

## *Full Length Research Paper*

# **Gas waste, local or global problem**

**Vojkan Vaskovic**

Technical Faculty of Bor, University of Belgrade, Serbia. E-mail: [vaskovic@bvcom.net](mailto:vaskovic@bvcom.net).

Accepted 20 July, 2011

**Production of bricks is one of the most spreaded industries worldwide. At the same time, it is one of the large energy power consumers, where the energy has a large share in the price of product. It is natural that more efficient exploitation of energy has an impact on decrease in cost price making the final product more competitive. An attempt to exploit waste heat energy of smoke emitting gases led to significant energy power savings. However, it created another problem which proved to be an insurmountable difficulty. This material deals with the consequences of introduction of devices for exploitation of waste heat energy power into the plant for brick manufacturing and ecological dilemma raised as a result of waste gas condensation.**

**Key words:** Gas waste, energy power savings, smoke, acid rains, cross plate shaped exchanger, waste heat energy.

## **INTRODUCTION**

Brick production is nearly as old as civilization. Modern technology of brick manufacturing implies industrial production. Earth is dug by machinery, transported to plant for cleaning and processing where, afterwards it is being prepared and dampened, whereupon it gets the desired form by use of machine tools (Akhtar et al., 2010). Brick thus formed is then ready to be dried. Finally, brick is generally baked in tunnel furnace which (often) use natural earth gas as fuel. A large quantity of heat energy is required when baking brick, first for drying and then for its baking. Entire technology process of brick production is devised in such a way as to reduce the energy consumption to the least possible extent. When bricks are taken out of tunnel furnace they are cooling by being exposed to heated air flow. Thus, the generated waste energy is used and reversed to drying process (Fayomi and Popoola, 2011).

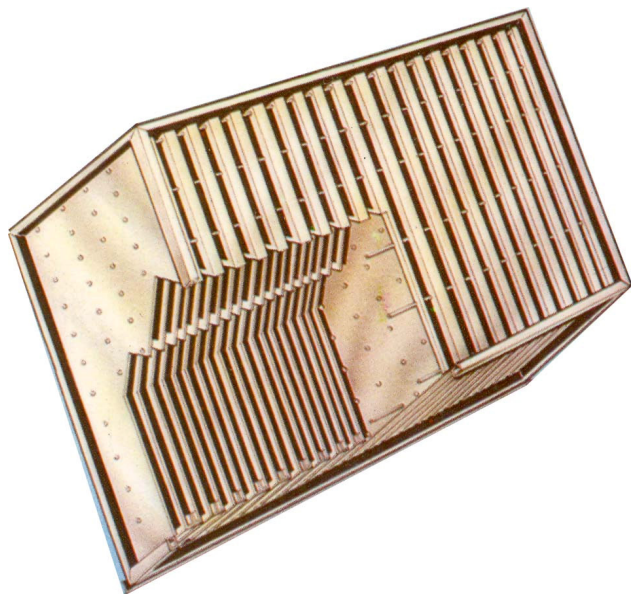
Second part of waste heat energy joins smoke emitting gases in the atmosphere. By exploiting this part of energy power, process of brick production would become more cost effective, therefore the company management took steps to make this energy available for exploitation (Hasanuzzaman et al., 2011). Several alternatives were offered as solution. Direct letting of waste gases into the drying process is not possible due to occurrence of condensation on the dried bricks, which later within baking process creates stains on products making them fall under the category of waste materials. After the

analyses of potential technical solutions were made, it was concluded that the cross plate shaped exchanger is the only solution to fully satisfy the requirements for reversal of waste heat energy, without it resulting in mixing of fresh and waste air.

## **CROSS PLATE SHAPED EXCHANGER WITH DISTANT SPHERICAL SECTOR**

Plate shaped exchangers are ranked among the best known exchangers generally and are noted in all books and textbooks dealing with heating on air and ventilation (Reknagel and Shprengel, 1982). Key problem faced with these exchangers is due to thermic dilatation. There is a decrease in cross sections of flow channels leading to reduction of efficiency of exchangers. With the aim to exclude mentioned problems, cross plate shaped exchangers with distant spherical sector were applied (Figure 1).

Technical problem to be solved by cross plate shaped exchanger is exploitation of waste heat energy which is let into the atmosphere from air conditioners and ventilation installations (Wilcox and Poerner, 2011). Exchanger is used for waste air, let out of premises, to heat outer air which is then thrown into premises. Novelty applied in this technical solution are distant spherical sectors, the aim of which is to prevent the occurrence of decrease in



**Figure 1.** Plate shaped heat exchanger with distant spherical sector (Vasković and Vasković, 1992).

cross section of flow channels. Relevant technical solutions enabled the making of more quality exchangers made of thin aluminium folia or sheet steel with the least possible weight of material. Constructive solutions given for plates, eliminated the problems of decrease in cross section of flow channels due to thermal dilatation of Al-foolia and sheet steels as well as effects resulting from difference in pressure of fresh and waste air which enables the making of plates of significantly larger dimensions as compared to existing technical solutions. Extracted spherical sectors at particular distance on the surface of Al-foolia or sheet steels increase the turbulency of air flows, which increases a degree of heat transfer.

