

# Humidity at a glance

## Abstract

This summary provides an overview on the most used humidity related formulas. The sample code is optimized for microprocessors (e.g. the common logarithm “log10” is used rather than the natural logarithm “ln”). For an in-depth explanation of the equations please refer to our complementary information note “Introduction to Humidity”.

## 1 Relative humidity

The following formula relates two states (temperature and relative humidity) of a system. It is only valid at constant absolute humidity (e.g. closed system).

$$RH_2 = RH_1 \exp \left( m T_n \frac{T_1 - T_2}{(T_n + T_1)(T_n + T_2)} \right)$$

$RH_1$	Relative humidity at state 1
$RH_2$	Relative humidity at state 2
$T_1$	Temperature [°C] at state 1
$T_2$	Temperature [°C] at state 2
$m$	17.62
$T_n$	243.21°C

Sample code:

```
RH2 = RH1*exp(4283.78*(T1-T2)/(243.12+T1)/(243.12+T2));
```

## 2 Dew point

The dew point is the temperature at which air must be cooled (at constant barometric pressure) so that water vapor starts condensing into liquid water.

$$T_d(T, RH) = T_n \frac{\ln\left(\frac{RH}{100}\right) + \frac{m T}{T_n + T}}{m - \left(\ln\left(\frac{RH}{100}\right) + \frac{m T}{T_n + T}\right)}$$

$T_d$	Dew point temperature [°C]
$T$	Actual temperature [°C]
$RH$	Actual relative humidity [%]
$m$	17.62
$T_n$	243.21°C

Sample code:

```
RH = max(0, min(RH,100));
h = (log10(RH)-2.0)/0.4343+(17.62*T)/(243.12+T);
Td = 243.12*h/(17.62-h);
```

## 3 Absolute humidity

The absolute humidity is the mass of water vapor in a particular volume of dry air. The unit is [g/m<sup>3</sup>].

$$\rho_v(T, RH) = 216.7 \left( \frac{\frac{RH}{100} A \exp\left(\frac{m T}{T_n + T}\right)}{273.15 + T} \right)$$

$\rho_v$	Absolute humidity [g/m <sup>3</sup> ]
$T$	Actual temperature [°C]
$RH$	Actual relative humidity [%]
$m$	17.62
$T_n$	243.21°C
$A$	6.112 hPa

Sample code:

```
RH = max(0, min(RH,100));
rho_v = 216.7*(RH/100.0*6.112*exp(17.62*T/(243.12+T))/(273.15+T));
```

## 4 Mixing ratio

The mixing ratio is the mass of water vapor in a particular mass of dry air. The unit is [g/kg].

$$r(T, RH) = \frac{622 \frac{RH}{100} A \exp\left(\frac{m T}{T_n + T}\right)}{p - \frac{RH}{100} A \exp\left(\frac{m T}{T_n + T}\right)}$$

$r$	Absolute humidity [g/m <sup>3</sup> ]
$T$	Actual temperature [°C]
$RH$	Actual relative humidity [%]
$p$	Barometric air pressure [hPa]
$m$	17.62
$T_n$	243.21°C
$A$	6.112 hPa

Sample code:

```
RH = max(0, min(RH,100));
e = RH/100.0*6.112*exp(17.62*T/(243.12+T));
r = 622.0*e/(p-e);
```

## 5 Heat index

The heat index expresses the “felt” air temperature based on actual air temperature and relative humidity. It is determined according to the National Weather Service and Weather Forecast Office of the National Oceanic and Atmospheric Administration (NOAA).

$$HI = c_1 + c_2 T + c_3 RH + c_4 T RH + c_5 T^2 + c_6 R^2 + c_7 T^2 RH + c_8 T RH^2 + c_9 T^2 RH^2$$

$$\text{adj}_1 = \frac{5}{9} \left( \frac{RH - 13}{4} \sqrt{\frac{17 - |1.8 T - 63|}{17}} - 32 \right)$$

$$\text{adj}_2 = \frac{5}{9} \left( \frac{(RH - 85)(55 - 1.8 T)}{50} - 32 \right)$$

$HI$	Heat index [°C]
$T$	Actual temperature [°C]
$RH$	Actual relative humidity [%]
$c_1$	- 8.78469475556
$c_2$	1.61139411
$c_3$	2.33854883889
$c_4$	- 0.14611605
$c_5$	- 0.012308094
$c_6$	- 0.0164248277778
$c_7$	0.002211732
$c_8$	0.00072546
$c_9$	- 0.000003582

If  $RH < 13\%$  and  $26.7^\circ\text{C} < T < 44.4^\circ\text{C}$ , then one should correct HI with the first adjustment term:

$$HI \leftarrow HI + \text{adj}_1$$

If  $RH > 85\%$  and  $26.7^\circ\text{C} < T < 30.6^\circ\text{C}$ , then one should correct HI with the second adjustment term:

$$HI \leftarrow HI + \text{adj}_2$$

In practice, one should first compute the simple formula for HI given below and average its result with the actual temperature. If the averaged value is  $26.7^\circ\text{C}$  or higher, the full regression equation with possible adjustments as described above is applied – else the result of the simple formula can be kept.

$$HI = \frac{5}{9} (1.98 T - 7.1 + 0.047 RH)$$

$HI$	Heat index [°C]
$T$	Actual temperature [°C]
$RH$	Actual relative humidity [%]

Sample code:

```

RH = max(0, min(RH,100));
HI = 1.1*T + 5*(0.047*RH - 7.1)/9;
If (HI+T)/2 >= 26.7 Then {
    HI = - 8.78469475556
    + 1.61139411*T
    + 2.33854883889*RH
    - 0.14611605*T*RH
    - 0.012308094*T*T
    - 0.0164248277778*RH*RH
    + 0.002211732*T*T*RH
    + 0.00072546*T*RH*RH
    - 0.000003582*T*T*RH*RH;
}
If RH<13 && T>26.7 && T<44.4 Then
    HI = HI + (5/36)*(RH-13)*sqrt((17-abs(1.8*T-63))/17)
        - 160/9;
If RH>85 && T>26.7 && T<30.6 Then
    HI = HI + 5*(RH-85)*(55-1.8*T)/450 - 160/9;
}

```

## Version history

Date	Revision	Changes
Aug. 2008	1.0	Initial version
Jun. 2021	2.0	Corrected heat index definition, updated design
May 2025	2.1	Modified sample code

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