

# Steam

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**Steam** is water in the gas phase, which is formed when water boils. Steam is invisible; however, "steam" often refers to wet steam, the visible mist or aerosol of water droplets formed as this water vapour condenses. At lower pressures, such as in the upper atmosphere or at the top of high mountains, water boils at a lower temperature than the nominal 100 °C (212 °F) at standard pressure. If heated further it becomes superheated steam.

The enthalpy of vaporization is the energy required to turn water into the gaseous form when it increases in volume by 1,700 times at standard temperature and pressure; this change in volume can be converted into mechanical work by steam engines such as reciprocating piston type engines and steam turbines, which are a sub-group of steam engines. Piston type steam engines played a central role to the Industrial Revolution and modern steam turbines are used to generate more than 80% of the world's electricity. If liquid water comes in contact with a very hot surface or depressurizes quickly below its vapor pressure, it can create a steam explosion. Steam explosions have been responsible for many foundry accidents, and may also have been responsible for much of the damage to the plant in the Chernobyl disaster.



Liquid phase eruption of Castle Geyser in Yellowstone Park

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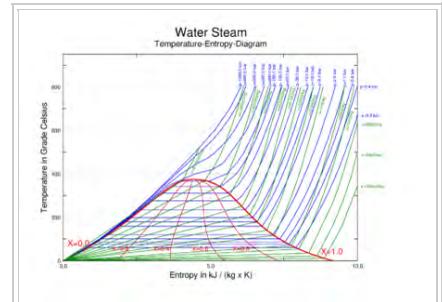
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## Types of steam and conversions

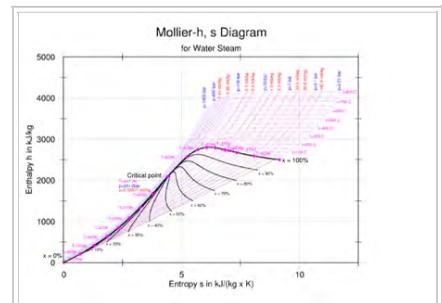
Steam is traditionally created by heating a boiler via burning coal and other fuels, but it is also possible to create steam with solar energy.<sup>[1][2][3]</sup> Water vapor that includes water droplets is described as *wet steam*. As wet steam is heated further, the droplets evaporate, and at a high enough temperature (which depends on the pressure) all of the water evaporates and the system is in vapor–liquid equilibrium.<sup>[4]</sup>

Superheated steam is steam at a temperature higher than its boiling point for the pressure, which only occurs where all liquid water has evaporated or has been removed from the system.<sup>[5]</sup>

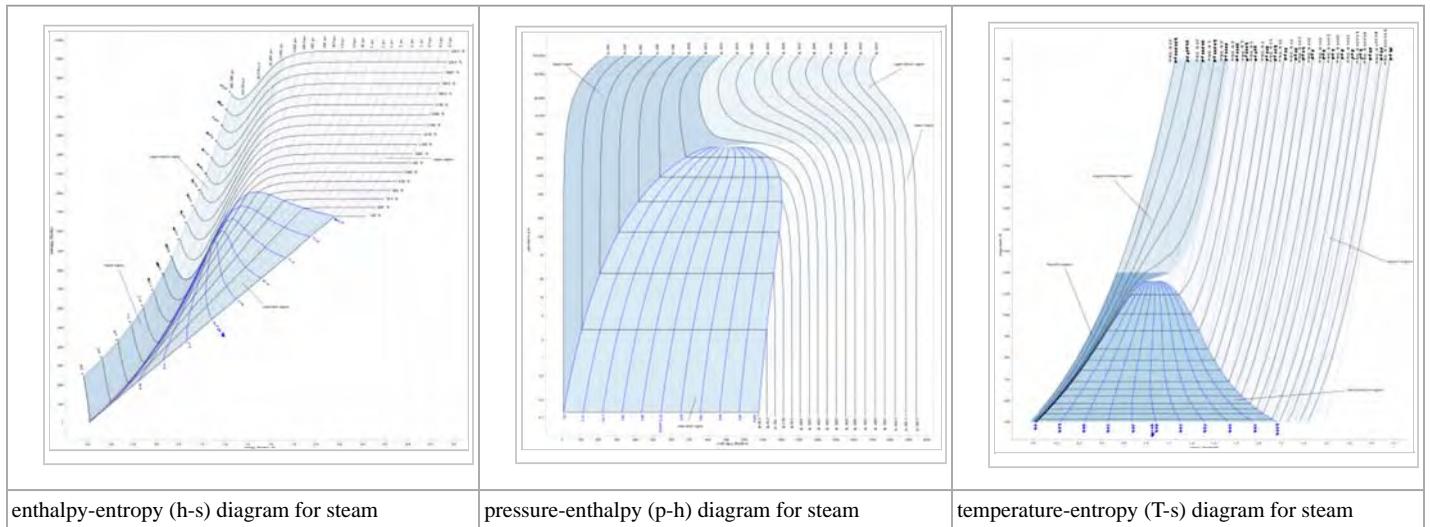
Steam tables <sup>[6]</sup> contain thermodynamic data for water/steam and are often used by engineers and scientists in design and operation of equipment where thermodynamic cycles involving steam are used. Additionally, thermodynamic phase diagrams for water/steam, such as a temperature–entropy diagram or a Mollier diagram shown in this article, may be useful. Steam charts are also used for analysing thermodynamic cycles.



