THE INFLUENCE OF THE DEGREE OF CONTAMINATION OF WOOD WASTE WITH UREA-FORMALDEHYDE RESINS ON THE EMISSION OF GASEOUS COMBUSTION PRODUCTS DURING BURNING IN LOW-POWER BOILER

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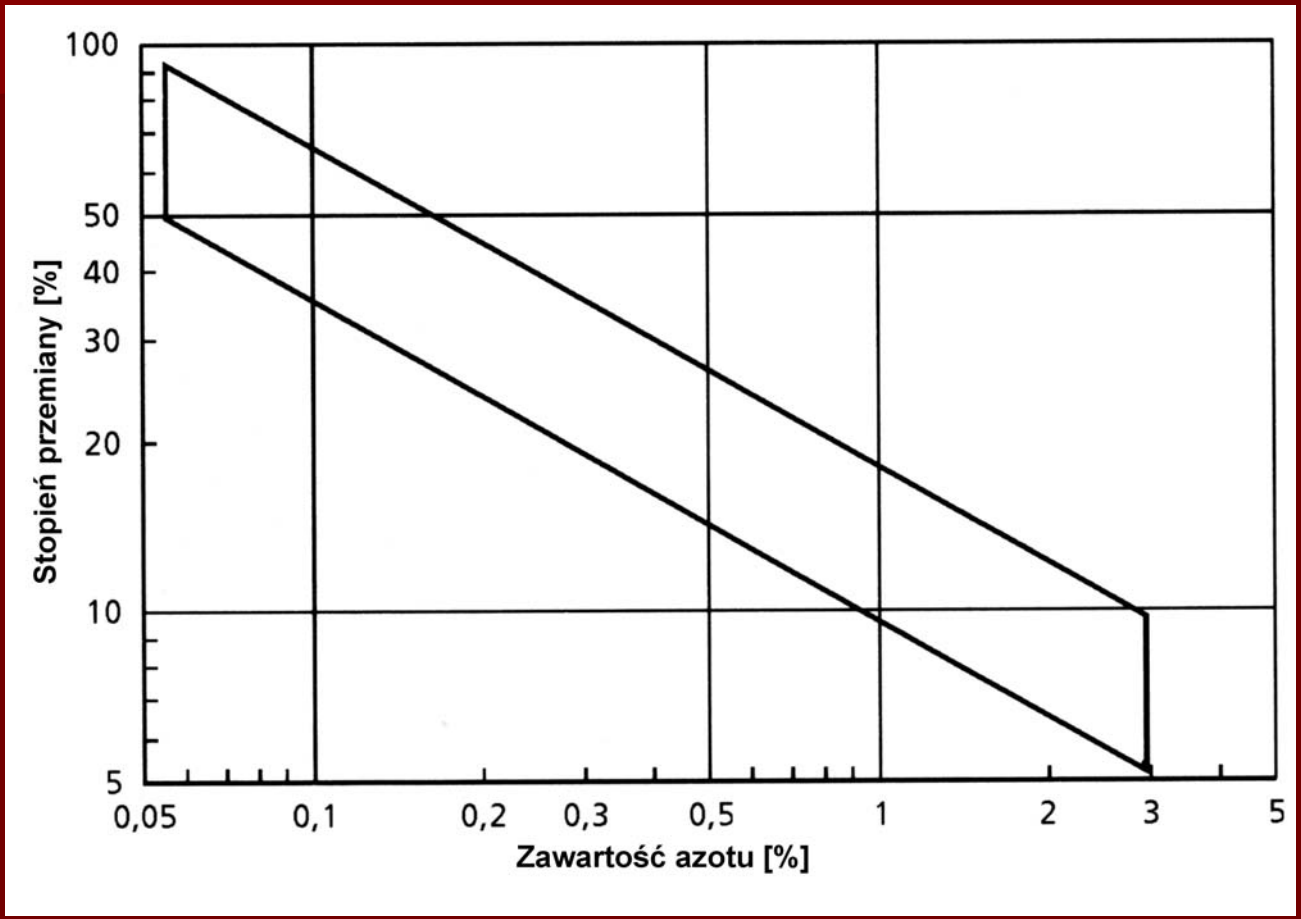
Degree of nitrogen change into NOx during combustion of wood materials by Nussbaumer

Degree of nitrogen change [%]



Nitrogen content [%]

The aim of this research was to identify the influence of the content of

urea-formaldehyde resin
in burnt wood materials on the emission of chosen toxic combustion products.

