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Standard Terminology Relating to Geothermal Energy[1]

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ε[1] NOTE—Typographical errors were corrected editorially in September 2011.

aquifer, *n*—a water-bearing, permeable body of rock or granular material below the surface of the earth.

binary cycle plant, *n*—a facility that generates electric power by transferring heat from produced geothermal fluids to a non-aqueous working fluid that vaporizes and causes a turbine to rotate the shaft of a generator.

brine, *n*—in geothermal, fluids in a liquid phase that have been produced from geothermal wells or from hot springs and that contain appreciable amounts of sodium chloride and other salts.

capacity, *n*—the power which a component of a geothermal facility (e.g., a well, a reservoir, a power plant, or a direct-use facility) is capable of supplying at a point in time, assuming that other required components of the geothermal facility are available. Capacity is expressed in units of power (e.g., Megawatts, kilowatts).

direct-use facility, *n*—a facility which uses geothermal energy for purposes other than the generation of electricity (e.g., space heating, greenhouses, bathing, and industrial processes).

fumarole, *n*—a vent at the earth's surface that emits steam or gaseous vapor.

DISCUSSION—Such vents are usually found in volcanic areas.

geochemistry, *n*—the study of the chemistry of the rocks and fluids of the earth for the purpose of understanding their composition, their temperature, and their origin.

geothermal, *adj*—relating to or derived from the natural heat of the earth.

geothermal anomaly, *n*—a conspicuous deviation of the earth's temperature, geothermal gradient, or heat flow from average values; an area where such a deviation exists.

geothermal energy, *n*—the thermal energy contained in the rocks and fluids of the earth.

geothermal facility, *n*—the physical components necessary for the utilization of geothermal energy, including the reservoir, production and injection wells, pipelines, and the power plant or direct-use facility.

geothermal fluid, *n*—water in a vapor or liquid phase or in a mixture of these phases that exists within or has been emitted from a geothermal reservoir, together with any entrained or dissolved substances.

geothermal gradient, *n*—the change in temperature of the earth with depth, expressed either in degrees of temperature per unit depth, or units of depth per degree.

geothermal power plant, *n*—a facility for the production of electricity using geothermal energy, typically including a turbine, a generator, and associated surface equipment.

geothermal heat pump, *n*—a heat pump that transfers energy to or from the earth.

geothermal reserves, *n*—the amount of energy anticipated to be economically recoverable from a geothermal facility over a specified time period (e.g., the project life) using existing technology. Geothermal reserves are expressed in units of energy (e.g., terajoules in SI units), which are dimensionally equivalent to units of power multiplied by units of time (e.g., Megawatt-years or kilowatt-hours). Geothermal reserves may also be expressed as an equivalent amount of another energy source (e.g., barrels of oil equivalent).

DISCUSSION—Geothermal reserves can also be characterized as to the degree of certainty of recovery. By analogy to usage in the mining and petroleum industries, reserves may be qualified as proven, probable, or possible.

Example of Usage:
This facility has geothermal reserves of 4,000 Megawatt-years, recoverable over a project life of 30 years.

geothermal reservoir, *n*—an aquifer of sufficient temperature and permeability to support the economic use of geothermal energy.

DISCUSSION—The extent of a geothermal reservoir is determined by the degree of hydrologic interconnection. When an aquifer contains

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both hot portions and portions that are too cool for economic use, those portions that are sufficiently interconnected to have a significant hydrologic or thermal impact on each other are considered part of the same geothermal reservoir.

geothermal steam, *n*—a geothermal fluid in the vapor phase.

geothermometer, *n*—a method of estimating the temperature of a geothermal reservoir based on the minerals in the reservoir rock or the concentration of chemical species in geothermal fluids that have come from the reservoir.

geyser, *n*—a spring that intermittently blows forth hot water and steam.

heat flow, *n*—dissipation or transfer of heat coming from within the earth by conduction, convection or radiation at the surface; usually reported in units of energy per unit time per unit area, for example, joules per second per square metre or watts per square metre.

hot spring, *n*—a thermal spring whose temperature is above that of the human body. **(***Meinzer 1923)*

magma, *n*—molten rock within the earth or within other planets.

moisture content, *n*—the percentage by mass of liquid-phase water in a two-phase mixture of vapor-and liquid-phase water.

DISCUSSION—The moisture content of a two-phase mixture is equivalent to 100 minus the steam quality.

noncondensible gas content, *n*—the concentration of noncondensible gas in a geothermal fluid.

DISCUSSION—The principal geothermal noncondensible (NC) gases include carbon dioxide, hydrogen sulfide, ammonia, nitrogen, methane, hydrogen, and argon. Standard usage is to express NC gas content as a percentage by mass in the reference fluid; that is,

(NC gas content = [mass NC gas/ (mass fluid + mass NC gas)] × 100, where fluid = water vapor, or water vapor + liquid (total fluid).

