THE MEASURES OF ENERGY EFFICIENCY IN NATRON-HAYAT MAGLAJ

Nusret Imamović
The University of Zenica, Faculty of Mechanical Engineering
Zenica, B&H

Armina Čamić, Haris Lepić
Natron-Hayat d.o.o.
Maglaj, B&H

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ABSTRACT
In industries such as the chemical industry, the oil industry, the steel industry, and the pulp and paper industry, energy systems are the basis of the production process and represent key indicators of the profitability of the process. Energy efficiency in industry is long-term related to technological development and the dynamics of renewal of production capacities. Increasing energy efficiency in the industry leads to a reduction in energy consumption but also reduces the negative impact on the environment. The rise in energy prices, both electricity and other energy sources, and the development of fees for emissions into the environment will mean important economic incentives in efforts to reduce energy consumption and emissions, thus increasing efficiency and the use of renewable sources in the industry. The paper presents several measures that achieve fuel, energy, and air savings in Natron-Hayat Maglaj.

1. ENERGY EFFICIENCY

Energy efficiency measures are actions taken to reduce energy consumption, getting the same or even better energy service level, but at the same time using the same or less energy. So, improving energy efficiency means avoiding/reducing energy losses without impairing comfort, the standard of living, or economic activity and can be realized both in the field of production and in the field of energy consumption [1,2]. The industrial sector in BiH has great potential for improving energy efficiency (EE) since, in most industrial plants, production is based on several decades-old technologies [1].

2. EXAMPLES OF MEASURES TO IMPROVE ENERGY EFFICIENCY IN NATRON-HAYAT MAGLAJ

Natron-Hayat is working continuously on improving energy efficiency (EE) in the production processes according to Energy Standard documentation ISO 50001 and literature [3,4]. This is provided through the set of company measures and activities with an ultimate goal of minimizing energy consumption, but remaining the same or improving productivity.

Further are shown some examples of energy savings in Natron-Hayat according to the suggestion of literature [2].

2.1. Utilization of waste heat oil cooling of screw compressors in Natron-Hayat - Recuperation

Only about 5% of the total energy supplied to the compressor is used to raise the air pressure. The remaining energy is present in the compressor in the form of heat. A large part of this heat (85-95%) is removed via compressor cooling water and lubricating oil. It is possible to achieve considerable savings by constructing an optimized heat recovery system. With air-cooled compressors, the available heat is hot air at 50-60°C, and with water-cooled compressors, the water that can be used for recuperation is at the temperature of 90-95°C. The waste heat of the compressor can be used satisfactorily for heating, drying, and preheating of combustion air, as well as for the preparation of hot process water [2].

There are five Kaeser rotary screw compressors installed in the compressed air area used to supply compressed air in Natron-Hayat Maglaj [5]. The system for compressors' waste heat energy recovery is designed in such a manner that heat is transferred from the cooling medium of compressors to demineralized water used for the feedwater tank in Energana II replenishing. Demineralized water is pumped from two tanks each of them 500 m^3 in volume.

Also, the heat recovery system of rotary screw compressors is automated to the required level, so the recovery system easily adapts to expected changes in system operation and achieves full efficiency in each operating mode without manual manipulation. The use of waste heat from rotary screw compressors is realized in two separate circuit exchangers, namely:

- The primary circuit where the heat from the compressors' oil is transferred to the working fluid (condensate) via the heat exchanger;
- The secondary circuit where the working fluid transfers the heat to the demineralized water used to replenish the supply tank;

Annual heat production expressed in MJ of installed Kaiser Compressors in Natron-Hayat is:

$$Q_{MJ/year} = 17{,}853{,}376.16 \text{ MJ/ann}$$

The recovery heat energy will be manifested through a reduction in 3.5 bar(g) steam consumption used for the boiler feed water heating, as a direct effect of the compressors' area recovery heat energy system operation, so we will show it through the saved amount of 3.5 bar(g) steam. So, the saved amount of steam for heating the feed water is

$$Q_{3.5\ bar} = 6{,}245.80 \text{ t/ann}$$

2.2. Analysis of system performance improvements and energy efficiency of the new method for control of pump operation in Natron-Hayat Maglaj

