

Real measurement of selected biomass boilers in households

INTRODUCTION

- Home heating with solid fuels is a significant source of atmospheric pollution.
- As from 2020, only biomass boilers that fulfil the requirements of the Ecodesign Directive will be sold. Ecodesign requirements are described in EU Commission Regulation 2015/1189, Annex II. Most of boilers which fulfil Ecodesign requirements, meet requirements for class 5 according to EN 303-5:2012.
- Change of old boilers means: 1) combustion of biomass in automatic or gasification boilers, 2) gas condensing boilers, 3) heat pumps.
- In the Czech Republic when a new biomass boiler is installed, there are currently no legal requirements for a final inspection before use.

AIM OF OUR RESEARCH

- Determination of real parameters in field measurements of five biomass boilers with heat output 20-30 kW (three wood gasification and two wood pellets automatic boilers). All measured boilers met the Ecodesign requirements during the certification. The measurements were conducted during routine daily use. Obtained results were compared to declare emission classification (according to EN 303-5:2012).

EXPERIMENTAL METHODS

Investigated parameters

- Continuous measurement of flue gas temperature
- Continuous measurement of oxygen and carbon monoxide content in flue gas (OGC - organic gaseous compounds were not measured)
- Manual gravimetric measurement of TSP (total suspended particles) in flue gas
- Fuel consumption
- Fuel analysis
- Assessment of boiler thermal efficiency (indirectly)
- Boiler heat output (calculated)
- Class assessment of measured values according to EN 303-5:2012

EN 303-5:2012 class requirements (CO and TSP emission and efficiency)

