British thermal unit

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The **British thermal unit** (**Btu** or **BTU**) is a traditional unit of work equal to about 1055 joules. It is the amount of work needed to raise the temperature of one pound of water by one degree Fahrenheit. One four-inch wooden kitchen match consumed completely generates approximately 1 Btu. In science and engineering, the joule, the SI unit of energy, has largely replaced the Btu.

The Btu/h is most often used as a measure of power in the electric power, steam generation, heating, and air conditioning industries. It is still used in some metric English-speaking countries. In North America, the heat value (energy content) of fuels is often expressed in Btus.

The notation **kBtu** or **KBtu** is often used for thousand Btu, in sizing of heating systems and in the Energy Use Index (EUI) expressed as thousand Btu annual energy use per square foot of building. **MBtu** represents one million Btu, although the atypical notation **MMBtu** or **mmBtu** is sometimes used to represent one million Btu.(see definitions below)

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Definitions

A BTU was originally defined as the amount of heat required to raise the temperature of 1 avoirdupois pound of liquid water by 1 degree Fahrenheit at a constant pressure of one atmosphere.[1] As with the calorie, several definitions of the Btu exist, because the temperature response of water to heat energy is non-linear. This means that the change in temperature of a water mass caused by adding a certain amount of heat to it will be a function of the water's initial temperature. Definitions of the Btu based on different water temperatures can therefore vary by up to 0.5%.

Nominal temperature	Btu equivalent in joules	Notes
39 °F (3.9 °C)	≈ 1059.67	Uses the calorie value of water at its maximum density (4 °C or 39.2 °F)
Mean	≈ 1055.87	Uses a calorie averaged over water temperatures 0 to 100 °C (32.0 to 212.0 °F)
IT	≡ 1055.05585262	The most widespread Btu uses the International Steam Table (IT) calorie, which was defined by the *Fifth International Conference on the Properties of Steam* (London, July 1956) to be exactly 4.1868 J
ISO	≡ 1055.056	International standard ISO 31-4 on *Quantities and units—Part 4: Heat*,[2] Appendix A. This value uses the IT calorie and is rounded to a realistic accuracy
59 °F (15.0 °C)	≡ 1054.804	Chiefly American. Uses the 15 °C calorie, itself now defined as exactly 4.1855 J (*Comité international* 1950; PV, 1950, 22, 79–80)
60 °F (15.6 °C)	≈ 1054.68	Chiefly Canadian
63 °F (17.2 °C)	≈ 1054.68	
Thermochemical ("Th"[3])	≡ 1054.35026444	Uses the "thermochemical calorie" of exactly 4.184 J

The unit **MBtu** or **mBtu** was defined as one thousand Btu, presumably from the Roman numeral system where "M" or "m" stands for one thousand (1,000). This notation is easily confused with the SI *mega- (M)* prefix, which denotes multiplication by a factor of one million ($\times 10^6$), or with the SI *milli- (m)* prefix, which denotes division by a factor of one thousand ($\times 10^{-3}$).

To avoid confusion, some companies and engineers use the notation "MMBtu" or "mmBtu" to represent one million Btu. Alternatively, the term *therm* may be used to represent 100,000 (or 10^5) Btu, and *quad* for 10^{15} Btu. Some companies also use 'BtuE6' in order to reduce confusion between 10^3 Btu and 10^6 Btu.[4]

Conversions

One Btu is approximately:

- 1.054 to 1.060 kJ (kilojoules)
- 0.293071 W·h (watt hours)
- 252 to 253 cal (calories, or "little calories")
- 0.25 kcal (kilocalories, "large calories", or "food calories")
- 25,031 to 25,160 ft·pdl (foot-poundal)
- 778 to 782 ft·lbf (foot-pounds-force)
- 5.40395 $(\text{lbf/in}^2)\cdot\text{ft}^3$

A Btu can be approximated as the heat produced by burning a single wooden kitchen match[5] or as the amount of energy it takes to lift a one-pound (0.45 kg) weight 778 feet (237 m).[6]

For natural gas

- In natural gas, by convention 1 MMBtu (1 million Btu) = 1.054615 GJ.[7]
- The energy content (high or low heating value) of a volume of natural gas varies with the composition of the natural gas, which means there is no universal conversion factor for the number of Btu to volume. 1 standard cubic foot of average natural gas yields ≈ 1030 Btu (between 1010 Btu and 1070 Btu, depending on quality, when burned)
- As a coarse approximation, 1000 ft^3 of natural gas yields ≈ 1 MMBtu ≈ 1 GJ
- For natural gas price conversion 1000 m^3 ≈ 36.906 MMBtu and 1 MMBtu ≈ 27.096 m^3

