Cilegon Gas Turbine Combined-Cycle (GTCC) Power Plant, Indonesia

Project Credits:

Owner: PT PLN (Persero), Indonesia's state-owned electricity company
Location: Cilegon, Banten Province, Indonesia
EPC Controller: Mitsubishi Heavy Industries Ltd. and Mitsubishi Electric Corporation
Funding: Japan Bank for International Cooperation (JBIC), Indonesian Government, and Nippon Export and Investment Insurance (NEXI)
Gas supplier: CNOOC
Plant Type: Gas turbine combined-cycle power plant
Total Output: 740 megawatt
Start Date: Phase 1: November 2006-August 2007
Gas Turbine Supplier: Mitsubishi (M701F type)
Steam Units Supplier: Mitsubishi
Fuel Type: Natural gas

The city of Cilegon in Indonesia is all set to make its mark in history with its new combined-cycle power plant!

Introduction

With the new era of the economy in the year 2004, the total demand for electricity in the country of Indonesia rapidly increased and shot up by 6% per annum approximately. With this splurge in the electricity need of the country, the Indonesian government expected a massive electric shortage to occur by the end of the 2005. Thus, looking at the rising need of electricity and future concerns, the Indonesian government along with PT.PLN, Persero – the state-owned electric company in Indonesia, came up with the decision to pass an order urgently to Mitsubishi Heavy Industries Ltd., abbreviated as MHI, to supply the Indonesian country with a 740 megawatt gas turbine combined-cycle (GTCC) power plant. The MHI along with the Mitsubishi Electric Corporation (MEC) and a local company received the turnkey order for the full engineering work, procurement and construction work (EPC) to be started for this power plant. This was how the idea behind the Cilegon gas turbine combined-cycle (GTCC) power plant was conceived in the year 2004.

Idea and Ownership

This project was awarded to MHI because of its prior experience in supplying many power plants in Indonesia. The Mitsubishi Heavy Industries Ltd. is a company based out of Japan, with its headquarters in Tokyo. The company is involved in steel structures, chemical plants, ship building, power plants, environmental equipments, aircrafts, air-conditioning systems, steel plants, space rocketry, and general and industrial machinery. The company's history in construction and its high technical abilities and approach were thoroughly evaluated by PT.PLN, before the company went ahead and signed the contract with MHI. Prior to start working on the Cilegon gas turbine combined-cycle (GTCC) power plant, the company had received the following power plant orders from PT.PLN: the Gresik GTCC power plant in the year 1990 and the Grati GTCC power plant in the year 1994.

Location Preference

For the Cilegon gas turbine combined-cycle (GTCC) power plant, the region of Cilegon was found suitable because of many reasons. One of the main reasons is that Cilegon is the centre point for the heavy and chemical industry in Indonesia. The city has gained this recognition because of many petrochemical and steel plants that are operating in Cilegon. Owing to this reason, the electricity demand in the region of Cilegon and its surrounding areas was increasing, and PT.PLN decided to pass orders to build the new gas turbine combined-cycle (GTCC) power plant using the company's land in Cilegon and making use of the available natural gas in the area.

The 740 megawatt of the Cilegon gas turbine combined-cycle (GTCC) power plant comprises two gas turbines, two heat recovery steam-based generators (HRSG), and one steam turbine. The power plant is constructed at Cilegon in the Banten province of Indonesia, located about 90 kilometres in the west of Jakarta. The MHI supplied the two M701F gas turbines that had been the first high-efficiency, high-output gas turbines in Indonesia. The company also supplied the two HRSGs and the steam turbine along with some peripheral equipments such as the electric generators.

The complete project work on the Cilegon gas turbine combined-cycle (GTCC) power plant was started on full turnkey basis. The local company that was involved in the construction of this power plant took the complete charge of all the works related to the civil engineering of the plant and the proper installation of the equipments along with the associated transmission line. The operations of the Cilegon gas turbine combined-cycle (GTCC) power plant were planned to commence in the year 2005 and complete in the first half of the year 2006.

The funding for the project took little longer because of constant negotiations among the Indonesian government, Nippon Export and Investment Insurance (NEXI) and the Japan Bank for International Cooperation (JBIC). Because of this reason the operations that were planned in the year 2005 were delayed. The Cilegon gas turbine combined-cycle (GTCC) power plant finally ran to its full power in the month of August in the year 2007. The final construction work for the plant was completed in the year 2006; however, the maintenance work on the gas pipeline had some interrupted supplies.

