WELCOME
Introduction to Gas Turbines

- Gas turbines have been used for electricity generation.
- Gas turbines are ideal for this application as they can be started and stopped quickly.

There are two basic types of gas turbines –

- Aero derivative and,
- Industrial.
Layout gas turbine power plant
Gas turbines use the hot gas produced by burning a fuel to drive a turbine. They are also called combustion turbines or combustion gas turbines.

Because some of its heat and pressure energy has been transferred to the turbine, the gas is cooler and at a lower pressure when it leaves the turbine. It is then either discharged up a chimney (often called a stack) or is directed to a special type of boiler, called a Heat Recovery Steam Generator (HRSG), where most of the remaining heat energy in the gas is used to produce steam.
The cross section of a typical large gas turbine
A schematic of a gas turbine-based CHP system. Some combined cycles extract steam at an intermediate pressure for use in industrial processes and are combined cycle CHP systems.
The photo shows, for a large gas turbine, the cross-section of a typical burner/combustor combination, the arrangement of these combustors and the area between the combustors and the turbine. The heat resistant ceramic tiles used in these hot areas can be clearly seen.
The air compressors used in gas turbines are made up of several rows of blades (similar to the blades on a household fan). Each row of blades compress and push the air onto the next row of blades. As the air becomes more and more compressed, the sizes of the blades become smaller from row to row. The row of largest blades can be seen at the left end of the compressor in the photo above, with the smallest blades to the right (the direction of air flow is from left to right). Note: A row of blades fixed to the outer casing of the compressor is also located after each row of moving blades.
Fuel

Gas turbines can operate on a variety of gaseous or liquid fuels, including:

Liquid or gaseous fossil fuel such as crude oil, heavy fuel oil, natural gas, methane, distillate and "jet fuel" (a type of kerosene used in aircraft jet engines);
Gas produced by gasification processes using, for example, coal, municipal waste and biomass; and
Gas produced as a by-product of an industrial process such as oil refining.
When natural gas is used, power output and thermal efficiency of the gas turbines are higher than when using most liquid fuels.
The air coming into the compressor of a gas turbine must be cleaned of impurities (such as dust and smoke) which could erode or stick to the blades of the compressor or turbine, reducing the power and efficiency of the gas turbine. Dry filters or water baths are usually used to carry out this cleaning.
Burners and Combustors

The compressed air and fuel is mixed and metered in special equipment called burners. The burners are attached to chambers called combustors. The fuel & air mixture is ignited close to the exit tip of the burners, then allowed to fully burn in the combustors. The temperature of the gas in the combustors and entering the turbine can reach up to 1350°C. Special heat resistant materials (such as ceramics) are used to line the inside walls of the combustors. The area between the combustors and the turbine are also lined.
The inlet air (blue) enters the compressor at the left. The exhaust gas (red) leaves the turbine at the right. The burners and combustors are located between the compressor and turbine.

Gas turbines are very compact and occupy small ground area. Silencers are usually fitted in the inlet air and exhaust gas ducts.
The photo shows what such a gas turbine looks like when its top half casing has been removed for inspection or maintenance. The air compressor is on the left and the turbine is on the right. The section that would hold the burners and combustors is between the compressor and the turbine. Note the large bolts that are used to hold the two halves of the casing together.
Gas Turbines

- Gas turbines are an established technology available in sizes ranging from several hundred kilowatts to over several hundred megawatts. Gas turbines produce high quality heat that can be used for industrial or district heating steam requirements. Alternatively, this high temperature heat can be recuperated to improve the efficiency of power generation or used to generate steam and drive a steam turbine in a combined-cycle plant. Gas turbine emissions can be controlled to very low levels using dry combustion techniques, water or steam injection, or exhaust treatment. Maintenance costs per unit of power output are about a third to a half of reciprocating engine generators. Low maintenance and high quality waste heat often make gas turbines a
The combustion (gas) turbines being installed in many of today's natural-gas-fueled power plants are complex machines, but they basically involve three main sections:

- The compressor which draws air into the engine, pressurizes it, and feeds it to the combustion chamber literally at speeds of hundreds of miles per hour.
Technical Information
The AE 3007's two shaft axial design consists of a single LP compressor, 14-stage HP compressor followed by an effusion-cooled annular combustor, two stage HP turbine and a three stage LP turbine.

Power Specifications
8,600 lbf (38 kN)

Applications
Northrop Grumman RQ-4A Global Hawk
Embraer 145 AEW&C, B-52/AGS & P 99
Gas Turbine Parts

Pratt & Whitney F100 Engine

Inlet  Compressor  Shaft  Burner  Turbine  Nozzle

Photo

Simplified Computer Drawing
\[ pt = \text{total pressure} \]
\[ T_t = \text{total temperature} \]
\[ h_t = \text{specific stagnation enthalpy} \]
\[ c_p = \text{specific heat} \]
\[ \gamma = \text{specific heat ratio} \]
\[ \eta_t = \text{adiabatic efficiency} \]

**Turbine Pressure Ratio** = TPR

\[ \text{TPR} = \frac{p_{t_5}}{p_{t_4}} = \left( \frac{T_{t_5}}{T_{t_4}} \right)^\frac{\gamma}{\gamma - 1} \]

Station 4 – turbine entrance
Station 5 – turbine exit

**Turbine Work / mass** = TW

\[ \text{TW} = (h_{t_4} - h_{t_5}) \]
\[ \text{TW} = c_p (T_{t_4} - T_{t_5}) \]

\[ \text{TW} = \eta_t c_p T_{t_4} \left( 1 - \text{TPR}^{(\gamma -1)/\gamma} \right) \]
THANK YOU