



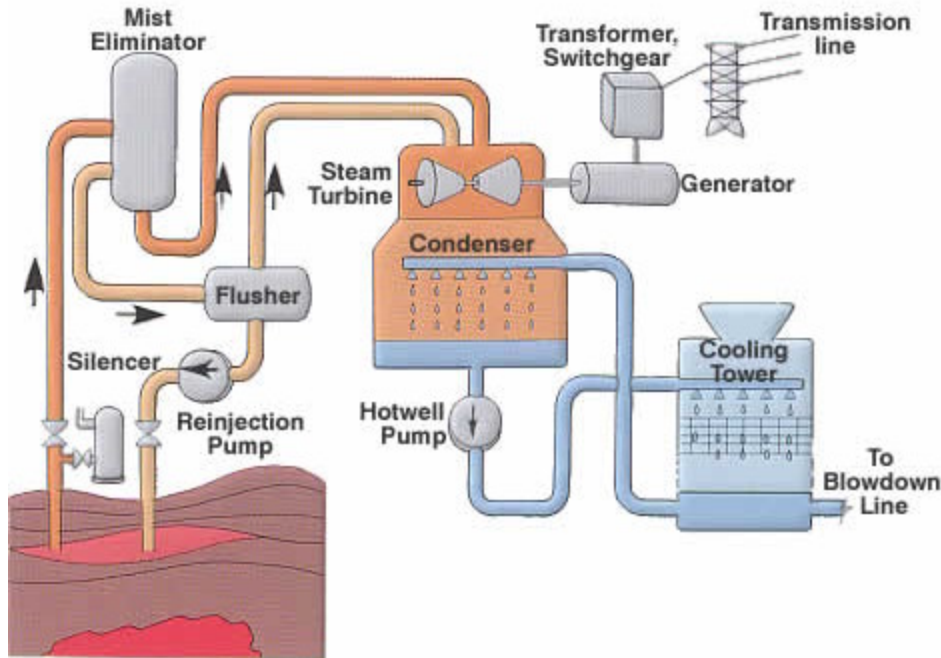
دانشنامه مرجع مهندسی ایران

Iran Engineering Reference Encyclopedia

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Geothermal Power Plants

This unique system taps the natural supplies of heat energy that have accumulated inside the earth. Thus, geothermal power is generally considered to be "earth friendly".



Design & Construction Features

HIGHLY EFFICIENT AND STRONG STEAM PATH

The steam path is designed on the basis of massive results of tests and studies and by means of the most advanced computer techniques so that the maximum stage efficiency can be obtained. The impulse type design, in which the diaphragm type nozzles are combined with strong cross section blades, is strong enough against foreign matter.

STABLE AND LOW-FATT ROTOR

Because the turbine rotor operates in erosive geothermal steam, it is made of highly corrosion-resistant Cr- Mo-V steel. This rotor is a low-FATT type, which has been used for many high and intermediate-pressure united rotors in fossil fuel powered steam turbines.

EFFECTIVE SEPARATION OF MOISTURE AND DUST

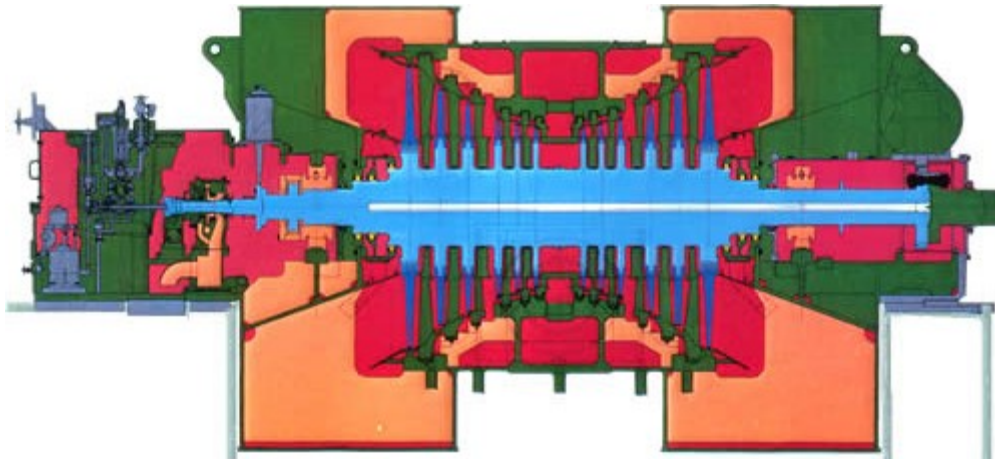
Moisture and dust in the steam path are satisfactorily shaken off by centrifugal force toward the outside wall. The wall is covered with a stainless steel impingement shield to prevent erosion.