As a unit of power

When used as a unit of power for heating and cooling systems, Btu *per hour* (Btu/h) is the correct unit, though this is often abbreviated to just "Btu".[8]

- 1 watt is approximately 3.41214 Btu/h[9]
- 1000 Btu/h is approximately 293.071 W
- 1 horsepower is approximately 2544 Btu/h

Associated units

- 1 *ton of cooling*, a common unit in North American refrigeration and air conditioning applications, is 12,000 Btu/h (3.52 kW). It is the amount of heat transfer needed to freeze 1 short ton (0.893 long tons; 0.907 t) of water into ice in 24 hours.
- 1 *therm* is defined in the United States and European Union as 100,000 Btu—but the U.S. uses the $Btu_{59\,°F}$ while the EU uses the Btu_{IT}. The therm is used to price natural gas.[10]
- 1 *quad* (short for quadrillion Btu) is 10^{15} Btu, which is about one exajoule (1.055×10^{18} J). Quads are used in the United States for representing the annual energy consumption of large economies: for example, the U.S. economy used 99.75 quads in 2005.[11] One quad/year is about 33.43 gigawatts.

The Btu should not be confused with the Board of Trade Unit (B.O.T.U.), which is a much larger quantity of energy (1 kW·h or 3,412 Btu).

The Btu is often used to express the conversion-efficiency of heat into electrical energy in power plants. Figures are quoted in terms of the quantity of heat in Btu required to generate 1 kW·h of electrical energy. A typical coal-fired power plant works at 10,500 Btu/kW·h, an efficiency of 32–33%.[12]

See also

- Conversion of units
- Latent heat

- Metrication
- Ton of refrigeration

References

1. "What is British thermal unit (Btu)? definition and meaning". Businessdictionary.com. Retrieved 2011-11-11.
2. International standard ISO 31-4:1992 Quantities and units—Part 4: Heat (http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=3632)
3. Btu - Kilocalories units conversion (http://www.unitsconversion.com.ar/energyunitsconversion/btu-kilocalorie.htm)
4. "What are Mcf, Btu, and therms? How do I convert prices in Mcf to Btus and therms?". U.S. Energy Information Administration. April 6, 2016. Retrieved 2016-12-30.
5. Energy and the Environment. Ristinen, Robert A. c. 2006, pg 13
6. Energy and the Environment. Ristinen, Robert A. c. 2006, pg 14
7. "Energy Measurements". Energy.gov.ab.ca. Retrieved 5 April 2014.
8. Ken Matesz (2010). *Masonry Heaters: Designing, Building, and Living with a Piece of the Sun*. Chelsea Green Publishing. p. 148.
9. 2009 ASHRAE Handbook – Fundamentals (I-P Edition) (http://app.knovel.com/web/toc.v/cid:kpASHRAE22/viewerType:toc/root_slug:ashrae-handbook-fundamentals/url_slug:ashrae-handbook-fundamentals/?). (pp: 38.2). American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc
10. "The GB gas wholesale market". OFGEM. Retrieved Jan 13, 2013. "The wholesale gas market in Britain has one price for gas irrespective of where the gas comes from. This is called the National Balancing Point (NBP) price of gas and is usually quoted in price per therm of gas."
11. Husher, John Durbin. *Crises of the 21st Century: Start Drilling-The Year 2020 Is Coming Fast*, iUniverse, 2009. Page 376.
12. Bellman, David K., ed. (July 18, 2007). "Electric Generation Efficiency" (PDF). National Petroleum Council (NPC). Working Document of the NPC Global Oil & Gas Study.

External links

- The Units of Measurement Regulations 1995 (http://www.legislation.gov.uk/uksi/1995/1804) HMSO
- Natural Gas: A Primer (http://www.nrcan.gc.ca/energy/natural-gas/5641?destination=node/1233) Natural Resources Canada 2015-06-17
- Thompson, Ambler; Taylor, Barry N. "Guide for the Use of the International System of Units (SI) 2008 Edition" (PDF). National Institute of Standards and Technology (NIST). p. 58. NIST Special Publication 811. Lists conversions into joules for the several definitions of a Btu.

Categories: Units of energy | Imperial units | Customary units of measurement in the United States

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