Denitrification process in energy sector and transport as source of increased nitrous oxide emissions

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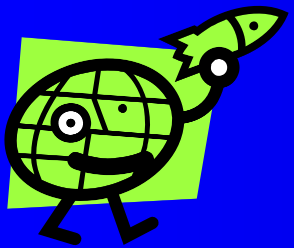
Denitrification process in energy sector and transport as source of increased nitrous oxide emissions

Overview

- Theoretical part
- Measurement metod
- Experimental part

  Coal combustion, municipal solid waste, mobile sources - cars
- Conclusion

Nitrous oxide is one of the trace gases that contribute to greenhouse warming as well as stratospheric ozone depletion.



$$N_2O + O = 2\ NO$$

$$NO + O_3 = NO_2 + O_2$$

$$O + O_3 = 2\ O_2$$

N_2O – Greenhouse Gas

Greenhouse Gas	Global Warming Potential	Antropogenic sources (%)	Long Lifetime on Atmosphere (Years)
CO_2	1	60	5 – 10
CH_4	21	15	10
N_2O	315	6	10 - 150

*Without H_2O

The global contribution of N_2O by sectors

The share of anthropogenic emissions by sector varies according to world region and specific economic activities. Based on various studies the approximate global contribution by sector is follows:

The global contribution of N_2O by sectors

- Agriculture and land 50-70%
- Industrial sources, mainly nitric acid and adipic production 15-25%
- Stationary and mobile fossil fuel combustion 15-25%

Production of N_2O from fossil fuel combustion

Oxidation of the fuel-nitrogen

N_2O is formed via two different pathway

- gas phase oxidation of nitrogenous groups in the volatile – HCN,
- the heterogeneously catalysed oxidation of the char-bound N – species