SIMPLE SINGLE-SHELL CONSTRUCTION

Simple single-shell construction without an internal casing considerably simplifies maintenance. Furthermore, careful consideration is given to minute details including the dust-and-drain prevention and disposal structures, corrosion-resisting protector, and the inspection manhole.

HIGHLY RELIABLE LONG BLADE SERIES

12Cr steel blades backed up by close calculation and ample experience are adopted. Special care is given to determine blade width and blade tip shroud band construction.



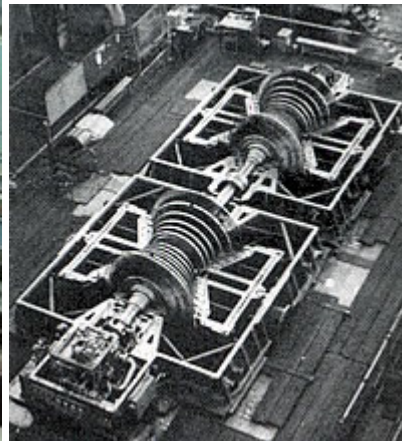
Geothermal Turbine Sectional View

110MW Geothermal Steam Turbine

The geothermal steam turbine is, so to speak, a thermal turbine in which mother nature plays the role of a boiler. However, since geothermal steam contains up to several percent of gaseous impurities, geothermal steam turbines require much more technical consideration than do standard thermal steam turbines. Issues involved include such phenomena as corrosion of turbine component parts and the accumulation of and erosion by solid substances in the steam paths.



