

RH Calculator

Designed and maintained by InstruQuest Inc.

The equations accepted in 1997 by International Association for the Properties of Water and Steam (IAPWS) are used for water vapor pressure in the temperature range -100 °C to +100 °C. Please note that the program does not restrict obtaining values beyond the stated range.

The screenshot shows the RH Calculator v. 1.00 software interface. The window title is "RH Calculator v. 1.00, InstruQuest Inc.". The interface is divided into several sections:

- Temperature Units:** Radio buttons for Celsius (selected), Kelvin, and Fahrenheit.
- Pressure Units:** Radio buttons for Torr (selected), mbar = 100 Pa, and psi.
- Use for WVP calculations:** Radio buttons for IAPWS eqns. (1997) (selected) and Water Vap. Pres. Tables.
- F to C and C to F temperature conversion:** Input fields for "Enter Temp. [F]" and "Enter temp.[C]", with buttons for "Convert: F to C" and "Convert: C to F".
- 1. Calculate Saturated Water Vapor Pressure (WVP):** "Known: Temperature. Unknown: WVP." Input field for "Enter Temperature:" and a "Calculate" button.
- 2. Calculate Dew Point for a given Water Vapor Pressure:** "Known: WVP. Unknown: Dew Point Temperature." Input field for "Enter WVP:" and a "Calculate" button.
- 3. Calculate RH for given Temperature and WVP:** "Known: Temperature and WVP. Unknown: RH." Input fields for "Enter Temp.:" and "Enter WVP:" and a "Calculate" button.
- 4. Calculate RH at T2 given RH at T1:** "Known: RH, Temp.1, Temp.2. Unknown: RH at Temp.2." Input fields for "Enter RH at T1:", "Enter Temp.1:", and "Enter Temp.2:" and a "Calculate" button.
- 5. Calculate Dew Point given RH and Temperature:** "Known: RH, Temperature. Unknown: Dew Point Temp." Input fields for "Enter RH:" and "Enter Temp.:" and a "Calculate" button.
- 6. Calculate RH for given Dew Point and Temperature:** "Known: Dew Point, Temperature. Unknown: RH." Input fields for "Enter DP:" and "Enter Temp.:" and a "Calculate" button.

The purpose of the application is to facilitate solving simple “relative humidity” problems. Several units of pressure and temperature can be used in the calculations. Changing the units of measurements, however, does not automatically updates previously calculated results. Abbreviations used: **RH**, **WVP**, and **DP** stand for relative humidity, water vapor pressure, and dew point, respectively.

In the frame “**1. Calculate Saturated Water Vapor Pressure (WVP)**”, by entering a temperature value and pressing ‘Calculate’ button, the saturated WVP is calculated in several pressure units. In other words, the result answers the question: what is the WVP corresponding to the entered Dew Point temperature?

The second frame, “**2. Calculate Dew Point for a given Water Vapor Pressure**”, performs reverse calculations. If WVP is known, the calculated result yields Dew Point temperature (at which saturation with WVP exists and below it condensation begins).

The third frame, “**3. Calculate RH for given Temperature and WVP**”, allows calculation of relative humidity value that corresponds to a given WVP value at a stated temperature.

The fourth frame, “**4. Calculate RH at T2 given RH at T1**”, answers the classical problem: Knowing relative humidity at a given temperature T1, what would be the relative humidity value at a different temperature T2?

The last two frames are more useful during manual operation of DP Generators. Let say, your sample is inside a chamber maintained at 50 °C and 80 % RH is required for the experiment. What DP temperature has to be set on the temperature controller of the DP Generator to satisfy the experiment RH requirements? By entering the number 80 in the RH text box and the number 50 in the Temperature text box, the required DP value can be calculated in frame “**5. Calculate Dew Point value given RH and Temperature**”.

Frame “**6. Calculate RH for given Dew Point and Temperature**” solves reverse problem to the one presented in frame 5. Namely, what RH value can be obtained at an established temperature of experimental setup for a set DP temperature on the DP generator?

The frame is especially useful in addressing RH errors calculations. Both sources of error, DP accuracy and temperature variations in a user experimental setup can be evaluated. One has to keep in mind that the saturated WVP versus temperature is a nonlinear function and in the temperature range from -100 °C to +100 °C, the values span over many orders of magnitude, from 1.4009×10^{-3} to 101417.98 Pa, respectively. There is not a simple answer to the frequent question: **What is the RH error for the DP Generator?**

For the stated DP accuracy, the error varies with current DP setting and the temperature of the experimental setup at which the RH is to be calculated. Assuming constant and perfect distribution of temperature throughout the target chamber, RH error limits can be found for a given DP value and the DP value plus minus the stated accuracy. Changing the temperature of the user chamber, the errors can be similarly evaluated for other DP values.

Likewise, assuming constant DP value and using the temperature of the target chamber and its variation limits, the RH errors can be calculated at any DP value.

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