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PROPOSAL OF THE UTILIZATION OF WASTE HEAT FROM IRON & STEEL METALLURGICAL CONCERN SARTID A.D. FOR A DISTRICT HEATING OF SMEDEREVO TOWN

PREDLOG KORIŠĆENJA OTPADNE TOPLOTE IZ KONCERNA METALURGIJE GVOŽĐA I ČELIKA ZA DALJINSKO GREJANJE SMEDEREVA

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ABSTRACT

Sartid a.d. is a metallurgical concern including Sintering Plant, Blast Furnace Plant, Steelmaking Plant, Hot and Cold Rolling Mills, with an annual production of 1,000,000 tons of steel, hot and cold rolled strips as its main products.

This paper describes the proposal of the use of waste heat from SARTID a.d. for a district heating of Smederevo town, and for technology and space heating of SARTID a.d. itself.

The uses of waste heat of the Sintering Plant (waste heat from the sinter cooling process), Steel making Plant (waste heat from converter gases cooling process) and Hot Rolling Mill (heat of delivery combustion output) are taken into consideration.

An annual average waste heat power, at rated steel production of 1,650,000 tpy, amounts about 65 MW (estimations are based on measurements). This capacity is sufficient for meeting the district heating needs of the town in supstantially heating season, and for technology and space heating of Sartiod a.d. When available amount of waste heat is not sufficient (because of less steel production, or too low external temperature), additional heat is delivered from SARTID a.d. Power Plant.

Construction and investment projects are completed, installation of main heat-trasnsport piping is started.

Key words: waste heat, steel plant, district heating

APSTRAKT

SARTID a.d. je metalski koncern koji ima sledeće pogone: Aglomeracija, Visoka peć, Čeličana, Hladna i Topla valjaonica. Godišnja proizvodnja koncerna je 1 milion tona čelika u obliku hladno i toplo valjanih limova.

U članku je prikazan predlog da se otpadna toplota iz pogona koristi za grejanje u SARTID-u, kao i za daljinsko grejanje grada Smedereva. Razmatranjem su obuhvaćene otpadne toplote iz pogona Aglomeracija (iz vazdušnog hlađenja sintera), otpadna toplota iz Čeličane (hlađenje konvertorskih gasova) i iz Tople valjaonice (otpadna toplota iz dimnih gasova potisne peći).

Na osnovu merenja je procenjeno da je za kapacitet od 1,65 miliona tona čelika godišnje na raspolaganju oko 65 MW otpadne toplote. Ova toplotna snaga može da zadovolji potrebe grejanja grada u prelaznim režimima grejanja, kao i potrebe SARTID.a u toplotnoj energiji za grejanje. Kada ova količina energije nije dovoljna (kod manje proizvodnje čelika, ili veoma niskih temperatura), ostatak energije obezbeđuje se iz Energane SARTID-a.

Urađeni su glavni i investicioni projekti, a započeta je i izgradnja toplovoda.

1. INTRODUCTION

Smederevo is an industrialized town with 100.000 inhabitants and it is one of bigger cities of FR of Serbia. Smederevo town, with approximately 20.500 apartements, didn't resolve a problem of centralized thermal energy supply, but it is performed individualy through small local heating systems. Mainly crude oil and gas are used in boiler houses as a fuel.

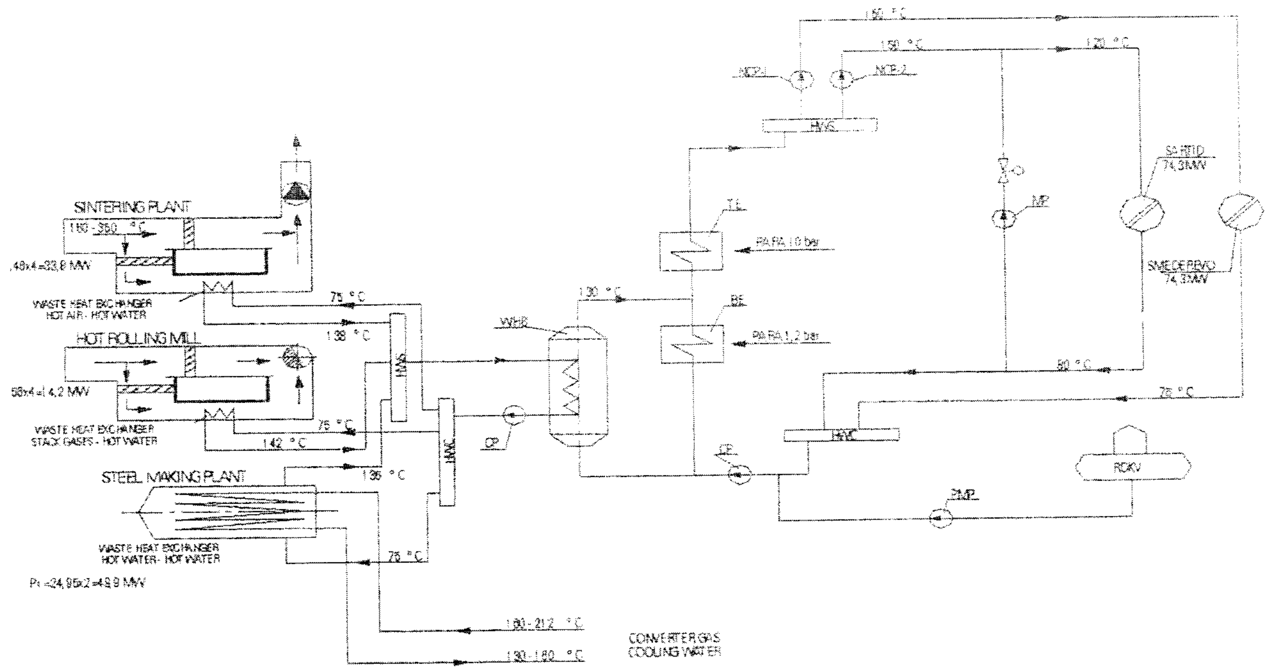
Available sources of waste energy from Sartid a.d. Concern are determined to be the base of resolving the space heating problem.