Materials and methods

Model wood waste characterised by various contents of urea-formaldehyde resin were prepared for tests in proportions corresponding to actual waste.

- Dry coniferous particles were glued in a laboratory gluing machine where glue resin was sprayed on chip surface in proportions which guaranteed that model waste obtained in this way contained 5 – 30 % of dry mass of resin in relation to dry mass of wood.

Materials and methods (continuous)

After the resin was hardened the obtained model waste was characterised in terms of:

- moisture content,
- ash content,
- content of volatile components,
- calorific value
- elementary composition in the scope of content of carbon, hydrogen, nitrogen and oxygen.

Materials and methods (continuous)

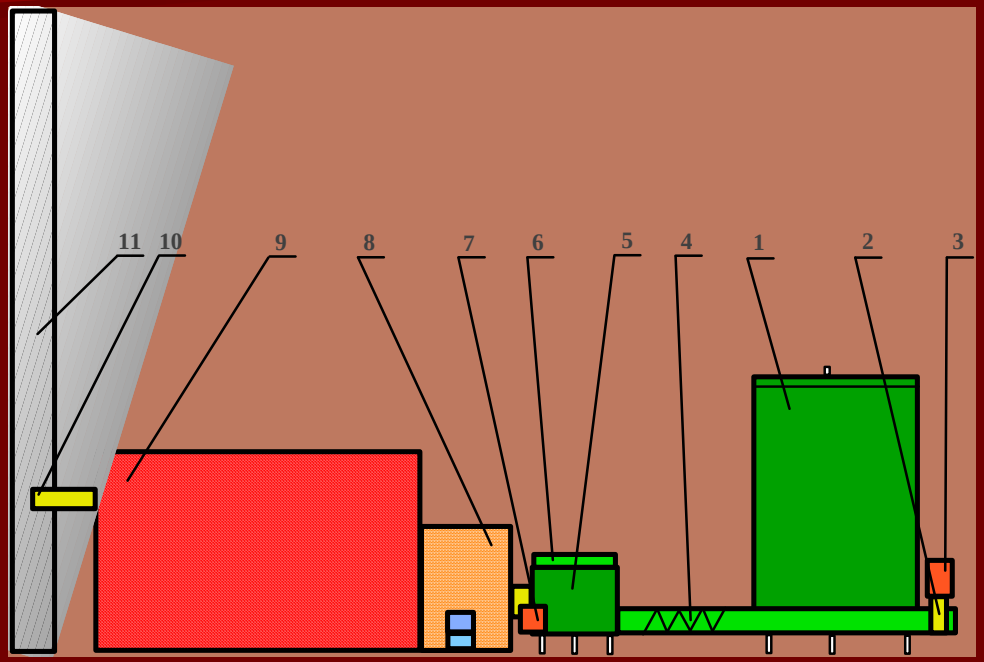
• Combustion tests were carried out at a laboratory test station consisting of a typical hearth of power of 50 kW for burning wood fuels and of heat exchanger.

