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INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

Important values measuring for choosing suitable heat exchanger with premix burner

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Abstract: *The purpose of this thesis is measuring of important values for choosing a new heat exchanger for smaller heating unit with premix burner and to obtain the highest efficiency and the lowest price possible. Measuring of the different heat exchangers with thermo-camera, infra-thermometer and with thermocouple were mentioned in this thesis. Design is based on previous measuring similar heat exchanger for bigger heating unit.*

1. Introduction

The main reason for the change to the new premix burner technology is better mixing of moist air and natural gas and thus lower air pollution (NOx < 30 ppm and CO = 0) and lower fuel consumption.
Proposal a heat exchangers mentioned in this thesis is based on proposal and tests of the heat exchanger for different heat power (25-45kW and 40-65kW).
In this thesis are mentioned two similar heat exchangers with 8 and 11 tubes in exhaust gas path. These heat exchangers were designed for 15-25kW and 20-30kW. Burner´s heat output changes according to the tension 0-10V.
The heat exchanger for bigger unit is showed in Fig. 1. The bigger unit have mating dimension 854mm and the smaller one have mating dimension 566mm.

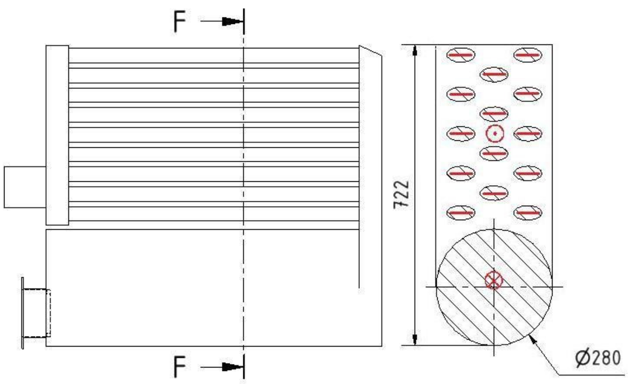

Figure 1: The Heat Exchanger for bigger heating units.

Fig. 2 shows the heating exchangers for smaller heating unit. The combustion chamber diameter was reduced from 280mm to 250mm. One flue path for exhaust gas after the combustion chamber was suggested. Number of tubes in exhaust gas path was reduced to 11 and 8.
Inside flue path were tested bigger and smaller Vortex-Generators.
V1 presented the HE with 11 tubes and bigger VG, **V2** he HE with 11 tubes and smaller VG, **V3** he HE with 8 tubes and bigger VG and **V4** presented the HE with 8 tubes and smaller VG.
The surface of the heat exchanger with 11 tubes was bigger about 15%.

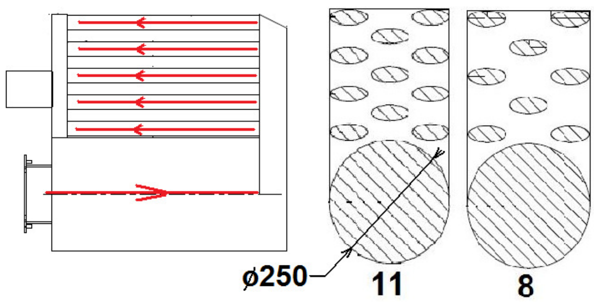

Figure 2: The HE for smaller heating units.

A thermo-camera was used at measuring temperatures. The infra-thermometer had to be used too, because the thermo-camera measured only to the temperature of 370°C.
Fig. 3 shows points of measurement, where temperatures on the surface of the heat exchanger were measured with infra-thermometer and after automatization with thermocouple.

Air ventilator with 3 stages was used. Fan had with 1st stage 690rpm, with 2nd stage 1060rpm and with 3rd stage 1380rpm.

Figure 3: Points of measuring.

2. Measuring

Fig. 4 - 6 shows temperature distribution on the surface of the heat exchanger for chosen conditions-measured with infra-thermometer.

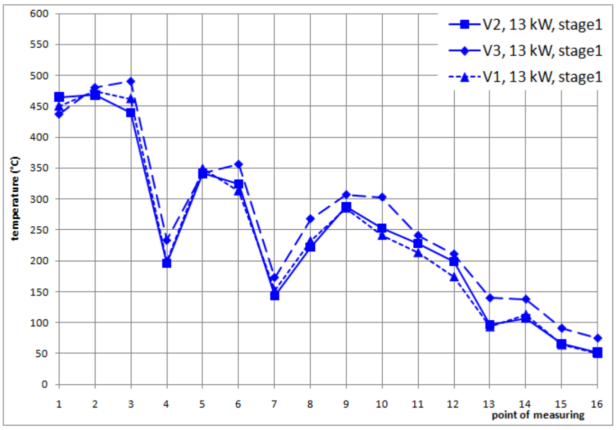

Figure 4: Temperature on the surface of the HE for 13kW and 1st stage of fan.