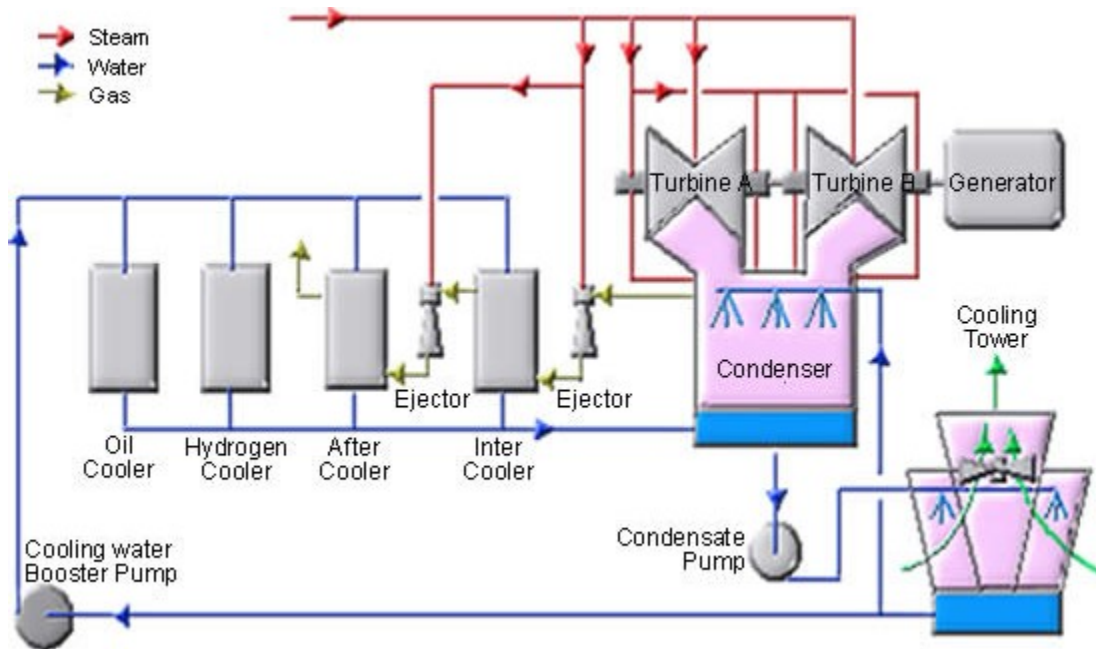
Left: 110MW Geothermal Turbine



Above: 110MW geothermal turbine under shop assembly

Since the steam does not contain hot water and its maximum superheating degree is 9°C, no flashing was required. Consequently, direct condensing system utilizing natural steam spurting out from production wells was employed for the power plant. Superheating steam is changed into wet steam from the turbine second stage and is expanded up to 102 mmHg absolute, 52°C. When contacting and mixed with sprayed cooling water in the condenser, which is directly connected to the turbine, the wet steam becomes condensed water at 49°C. This condensed water is pumped to the cooling tower by a condensate pump and is cooled to 27°C. Cooled water is used as condenser cooling water, oil cooling water, etc. This cooling water is delivered to the condenser by utilizing potential energy between the cooling tower and the condenser rather than by pumping, and also by vacuum conditions in the condenser interior. Since the condensed water is recycled in this system, no water replenishment is required from the exterior.

Overflowing condensed water is fed back to the underground through injection wells. Noncondensed gases contained in the steam are continuously ejected from the condenser by using steam ejectors. Steam flowing through the ejectors amounts to approximately 34 tons per hour, about 4% of the total steam. Since 4,000kW power is consumed for driving the condensate pump and the cooling fans and other pumps, the net power output at high tension side of step-up transformer is 106,000kW.



Geothermal power plant unit capacity has been increasing in recent years, supported by technological innovation and driven by the economics of larger installations. At the same time, demand for small sized geothermal power plant has also expanded. Small sized geothermal power plant is generally used for the following purposes:

- An experimental unit as a pilot plant for a larger size installation
- Meet the needs of electricity demand in limited area
- Power source during construction
- Auxiliary or emergency power source for main geothermal generating plant
- Simplification steam transmission lines as a well-head unit, because geothermal wells are scattered in geothermal field

Toshiba has developed a standardised series of portable small size geothermal turbine and generator sets, suitable to a range of applications. This portable type turbine and generator set is supported by our extensive experience with geothermal units. Special consideration is given to easy transportation, easy operation including start and stop, maintainability, high efficiency and high reliability. The Toshiba portable type turbine and generator set is completely assembled on a common base then shipped to the site. Consequently, installation and adjustment work at site can be minimised. Toshiba is always working to satisfy customer needs in the geothermal power generation field, based on our high engineering capability and extensive experience.

Frame	Type-TPO	Type-TPB	Type-TPC
Turbine type	Back pressure/ condensing	Back pressure	Condensing
Type	Single stage curtis with reduction gear	Multistage rateau with reduction gear	Multistage rateau with reduction gear
Power range	500-2000kW	2000-9000kW	2000-9000kW
Steam condition throttle press	3-10 kg/cm ² g	3-10 kg/cm ² g	3-10 kg/cm ² g
Speed	50Hz 6200/1500RPM 60Hz 7400/1800RPM	50Hz 6000/1500RPM 60Hz 6000/1800RPM	60Hz 5000/1800RPM 50Hz 5000/1500RPM
No of stage	1 stage	Max. 6 stages	Max. 6 stages
Oil cooler	Water or air	Water or air	Water or air
Application	Power source for construction and start for blackout	Power generation and power for auxiliaries	Power generation and power for auxiliaries

