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DEPARTMENT OF AGRICULTURE ENGINEERING

19AGO304 Energy Management in Agriculture

TOPIC 3,4 & 5 – ENERGY UNITS AND THEIR CONVERSIONS

ENERGY UNITS AND CONVERSIONS

Energy Units and Conversions(SYSTEMS INTERNATIONAL – SI UNITS)

Joule :

1 Joule (J) is equal to the force of one Newton acting through one meter.

1 Joule [J] = 1 Watt-second [Ws] = 1 V A s = 1 N m = 1 kg $m^2 s^{-2}$.

1 Watt is the power of a Joule of energy per second

Power = Current x Voltage (P = I V)

1 Watt is the power from a current of 1 Ampere flowing through 1 Volt.

Definition of Calorie :

one calorie is the amount of heat required to raise the temperature of 1 gram of water by 1°C, from 14.5 °C to 15.5 °C. (This is sometimes referred to as the 15 °C calorie)

1 cal = 4.1868 J

1 kcal=4.1868 kJ (SI UNIT)

1 British Thermal Unit (BTU)= 1 BTU = 251.9958 cal. =252 cal

REF : ENERGY UNITS- AMERICAN PHYSICAL SOCIETY(APS)

https:// aps.org/policy/reports/popa-reports/energy/units.cfm

BTU AND kWh

1 British Thermal Unit (BTU)= 1 BTU = 251.9958 cal. =252 cal

1 Btu = 1055.06 J = 1055 J = 1.055 kJ

1 BTU = 0.252 kcal

1 BTU = 1055 J

1 kcal=4.1868 kJ (SI UNIT)

kilo Watt-hour (kWh).

The kilowatt-hour is a standard unit of electricity production and consumption. By definition, noting that 1 kilowatt = 1000 watts.

1 kilowatt-hour is the energy of one kilowatt power flowing for one hour. (E = P t).

1 kilowatt-hour (kWh) = 1 x 10 x (J/s) x 3600 s = 3.6 x 10^6 J = 3.6 million Joules =3.6 Mega Joules

1 kWh = 3.6 x MJ .

1 kWh = 3412 Btu.

This corresponds to the International Table Btu. [More precisely, 1 kWh = 3412.14 BTU (IT-INTERNATIONAL TABLES).]

MULTIPLICATION TABLE AND LARGE SCALE UNITS

Symbol	Exponential	Prefix	Quantity
k	10^3	kilo	Thousand
M	10^6	Mega	Million
G	10^9	Giga	Billion
T	10^{12}	Tera	trillion
P	10^{15}	Peta	quadrillion
E	10^{18}	Exa	quintillion

The unit Megagram is not used, since there is a special ame for one million grams, one tonne (t): 1 t = 1000 kg.

Large-scale units.

In describing national or global energy budgets, it is common practice to use large-scale units based upon the joule, Btu, and kWh:

Exajoule (EJ): 1 EJ = 10^{18} J

Quadrillion Btu(quad): 1 quad = 10^{15} Btu = 1.055 EJ

Terawatt-year (TWyr): 1 TWyr = 8.76 x 10^{12} kWh = 31.54 EJ = 29.89 quad

CONVERSION FACTORS FOR OIL

A nominal conversion factor is sometimes used for a barrel of crude oil, which is close to its actual average energy content: 1 barrel of oil equivalent = 5.80 MBtu.

1 toe = 1.00 x 10^{10} cal (IT) = 41.868 GJ = 39.68 MBtu (IT- INTERNATIONAL TABLES)

In OECD/IEA tabulations, the *megatonne of oil equivalent* (Mtoe), equal to 4.1868 x 10^{16} J, is used as the general unit to describe the energy content of all fuels. A corresponding larger unit, the *gigatonne of oil equivalent* (Gtoe) can be related to the exajoule and quad:

1 Gtoe = 41.868 EJ = 39.68 quad.

CONVERSION FACTORS FOR COAL AND NATURAL GAS

Tonne of Oil Equivalent(toe)

tonne of oil equivalent (toe) is a unit of energy: the amount of energy released by burning one tonne of crude oil approximately 42 GJ (as different crude oils have different calorific values, the exact value of the *toe* is defined by convention).

