Dilemmas over industrial power engineering – Combined Heat and Power Plant in Azoty Tarnów

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Power engineering in Zakłady Azotowe in Tarnów-Mościce has more than 83 years of tradition. The construction of the power plant for the needs of the State Works of Nitrogen Compounds in Mościce (PFZA - Państwowe Zakłady Związków Azotowych w Mościcach) with the capacity of more than 30 MW began in May 1928; it was commissioned in October 1929. The combined heat and power plant No. 2 was built in the years 1955÷1967 in connection with the expansion of the State Works. In the 1970s, the Combined Heat and Power Plant No. 1 was shut down.

The Combined Heat and Power Plant Centre, placed in the company structure, is responsible for power engineering in Azoty Tarnów. The present combined heat and power plant was built 55 years ago and it operates with the installed capacity of 96.8 MW. It generates 100% of heat in process steam at a pressure of 1.7 MPa, 0.9 MPa, 4.0 MPa and heating water, and ca. 85% of electricity for the needs of production lines. The Combined Heat and Power Plant uses four boilers: two pulverized-fuels boilers TP 170 and OP 230, one fluid boiler OPF 230 and one gas boiler TPG 170 as well as four turbines: two pass-out and condensing turbines WPT 25, and two pass-out and backpressure turbines LANG. The Combined Heat and Power Plant produces heat and electricity from cogeneration providing the possibility for reducing fresh steam in reduction stations.

The fundamental task of the Combined Heat and Power Plant is to provide continuity and reliability of heat and electricity supplies for the production and maintenance needs of the Nitrogen Plant and tariff needs of external consumers. The Combined Heat and Power Plant is operating in the manifold system at a side of feed water, fresh steam and process steam.

Pic. 1. Combined Heat and Power Plant

Rated output of four boilers is 800 t/h of steam-gas production having a temperature of 510°C and a pressure of 10 MPa. The steam feeds a main steam pipeline, from which it is delivered to turbines and reduction stations.

Hard coal – small coal IIA is basic fuel for boilers and sieved coal for the boiler K-4, whereas natural gas/methane is basic fuel for the boiler No. 1. Because of high gas prices, the boiler No. 1 is a stand-by boiler now. Additionally, (gas and liquid) fuels originating from the production line technology in the company are combusted in the boilers. Coal is delivered to the Combined Heat and Power Plant by means of rail transport. Coal is stored in a warehouse enabling the maintenance of reserves. Auxiliary fuel (mazout) is used to fire out boilers. Each coal boiler is equipped with a high-performance electrostatic precipitator to reduce dust emission to the atmosphere. Flue gases from the boilers No. 1 and 3 are introduced to the air by the chimney No. 1, and flue gases from the boilers No. 4 and 5 are introduced to the air by the chimney No. 2.

Water is delivered gravitationally to the Combined Heat and Power Plant from sedimentation tanks supplied from the Danube River. The Combined Heat and Power Plant is operating in a closed circuit, water from condensers is cooled in two cooling towers, each with the capacity of 5000 m^3/h. The Combined Heat and Power Plant has its own water purification plant with the rated output of 480 m^3/h and demineralised water constant efficiency of 360 m^3/h. It satisfies the Combined Heat and Power Plant internal purposes. Processes steam at 0.9 MPa and 1.7 MPa is produced simultaneously with electricity or, in case of emergency cases, in reduction stations; whereas steam at 4.0 MPa is generated in the reduction station.

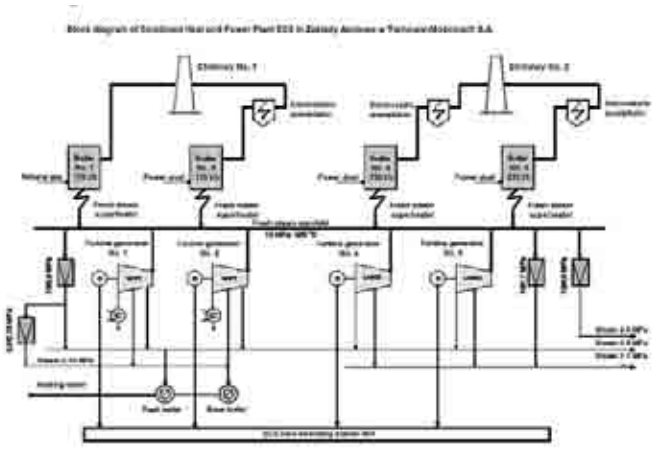

Fig. 1. Block diagram of Combined Heat and Power Plant EC2 in Azoty Tarnów S.A.

