Thermoset Polymer-based Capacitive Sensors

Application Sheet

THERMOSET POLYMER-BASED CAPACITIVE SENSORS

Thermoset polymer-based capacitive RH sensors directly detect changes in “relative saturation” as a change in sensor capacitance with fast response, high linearity, low hysteresis and excellent long term stability. Relative saturation is the same as ambient relative humidity when the sensor is at ambient temperature. Because this is almost always the case, sensor capacitance change is then a measure of RH change.

CAPACITIVE RH

Capacitive RH sensors dominate both atmospheric and process measurements and are the only types of full-range RH measuring devices capable of operating accurately down to 0% RH. Because of their low temperature effect, they are often used over wide temperature ranges without active temperature compensation.

THERMOSET POLYMER

Thermoset polymer-based capacitive sensors, as opposed to thermoplastic-based capacitive sensors, allow higher operating temperatures and provide better resistivity against chemical liquids and vapors such as isopropyl, benzene, toluene, formaldehydes, oils, common cleaning agents, and ammonia vapor in concentrations common to chicken coops and pig barns. In addition, thermoset polymer RH sensors provide the longest operating life in ethylene oxide-based (ETO) sterilization processes.

RELATIVE SATURATION VS RELATIVE HUMIDITY

Thermoset thin film polymer capacitive sensors have been shown to have an almost ideal response to RH, as opposed to absolute moisture, (i.e., water vapor pressure). This response is due to the driving force-free energy for absorption, G:

$$G = R\ T\ \ln(P/P_0)$$

where

G = driving force
R = gas constant
P = partial water vapor pressure
P_0 = saturation water vapor pressure

P/P_0 is the same as ambient RH when the sensor is at ambient temperature. The relative saturation level driving sensor response is 100% at the sensor temperature T.

Research has also demonstrated that the RH sensor calibration in air applies to relative saturation measurement in oil to within 0.3% (a result which can be extended to other chemically compatible liquids).

HUMIDITY SENSOR COMPARISON CHART

Active Material	Thermoset Polymer[1]	Thermoplastic Polymer	Thermoplastic Polymer	Bulk Thermoplastic	Bulk AlO_3	Lithium Chloride Film	Evaporative Saturation
Substrate	ceramic or silicon	ceramic, silicon or glass	polyester or mylar film	N/A	N/A	ceramic	N/A
Changing Parameter	capacitance	capacitance	capacitance	resistance	resistance	conductivity	temperature
Measured Parameter	% RH	% RH	% RH	% RH	% RH	% RH	wet and dry bulb temperature
RH Range	0% to 100%	0% to 100%	0% to 100%	20% to 100%	2% to 90%	15% to <100%	20% to 100%
RH Accuracy	±1% to ±5%	±3% to ±5%	±3% to ±5%	±3% to ±10%	±1% to ±5%	±5%	±3% to ±4%
Interchange-ability[2]	±2% to ±10% RH	±3% to ±20% RH	±3% to ±20% RH	±5% to ±25% RH	poor	±3% to ±10% RH	excellent

HUMIDITY SENSOR COMPARISON CHART (Continued)

Active Material	Thermoset Polymer[1]	Thermoplastic Polymer	Thermoplastic Polymer	Bulk Thermoplastic	Bulk Al O_3	Lithium Chloride Film	Evaporative Saturation
Hysteresis	<1% to 3% RH	2% to 5% RH	2% to 5% RH	3% to 6% RH	<2% RH	very poor	poor
Linearity	±1% RH	±1% RH	±2% RH	poor	poor	very poor	poor
Risetime	15 sec to 60 sec	15 sec to 90 sec	15 sec to 90 sec	2 min to 5 min	3 min to 5 min	3 min to 5 min	2 min to 5 min
Temperature Range	-40 °C to 185 °C	-30 °C to 190 °C	-25°C to 100 °C	10 °C to 40 °C	-10 °C to 75 °C	3 min to 5 min	0 °C to <100 °C
Temperature Effect[3]	-0.0022% RH/%RH/°C	0.3% RH/°C	<0.3% RH/°C	>1% RH/°C	>1% RH/°C	>1% RH/°C	<0.5 % RH/°C
Long Term Stability	±1%RH/5yr	±1%RH/yr	±1%RH/yr	±3%RH/yr	±3% RH/yr	>1% RH/°C	±0.1% RH/yr
Contamination Resistance	excellent	fair to good	fair	fair	fair	±1% RH/yr	fair
Condensation Resistance	excellent	very good	fair to good	fair	fair	fair	very good

Notes:
1. Sensing and Control exclusive.
2. Value depends on sensor model.
3. Values quoted are for 0 C° to 50 °C.

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