This idea is exterimely favorable, as a considerable amount of waste heat is produced in Sartid a.d. Concern, but up to the present, the same is not used. In a world-wide similar metallurgical complexes, the facilities for waste heat utilization are in operation for years. Bearing thus in mind, a special attention is devoted to the analysis of heat sources in the SARTID a.d. Concern. The waste heat produced in main parts of steel making process in normal operating conditions is sufficient for meeting the space heating needs of the town and there is the rest which could be used for SARTID a.d. technology and heating needs.

Only in the most unifavorable conditions, at the external temperature od – 11 ^{o}C, or in case of technology facilities' downtime, a heat production in Power Plant needs to be activated.

The system's waste heat is very cost-effective because of the fact that heat price is influenced only by the investment costs, while the operating costs are minimal.

Heat consumers in the town are connected to the heat source through the transportation system, including pumping house with a dispatching center, major hot water network and substations in the town.



Legend: WHB – waste heat bateries, BE – basic exchangers, TE – top echangers, NCPI – network circulation pumps of the town heating plant, NCP2 – network circulation pumps of the Sartid heating plant, MP – maxing pumps, HWS – hot water separator, HWC – hot water collector, CP – circulation pump, PMP – presure maintening pumps

Figure 1 – General scheme of the utilization of waste heat from Sartid a.d. Concern for a district heating of the Smederevo town

2. GENERAL SCHEME OF THE USE OF WASTE HEAT FROM IRON AND STEEL METALLURGICAL CONCERN SARTID AD FOR SPACE HEATING OF TOWN SMEDEREVO

Waste heat from production processes in SARTID a.d. has been permanentely lost, but it is planned to be used for a district heating of the Smederevo town, technology and space heating needs of SARTID a.d. complex. Water parameters of Secondary Heating Plant System are: temperature of 150/75°C, varying according to sliding diagram, and maximum pressure of 22,7 bar. The most distant consumers are located appr. 11 km from heating source. The Heat Plant pumping house is located within the SARTID a.d. Complex. In the scope of pumping house facility a dispatching center is planned for managing and monitoring of the whole Heating plant system of the Smederevo from Sartid a.d. Concern.

Atractive sources of waste heat for the I stage use to cover Heat Plant needs of Smederevo and a new sources of waste heat intended for the utization in the II stage are presented on the sheme in Figure 1.

The waste heat which will be used in the I stage is from:

- facilities for sinter cooling
- facilities for flue gases cooling of the Hot Rolling Mill pusher type furnace
- facilities for converter gases cooling of Steel Making Plant.

3. SARTID AD CONCERN PLANTS FROM WHICH THE WASTE HEAT IS USED

3.1 Sintering plant

One of the ore preparation stages is its sintering in sinter-machines. After primary mixing, ore is annealed in sinter-machines by combustion of coke fired by natural or mixed (blast furnace and natural) gas. The annealed sinter is further conduced to glass-like cooler up to temperature from 200 to 400 °C. The exhauste air temperature after cooler is variable and exclusively dependant on the sinter-machine operating mode and the amount of annealed sinter. The heated air is conducted from glass-like cooler to multicyclone battery where it is cleaned, and transported by a fan into the stack and exhausted to the atmosphere The scheme of the sintering plant is presented in Figure 2.