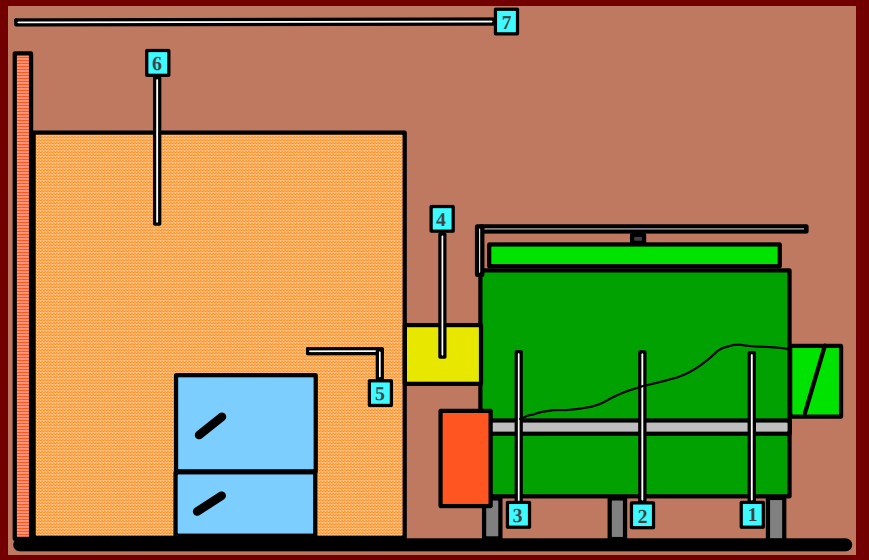
• Combustion gases emission was measured using gas analyzer with electrochemical cells of LANCOM Series II type by LAND Combustion which recorded content of carbon oxide, nitrogen oxides, hydrocarbons and parameters of combustion process.

• Additionally, there were conducted thermal analyses using apparatuses of LABSYSTM TG type and SETSYS TG-DSC 15 type by SETARAM.

Fig. 1. Schematic diagram of laboratory test station

(typical hearth of power of 50 kW for burning wood fuels and of heat exchanger)





Content of basic elements in model waste from composite wood products

Gluing degree	Element content			
	Carbon	Hydrogen	Nitrogen	Oxygen
[%]	[%]			