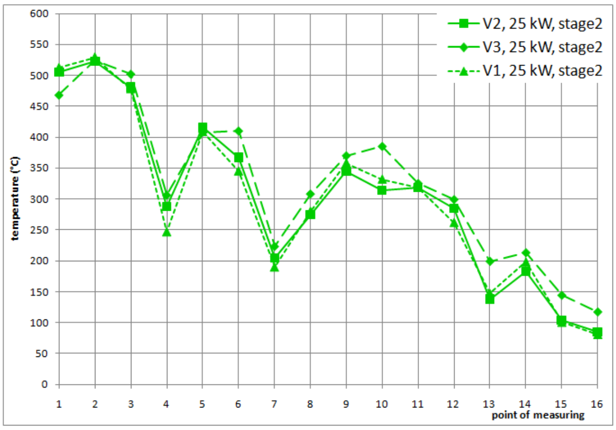

Figure 5: Temperature on the surface of the HE for 25kW and 2nd stage of fan.

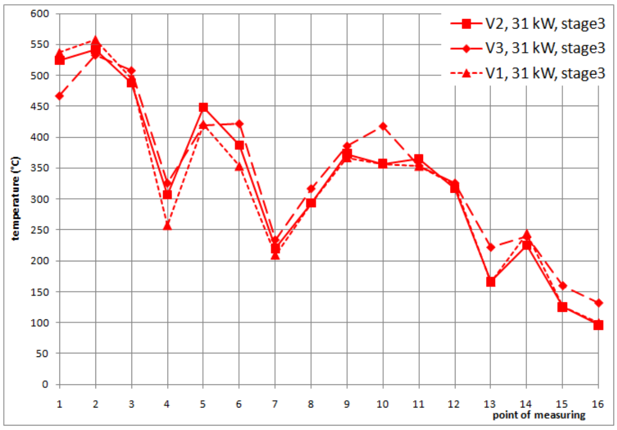

Figure 6: Temperature on the surface of the HE for 31kW and 3rd stage of fan.

Temperature distribution on the surface of the heat exchangers were similar for variants V1+V2 and for V3+V4 are temperatures about 20-40°C higher.

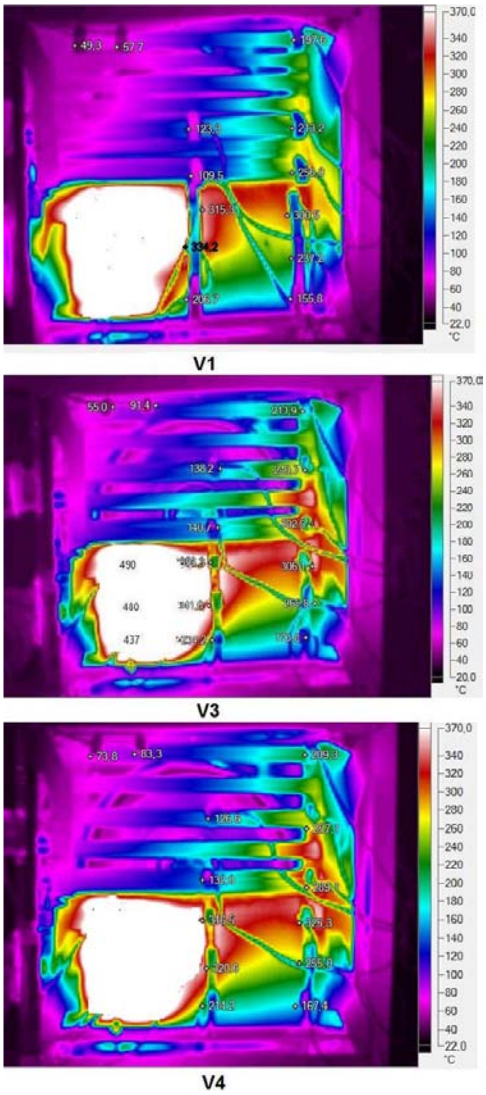

Figure 7: Thermo-camera´s pictures for 13kW and 1st stage of fan.