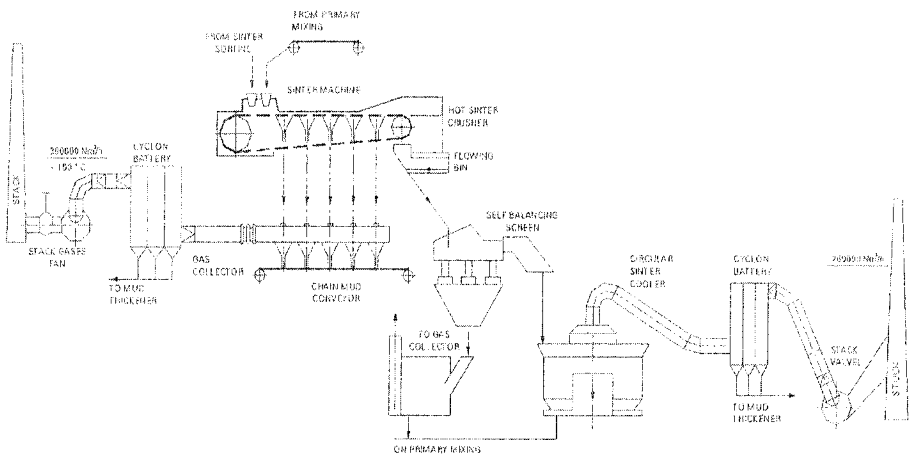


Figure 2 – Technology scheme of sintering plant facility

The average waste heat rate(Q) measured in time of the operation of two lines with glass-like cooler amounts 8,5 x 2 = 17 MW

On the basis of estimations of production breaks, the simultaneousness rate assessed at 0,75, so that:

$$Q_{sp} = Q \times 0{,}75 = 2 \times 8{,}5 \times 0{,}75 = 12{,}75\ MW$$

The existing technology process is not effected by technical solution of waste heat utilization. The possibility of the change of the sinter cooling system operation is shown in Figure 3.

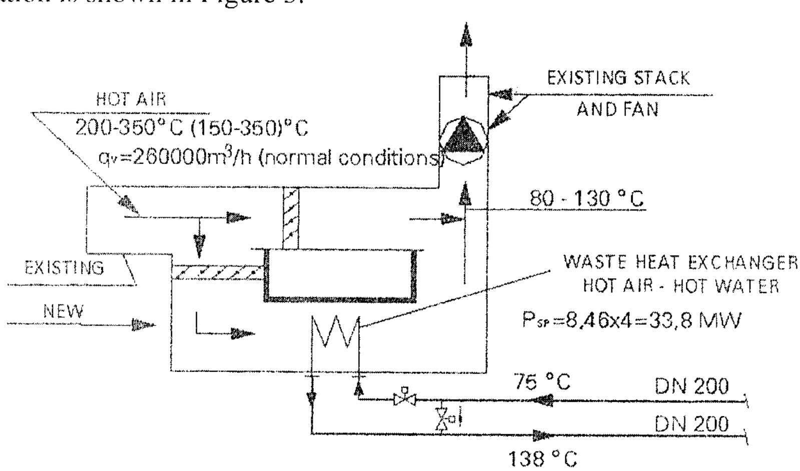


Figure 3 – Waste heat utilization in Sinter cooling facility –sintering plant (4 heat exchangers)

3.2. Steel making plant

The crude steel is produced in 100 t oxygen converters. The gas cooling system consists of three independent blocks, one by each converter. Each block comprises converter gases cooler (dust exhauster – VOKG), west gases purifying system (gas scrubber), drop separator and stack gases fan. Two converters of 100 t capacity are located in the plant, and the third is in stand-by or in the refractory repair. Combustion products of converter gases at temperature of 1700 °C are conducted through the water cooling pipe system (VOKG-85) and cooled at 1050 °C by delivering heat to the cooling water. They are washed and cooled in the scrubber and exhausted by the fan through the stack to the atmosphere.

The cooling water heats up to maximum 212 °C in the VOKG-85 cooling system and then it is conducted to the air cooler AVZ. When two converters are in operation available waste heat amounts:

$$Q = 24{,}95 \ x\ 2 = 49{,}9\ MW$$

On the basis of reviewed production breaks the simultaneousness and inequality rate is assessed at 0,85:

$$Q_s = Q\ x\ 0{,}85 = 2\ x\ 24{,}9\ x\ 0{,}85 = 42{,}5\ MW$$

The heating system for Steel making plant is shown in Figure 4.

