measurement

Choose the Best Technology for Your Application

Glovebox where you have to maintain 5 ppm water vapor.

- Temperature is 23C
- Air is very clean
- Minimal chance of condensation
- Need very high accuracy, reliability and stability.
- Money is no object



Image source: Flickr: Glovebox; Author: Idaho National Laboratory

Choose the Best Technology for Your Application

- **Compressed air system**
 - Desiccant dryers -40C dew point
 - 90 psig operating pressure
 - Industrial environment
 - Condensation likely at some point in the system (**unreliable dryers**)
 - Need inline measurement at critical points of use
 - Low budget operation



Choose the Best Technology for Your Application

Fire Fighter checking the level of danger for forest fires.

- Temperature is 23 - 40C
- Wide open spaces
- Needs to minimize carrying weight
- He's one of three guys who does this in his district.
- He's fairly coordinated.
- Not much money available.



Comments & Questions



If we don't get to your question today, we'll respond via email after the webinar.

Humidity Academy

- Resources for making a better measurement
 - Psychrometric charts
 - Technical notes
 - Humidity calculator
 - Application notes
 - more



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Next Webinar

How to Choose a Best-fit Humidity Instrument

Thursday, October 15th 1:00PM EDT

- Register at www.rotronic-usa.com/humidity-webinars
- These are the 9 selection areas we'll cover in the webinar:
 - Measurement objective
 - Measurement environment
 - Required performance
 - Measurement parameter
 - Measurement reporting
 - Instrument utilization
 - Logistical restrictions
 - Pricing
 - Manufacturer

Helping you make a better humidity measurement – and more.

Your source for:

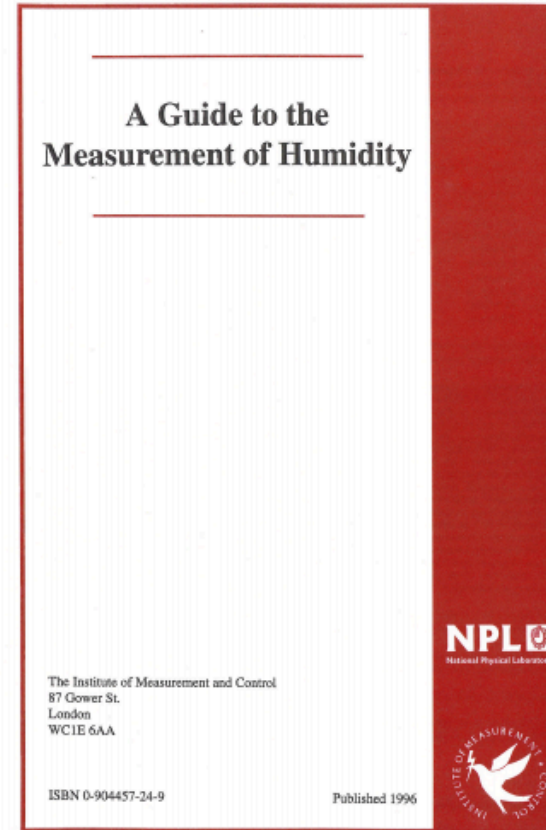
- Humidity transmitters, meters, generators
- HVAC humidity, temperature, CO2, diff-press
- Portable meters; humidity, dew point, CO2
- Data loggers for mapping and monitoring
- Water activity transmitters, testers, meters
- NVLAP Accredited calibrations – humidity & temperature



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you'll get a free copy of NPL
Guide.



Thank you!

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