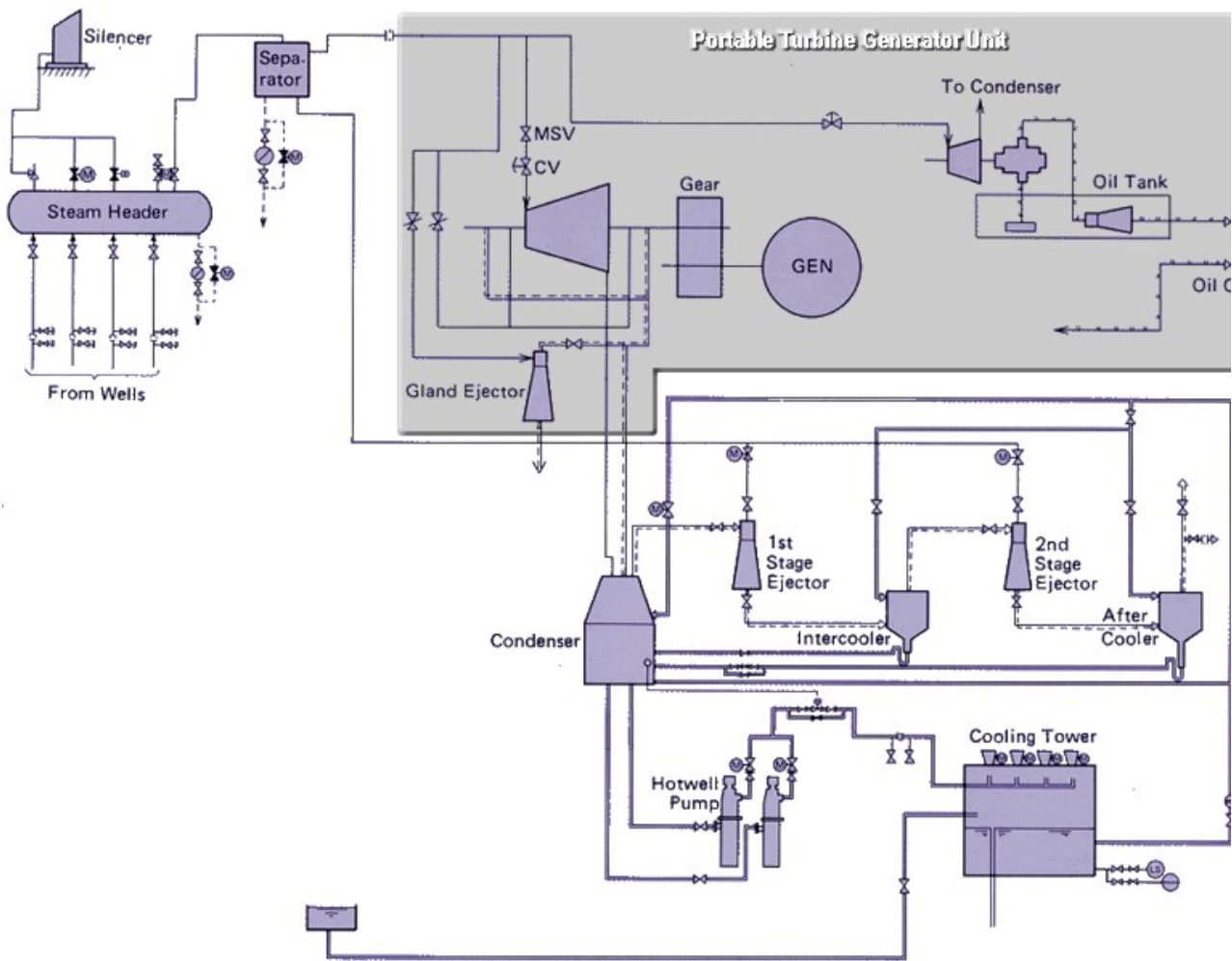
High efficiency and high reliability

Toshiba portable steam turbines are of impulse type, multistage nozzles and blades and low steam consumption. The impulse design features sturdy and simple construction. This construction minimized damages from foreign materials and less susceptible to deterioration of performance due to increased leakage caused by packing rules. The nozzle diaphragm consists of web with an inner and an outer ring of sufficient strength, and the nozzle partitions are rugged and efficient cross section. The blades also have a rugged and efficient cross section, and are strongly fixed to a solid type rotor wheel.