Electricity in the condensing part is produced by pass-out and condensing turbines

No. 1 and 2; combined production of electricity and process steam at 0.9 MPa can be obtained from all turbine sets, while with process steam at 1.7 MPa it can be obtained from pass-out and backpressure turbines No. 4 and 5.

Regarding electric power generation, the Combined Heat and Power Plant Centre is also in charge of electric power system operation, purchase and resale of electricity.

Electricity distribution in Zakłady Azotowe in Tarnów-Mościce is based on 6kV cable system. It refers to both the system for the Combined Heat and Power Plant internal purpose and Azoty Tarnów distribution network. Electric power needs of the company are provided by the combined heat and power plant in-house production and electricity purchase from 110 kV and 220 kV transmission grid through interbusbar transformers.

Electricity is distributed into particular production plants through 6 and 0.4 kV distribution cable networks with a total length of ca. 200 km.

In terms of the Energy Regulatory Office, it is obligatory for the Combined Heat and Power Plant Centre activity to obtain and adhere to energy concession requirements, to have electricity tariffs approved and to meet the requirements of a Distribution System Operator. A versatile scope of actions for the mentioned administrative acts requires an efficient management of energy area supported by a vast knowledge of the CHP Centre staff and employees.

For many years, the CHP Centre, first as the Nitrogen Plant and currently as a power engineering company, has been generating heating water and offering the delivery of electricity for Tarnów-Mościce district. The service is offered at the highest quality providing equality and non-discrimination towards the consumers.

The CHP Centre acts in a responsible manner respecting the principles of sustainable development with a special emphasis on the environmental responsibility and efficiency.

The pro-ecological investments realised for many years reflect the care of the surrounding natural environment. Financial resources are also poured into the activity of social responsibility which is mainly based on minimising the effects of industrial activity.

The actions related to the reduction of CO_2 emission are particularly important for the CHP Centre. In the past, it was achieved by biomass combustion, and currently it is obtained by increasing the process efficiency and decreasing the own needs of the company. The production costs of energy carriers can be lowered by reducing the emission.

Pic. 2. Engine room

The CHP Centre conducts regular measurements of pollution emissions in line with the regulatory requirements for air purity.

In previous years, similarly as nowadays, Azoty Tarnów was investing in the modernisation using pro-ecological technologies, which is particularly meaningful for preserving the natural environment for future generations. These investments included the modernisation of the Water Purification Plant, thorough modernisations of the boilers No. 1 and 4 and complete overhauls of the electrostatic precipitators.

The performed modernisations resulted in considerable reduction in pollutant emissions; dust removal efficiency increased to 99.88% due to the complete overhauls of the electrostatic precipitators.

In the years 1998÷2001, a large investment in the Water Purification Plant was performed which consisted in enhancing demineralised water parameters to the level providing a minimised level of boiler failures. Practically no failures related to the leakage of radiant tubes occur because of avoiding the formation of boiler scale.

In 1995, an innovative HUS technology-based (hybrid combustion system) modernisation of the coal-fired boiler No. 4 was performed in the Combined Heat and Power Plant with the involvement of the Research Institute for Electric Power Company – VEIKI from Budapest and AES-Atomenergoservis. Its purpose was to reduce nitrogen oxides and sulphur dioxide.

For the purposes of reducing nitrogen oxides, low emission burners were installed in the boilers No. 3 and 5 by Ecoenergia.

The pro-ecological modernisation, performed by Foster Wheeler Energy Fakop in 1998, consisted in adapting the boiler No. 1 for the combustion of natural gas instead of small coal was a next step towards reducing the environmental pollution.

Nowadays, the facilities of the Combined Heat and Power Plant entirely meet the requirements of the regulations on ecology. The production of energy carriers is characterised by high efficiency and effectiveness. A significant amount of heat is simultaneously produced with electricity to a level which enables heat to be classified as heat suitable for obtaining certificates of origin, so called red certificates. The combined production process of electricity and heat uses chemical energy of fuel more efficiently and simultaneously reduces the impact on the natural environment. The main task of the Combined Heat and Power Plant Centre is to maintain and improve the competitiveness of produced heat and electricity.