In view of the fact that it was necessary to install cross plate shaped exchanger with distant spherical sector in installation for outflow of smoke emitting gases, it was decided that it should be made of anti-corrosive steel.

#### DEVICES WITH INSTALLED EXCHANGER

Within the baking process of facade bricks, waste gases and the air of temperature  $t = 90-130^{\circ}\text{C}$  are thrown directly into atmosphere. With the installation of devices for exploitation of waste heat energy with cross plate shaped exchanger, this waste heat energy is used for preheating of fresh outer air in drying process of bricks in drying place chambers (Vasković, 2008). In this manner, preheated fresh outer air is mixed with corresponding quantity of heated air out of cooling process of facade bricks heated up to  $t = 140-180^{\circ}\text{C}$  and corresponding quantity of waste air from drying place chambers  $t = 50-70^{\circ}\text{C}$ , and upon the additional heating in generator up to  $t = 130^{\circ}\text{C}$ , it is diverted to drying place chambers of facade bricks (Figure 2). In view of the fact that waste air and smoke emitting gases include aggressive gases such as  $\text{SO}_2$  and others, which due to condensation of water steam in cross heat exchanger produce acid, as a consequence, the mentioned cross heat exchanger was

made of "Prokron" anti-corrosive steel with a distance between plates of  $h = 6 \text{ mm}$ . Table 1 survey displays potential fuel saving by hour, month and year of natural earth gas. Since this technology process is continual that is, lasting 24 h during the entire year, except for 15 days needed for maintenance, potential savings are more than significant and invested funds are repaid in the period of around 4 months.

#### RESULTS AND DISCUSSION

By installation of cross plate shaped exchanger a preconditions were made for significant saving of heat energy. Immediately upon its putting into operation, a large quantity of liquid-condensation was noted on draining pipe. The problem was solved by placing the pipe which diverted the condensation into plastic barrel. After few days a big problem had to be faced. Condensation was so enormous that there was not enough space to store it.

This condensation was measured and it was established that the quantity was from 40 to 60 l/h. Liquid was greenish-brown colour and exceptionally aggressive. It is not acceptable to let such enormous quantity of liquid into soil as it would result in pollution of all underground waters in the vicinity, which would then, as a consequence bring inspection offices on spot and create further problems for the company management. In this case, particularly unpleasant element is that tunnel furnace operates 24 h a day, 350 days of the year. The quantity to be stored or destroyed would amount to between 336000 l and 504000 l annually. This quantity of condensation resulted in a dilemma for company management. On one hand, saving of energy by 50 to 60%, with reduction of consumption of gas of  $50 \text{ m}^3/\text{h}$  amounting, on annual level, to  $414000 \text{ m}^3$ , represented a significant saving, whereas on the other hand, local pollution represented enormous obstacle. Possibilities of transport of condensation were analysed, but none of the plants would commit themselves to take on exploitation or destruction of such vast amount of waste liquid. Any delay in decision making produced additional amount of condensation accelerating arrival of inspection office to the door of the company. A decision was made to exclude cross plate shaped exchanger and to continue operation as before.

#### CONCLUSION

Exclusion of exchanger did not, in any way lessen the problem, but placed it at the level where it was previously. Earlier stated quantity of condensation remained that way, except not a local problem any more but a global one. When we have a local problem, an inspection can show and impose a fine or even worse, ordering the production to cease. When we have a global problem, it is not within the jurisdiction of anyone. In other words, local inspection is not in charge for the problem concerning acid rains. Local plants do not have the power nor are