The pulp after the cooking process goes into the Blow tank (1,000 m^3). Pump "P002" is used to transport pulp with 4% consistency from the Blow tank to the primary knot separator. The control system of this pump runs with an electric motor as a drive is regulated through the pressure. This pressure is measured at the inlet to the centrifugal separator and represents feedback in the control loop. Control is performed in such a way that the desired pressure is achieved by damping the valve installed in the discharge pipeline. The default value is set to 2.2 bar and corresponds to a valve opening of approx. 40%. In this case, the motor always rotates at a constant rated speed, and the desired pressure at the separator inlet is adjusted by opening/closing the valve. In short, the new way of controlling this electric motor drive involves regulating the pressure at the entrance to the separator by changing the rotation speed of the electric motor drive, instead of damping the valve. Based on the analysis and comparison, exact indicators of electricity savings were obtained. In addition to energy savings, a couple of additional issues were achieved; a reduction of CO_2 emissions, an improvement in the system operation stability, and easier management and maintenance of the desired parameters. As already mentioned, the consumption of electricity varies with the change of system parameters so the saving of electricity also varies from 206-309 MWh/ann.

2.3. Waste heat recovery of boilers' blowdowns in Natron-Hayat

In the process of operation of boilers, it is necessary to carry out continuous blowdown - desalination from boiler drums. In practice, this is called "constant boiler blowdown", and its amount is variable depending on the conductivity of the boiler water measured on the blowdown sample. Constant blowdown of the boiler drum drains a certain amount of water from the level where the water and steam meet each other, i.e. from the position where soluble salts float and their concentration is gradually increased by continuous water evaporation. Before the EE measure was implemented, the blowdown water from the boiler drums was discharged into an expansion vessel (atmospheric type), where it expanded and separated into two phases: the water phase and the steam phase - evaporation. The vapor from the expansion vessel was discharged directly into the atmosphere, and the liquid phase in the expander was cooled by direct mixing with mill water, and as such is discharged into the wastewater channel. Therefore, all the blowdown water from the boiler, i.e. the thermal energy contained in it, was irretrievably lost, along with the additional consumption of cooling mill water used for blowdown cooling. Since the blowdown water carries a certain content of impurities, it must be thrown into the wastewater channel as such, but the energy it carries with it can be used and returned to the process. The evaporated part of the blowdown that is separated in the expander does not contain impurities and as such can be directly returned to the process. The idea is to use this evaporated part of the blowdown to heat the boiler feed water in the feed tank, where normally the steam taken from the turbine at a pressure of 3.5 bar(g) is used. Using steam from the expander in this way directly reduces the consumption of 3.5 bar(g) of steam, that is, part of the energy that is currently lost is used. It is necessary to ensure with a technical solution that the pressure in the expander is at least 3.5 bar(g), so the vapor from the expander can be used altogether with extraction steam in heating the boiler feed water in the feed tank. The liquid phase of blowdown in the expander is "dirty water", and the only way to use it is to extract thermal energy through a heat exchanger before it is discharged into the wastewater channel. The process of using this thermal energy will be carried out in two steps - degrees, namely: The first-stage heat exchanger will take the heat from the blowdown water and transfer it to the turbine condensate, which returns from the turbine condenser to the feed tank [6]. The turbine condensate temperature ranges from 33 °C (winter) to 55 °C (summer), which is the actual process data; Heat exchanger 2nd stage will take the remaining heat from the blowdown water (after passing through the 1st stage) and deliver it to the demi-water used to replenish the boiler feed tank. The temperature of demi-water ranges from 5 °C (winter) to 30 °C (summer), determined on the basis of real data (local environmental dates). In this way, the liquid phase of the blowdown water will be cooled to the desired 35 °C, with a minimum consumption of demi water, the amount of which is limited. The technical solution enables fully automatic operation of the system for the utilization of waste heat of blowdown, and automatic adaptation to changes that occur in the process (change in the amount of boiler blowdown, change in the amount of turbine condensate, etc.). Recovery of thermal heat energy with boilers blowdown system, for an average descaling of 3.5 t/h for each of the two boilers.