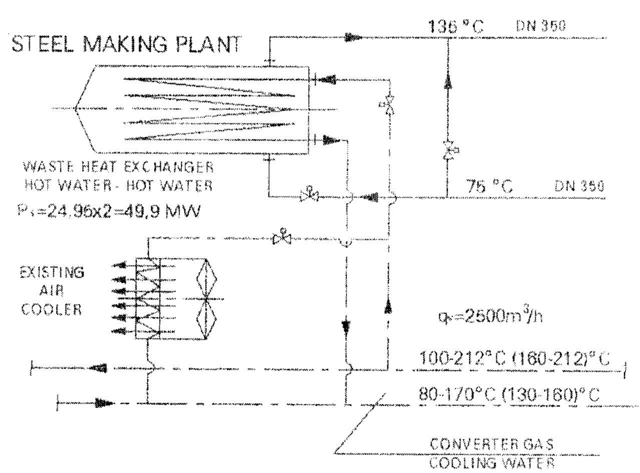


Figure 4 – Converter gases cooling facility – steel making plant (3 heat exchangers – 2 operate simultaneously)

3.3. Hot rolling mill

Hot Rolling Mill large strips facility is used for rolling of steel slabs in the hot condition to manufacture hot rolling strips of determined width and thickness. Two pusher type furnaces are installed in the Hot Rolling Mill plant for steel slabs heating to the temperature needed for rolling (1250 °C). Slabs are transported through the furnace over the sliding rails system placed in all furnace heating areas.

Natural gas or natural and blast furnace gas mixture is used for furnace heating. Combustion products deliver a part of their heat to slabs and then pass through regenerative and recuperative combustion air heaters. Cooled flue gases are exhausted to the atmosphere by two stacks.

The average waste heat rate (Q) in flue gases after existing air heaters, measured in time of the operation of two furnaces, amounts:

$$Q = 7{,}1 \times 2 = 14{,}2\ MW$$

Based on reviewed production breaks, the simultaneousness and inequality rate of pusher type furnaces operation is assessed at 0,7, so that:

$$Q_H = Q \times 0{,}7 = 14{,}2 \times 0{,}7 = 10.0\ MW$$

The solution of waste heat utilization for heating of return Heat Plant water using flue gases waste heat is presented in Figure 5. The existing technology process is not affected by this solution.

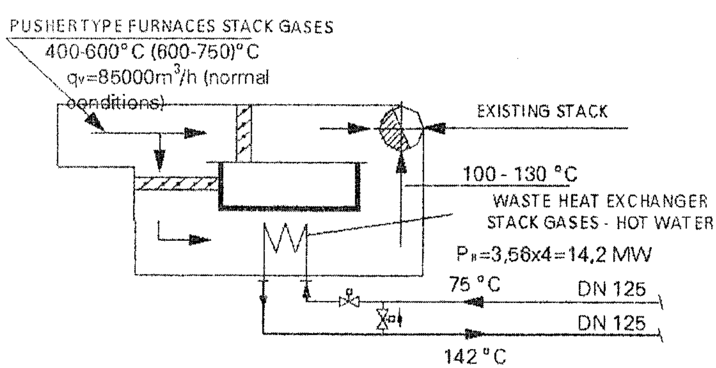


Figure 5 – Proposal for Pusher type furnaces stack gases cooling facility (4 heat exchangers)

4. CONCLUSION

The anticipated solutions of rational waste energy utilization in SARTID a.d. for covering the needs of the Heat Plant for heating of Smederevo and SARTID a.d. are economically justified and technically feasible.

There are two factors of the great importance.

First: safe heating system without oscillations, continuous and independent of many external factors (aggravated transport conditions during the winter, irregular import, et.) is provided by utilization of local source of energy beining in the immediate vicinity to the town itself.

Second, more important: one of the great environmental pollution sources is eliminated.

In relation to the heating so far, this kind of heating provides Smederevo with low-cost residential and other public and industrial facilities heating.

Due to the waste energy utilization and sale, which was not used until now, there would occur some changes in SARTID a.d, as well. The energy saving per ton of product amounts from 3 to 5%. The anticipated kind of heating will substitute expensive import fuel for cost-free local waste energy.

The main disadvantage of the proposed use of waste heat is great initial capital investments, specially in the main pipeline which has to be sized at the full capacity although it can be used only after few years.

However, the position of Smederevo is very favorable because of cost-free waste heat at minimal blast furnace and natural gas expenses. The fuel saving are remarcable and it can provide very fast the necessary assets.

5. LITERATURE

[1] Malić D., Termodinamika i termotehnika, Građevinska knjiga, Beograd, 1963

[2] Bošnjaković F., Nauka o toplini, Tehnička knjiga, Zagreb, 1970

[3] Reknagel-Sprenger, Taschenbuck für Heizung, Lüfting und Klimatechnik, R. Oldenbourg München-Wien, 1970

[4] Prospektni materijal, Korišćenje otpadnih toplota u Železari Rautaruukkioy, Finska

[5] Rudarski institut (grupa za termotehniku), Utvrđivanje veličina otpadne toplote, 1986

[6] Termoenergoinženjering, Beograd, Glavni projekat toplifikacije – Smederevo, 1996