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Commentary

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Thermal power station

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Editorial

A thermal power station is a power station in which heat energy is converted to electricity. Typically, water is heated into steam, which is used to drive an electrical generator. After it passes through the turbine the steam is condensed in a steam condenser and recycled to where it was heated. This is known as a Rankin cycle. The greatest variation in the design of thermal power stations is due to the different heat sources: fossil fuel, nuclear energy, solar energy, biofuels, and waste incineration are all used. Certain thermal power stations are also designed to produce heat for industrial purposes, for district heating, or desalination of water, in addition to generating electrical power. Almost all coal-fired power stations, petroleum, nuclear, geothermal, solar thermal electric and waste incineration plants, as well as all natural gas power stations are thermal. Natural gas is frequently burned in gas turbines as well as boilers. The waste heat from a gas turbine, in the form of hot exhaust gas, can be used to raise steam by passing this gas through a heat recovery steam generator (HRSG). The steam is then used to drive a steam turbine in a combined cycle plant that improves overall efficiency. Power stations burning coal, fuel oil, or natural gas are often called fossil fuel power stations. Some biomass-fueled thermal power stations have appeared also. Non-nuclear thermal power stations, particularly fossil-fueled plants, which do not use cogeneration, are sometimes referred to as conventional power stations. Commercial electric utility power stations are usually constructed on a large scale and designed for continuous operation. Virtually all electric power stations use three-phase electrical generators to produce alternating current (AC) electric power at a frequency of 50 Hz or 60 Hz. Large companies or institutions may have their own power stations to supply heating or electricity to their facilities, especially if steam is created anyway for other purposes. Steam-driven power stations have been used to drive most ships in most of the 20th century]. Shipboard power stations usually directly couple the turbine to the ship's propellers through gearboxes.

The Carnot efficiency dictates that higher efficiencies can be attained by increasing the temperature of the steam. Sub-critical pressure fossil fuel power stations can achieve 36–40% efficiency. Supercritical designs have efficiencies in the low to mid 40% range; with new "ultra-critical" designs using pressures above 4400 psi (30.3 MPa) and multiple stages reheat reaching 45-48% efficiency. Above the critical point for water of 705 °F (374 °C) and 3212 psi (22.06 MPa), there is no phase transition from water to steam, but only a gradual decrease in density. Currently most nuclear power stations must operate below the temperatures and pressures that coal-fired plants do order to provide more conservative safety margins within the systems that remove heat from the nuclear fuel. This, in turn, limits their thermodynamic efficiency to 30–32%. Some advanced reactor designs being studied, such as the very-high-temperature reactor, Advanced Gas-cooled Reactor, and supercritical water reactor, would operate at temperatures and pressures similar to current coal plants, producing comparable thermodynamic efficiency. The energy of a thermal power station not utilized in power production must leave the plant in the form of heat to the environment. This waste heat can go through a condenser and be disposed of with cooling water or in cooling towers. If the waste heat is instead used for district heating, it is called cogeneration. An important class of thermal power station is that associated with desalination facilities; these are typically found in desert countries with large supplies of natural gas, and in these plants freshwater production and electricity are equally important co-products. Other types of power stations are subject to different efficiency limitations. Most hydropower stations in the United States are about 90 percent efficient in converting the energy of falling water into electricity while the efficiency of a wind turbine is limited by Betz's law, to about 59.3%, and actual wind turbines show lower efficiency

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