A temperature-versus-entropy diagram for steam



A Mollier enthalpy-versus-entropy diagram for steam



## Uses

### Agricultural

In agriculture, steam is used for soil sterilization to avoid the use of harmful chemical agents and increase soil health.

### Domestic

Steam's capacity to transfer heat is also used in the home: for cooking vegetables, steam cleaning of fabric, carpets and flooring, and for heating buildings. In each case, water is heated in a boiler, and the steam carries the energy to a target object. Steam is also used in ironing clothes to add enough humidity with the heat to take wrinkles out and put intentional creases into the clothing.

### Electricity generation (and cogeneration)

About 90% of all electricity is generated using steam as the working fluid, nearly all by steam turbines.<sup>[7]</sup>

In electric generation, steam is typically condensed at the end of its expansion cycle, and returned to the boiler for re-use. However, in cogeneration, steam is piped into buildings through a district heating system to provide heat energy after its use in the electric generation cycle. The world's biggest steam generation system is the New York City steam system, which pumps steam into 100,000 buildings in Manhattan from seven cogeneration plants.<sup>[8]</sup>

### Energy storage

In other industrial applications steam is used for energy storage, which is introduced and extracted by heat transfer, usually through pipes. Steam is a capacious reservoir for thermal energy because of water's high heat of vaporization.

Fireless steam locomotives were steam locomotives that operated from a supply of steam stored on board in a large tank resembling a conventional locomotive's boiler. This tank was filled by process steam, as is available in many sorts of large factory, such as paper mills. The locomotive's propulsion used pistons and connecting rods, as for a typical steam locomotive. These locomotives were mostly used in places where there was a risk of fire from a boiler's firebox, but were also used in factories that simply had a plentiful supply of steam to spare.

### Lifting gas

Owing to its low molecular mass, steam is an effective lifting gas, providing approximately 60% as much lift as helium and twice as much as hot air. It is not flammable, unlike hydrogen, and is cheap and abundant, unlike helium. The required heat, however, leads to condensation problems and requires an insulated envelope. These factors have limited its use thus far to mostly demonstration projects.<sup>[9]</sup>

### Mechanical effort

Steam engines and steam turbines use the expansion of steam to drive a piston or turbine to perform mechanical work. The ability to return condensed steam as water-liquid to the boiler at high pressure with relatively little expenditure of pumping power is important. Condensation of steam to water often occurs at the low-pressure end of a steam turbine, since this maximizes the energy efficiency, but such wet-steam conditions must be limited to avoid excessive turbine blade erosion. Engineers use an idealised thermodynamic cycle, the Rankine cycle, to model the behavior of steam engines. Steam turbines are often used in the production of electricity.

### Sterilization

An autoclave, which uses steam under pressure, is used in microbiology laboratories and similar environments for sterilization.



Fireless steam locomotive

Despite the resemblance to a boiler, note the lack of a chimney and also how the cylinders are at the cab end, not the chimney end.

Steam, especially dry (highly superheated) steam, may be used for antimicrobial cleaning even to the levels of sterilization. Steam is a non-toxic antimicrobial agent.<sup>[10]</sup> <sup>[11]</sup>

## Steam in piping

Steam is used in piping for utility lines. It is also used in jacketing and tracing of piping to maintain the uniform temperature in pipelines and vessels.

## Wood treatment

Steam is used in the process of wood bending, killing insects and increasing plasticity.

## Concrete treatment

Steam is used to accentuate drying especially in prefabricates. Care should be taken since concrete produces heat during hydration and additional heat from the steam could be detrimental to hardening reaction processes of the concrete.

## Cleaning

Used in cleaning of fibers and other materials, sometimes in preparation for painting. Steam is also useful in melting hardened grease and oil residues, so it is useful in cleaning kitchen floors and equipment and internal combustion engines and parts. Among the advantages of using steam versus a hot water spray are the facts that steam can operate at higher temperatures and it uses substantially less water per minute.<sup>[12]</sup>

## See also

- Electrification
- Food steamer or steam cooker
- Geyser—*geothermally-generated steam*
- IAPWS—an association that maintains international-standard correlations for the thermodynamic properties of steam, including IAPWS-IF97 (for use in industrial simulation and modelling) and IAPWS-95 (a general purpose and scientific correlation).
- Industrial Revolution
- Live steam
- Mass production
- Nuclear power—and power plants *use steam to generate electricity*
- Oxyhydrogen
- Psychrometrics—*moist air/vapor mixtures, humidity and air conditioning*
- Steam locomotive
- Steamed

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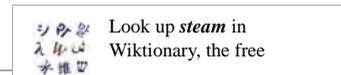
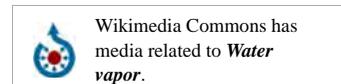
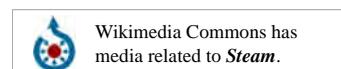
## External links

- Steam Tables & Charts by National Institute of Standards and Technology, NIST (http://webbook.nist.gov/chemistry/fluid/)

Wikiversity has steam tables with figures and Matlab code

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Categories: Forms of water | Water in gas | Steam power | Gases



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dictionary.



Wikivoyage has a travel guide for *Steam*.