Fig. 8 shows p-Q characteristics (air delivery side) for V1=V2 and V3=V4. In all cases max air volume delivery is better about 3-4.5% while using the heat exchanger V3.

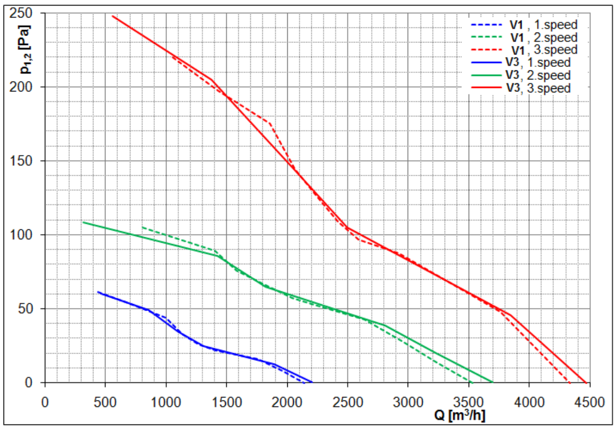

Figure 8: p-Q characteristics.

Fig. 9 shows there isn´t difference between V1 (V2) and V3 (V4) in noise characteristics.

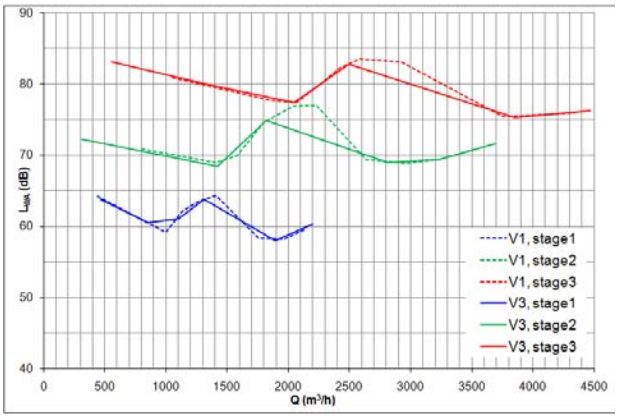

Figure 9: Noise characteristics.

variant	V1	V2	V3	V4
stage of fan	1	1	1	1
T inlet [°C]	22	22	23	20
humidity [%]	18	22	13	15
T exhaust gas [°C]	75	83	89	101
dewpoint [°C]	54	53	51	53
O2 [%]	5,3	6,1	7,3	5,7
CO2 [%]	8,8	8,4	7,7	8,6
CO [ppm]	0	5	0	0
NOX [ppm]	28	14	16	20
NO [ppm]	27	14	16	19
lamda	1,34	1,4	1,53	1,37
ETA [%]	97,2	96,7	96,4	95,2
pull [hPa]	0,26	0,04	0	0,25

Figure 10: Exhaust gas probe´s values for 13kW.

variant	V1	V2	V3	V4
stage of fan	2	2	2	2
T inlet [°C]	22	22	22	22
humidity [%]	19	23	12	15
T exhaust gas [°C]	157	159	198	203
dewpoint [°C]	54	53	53	53
O2 [%]	5,4	5,6	5,7	5,6
CO2 [%]	8,8	8,6	8,6	8,6
CO [ppm]	0	0	0	0
NOX [ppm]	23	13	21	18
NO [ppm]	22	13	20	18
lamda	1,34	1,37	1,37	1,37
ETA [%]	93,1	92,3	90,9	90,6
pull [hPa]	0,27	0,22	0,05	0,05

Figure 11: Exhaust gas probe´s values for 25kW.

variant	V1	V2	V3	V4
stage of fan	3	3	3	3
T inlet [°C]	22	22	20	20
humidity [%]	20	22	14	16
T exhaust gas [°C]	201	204	234	241
dewpoint [°C]	54	54	54	54
O2 [%]	5,4	5,2	5,4	5,4
CO2 [%]	8,8	8,9	8,8	8,8
CO [ppm]	0	0	0	0
NOX [ppm]	23	16	22	22
NO [ppm]	22	16	21	21
lamda	1,34	1,32	1,34	1,34
ETA [%]	90,8	91	88,9	88,8
pull [hPa]	0,3	0,23	0,18	0,25

Figure 12: Exhaust gas probe´s values for 31kW.

The most important values were measured at the beginning of a chimney with exhaust gas probe and in fig. 10 - 12 are presented exhaust gas probe´s values for chosen conditions.