Multiples of the *toe* are used, in particular the megatoe (Mtoe, one million toe) and the gigatoe (Gtoe, one billion toe).

The IEA/OECD define one *toe* to be equal to 41.868 GJ or 11.630 MWh.

1 tonne of coal (equiv) = 29.3 GJ = = 11.630 MWh = 27.8 MBtu

Barrel of oil equivalent(boe)

A barrel of oil equivalent (boe), also a unit of energy, contains approximately 0.146 toe (i.e. there are approximately 6.841 boe in a toe). 1 boe = 6.14 GJ

Conversion factors for natural gas.

Natural gas is made up largely, but not entirely, of methane (CH_4) and its energy content is more uniform than that of coal.

Heat content of natural gas (CH_4) =1000 Btu/ft^3

1 therm = 100,000 Btu.

MORE UNITS OF ENERGY

1 erg = 10^{-7} J, cgs [centimeter-gram-second] unit

1 eV ≈ 1.60218 × 10^{-19} J, electron volt

1 Btu = 1055.06 J, British thermal unit according to ISO, to heat 1 pound water from 63 °F to 64 °F

1 tce = 29.3076 × 10^{9} J, ton of coal equivalent, 7000 $kcal_{IT}$

1 toe = 41.868 × 10^{9} J, ton of oil equivalent, 10000 $kcal_{IT}$

CONVERSION FACTORS

1 t diesel	=	1.01 toe
1 m^3 diesel	=	0.98 toe
1 t petrol	=	1.05 toe
1 m^3 petrol	=	0.86 toe
1 t biodiesel	=	0.86 toe
1 m^3 biodiesel	=	0.78 toe
1 t bioethanol	=	0.64 toe
1m^3 bioethanol	=	0.51 toe

1 toe = 42 GJ

1 toe = 41.85 GJ

1 toe = 7.11, 7.33, or 7.4 boe

1 tonne petroleum equivalent (TPE), a parameter used in renewable energy, 45.217 gigajoules.

QUIZ

1. 1 toe =
2. 1 boe =
3. 1 tce =
4. 1 EJ =
5. Gtoe =
6. 1 kWh =

ANSWERS

1. 1 toe = 42 GJ

2. 1 boe = 6.14 GJ

3.1 tce = 29.3 GJ

4. 1 EJ = 10^{18} J

5.Gtoe = 10^{9} J

6.1 kWh = 3.6 MJ

WEB LINKS

1. https://www.researchgate.net/publication/272488661_Energy_efficiency_in_agriculture_-_Energy_audit_impact_on_environmental_and_economic_performance_at_farm_level

   Energy efficiency in agriculture - Energy audit impact on environmental and economic performance at farm level

2. https://www.blogs.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_066326.

   Farm energy audit

3. https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs141p2_018358.pdf

   Energy audit of agricultural Operations

4. http://www.fao.org/3/x8054e/x8054e05.htm

   Energy for Agriculture

5. http://www.fao.org/3/x8054e/x8054e05.htm

Farm energy Audits by Sustainable Agriculture Research Program by the National Institute of Food and Agriculture, US Dept of Agriulture

REFERENCES

1.Pimental D., Handbook of Energy Utilization in Agriculture, CRC Press, 1980.

2. Verma SR, Mittal JP & Surendra Singh, Energy Management and Conservation in Agricultural Production and Food Processing, USG Publs, Ludhiana, 1994.

3.Kennedy WJ Jr. & Wayne C Turner, Energy Management, Prentice Hall, 1984.

Fluck RC & Baird CD., Agricultural Energetics, AVI Publs, 1984.

4.L.C. Witte, P.S. Schmidt, D.R. Brown, Industrial Energy Management and Utilisation , Hemisphere Publication, Washington, 1988.

THANK YOU