0 *)	49.54	6.38	**0.42**	42.03
5	49.94	6.50	**2.11**	41.87
10	48.77	6.39	**3.39**	42.15
15	48.00	6.39	**5.58**	41.40
20	47.36	6.29	**7.23**	39.71
25	46.88	6.23	**8.05**	38.98
30	47.31	6.44	**9.34**	37.51
100 **)	33.18	5.98	**36.79**	23.83

*) chips without glue **) glue resin

Basic fuel properties of model waste from composite wood products

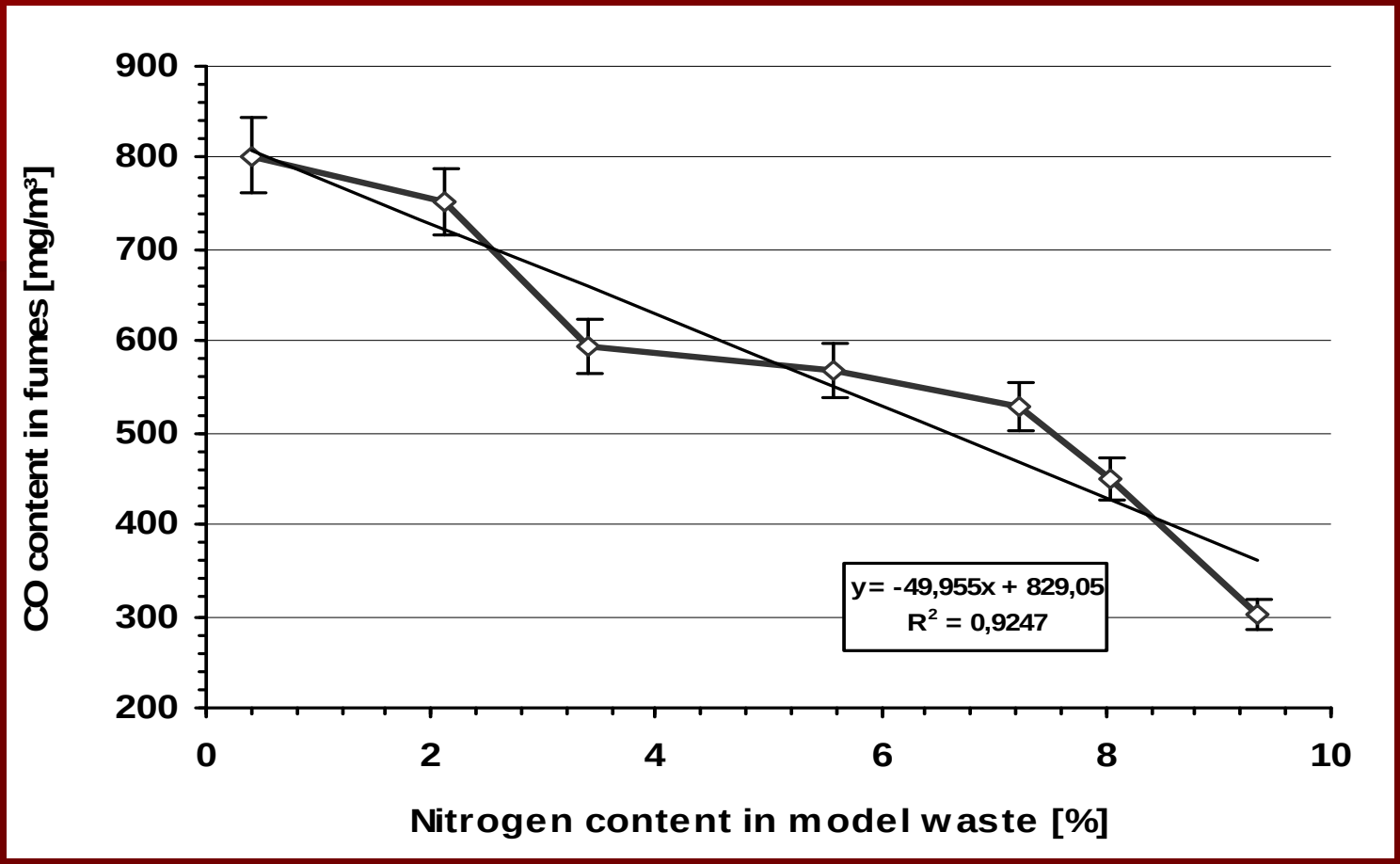
Gluing degree	Type of determination			
	Moisture content	Ash	Volatile components	Calorific value
[%]	[%]			[MJ/kg]
0*)	7.84	0.68	81.77	18.527
5	6.01	0.56	79.99	18.504
10	5.91	0.50	79.04	18.491
15	6.01	0.51	78.49	18.438
20	5.72	0.53	78.74	18.414
25	5.72	0.46	78.72	18.322
30	5.49	0.48	78.48	18.265
100**)	2.76	0.18	89.90	18.166

