ECOENERGÍA: COMBINED CYCLE ASSOCIATED TO A GAS PIPELINE COMPRESSOR STATION IN ARGENTINA

Rodolfo Moraga, Hector Frare – Petrobras Argentina SA,
Benjamín Guzmán, Claudia Trichilo, Guillermo Zanzoterra, Luis Gavella,
Marcelo Cordoba – TGS, Argentina

1- Background

PETROBRAS ENERGÍA, the Argentine affiliate to the Brazilian Petrobras, is an integrated energy company that owns oil l& gas assets, refineries, petrochemicals and power plants in Argentina.
TGS is the largest gas Transmission Company in Argentina that owns and operates 9,000 Km and 720,000 HP Pipeline System, including almost 100 turbo compressor units.

In 2007, both Companies enter into a Joint Venture agreement in order to install a 14 MW combined cycle power plant based on a heat recovery steam generator associated to the exhaust gases of a Compressor Station General Cerri located near the City of Bahía Blanca in the Province of Buenos Aires.

In 2011, the plant, named Ecoenergía, was commissioned and currently is in operation delivering power to the National Grid.

In particular, this will lead to an increased energy efficiency of operations and will allow using zero-emission source of energy to displace fossil fuels used for internal energy needs as well as displace the fossil-fuel based power generation of the grid. Furthermore, this project is the first of its kind implementation of waste heat recovery for power generation in the gas transmission sector in Argentina and South-America. The project will provide a valuable operational and management experience for PESA and create a pilot that may be largely replicated at the corporate level.

The project activity will contribute to the sustainable development of Argentina by:

- reducing greenhouse gas emissions caused by the use of fossil fuels for electricity generation in Argentina;
- generating clean energy by using waste heat and a small amount of auxiliary fossil fuel, therefore saving the non-renewable hydrocarbon resources that otherwise would have been used to generate electricity;
- creating new jobs during the construction, operation and maintenance of the project. Once the project becomes operational, it will created 10 direct jobs and a similar quantity of indirect jobs
- contributing to establishing a new model of power generation based on the recovery and use of waste energy that could be replicated in other NG compression plants along the extensive NG pipeline system in Argentina and the region.

2- Feasibility of the used of cogeneration technologies in Pipeline Compressor Stations

The total fuel gas consumed by the Compressor Station reaches approximately 170.000.000 stm3 per year. Third part of the heat produced by the combustion is actually transformed into mechanical power to compress the gas trough the pipelines, while one of the other two third parts are released into the natural environment, flue gas, a waste by-product (at 450 °C), through the turbines exhaust stack.

The growing energy demand in the country is encouraging to seek new ideas for clean, efficient and economic electricity generation projects.

The aim was to recover the extra heat exhausted as waste by-product by compressor stations through the heat efficient and environmentally conscious process of cogeneration, generating power that could be delivered to the Grid, minimizing natural gas consumption in the process.

3- Methods

First step was to verify the technical feasibility of the project, studying the flue gas characteristics, available flow, exhaust temperature, gas turbine operation conditions, reduction on available power for gas compressor, water availability, etc. at each one of the Compressor Stations of the Natural Gas Transmission System.

Second step, the economic analysis was developed, looking at necessary investment for the required facilities, electricity customer's proximity, market prices, etc in each case.

After the first compressor station was selected, a detailed analysis was carried on for Fiat Cerri Compressor Station. The process gathers the flue gas exhausted through the stacks of the three turbocompressors installed at the Compressor Station and generates steam in a heat recovery generator. The steam is finally expanded in a steam turbine and used to generate electricity.

4- Results

The compressor station selected consists of three turbocompressors that, due to the ageing, has a low thermal efficiency, making them a good option to a hot exhaust gases recovery project that captures them to produce superheated steam.

Each of these turbines is rated at 6,000 HP ISO and the compressor station is practically always running at full load, except for maintenance periods.

In order to make a comprehensive description of the whole process, a thermal balance scheme is included.

The system is divided into three main sections:

1- Diverter system: the flue gas flow is guided through a diverter system, consisting of three different conducts, one from each turbocompressor that gathers the exhaust gases to a unique boiler.
2- One 14 Mw turbogenerator that is driven by a steam turbine. The superheated steam is produced at 30 bar-a and 400°C in a unique boiler where the flue gas of the three turbocompressors is guided. The 64.7 Tn/h of vapor produced is headed to the steam turbine where it is expanded to a vacuum pressure value of 0.1 bar-a that drives the turbogenerator to produce electricity.
3- Auxiliary systems: condenser, economizer, refrigeration systems, pumps, etc.

One of the main requirements of the project was not to introduce a big reduction of available power for the transportation system. The installation of the diverter system, produces an additional back pressure to the natural gas turbine exhaust that reduces the available power that could be used for the compression process. This must be one of the considerations to be taken into account in the boiler engineering design.