Components and Technology Involved

The combined-cycle power plant is a special kind of power generation that makes use of a steam turbine and a gas turbine in a unique combination for two-stage of electricity generation. The plant utilizes the high exhaust temperature from the gas turbine at the first stage. With the help of this high exhaust temperature, the heat recovery steam generator, called the HRSG, generates steam which is further utilized in the steam turbine for generating electricity in the second stage. The MHI took charge of supplying a complete range of gas turbines, ranging from 6 megawatt class to 300 megawatt class.

Thus, by combining steam and gas cycles, both low output and high input temperatures can be successfully achieved. The efficiency of such combined cycles gets added because both the cycles are powered with the help of a common fuel source. The company also supplied the M701F gas turbines that have a total power output of about 270 megawatt along with a heat rate of about 2250 kilocalories per kilowatt hour (kcal/kWh). These M701F gas turbines feature an axial exhaust and a two-bearing, cold-end, single-shaft construction power drive.

Such combined cycle plants are much efficient in working because they have a thermodynamic cycle, which operates between the wasted heat temperature that comes from the condensers and the high firing temperature that comes from the gas turbine.

The M701F Special Gas Turbines

The special M701F gas turbines supplied by MHI feature a unique stacked disc-type rotor, a cold end drive, a cannular-type combustor, a four-stage reaction turbine, a two-bearing supported rotor, and a tangential strut design. These special "F" series of gas turbines were developed in the late years of the 1980s, and their initial research on the related advanced technologies started at the MHI's Takasago Research and Development (R&D) centre.

The compressor shaft of these "F" series gas turbines has radial pins at the surface of the disc contact. These pins ensure proper transfer of torque and also prevent disc slippage, if any. The rotating blade is detachable and can be easily removed without the rotor being disassembled. The later stages of the compressor and the turbine are designed with inner casings to provide ideal and perfect tip clearances. The dissipated heat from the cooler is recovered effectively as fuel in order to obtain much better thermal efficiency. This rotor cooling air comes from the compressor discharge and is then cooled in cooler based externally.

Delay in Operations

The delay in operations of the Cilegon gas turbine combined-cycle (GTCC) power plant took place because of many reasons. The main reasons comprised disturbance in the gas supply from the Pabelokan gas station located in the Banten province. This gas disturbance took place in the midst of a routine maintenance check that was conducted by CNOOC, the regular supplier of the Cilegon gas.

According to the initial contract that was signed, the Cilegon gas turbine combined-cycle (GTCC) power plant should have received a total gas supply of about 85 million cubic feet per day (mmcfd) to 125 mmcfd. However, the contract did not proceed as planned and the Cilegon gas turbine combined-cycle (GTCC) power plant received only about 40 mmcfd of the gas.

This unpredictable disturbance in the gas supply affected the operations at the Cilegon gas turbine combined-cycle (GTCC) power plant adversely and the plant was not able to work at its full potential and generate maximum output. As per the initial schedule, Cilegon was to supply a total of 240 megawatt of electricity starting from the month of November in 2006 and this level was to rise to about 420 megawatt by the month of February in 2007, to further 740 megawatt by April 2007. However, none of this was made possible and this gas shortfall resulted in the Cilegon gas turbine combined-cycle (GTCC) power plant generating only about 50 megawatt of electricity.

However, the Cilegon gas turbine combined-cycle (GTCC) power plant slowly took its form and started yielding electricity generated close to what it was expected to yield. The company PT.PLN finally reported in one of its public appearances that the eventual operations at the Cilegon gas turbine combined-cycle (GTCC) power plant has significantly helped PT.PLN to come out of its losses that it had incurred during the times of disturbances and disruptions in the supply of gas to the Cilegon gas turbine combined-cycle (GTCC) power plant. The company said that the losses that the company had incurred because of this reason had doubled in the year 2005; however, regular operations at the Cilegon gas turbine combined-cycle (GTCC) power plant now have helped the company to bring those losses down by considerable numbers. In addition to the irregularity in the

supply of gas, the other reason that brought these losses to PT. PLN was the globally high, sky-shooting prices of crude oil that had crossed a mark of almost $74 per barrel.