*) raw wood **) glue resin

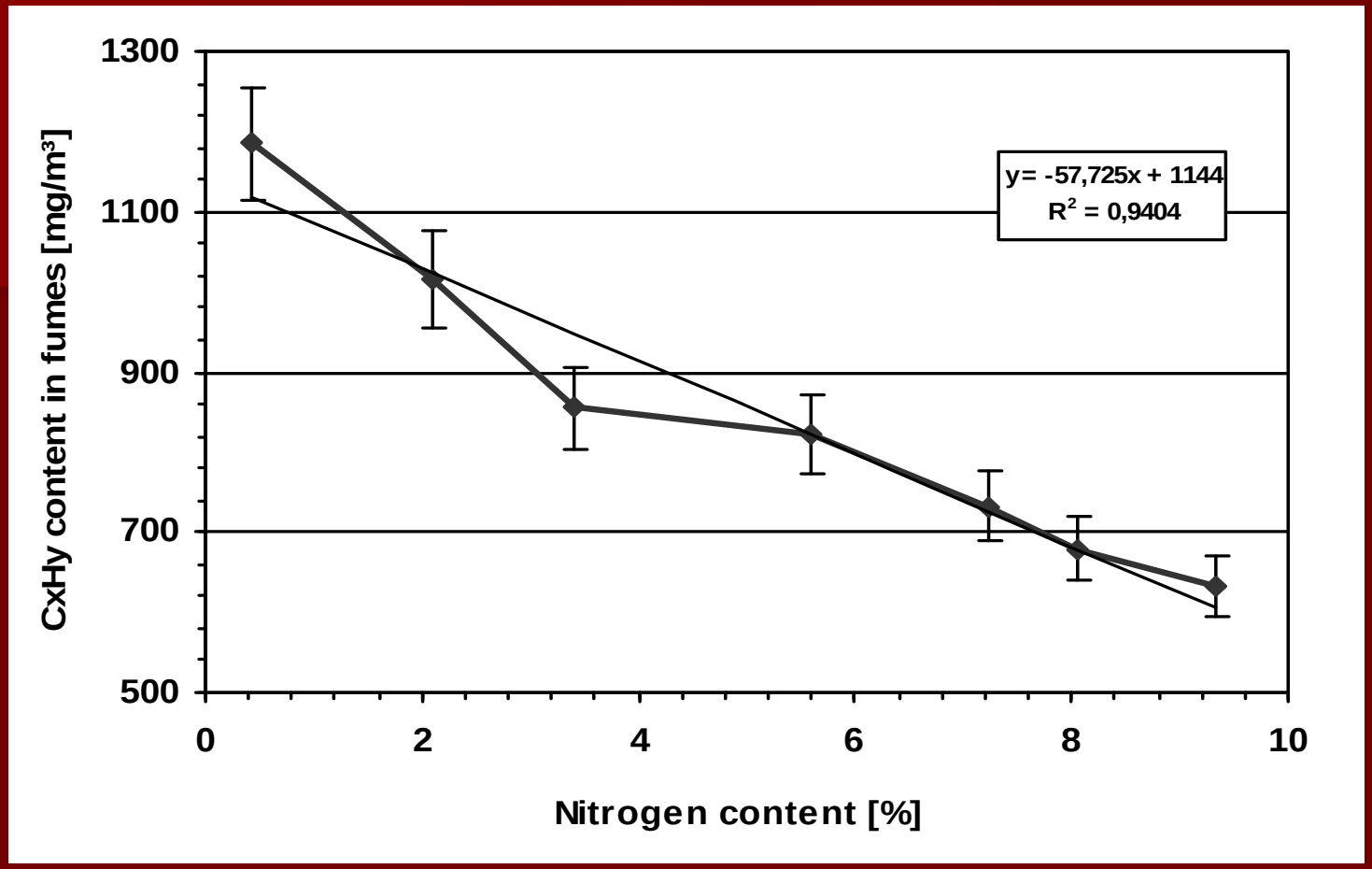
Basic kinetic parameters of the main period ("degasification") of thermo-oxidation process of model particleboards