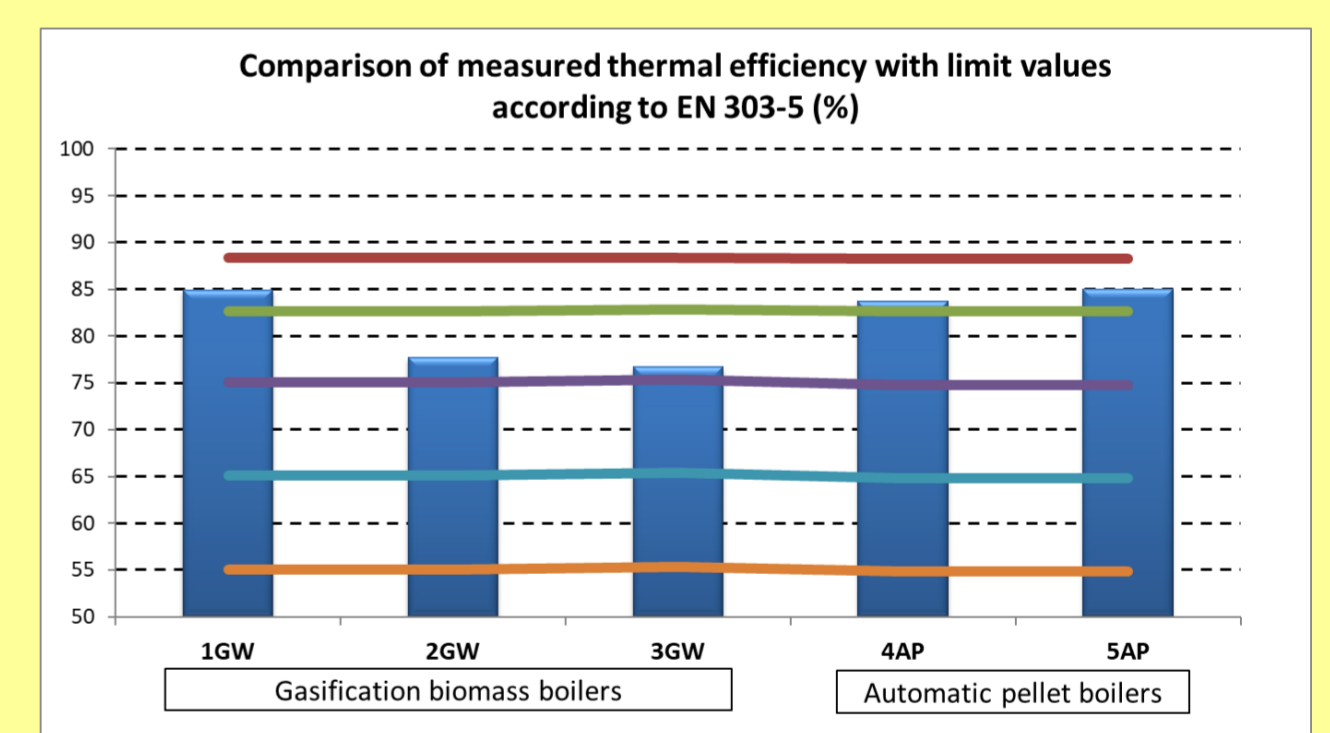
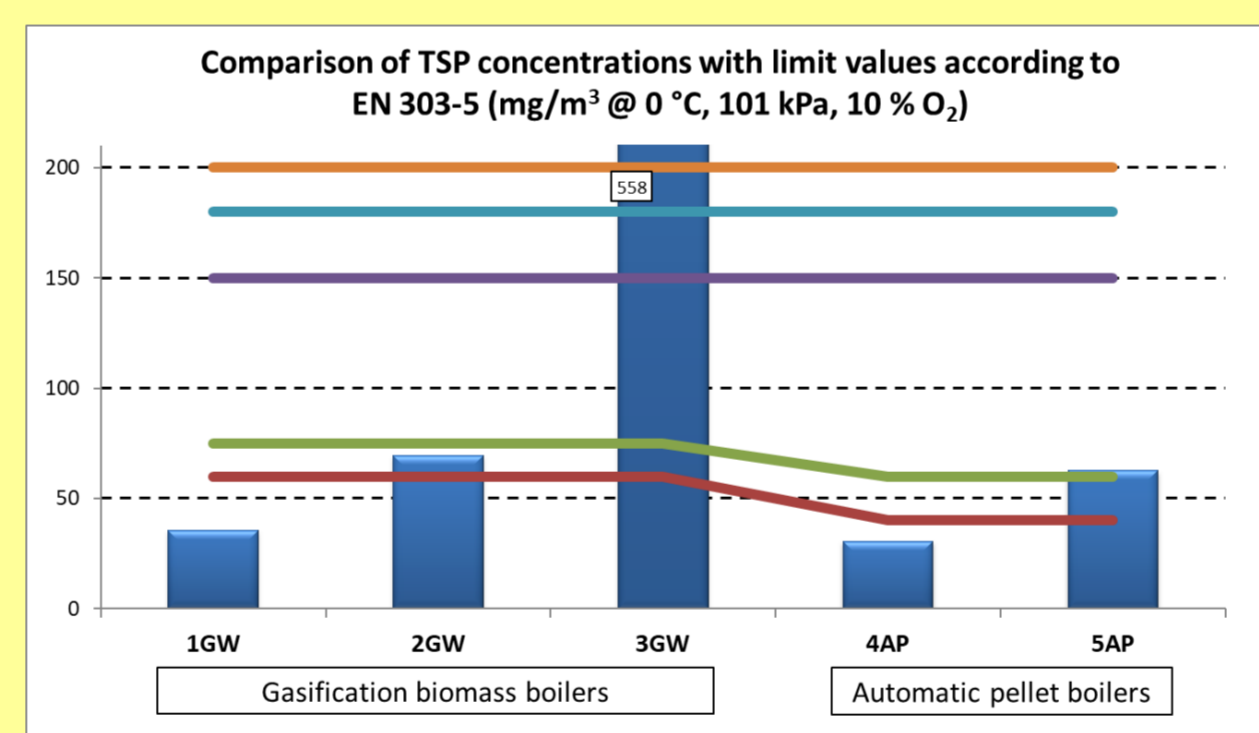
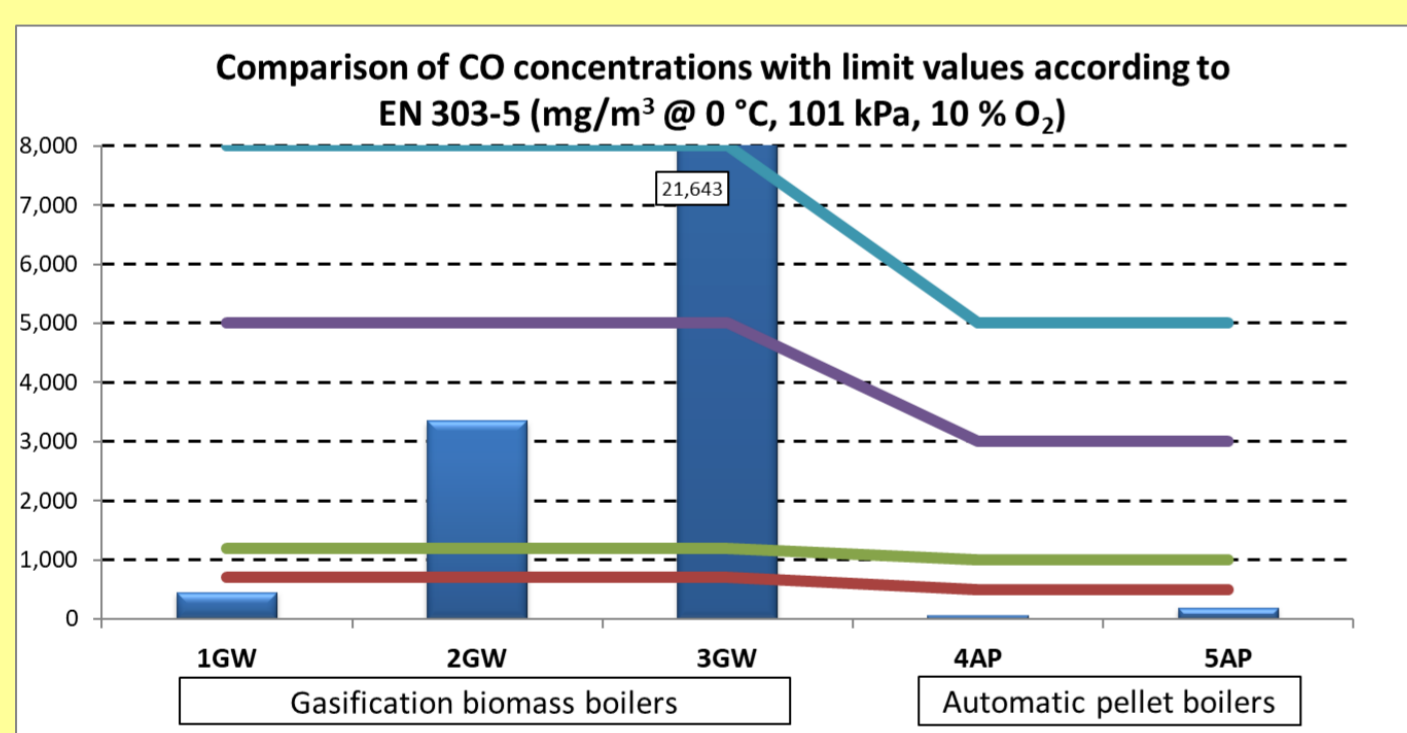
Parameter	Emission class	Device category	
		Manual	Automatic
CO [mg.m ⁻³]	5	700	500
TSP [mg.m ⁻³]	5	60	40

