

Humidity —

Part 1: Terms, definitions and formulae

ICS 01.040.13

Confirmed January 2008

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee CPI/29, Humidity and temperature conditioning requirements, upon which the following bodies were represented:

- British Compressed Gases Association
- Institution of Chemical Engineers
- Institute of Measurement and Control
- Institute of Printing
- National Physical Laboratory
- SIRA
- Society of Environmental Engineers

This British Standard, having been prepared under the direction of the Materials and Chemicals Sector Policy and Strategy Committee, was published under the authority of the Standards Policy and Strategy Committee on 02 August 2002

© BSI 24 October 2002

First published April 1965
Published as Part 1 29 July 2002

The following BSI references relate to the work on this standard:
Committee reference CPI/29
Draft for comment 97/126683 DC

ISBN 0 580 38475 6

Amendments issued since publication

Amd. No.	Date	Comments
14209 Corrigendum No. 1	24 October 2002	Corrections to equation (1) and equation (20)

Contents

	Page
Committees responsible	Inside front cover
Foreword	ii
1 Scope	1
2 Terms and definitions	1
3 Formulae and constants	14
Table 1 — Air–water system, to three significant figures	21
Bibliography	23

Foreword

This British Standard has been prepared by Technical Committee CPI/29, Humidity and temperature conditioning requirements. It supersedes BS 1339:1965 (which was concerned solely with the humidity of the air), and extends the consideration of humidity to that of any gas. BS 1339:1965 is now withdrawn.

It is based partly upon *A Guide to the Measurement of Humidity* [1] published by the Institute of Measurement and Control under Crown Copyright.

This is part 1 of a series of parts of BS 1339 on humidity as follows:

- *Part 1: Terms, definitions and formulae;*
- *Part 2: Humidity calculation and tables;*
- *Part 3: Guide to the measurement of humidity.*

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 23 and a back cover.

The BSI Copyright notice displayed in this document indicates when the document was last issued.

1 Scope

This part of BS 1339 gives terms, definitions, symbols, units, formulae and constants associated with humidity and its measurement.

2 Terms and definitions

NOTE Some alternative and obsolescent terms and definitions used in considering humidity and its measurement are discussed in part 3 of this British Standard.

2.1 Definitions of general terms

2.1.1

absorption

retention of a substance, e.g. water or **water vapour**, by penetration into the bulk of a material

2.1.2

adsorption

retention of a substance, e.g. water or **water vapour**, as a layer on the surface of a material or within a material

2.1.3

absolute humidity

deprecated term used loosely to describe either **mixing ratio** (2.1.29), **specific humidity** (2.1.41) or **volumetric humidity** (2.1.49)

2.1.4

adiabatic saturation temperature

final temperature reached by a small quantity of **vapour/gas** mixture into which water is evaporating

2.1.5

condensate

condensed substance, e.g. liquid water or ice

NOTE Technically, if vapour condenses directly to a solid without passing through a liquid phase, it is termed a sublimate. In this Standard, condensate is used as a general term for any liquid or solid produced by condensation of vapour.

2.1.6

condensation temperature

temperature at which **condensate** forms as liquid or solid on cooling a **humid gas**

2.1.7

desiccant

substance which exerts a drying action by **adsorption** or **absorption** of, or chemical reaction with, **water vapour**

2.1.8

desorption

release of a substance which has been retained by **absorption** or **adsorption**

2.1.9

dew point

temperature at which the **vapour pressure** of the **vapour in a humid gas** is equal to the **saturation vapour pressure** over pure liquid and at which **condensate** forms as liquid on cooling the **gas**

NOTE Below freezing point **dew point** is usually used to mean **frost point**. When referring to the **supercooled liquid dew point** (2.1.42) it is normal to state this explicitly.

2.1.10

dry-bulb temperature

measured air temperature, usually paired with a **wet-bulb temperature** to derive a value for **relative humidity**

2.1.11

dry gas

non-condensable **gas** or gas mixture containing no **vapour**, e.g. dry air at zero humidity

2.1.12

enhancement factor

water vapour enhancement factor

factor by which a value of pure **saturation vapour pressure** is multiplied to obtain the actual **saturation vapour pressure** which takes into account the effect of the presence and overall pressure of air or other **gases**.

NOTE The enhancement factor also applies to unsaturated **humid gas**, where it modifies the pure **vapour pressure** to the actual **vapour pressure**.

2.1.13

enthalpy (of humid gas)

measure of the total energy in a **humid gas**, being the nominal sum of the enthalpies of the **dry gas** (**sensible heat**) and of the **vapour** (**sensible heat** and **latent heat**)

2.1.14

equilibrium relative humidity (of a substance)

value of the **relative humidity** of a **humid gas** at which there is no net exchange of **moisture** with a given substance

NOTE *Equilibrium relative humidity* is a property of the substance and is used for indirectly indicating or controlling the condition of moisture-sensitive substances such as paper. It is normally measured in an enclosed space.

2.1.15

frost point

temperature at which the **vapour pressure** of the **vapour** in a **humid gas** is equal to the **saturation vapour pressure** over ice (frozen solid) and at which **condensate** forms as frost on cooling the **gas**

2.1.16

gas

fluid in which molecules move freely and can expand indefinitely to occupy the total volume in which it is contained

NOTE The term **gas** is used especially for substances which do not become liquid or solid at normal ambient conditions, e.g. air. If this is not the case, the term **vapour** is generally used.

2.1.17

gas density

mass of **humid gas** present in a unit volume of **humid gas**

2.1.18

humidity

presence of **vapour**, e.g. **water vapour**, in air or other **gas**

NOTE **Humidity** is often used to mean only **relative humidity** although, strictly speaking, **humidity** refers to all kinds of absolute indications of **humidity**; for very low humidities, other more specific terms tend to be used.