Other units for NC gas content (such as percentage by volume or mole ratio) may also be used. The units and the reference fluid for NC gas content should always be explicitly stated.

noncondensible gases, *n*—in geothermal, chemical species (such as carbon dioxide or hydrogen sulfide) that are constituents of geothermal fluids, that partition primarily into the vapor phase when geothermal fluids boil, and that do not condense along with geothermal steam when put through a condenser in a geothermal power plant.

permeability, *n*—the ability of a rock to transmit fluid.

DISCUSSION—The amount of permeability of a rock depends on the size, shape, and degree of interconnection of the rock's pores and fractures. Permeability is expressed as the ability to transmit fluid of a specified viscosity at a specified flow rate through a specified area under the influence of a specified pressure gradient. The traditional unit of permeability is the darcy or the millidarcy. The SI unit is the square micrometre. These units have the dimension of length squared.

phreatic eruption, *n*—an explosion of the surface of the earth that results from a sudden increase in the volume of groundwater when it flashes to steam due to contact with hot rocks.

DISCUSSION—Typically in an area of hot springs or fumaroles, and no lava or other materials derived from magma are erupted.

porosity, *n*—the ratio of the aggregate volume of interstices in a rock or soil to its total volume, usually stated as a percent.

project life, *n*—the time period over which the economic viability of a geothermal facility is evaluated.

reinjection/injection, *n*—the process of conveying geothermal fluids to sub-surface formations through wells.

DISCUSSION—After such fluids have been processed by a geothermal power plant or its associated facilities, or both, this process is sometimes referred to as "reinjection" when injected water circulates back through the geothermal reservoir to the production wells.

steam purity, *n*—the proportion by mass of pure vapor-and liquid-phase water in a fluid mixture that consists primarily of steam.

DISCUSSION—Geothermal steam may contain impurities, such as silica, sodium, chloride, iron and solid particulates. Steam purity expresses the proportion by mass of pure water (in both liquid and vapor phases) in this mixture. Typically, only steam impurity is discussed in quantitative terms; the impurities are expressed in units of concentration by mass in the steam mixture.

Impurities such as sodium and chloride may be present as dissolved species in liquid water, or as particulate material, such as solid NaCl. Likewise, silica may be dissolved in water or present as a solid particulate. In cases where volatile chloride exists (HCl and/or NH_4Cl), the volatile and nonvolatile species of chloride may be listed independently. Boron is a semi-volatile species that partitions between the vapor and liquid phases and is typically not grouped with the other non-volatile species. Noncondensible gas is not usually classified as a steam impurity, but is considered separately.

Example— Geothermal steam purity may be expressed in terms of the known impurities in the steam:

Chloride	0.75 ppm
Sodium	0.30 ppm
Silica	0.05 ppm
Iron	0.02 ppm
Other nonvolatile dissolved impurities	0.18 ppm
Total Dissolved Solids (TDS, sum of nonvolatile, dissolved impurities)	1.3 ppm
Particulate matter	0.50 ppm
Total Solids (TS, sum of all nonvolatile impurities)	1.8 ppm
Boron (semi-volatile impurity, considered separately)	35.0 ppm

steam quality, *n*—the percentage by mass of vapor-phase water in a two phase mixture of vapor- and liquid-phase water.

DISCUSSION—Geothermal steam may contain a small amount of liquid-phase water, as well as non-aqueous constituents, such as noncondensible gas and silica. Steam quality expresses the proportion of vapor-phase water relative to the mixture of vapor-and liquid-phase water only. The term "steam quality" is synonymous with the term "steam dryness".

Example — A two-phase geothermal fluid consists of the following mass percentages: 90% vapor-phase water, 6% liquid-phase water, 3% noncondensible gas, 1% total dissolved solids.

The steam quality of this mixture is [90/(90+6)]×100 = 93.75%.

sustainable capacity, *n*—the power which a component of a geothermal facility (such as a reservoir or a power plant) is capable of sustaining for a specified period of time.

DISCUSSION—The period of time over which a certain capacity can be sustained may be different than the project life.

Examples of Usage:

This reservoir has a sustainable capacity of 100 MW for at least 30 years.

This reservoir has a capacity of 50 MW, sustainable for at least the first 20 years of a 30-year project life.

With proper maintenance, this power plant has a sustainable

capacity of 30 MW for 30 years.

total dissolved solids content of steam, *n*—the concentration by mass of non-volatile, dissolved impurities in geothermal steam.

DISCUSSION—Geothermal steam may contain non-volatile impurities, such as silica, sodium, chloride and iron, that may be considered dissolved in droplets of liquid water. The total dissolved solids content (TDS) of steam expresses the sum of these impurities as a concentration by mass in the water vapor and liquid mixture. Semi-volatile constituents such as boron (boric acid, H3BO3) are not usually considered part of the total dissolved solids in steam.

warm spring, *n*—thermal spring whose temperature is appreciably above the local mean annual temperature but below that of the human body. (*Meinzer 1923*)