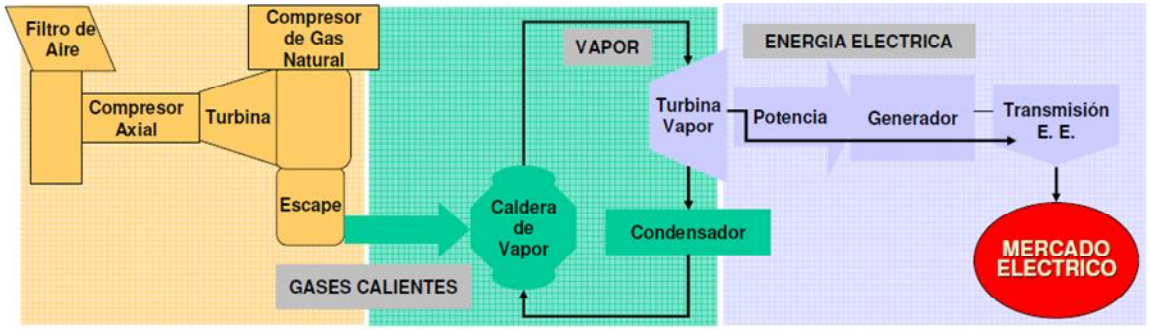
The system is completed with the alternative of fuel gas combustion, to complete the steam generation during turbocompressors out of service maintenance periods.

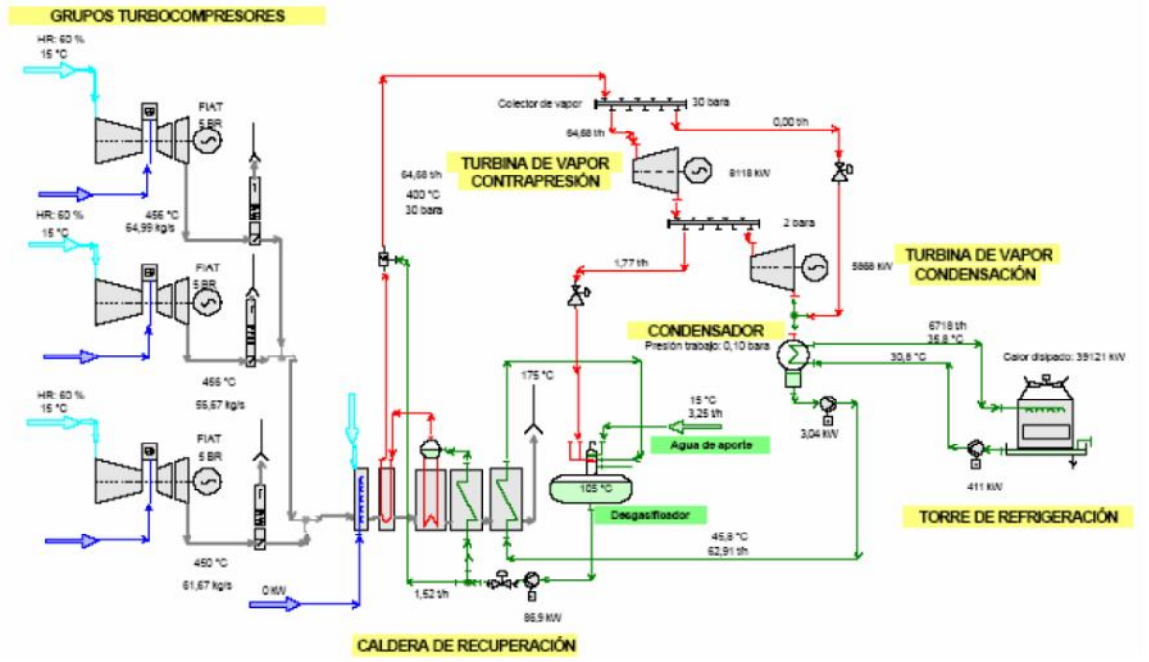
~~6~~Summary

All compressor stations in a gas pipeline system emit a certain amount of heat during compression process that can be captured for electricity generation purposes. A heat recovery steam generator allows you to simultaneously apply pressure to natural gas in a transportation system and generate electricity.

Main requirements for an economically efficient project:

1- It is recommended that the selected compression station operates at a high load rate, otherwise supplementary fuel gas should be needed to achieve power commitments.
2- The selected compression station needs not to be required at it maximum power availability, as to be able to handle a certain reduction due to the additional back pressure in the exhaust system.
3- Water availability at site is needed as one of the main incomes of the process. Water treatment is required.
4- Electricity Grid proximity is necessary to assure an easy access to the market, otherwise, a greater investment will be needed.


Filtro de Aire
Compresor de Gas Natural
Compresor Axial
Turbina
Escape
GASES CALIENTES
Caldera de Vapor
VAPOR
Turbina Vapor
ENERGIA ELECTRICA
Potencia
Generador
Transmisión E. E.
Condensador
MERCADO ELECTRICO


GRUPOS TURBOCOMPRESORES
HR: 60 %
15 °C
FIAT
5 BR
456 °C
64,99 kg/s
466 °C
55,67 kg/s
460 °C
61,67 kg/s
0 kW
Colector de vapor
30 bara
64,68 t/h
0,00 t/h
TURBINA DE VAPOR CONTRAPRESIÓN
64,68 t/h
400 °C
30 bara
8118 kW
2 bara
1,77 t/h
5868 kW
TURBINA DE VAPOR CONDENSACIÓN
CONDENSADOR
Presión trabajo: 0,10 bara
6718 t/h
35,8 °C
30,8 °C
Calor disipado: 39121 kW
3,04 kW
411 kW
175 °C
15 °C
3,25 t/h
Agua de aporte
105 °C
Desgasificador
45,8 °C
62,91 t/h
1,52 t/h
86,9 kW
TORRE DE REFRIGERACIÓN
CALDERA DE RECUPERACIÓN