Description of sample			Kinetic parameters		
No.	Gluing degree	Nitrogen content	Activation energy	Pre-exponential factor	Constant velocity of reaction
			E_a	A_0	k
	[%]		[kJ/mol]	[min^{-1}]	[s^{-1}]
1.	0*)	0.42	63.15	$8.00 \cdot 10^4$	$237.82 \cdot 10^{-6}$
2.	5	1.86	55.82	$1.81 \cdot 10^4$	$210.22 \cdot 10^{-6}$
3.	10	3.50	66.31	$1.18 \cdot 10^5$	$243.11 \cdot 10^{-6}$
4.	15	5.17	71.18	$3.95 \cdot 10^5$	$270.49 \cdot 10^{-6}$
5.	20	7.00	84.26	$8.58 \cdot 10^6$	$340.43 \cdot 10^{-6}$
6.	25	7.54	85.83	$1.05 \cdot 10^7$	$342.50 \cdot 10^{-6}$
7.	30	8.38	136.41	$1.57 \cdot 10^{11}$	$534.37 \cdot 10^{-6}$
8.	100**)	36.79	83.12	$4.63 \cdot 10^4$	$254.91 \cdot 10^{-6}$

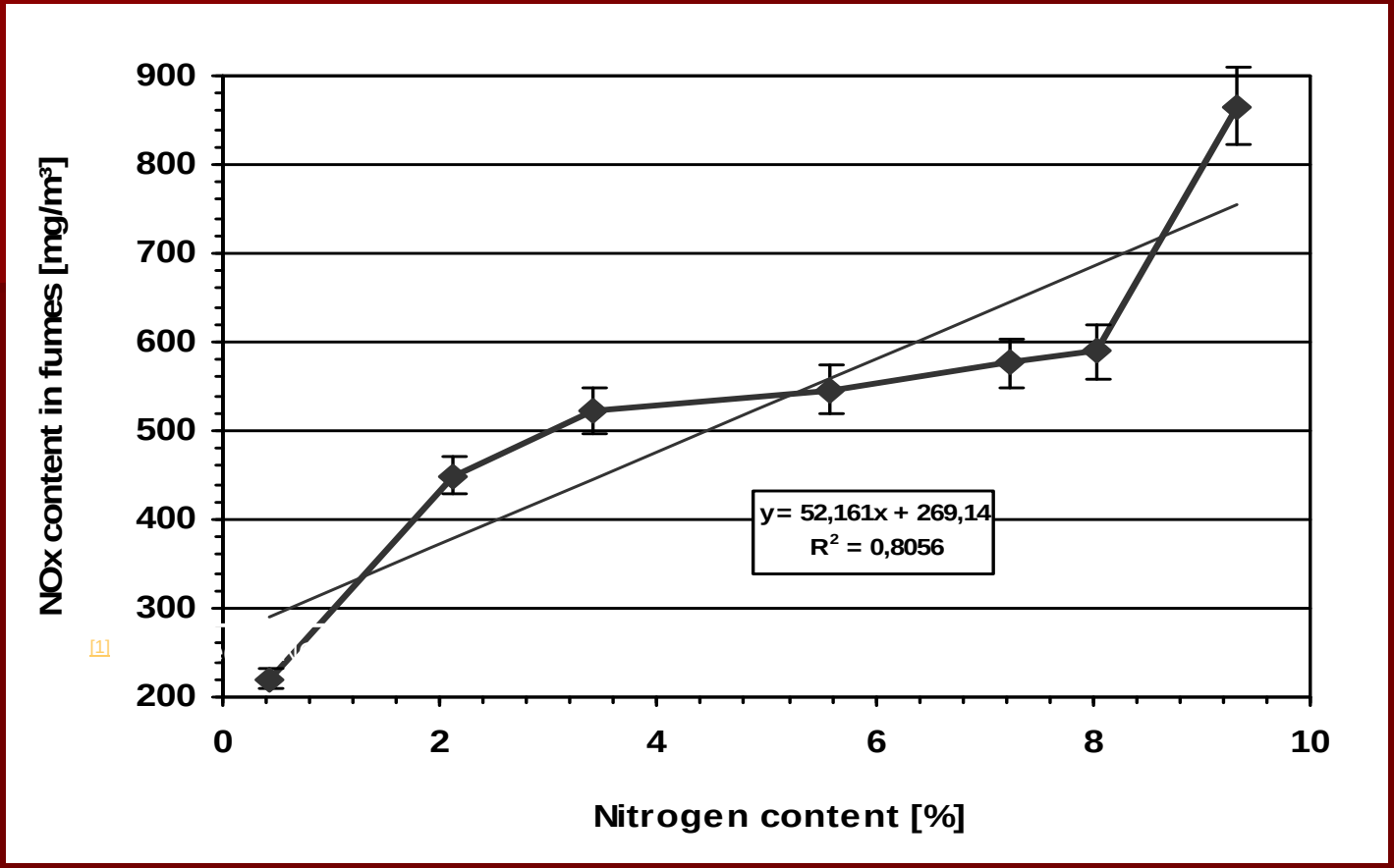
*) raw wood **) glue resin



The influence of nitrogen content in model wood waste on carbon oxide content in fumes during combustion in the test hearth (per 11% of O_2)