This thermal energy amounts:

$$Q = 2{,}164.1\ kW$$

Energy absorbed from the system of heat recovery of blowdown on an annual basis:

$$Q_{ann} = 17.399.364\ kWh/ann$$

Expressed in MJ:

$$Q_{MJann} = 62.637.710{,}40\ MJ/ann$$

The used energy will be manifested through a reduction in steam consumption of 3.5 bar(g) for heating the boiler feed water, as a direct effect of the operation of the system for recovery of waste heat from boiler blowdown, so it will show that through the saved amount of steam 3.5 bar(g) per year.
So, the amount of saved steam for heating the feed water is:

$$Q_{3,5bar} = 21{,}913.09\ t/ann$$

2.4. Energy production from biomass in Natron-Hayat

The power plan named "Energana 1" as a part of the energy department in Natron-Hayat consists of a biomass boiler "BB-2" and condensing steam turbine with one controlled steam extraction is presented in Table 1.

Table 1. Design features of biomass boiler BB-2 Natron-Hayat

Boiler type	Two-drums with natural circulation
Maximum permanent boiler capacity	35 ton/h
Minimum permanent boiler capacity	12 ton/h
Pressure: Working/ Projected/ Tested	62 bar/ 68bar/ 93 bar
Outlet steam temperature	460°C
Boiler efficiency	82,5% (with 75-100% load)
Fuel	Biomass

The boiler is a two-drum type with natural circulation, designed for burning wood biomass, mainly conifer bark, which is a by-product of the pulp production process. The fuel is mechanically separated and chopped to the designed granulation d_e100 (equivalent diameter; in Austrian biomass standard "Onorm 20"- in the biomass preparation plant). The biomass is then transported to a daily biomass storage facility with a capacity of 1,000 m^3. From this storage, biomass is delivered to the boiler bunkers and from the bunkers is dosed into the combustion chamber, i.e. on the moving fire grid, which consists of five zones (first grid - drying and heating of fuel; second grid - first fuel combustion zone (ignition); third grid - fuel combustion zone (outgassing); fourth grid - fuel combustion zone (afterburning) and fifth grate - ash and slag removal zone). The combustion chamber is designed to burn wood biomass with a moisture content of up to 50%. The expected working combustion temperature is 750 to 1,100°C. The combustion chamber is closed by membrane walls composed of screen tubes. A steam superheater is installed at the exit of flue gases from the combustion chamber. Next comes the multi-cyclone, economizer, air heater, and electrostatic precipitator for good environmental standards (in the Federation of Bosnia and Herzegovina).
Fresh steam enters the turbine through a fresh steam valve connected to the inlet casing. The HP steam is distributed through throttling valves located on the inlet casing, which control the steam inlet to the first-stage nozzle groups depending on the turbine load. They are driven by a Voith actuator. Steam is continuing its path through the system of

nozzles, vanes, and blades releasing most of its energy to the turbine shaft rotating also the generator rotor. The steam turbine has the possibility of controlled steam extraction at the pressure of 4.5 bar(s) for the technological needs of production facilities. The amount of steam to be removed is regulated by the position of the LP valve, which is driven by a servo motor. The remaining steam flows towards the low-pressure side and enters the condenser where it condenses. In the condenser, there is a negative pressure provided by a steam ejector. Condensate is directed by condensate pumps to the supply tank or the mill condensate collector. The condenser is cooled by cooling water, provided by the cooling tower's closed circulation. All the necessary parameters of the turbo generator unit are given in Table 2.