Portable Turbine Generator

Main Flow Diagram

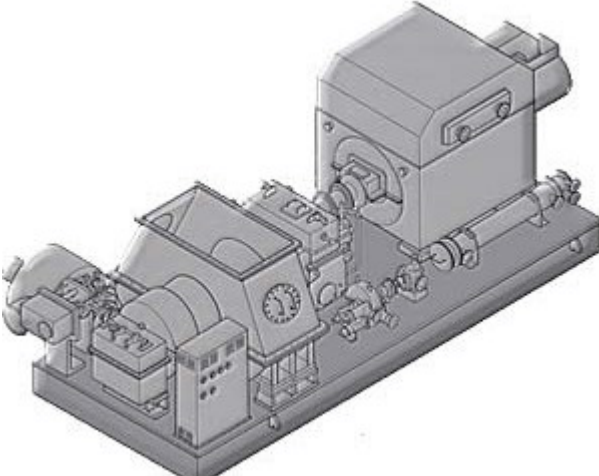
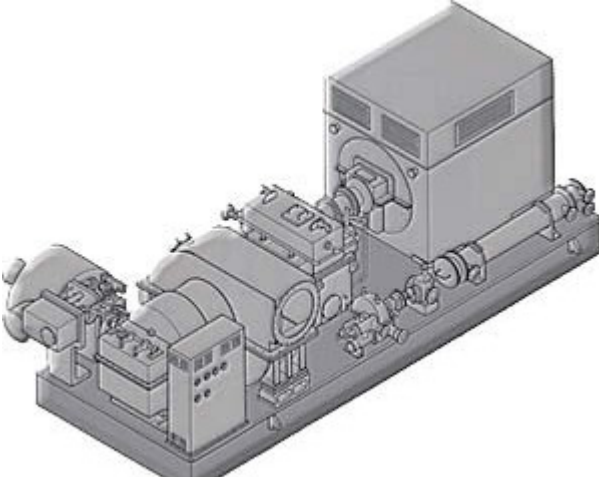
Typical main flow diagram of the portable turbine generator with low level type condenser and water cooled oil cooler is as follows.



(Click to Enlarge)

Toshiba's portable turbine generator's versatility is suited to a wide range of applications, operation patterns and site conditions. For example, oil cooler can be selected from two types-air cooled oil cooler and water cooled oil cooler-depending on site suitability.

Mechanical Outline

	Outline	Weight	Dimension
T Y P E · T P C		Turbine: 17.0 Reduction Gear: 2.5 Generator: 13.3 Others: 12.5 Total: 45.3 (ton)	2.7W 7.3L 2.6H (m)
T Y P E · T P B		Turbine: 15.0 Reduction Gear: 2.5 Generator: 13.0 Others: 12.3 Total: 42.8 (ton)	2.7W 7.0L 3.3H (m)

Easy transportation and construction

Toshiba's portable turbine generator unit's compactness ensures simplicity of construction and ease of handling. The equipment can thus be installed and relocated at various sites and operated successfully. In addition, since the turbine, generator and their necessary auxiliary equipment are all skid mounted in Toshiba's workshop so transportation to site is quite simple.

No power source for start

Toshiba portable turbine generator can be started without any auxiliary power source except a battery for instrumentation. The unit has a steam turbine driven oil pump and mechanical-hydraulic control system. Therefore the unit can be installed without need for any electric network in the area.

Reference

Web site :

http://www.atals.com/newtic/geo_home.htm

<http://Smsm.ir>