Parameter	Class	Nominal heat output [kW]			
		15	20	25	30
Thermal efficiency [%]	5	88.2	88.3	88.4	88.5

RESULTS AND DISCUSSION

Measured data and corresponding classification

Boiler		CO		TSP		Thermal efficiency		Class	
Designation	Technology	mg.m ⁻³	Class	mg.m ⁻³	Class	%	Class	Certified	Measured
1GW	gasification, wood logs (GW)	449	5	35	5	84.9	4	5	4
2GW		3 347	3	69	4	77.7	3	5	3
3GW		21 643	1	558	–	76.7	3	5	1
4AP	automatic wood pellets (AP)	62	5	31	5	83.8	4	5	4
5AP		191	5	63	3	85.0	4	5	3



Note: Class I (red), class II (green), class III (purple), class IV (turquoise), class V (orange).

- The real parameters of biomass boilers are worse than in the testing boiler laboratory. None of the measured boilers reached the labelled (certified) values. Wood pellet boilers were better than wood gasification boilers.
- Gasification boilers achieved the best parameters when operated at nominal output. Therefore, they are not certified at reduced output but must be operated in a system with storage tanks.
- Although all measured gasification boilers had discharged (cold) storage tanks, they were not operated at nominal output and therefore the quality of combustion was very poor. Incorrect setting of the control elements switched off the flue gas fan.
- Pellet boilers can be operated from 30-100% of output without significant deterioration of operating parameters (reduced output is also measured during certification, the requirements on Ecodesign give a large importance to value of 85%), which was also confirmed in our measurements.
- The effect of reduced output on higher production of pollutants is significantly greater in gasification boilers than in pellet boilers.
- The pellet boiler (4AP) burned well and was the one to meet the emission requirements for the 5th class in real operation. However, it did not meet the efficiency requirements due to non-performed maintenance (cleaning of the heat exchanger surfaces). After their cleaning, all measured requirements were met.

CONCLUSION

The effect of reduced output on higher production of pollutants is significantly greater in gasification boilers than in pellet boilers. For quality combustion, gasification biomass boilers must be operated at the nominal output. The installation of storage tanks does not guarantee that the boiler will be operated at nominal output. The difference between label values was significantly smaller for pellet boilers than for gasification boilers. Even such expensive and modern combustion devices cannot be operated without regular maintenance – cleaning of heat exchanger surfaces (higher chimney loss). Results lead to conclusion that there are four factors impacting generated pollution (boiler construction, operator awareness, quality of fuel, boiler maintenance). If one factor is omitted, generated pollution immediately or progressively increases.

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