Humidity

What is Humidity?

Humidity is the amount of water vapor in the air, typically measured as relative humidity. High humidity reduces the effectiveness of sweating to cool the body by preventing the evaporation of perspiration and so makes people feel hotter.

The measurement of relative humidity requires two inputs: the temperature and the dew point. The dew point is the temperature the air must be cooled to for condensation to occur. The higher the humidity, the closer the dew point is to the air temperature.

Why do we measure Humidity?

Humidity is used in weather forecasting to indicate the possibility of precipitation, dew, or fog. Engineers must consider humidity levels in their work to assure systems are working properly and safely. Humidity sensors (hygrometers) detect and measure the amount of water vapor or moisture that is contained in the air.

Humidity sensors play a key role in many systems and applications to help measure the level of humidity so that it can be controlled and changed as needed to maintain safety and comfort. It is also important in manufacturing processes and HVAC systems. The car industry uses humidity sensors to control ventilation and keep windshields from fogging. Food processing quality depends on accurate measurement of humidity levels for pasta and baked goods.

The semiconductor industry monitors humidity in clean rooms where integrated circuits are carefully produced.

How does a Humidity sensor work? What is the significance of studying Humidity?

There are three types of humidity sensors:

- Capacitive humidity sensors and Resistive humidity sensors sense relative humidity (RH).
- Thermal conductivity humidity sensors detect absolute humidity (AH).
- Relative humidity sensors usually also contain a capacitor with two electrode layers between which is a dielectric material. This dielectric material, typically a polymer film, is capable of absorbing moisture from the surrounding air.

In the absence of moisture, the capacitance (the ability to store electric charge) is determined by the geometry of the capacitor and the permittivity (dielectric constant) of the dielectric material.

As the dielectric material absorbs water vapor (which has a much higher dielectric constant) from the surrounding air, the dielectric constant of the material increases, which increases the capacitance of the sensor.

There is a direct relationship between the relative humidity in the air, the amount of moisture contained in the dielectric material, and the capacitance of the sensor. By measuring the change in capacitance (dielectric constant), the relative humidity level can be established.

A resistive humidity sensor makes use of the change in the resistivity measured between two electrodes to establish a value of humidity. The device contains a hygroscopic conductive layer (a polymer humidity sensing film mounted on a substrate) with a set of comb-like electrodes providing ample surface area. As more water vapor is absorbed, the non-metallic conductive material increases in conductivity and hence decreases in resistivity.

Thermal conductivity humidity sensors are used to measure absolute humidity. They do so by calculating the difference in the thermal conductivity of dry air versus humid air.

What data is collected? Units of measure?

Humidity is collected using a digital humidity and temperature sensor. The measurement of relative humidity requires knowing the temperature and dew point, the temperature at which condensation will occur.

The GoSense sensor covers a humidity range of 0 to 100% RH and a temperature range of -40° C to 125° C.

Resources
Dew Point vs Humidity (weather.gov)
Comparative Climatic Data (CCD) | National Centers for Environmental Information (NCEI) (noaa.gov)
NOAA's Ten Signs of a Warming World: Humidity

Extension Activities
Build Your Own Hygrometer
Moisture Sensor

Glossary
Absolute Humidity (noun): the amount of water vapor present in a unit volume of air
Capacitive (adjective): pertaining to electrical capacitance, or the property of being able to collect and hold a charge of electricity.
Capacitor (noun): the property of an electric nonconductor that permits the storage of energy as a result of the separation of charge that occurs when opposite surfaces of the nonconductor are maintained at a difference of potential; the measure of this property that is equal to the ratio of the charge on either surface to the potential difference between the surfaces
Condensation (noun): the conversion of a substance (as water) from the vapor state to a denser liquid or solid state usually initiated by a reduction in temperature of the vapor

Dielectric (noun): a nonconductor of direct electric current
Electrode (noun): a conductor (as a metal or carbon) used to make electrical contact with a part of an electrical circuit that is not metallic
Hygroscopic (adjective): readily taking up and retaining moisture
Permittivity (noun): the ability of a material to store electrical potential energy under the influence of an electric field measured by the ratio of the capacitance of a capacitor with the material as dielectric to its capacitance with vacuum as dielectric
Polymer (noun): a chemical compound or mixture of compounds that is formed by combination of smaller molecules and consists basically of repeating structural units
Relative Humidity (noun): the amount of water vapor actually present in the air compared to the greatest amount possible at the same temperature
Resistive (adjective): marked by resistance —often used in combination (fire-resistive material)
Resistivity (noun): the longitudinal electrical resistance of a uniform rod of unit length and unit cross-sectional area : the reciprocal of conductivity
Semiconductor (noun): any of a class of solids (as germanium) that have an ability to conduct electricity between that of a conductor and that of an insulator
Thermal Conductivity (noun): capability of conducting heat; the quantity of heat that passes in unit time through a unit area of plate whose thickness is unity when its opposite faces differ in temperature by one degree
Water Vapor (noun): water in a gaseous form especially when below boiling temperature and spread through the atmosphere