Table 2. Design features of steam turbo generator "TG-4"

Turbine type	Condensing with controlled steam extraction
Maximum generator power	8.1 MW
Maximum fresh steam entering	35 ton/h
Design steam extraction flow	0 – 25 t/h
Fresh steam pressure	61 bar(a)
Fresh steam temperature	460°C
Steam extraction pressure	4.5 bar(a)
Exhaust steam pressure	0.08 bar(a)
Maximum steam condensing capacity	30 t/h

3. CONCLUSION

The pulp and paper industry is an intensive consumer of energy. The main factors affecting specific energy consumption per unit of output are:

- The part of the production of high-quality products requiring higher energy consumption;
- The part of waste recycling in the technological production process, which reduces the consumption of input raw materials and energy consumption;
- Degree of processing of waste materials from the technological process, which affects increased energy consumption;
- Structure, supervision, and way of managing own energy plant;

Measures to improve energy efficiency, the use of renewable energy sources, and environmental protection are constant and continuous processes at Natron - Hayat. There is a long list of successfully implemented projects, and it should certainly be highlighted that 7 years ago the largest biomass cogeneration plant in Bosnia and Herzegovina was put into operation in Natron - Hayat - a steam boiler of 35 MWth and a steam turbine with regulated steam extraction of 8.1 MWe. The company also showed its responsibility towards the environment in 2015 when, as the only industrial power plant in Bosnia and Herzegovina, it was accepted to be part of the National Emission Reduction Plan (NERP). This company has implemented several important international standards in its operations. The most important among them are ISO 9001, ISO 14001, FSC, ISO 50001 [7], ISO 45001, and ISO 31000. By implementing a minimum number of measures in the function of increasing energy efficiency, as shown in the examples in Natron-Hayat in Maglaj city, significant savings were achieved, which represents a very significant item that, with the implementation and energy efficiency measures in buildings, represents a significant impulse in increasing the profitability and competitiveness of the company itself. The waste heat of the compressor can be used satisfactorily for heating, drying, and preheating of combustion air, as well as for the preparation of hot process water. The recovery heat energy will be manifested through a reduction in 3.5 bar(g) steam consumption used for the boiler feed water heating. Better energy management and investment in cost-effective energy efficiency measures can save up to 20% of the energy bill. Therefore, the Natron-Hayat company has recognized the importance of introducing ISO 50001, which enables a set of energy-related goals to be systematically set, thus achieving significant energy savings. The main measure of system performance success is obtained by analyzing energy efficiency indicators. According to data from 2020, about 17 certificates were issued in Bosnia and Herzegovina, and that number is growing. Based on the report of the ISO organization, the number of introduced ISO 50001 in the industry of pulp, paper and paper products is 172, which is another proof that the company Natron-Hayat Maglaj works as professionally as possible and according to all standards.

4. REFERENCES

[1] Harbaš N.: Projekti povećanja energijske efikasnosti u industriji BiH kao odgovor na COVID19 M-kvadrat, 2020 dostupno na: https://m-kvadrat.ba/projekti-povecanja-energijske-efikasnosti-kao-odgovor-na-covid19/, [12.03.2022.]

[2] Fawkes S., Oung K., Thrope D.: Best Practices and Case Studies for Industrial Energy Efficiency Improvement – An Introduction for Policy Makers, Copenhagen Centre on Energy Efficiency UNEP DTU PartnershipISBN: 978-87-93130-81-4, 2016

[3] Gvozdenac D., Gvozdenac-Urošević B., Morvaj Z.: Energetska efikasnost (put ka dekarboniziranom društvu), Fakultet tehničkih nauka, Novi Sad, 2021.

[4] Reference Document on Best Available Techniques for Energy Efficiency, European Commission, February 2009

[5] Projekat za iskorištenje otpadne toplote vijčanih kompresora, IBE d.d, Magaj, 2019.

[6] Neimarlija N.: Energetski sistemi, IPI d.o.o. Zenica, 2017.

[7] Šemić I.: Sistemi energetskog upravljanja: Tumačenje zahtjeva standarda ISO 50001:2018, Edukativni materijal za učesnike edukacije u kompaniji Natron-Hayat, Maglaj, 20