



GEOHERMAL POWER PLANTS



AnsaldoEnergia
A Finmeccanica Company

Geothermal Power Plants

Ansaldo Energia geothermal power plants represent the latest evolution of a well established expertise in design and manufacture of turnkey plants for the exploitation of geothermal fields.

Several technological improvements have been introduced in the main component's design as well as in the power block arrangement in order to have pre-engineered solutions that can quickly be customized according to the site conditions and the Client's requirements. Ansaldo Energia's experience in geothermal power plants dates back to 1913, when the first turbine-generator unit ever driven by geothermal steam rated 250 kW, entered service at Larderello (Italy).

Since then, units for over 2,136 MW have been installed both in Italy and abroad.

The range of Ansaldo conventional service ensures the implementation of geothermal power plants starting from the well-head up to the electric transmission lines, under an integrated "turnkey" approach.

This includes complete engineering and detailed design, construction and installation of equipment and machinery, construction works, management and coordination services, commissioning and trial operation of the plant, supervision to operation and training of Client's staff.



Experience in geothermal fields, demonstrates the advantages that can be achieved by prompts implementation of geothermal resources once the indications of the preliminary phases of field exploitation and development have shown the commercial exploitation is justified. To this purpose Ansaldo Energia, is fully available for establishing cooperation agreements with Italian and foreign engineering organizations involved in the development of geothermal resources, in order to provide integrated schemes including both assistance for field development and turnkey supply of power plants.



Main features

Turbine

- High efficiency, impulse reaction type
- Speed 3000 or 3600 RPM
- Single cylinder construction
- Single flow (GT 40) or double flow (GT 60)
- Length of last stage blades 20, 23, 26, 31 inch
- Top or side exhaust arrangement for low profile plant layout fully integrated with condenser
- Patented design solutions to prevent problems with dissolved solids or steam impurities

Generator

- Rated output: depending on the size
- Frequency 50 or 60 Hz
- Power factor 0.8
- Rated voltage 11.5 or 13.8 kV
- Brushless excitation
- Air cooling (air is cooled in turn with water), Hydrogen cooling is optional, but not necessary for these rated power values.

Condenser

The condenser is low-level, jet spray direct contact type and it is arranged beneath the turbine or laterally and connected by means of a crossover steam duct.

The condenser overall dimension and weight reduction is the result of a close analysis of heat transfer between the steam and the cooling water drops.

The water is injected into the condensing chamber by means of a network system consisting of horizontal manifolds, vertical pipes and spray nozzles.

The condensing chamber is connected to two gas cooler sections where the final condensation takes place along with the non condensable gases temperature abatement by means of the spray nozzles on the top and trays arranged beneath nozzles.

The nozzles are of the whirl-jet type with ample orifice section to prevent clogging and are easily removable for inspection and cleaning.

The Condenser shell and internals are in Aisi 316 type Stainless Steel.



Non condensable gas extraction

Two options:

- Steam ejectors
- Centrifugal compressor

The choice between the two is based on the gas percentage in the geothermal steam and the power cost (steam cost and equipment capital cost).

Steam Ejectors

- Three stage ejector featuring enhanced performance and reduce steam consumption
- Two inter-condensers and one after condenser.

Centrifugal compressor

- Package geared baseplate-mounted type
- Three stages with intermediate gas cooler
- High-speed impellers drives by pinion shafts
- Direct coupling to the turbo generator shafts (alternatively, the compressor can be driven by an electric motor).



Layout

The standard design is for one unit, with the option of extending the plant by adding a second unit.

In the GT 60 unit the condenser lies beneath the pedestal or laterally.

In the GT 40 units which are typically package solutions with no pedestal, the condenser is located laterally and crossover piping is required.

Materials

Proper material selection is extremely important in the geothermal environment to ensure reliability and minimize outages for maintenance. Corrosion problems are due both to chemicals contained in the geothermal fluid and to the presence of H₂S in the atmosphere.

Ansaldo has carried out detailed studies to test the resistance of various turbine materials to geothermal steam.

Stainless steel is widely used for condensate and gas service. For field mouted electrical equipment.

Where the use of copper cannot be avoided, a suitable surface treatment is applied (special painting, gold plating, tinning, etc).



Performance

For a GT 60 unit operating under the above design conditions and using steam ejectors for gas extraction, the plant performances, based on saturated steam at 6.5 bar are the following.

Total gross power	55 MWe
Steam flow rate	399.7 t/h
Gross efficiency	17.94 %
Gross heat rate	2007 kJ/kWh
Auxiliaries consumption	2.1 MWe
Total net output	52.9 MWe
Total heat rate	20880 kJ/kWh
Net steam rate	7.56 kg/kWh



Ansaldo Energia has over 150 years experience in the electrical and mechanical engineering business. It is a global player in the power generation sector with an installed capacity of over 170,000 MW. Ansaldo Energia offers the full range of manufacturing, engineering, contracting and service activities, as well as a flexible approach to power projects.

Steam fossil fired, gas turbine and combined cycle, hydroelectric, geothermal and nuclear power plants, supplied turnkey, in separate lots or by components. The Quality Systems, certified as complying with ISO 9001 by a recognised certification society, cover all aspects including, design, planning, manufacture, testing, inspection, installation and servicing.



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