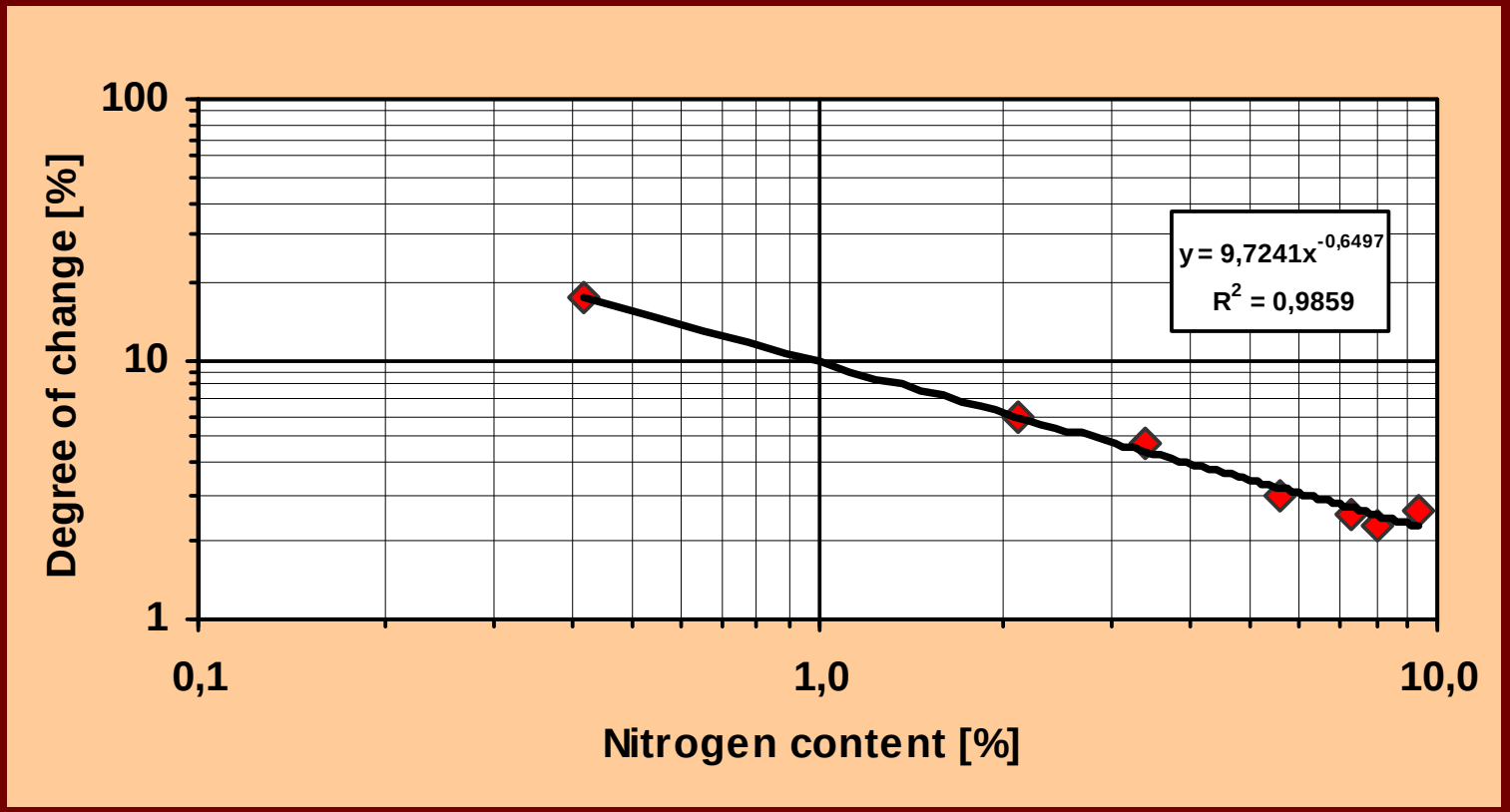


The influence of nitrogen content in model waste from composite wood products on the content of hydrocarbons in fumes during combustion in the test hearth (per 11% of O_2)



The influence of nitrogen content in model waste from composite wood products on the content of nitrogen oxides in fumes during combustion in ¼ in technical test hearth (per 11% of O_2)

The influence of nitrogen content in samples of model wood waste on the degree of its change into nitrogen oxides expressed as NO2 during combustion at the test station



Summary

- Nitrogen content characterising the share of urea-formaldehyde resins, on the basis of which the model samples were prepared, proved to have been the most adequate.
- Test described in the paper indicate that increase in the share of urea-formaldehyde glue resins in model waste from composite wood products causes increased emissions of nitrogen oxides during combustion process.
- These emissions however are significantly lower than indicated by stoichiometric calculations. At the same time a decrease in emission of carbon oxide and hydrocarbons was recorded. The degree of fuel nitrogen change into nitrogen oxides, determined on the basis of the above measurement data, was in the range of 2.5÷42%, where the highest values were observed in the case of combusted samples characterised by the lowest nitrogen content.
- The obtained results made it possible to look from a broader perspective at the character of nitrogen compounds changes during combustion of wood waste contaminated with urea-formaldehyde resins. As a result it was possible to complement interrelations presented by literature.

Thank you for your attention