AN APPROXIMATION FORMULA TO COMPUTE RELATIVE HUMIDITY FROM DRY BULB AND DEW POINT TEMPERATURES

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The WBAN punched card library at the National Weather Records Center, Asheville, N.C., contains millions of observations of simultaneous dry bulb and dew point temperatures for which relative humidities have never been computed. Relative humidity, however, is frequently required for climatological analysis, and must be computed from the available dry bulb and dew point temperatures.

The conventional approach for machine computation of relative humidity involves table lookup of the relative humidity, or of saturation vapor pressures over water for the dew point and dry bulb temperatures, respectively, in order then to compute the ratio

$$U=\frac{e}{e_s}$$

where U is the relative humidity, e the actual vapor pressure (saturation vapor pressure over water for the dew point temperature) and e_s the saturation vapor pressure over water for the dry bulb temperature.

The table lookup process requires either (a) sorting of the punched cards into dry bulb and dew point temperature sequence, matching with a punched card table of pre-computed relative humidities, and gang-punching the appropriate relative humidity values; or (b) the use of a relatively expensive electronic computer with sufficient memory to contain the saturation vapor pressure table for internal reference and computation of relative humidity. Either alternative represents a costly process. A third alternative might be the computation of vapor pressures by the approved Goff-Gratch formula [1]. This would use even more time on an electronic computer capable of performing the required complex of power series expansions, and has never been considered practical as an alternative to table lookup.

The cost of punched-card computation of relative humidity is cut to one-third or less by use of an approximation equation which has been developed and is now being used for this purpose:

$$U\cong\left(\frac{173-.1t+t_{dp}}{173+.9t}\right)^8$$

where t is the dry bulb temperature in °F. and t_{dp} is the dew point temperature in °F. This equation can be solved in a single operation on simple, relatively inexpensive punched card calculating machines, with no preprocessing of the cards.

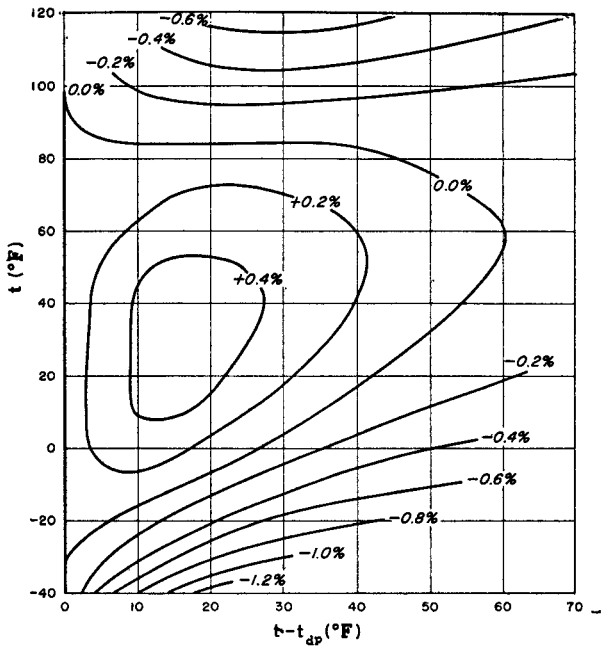

FIGURE 1.—Error in the approximation $U\cong[(173-.1t+t_{dp})/(173+.9t)]^8$

In the meteorological range of temperatures and humidities, the equation approximates relative humidity to within 1.2 percent; over the common range, the error is 0.6 percent or less. This is well within the limits of accuracy of the data.

The error of approximation over the meteorological range of atmospheric conditions is shown in figure 1.

ACKNOWLEDGMENT

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REFERENCE

1. R. J. List (Ed.), "Smithsonian Meteorological Tables," 6th Rev. Ed., *Smithsonian Miscellaneous Collections*, vol. 114, The Smithsonian Institution, Washington, D.C., 1951, 527 pp. (p. 350).

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