Temperature of exhaust gas were measured about 15 – 35℃ higher with the heat exchanger V3 compared with V1 accompanying the efficiency was about 1% lower while using the heat exchanger V3.

Fig. 13 shows exhaust gas temperature for heat exchanger V1 and V3 in all working point and with all stages of fan.

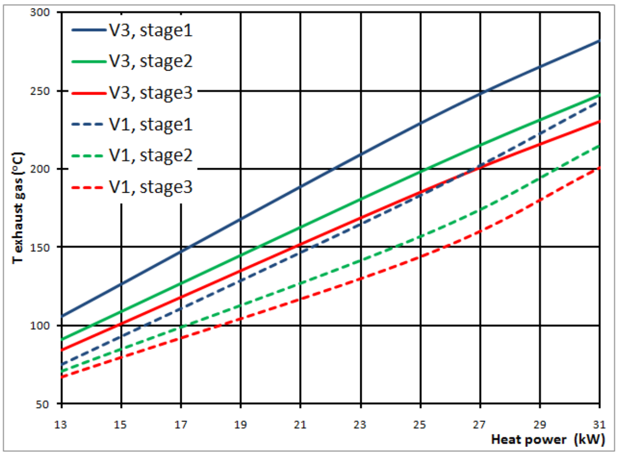

Figure 13: Exhaust gas temperature.

Corresponding with fig. 13 is fig. 14 which shows efficiency for heat exchanger V1 and V3 in all working point and with all fan stages.

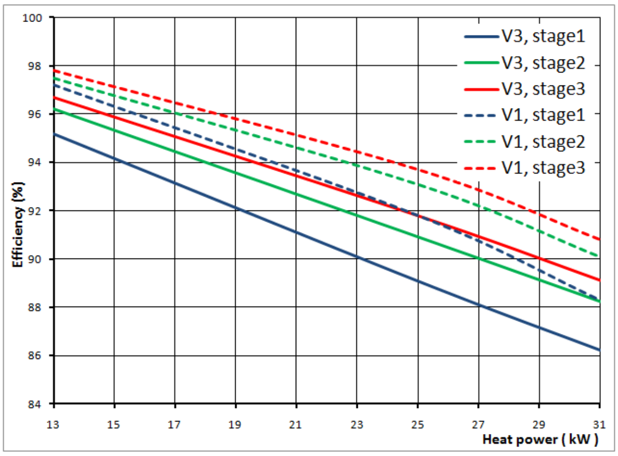

Figure 14: Efficiency.

For burner´s fan is important pressure loss (exhaust gas side) showed in fig.15.

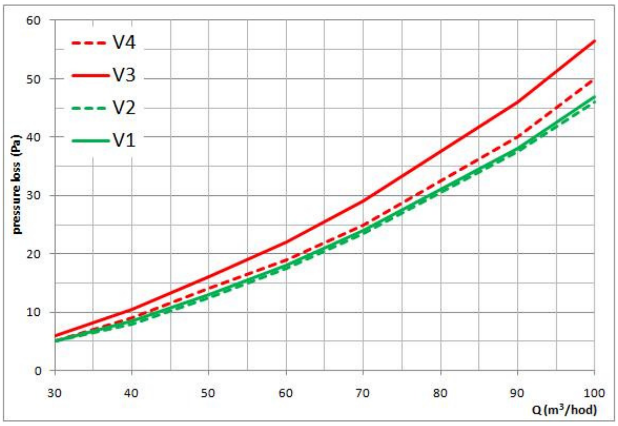

Figure 15: Pressure loss - exhaust gas side.

For the heat exchangers V1 and V2 practically isn´t difference between using bigger or smaller vortex generators.

The difference between vortex generators is bigger for heat exchanger V3 and V4.

3. Conclusion

A few settings of the new heat exchanger were measured. The temperatures and other values of exhaust gas and temperatures on the surface of the heat exchanger were measured.

Similar characteristics were measured for all variants of heat exchangers.
Temperature distributions on the surface of the heat exchangers were similar for V1+V2 and V3+V4. For variant V3 was exhaust gas temperature about 15-35°C higher than while using the heat exchanger variant V1.

The efficiency was about 1% lower while using the heat exchanger variant V3 but surface of this heat exchanger was about 15% smaller. It means -3.4 kg corresponding with lower price of the heat exchanger.

4. Literature

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Acknowledgments

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