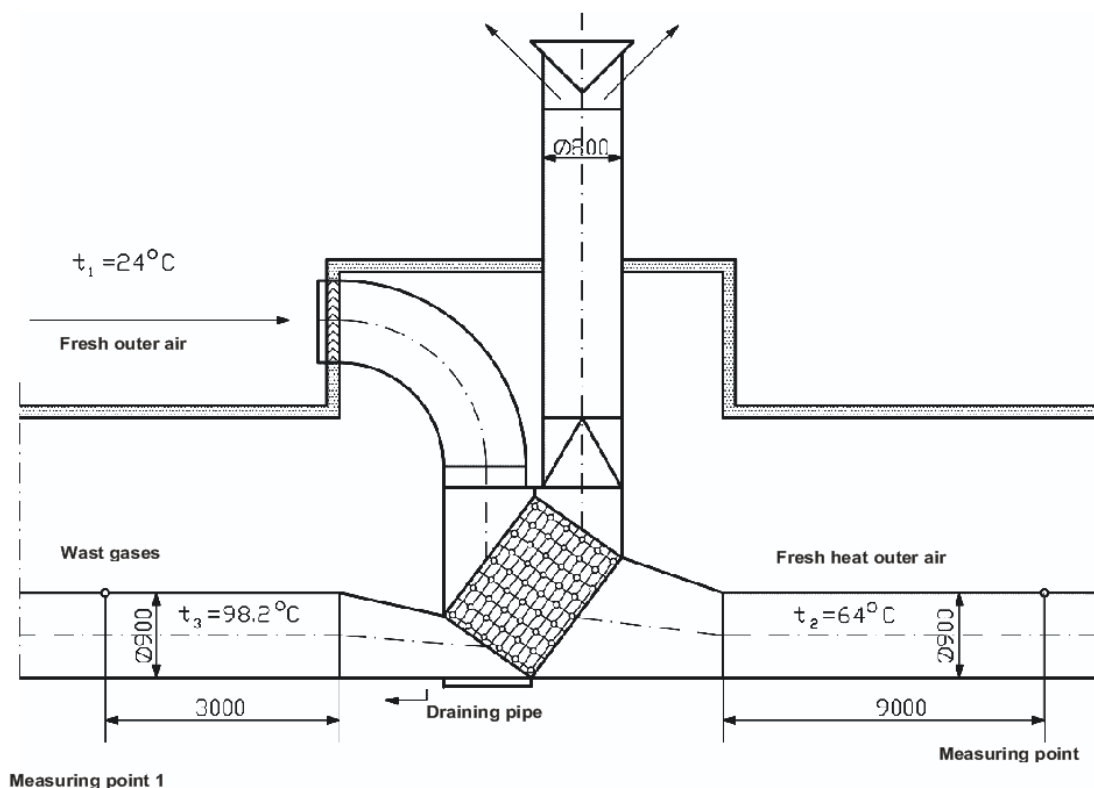


Figure 2. Breakdown of installation at length for exploitation of waste heat energy.

Table 1. Potential fuel saving by hour, month and year of natural earth gas.

Ref. No.	Quantity	Indicator	Unit	Waste air	Fresh air	Note
1.	Temperature of outer air	$t_1$	°C	-	24	Measured
2.	Atmospheric pressure	P	Pa		99400	
3.	Temperature of waste gases	$t_3$	°C	98.2		Measured
4.	Temperature of recuperated air	$t_2$	°C		64	Measured
5.	Channel diameter	D	mm	900	900	
6.	Active alternator surface	F	m <sup>2</sup>	409.3	409.3	n = 300 plates
7.	Fuel savings by hour	$V_h$	m <sup>3</sup> /h		50	
8.	Fuel savings by month	$V_m$	m <sup>3</sup> /month		36000	24 h 30 days
9.	Fuel savings by year	$V_q$	m <sup>3</sup> /year		414000	11.5 months

willing to tackle these problem. If a number of plants for production of bricks in the world is considered and multiplied by quantities measured in this installation, we arrive at the problematically high figures. Project represents small plant, but from the position of community it is very interesting to analyze behavior after introduction of the problem. Measurements which have been conducted clearly indicated to company's management, as well as to local community the problems, results and consequences deriving from this plant. On one hand, there is saving and on other, there is local pollution. It has to be mentioned that the pollution exists in any case, however, if it gets away with smoke emitting gases, it would not be local

problem any more. By the savings achieved in energy sources, storage and elimination of waste could be organized, but it implies additional activity and investments without obvious effects, thus there was no interest to continue activity regarding this problem. What is even more interesting, is the fact that neither company's management nor the local community considered it as their problem, as if gases would disappear to some other planet and not fall on the earth with the next rain. The aim of this paper is not to show technical solutions but to indicate that technic and technology hold significantly smaller part in relation to psychology in development and application of technological solutions regarding environment

protection. Company's management and local community have to be educated (maybe even alarmed) in order to comprehend that the need for ecological protection of earth has to start at local level and that when polluting elements are released, they would, eventually have to fall somewhere. The work of this project and measured results indicate that there is quite a series of unsolved problems which have to be settled. Continuation of work relating to these problems means analysing of chemical composition of liquid condensation from smoke emitting gases and proposal for solution for its capturing, storage and elimination.

#### REFERENCES

- Akhtar JN, Alam J, Akhtar MN (2010). An experimental study on fibre reinforced fly ash based lime bricks. *Int. J. Phys.Sci.*, 5(11): 1688-1695.
- Fayomi OSI, Popoola API (2011). Analysis of waste water with the use of activated carbon from local raw material. *Int. J. Phys. Sci.*, 6(8): 1915-1919.
- Hasanuzzaman M, Saidur R, Rahim NA (2011). Energy, exergy and economic analysis of an annealing furnace. *Int. J. Phys. Sci.*, 6(6): 1257-1266.
- Reknagel H, Shprengel G (1982). Heating and air conditioning. *Gradjevinska knjiga*: 635-643.
- Vaskovic R, Vaskovic V (1992). Cross plate shaped heat exchanger with distant spherical sectors. Patent J. P-526/88.
- Vasković V (2008). Project documentation "Plant for manufacturing of bricks".
- Wilcox M, Poerner N (2011). Small Scale Waste Heat Recovery Study GMRC Research Report 2010 SwRI® Project No. 18.15481.