Production units operating in the combined heat and power plant were subjected to technical evaluation and prognosis on production capacities and cost escalation. The evaluation of a present technical state determines the operational potential of the Combined Heat and Power Plant until 2025. Strategic operational trends of the Combined Heat and Power Plant come down to the performance of current repairs, the improvement of energy security, the enhancement of possibilities for realising production potential and the adjustment of the combined heat and power plant to meet the environmental regulations that will be effective after 2015.

Azoty Tarnów was also analysing a possible construction of a gas-steam block. However, the analyses demonstrated that it was more profitable to continue coal-fired generation regarding such aspects as prices of coal, natural gas, electricity and instability of legal regulations in a field of supporting gas co-generation and unpredictable costs of purchasing CO_2 emission rights. For the present demand for energy, the difference in costs is significant when two energy sources - coal and gas, are compared. In addition, the technical state of the operating combined heat and power plant is satisfactory, which has finally affected the decision of the plant to continue coal-fired generation.

Nowadays, the works in Azoty Tarnów are focused on three important projects: assembly of low-pressure turbine and ecological installation, and the installation for ash recovery from electrostatic precipitators being in a start-up phase.

A completed task of the low-pressure turbine assembly will result in the additional loading of currently operating back-pressure turbines and existing boilers, and it will be also possible to improve

energy security, particularly in a field of process steam generation, and satisfy the total company demand for electricity from its own combined heat and power plant.

The combined heat and power plant will be equipped with modern ecological installations for desulphurisation and denitrification of flue gases from the boilers by the end of 2015. The assembly of an installation using technologies of flue gas desulphurisation wet process and catalytic denitrification is being considered. In case of ammonia and magnesium-based desulphurisation technology, it is possible to use synergy based on using waste from desulphurisation installation for fertiliser production.

Pic. 3. Installation of dry ash collection

Because costs of storing ash from pulverized-fuel boilers are considerable, a decision on their collecting in a dry form and economic use by external companies was made. Such an action would also reduce the impact of Azoty Tarnów on the natural environment. This investment adapts Azoty Tarnów to the requirements of the community law which, inter alia, enforces the necessity of preventing or reducing waste production and their harmfulness, as well as waste recovery by means of recycling or reuse. The realised investment was co-financed from the European Union aid measures of the European Regional Development Fund as a result of signing a contract with the National Fund of Environmental Protection and Water Management.

A design of technological line included a non-failure transport of ash to retention tanks and safe loading of ash into means of rail and road transport. Considering ash composition, it is collected from the boilers No. 3 and 5 to two storage tanks through two pneumatic lines, and from the boiler No. 4 to a third tank through one pneumatic line. The volume of each tank is 600 m^3. Ash from the electrostatic precipitators is collected in intermediate tanks, from which it is periodically fed to a chamber feeder, and then pumped to transport lines. The installation is equipped with checking and measuring apparatus for checking individual process stages of ash collecting, transporting and storing.

Azoty Tarnów has decided to conduct energy efficiency improvement programme known as "white energy" which refers to the Energy Efficiency Act of 15 April 2011.

On the basis of previously performed and planned audits of production plants, the actions characterised by a high index of the simplest payback time is anticipated to be implemented. These actions will refer to the modernisation of steam networks, lightning, replacement of engines, construction of frequency converters, replacement of pump sets and fans.

The program of fast payback investments has been implemented for a few years. The energy-saving investment tasks such as the construction of feed pumps with hydrodynamic couplings or the construction of inverters are also implemented.

The investment actions on the reconstruction of the company electric power system at a voltage of 110 kV along with the modernisation of measurement and settlement systems and a regular complex modernisation of feeders and outlet cabinets in 6 kV switching stations have been undertaken on the basis of conclusions drawn from the studies on the modernisation plans for EC2.

The Combined Heat and Power Plant Centre has been cooperating with the following companies and universities: Alstom Power Sp. z o. o., Simens Sp. z o. o., the Silesian University of Technology, AGH University of Science and Technology, Abener Energoprojekt Gliwice S.A. and Elektroprojekt S.A. Gliwice. The cooperation with the universities also provides the opportunities for students to write their diploma theses related to the activities of the Combined Heat and Power Plant Centre.

The improvement in energy security and flexible delivery of energy carriers for the company production plants in 2025 perspective will be achieved due to the realisation of the planned investment actions.

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