2.1.19**humidity ratio**

deprecated term for **mixing ratio** (2.1.29)

2.1.20**humid gas**

mixture containing one or more non-condensable **gases** and one or more **vapours**, e.g. a mixture of air and **water vapour**

2.1.21**humid heat**

heat required to raise the temperature of a unit mass of **dry gas** and accompanying **vapour** by 1 K at constant pressure; the specific heat capacity of a gas/vapour mixture

2.1.22**humid volume**

volume occupied by **humid gas** containing unit mass of **dry gas**

2.1.23**hygrometry**

humidity measurement

2.1.24**hygroscopic**

tending to absorb **water vapour**

2.1.25**ice-bulb temperature**

steady state temperature reached by a small quantity of ice evaporating into a large quantity of unsaturated **water vapour/gas** mixture

2.1.26**ideal gas**

gas to which the laws of Boyle, Gay-Lussac and Avogadro are applicable

2.1.27**latent heat**

heat energy associated with a change of phase at constant temperature

2.1.28**mass fraction**

ratio of the mass of a component in a mixture to the total mass of substance present

NOTE For vapour in gases this is the **specific humidity** and for low humidities becomes approximately equal to the **mixing ratio**.

2.1.29**mixing ratio**

mass ratio

humidity ratio (deprecated)

mass of **vapour** per unit mass of **dry gas** with which it is associated; it is a dimensionless ratio although often expressed in units of mass per mass

NOTE The so-called “mixing ratio by volume” is a deprecated term for **mole ratio** or volume ratio.

2.1.30

moisture

water in any form

NOTE Moisture is also used specifically for water that is **absorbed** or **adsorbed** or bound into any material.

2.1.31

mole fraction

volume fraction

ratio of the number of moles of a component in a **humid gas** to the total number of moles of **humid gas** present

2.1.32

mole ratio

molal ratio

volume ratio

mixing ratio by volume (deprecated)

ratio of the number of moles of a component in a **humid gas** to the amount of **dry gas** present

2.1.33

partial pressure (of vapour)

that part of the overall pressure exerted by the **vapour** component in a **humid gas**

2.1.34

percentage saturation

ratio of the actual **mixing ratio** to the **saturation mixing ratio** at the same temperature and pressure, expressed as a percentage (%)

NOTE Under ordinary climatic conditions, **percentage saturation** is almost identical to **relative humidity**.

2.1.35

ppm_v

PPM_v

mole ratio, expressed as parts per million (10^{-6})

NOTE This may also be termed ppm_v (dry basis). At low humidities it is almost identical to ppm_v (wet basis), which is the **mole fraction** expressed as parts per million. Mole ratio may also be expressed in parts per billion (10^{-9}), ppb_v.

2.1.36

ppm_w

PPM_w

mixing ratio, expressed as parts per million (10^{-6})

NOTE This may also be termed ppm_w (dry basis). At low humidities it is almost identical to ppm_w (wet basis), which is the **specific humidity (mass fraction)** expressed as parts per million. Mixing ratio may also be expressed in parts per billion (10^{-9}), ppb_w.

2.1.37

relative humidity

ratio of the actual **vapour pressure** to the **saturation vapour pressure** over a plane liquid water surface at the same temperature, expressed as a percentage

NOTE 1 **Relative humidity** is commonly abbreviated to rh, although this is not a recognized abbreviation.

NOTE 2 Values of **relative humidity** are usually expressed in units of percentage **relative humidity**, % rh. “% rh” is not an agreed SI unit. However, the use of the symbol “%” alone to denote units of relative humidity is generally not advisable, since there is a risk of confusion between value of relative humidity and fraction of value.

2.1.38**saturation mixing ratio**

mixing ratio of **humid gas** in equilibrium with a plane surface of water or ice at the same temperature containing the equilibrium quantity of dissolved gas

NOTE This is the highest **mixing ratio** which non-supersaturated **humid gas** can attain at the given temperature, and corresponds to a **relative humidity** of 100 %.

2.1.39**saturation vapour pressure**

maximum pressure of **vapour** that can exist at a given temperature

NOTE Pure saturation vapour pressure is the pressure exerted by vapour with no other gases present, i.e. in a partial vacuum. Actual saturation vapour pressure of a **vapour** in a **humid gas** is slightly different; the difference is quantified by the **enhancement factor**.

2.1.40**sensible heat**

component of the **enthalpy** of a substance that varies according to temperature

2.1.41**specific humidity**

mass of **vapour** per unit mass of **humid gas**

2.1.42**supercooled liquid dew point**

supercooled water dew point

dew point with respect to liquid (e.g. water) below the normal freezing point

2.1.43**thermodynamic wet-bulb temperature**

deprecated term for **adiabatic saturation temperature (2.1.4)**

NOTE For the air–water system at atmospheric pressure between 0 °C and 100 °C, with water vapour contents of less than 0.1 kg·kg⁻¹, the thermodynamic wet-bulb temperature is within 1 °C of the **wet-bulb temperature**. For vapours other than water vapour, the thermodynamic wet-bulb temperature may be markedly different to the wet-bulb temperature.

2.1.44**vapour**

substance in the gaseous state which may be liquefied by increasing the pressure without altering the temperature

NOTE This is a **gas** below its critical temperature.

2.1.45**vapour density**

deprecated term used either for **gas density (2.1.17)** or **volumetric humidity (2.1.49)**

2.1.46**vapour pressure (of water)**

partial pressure

that part of the total pressure contributed by the **vapour**

NOTE Pure vapour pressure is the pressure exerted by vapour with no other gases present, i.e. in a partial vacuum. Actual vapour pressure of a **vapour** in a **humid gas** is slightly greater; the difference is quantified by the **enhancement factor**.