Production of N_2O from fossil fuel combustion

Denitrification processes, NO and NO_2 are removed, source of N_2O

- Primary denitrification

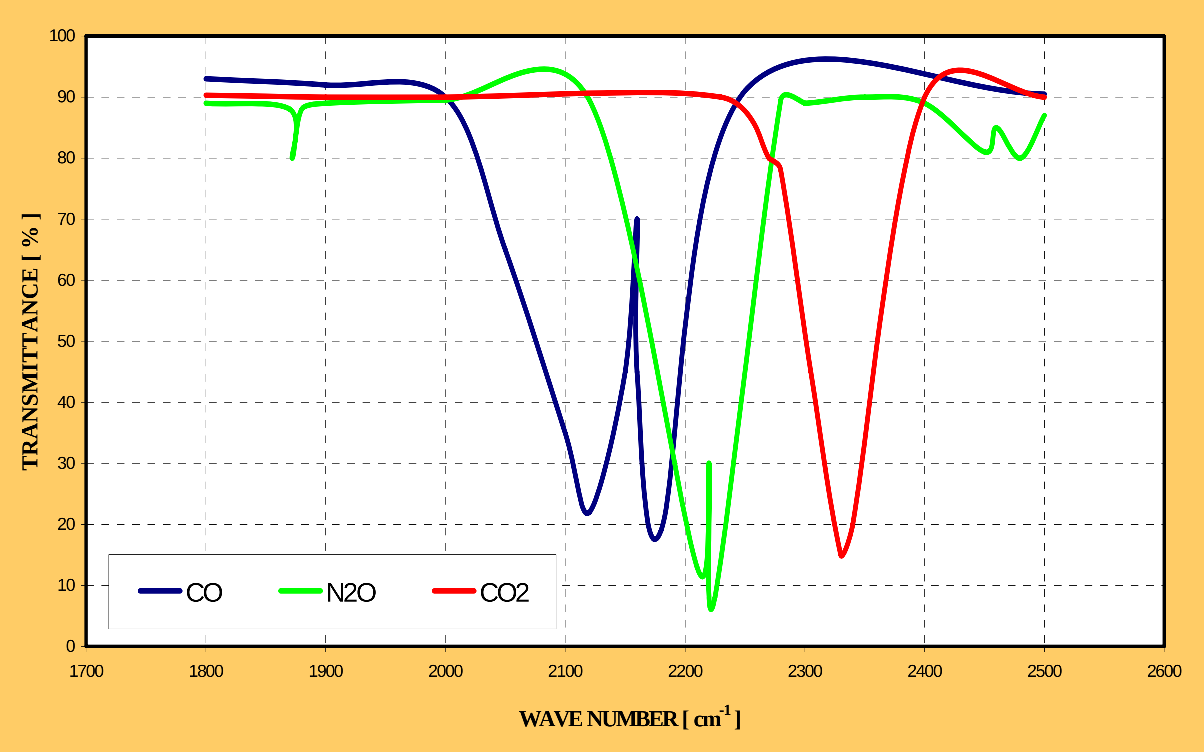
  modification of combustion process

- Secondary denitrification

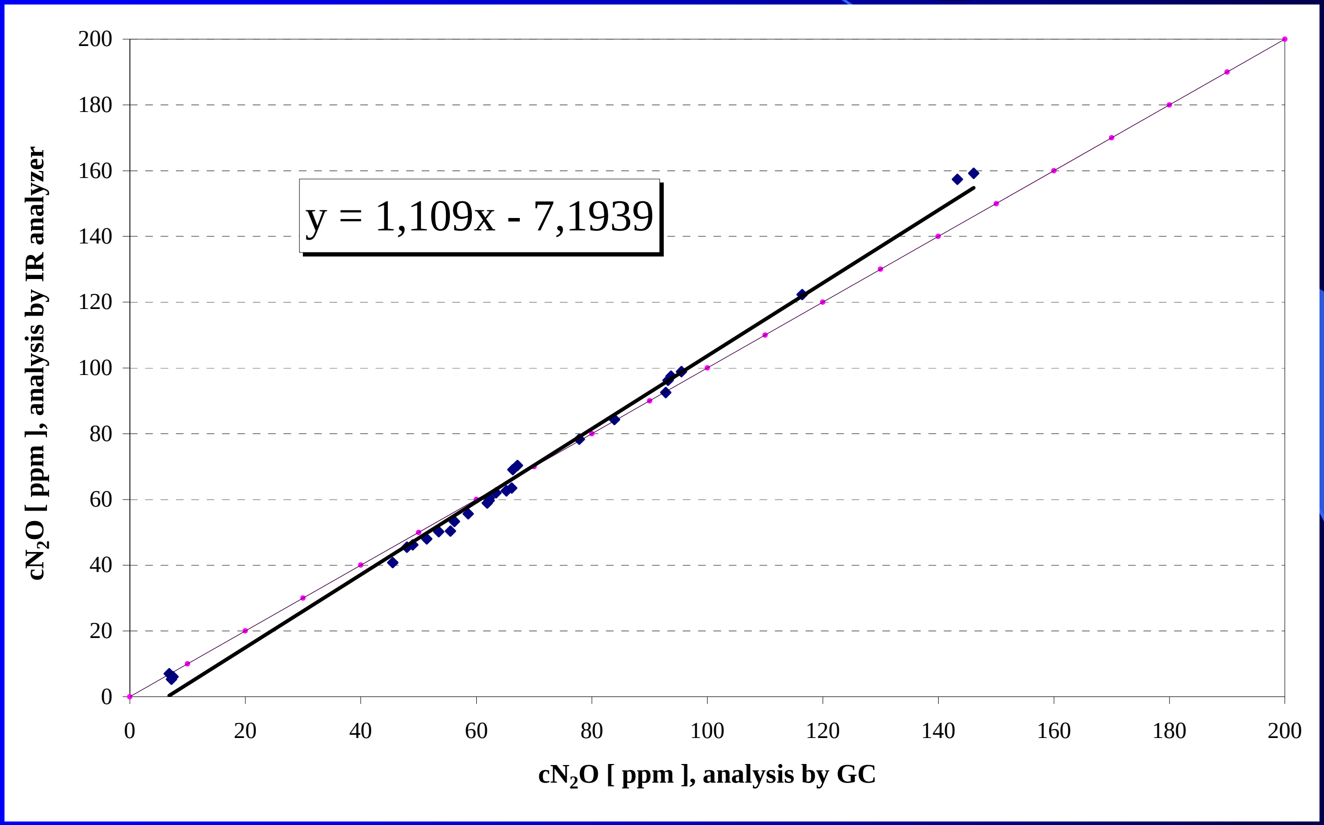
  post-combustion catalytic or non catalytic

Experimental part

- **<u>IR spektrofotometry</u>**
  - Advantage is continuous measurement
  - Possibility of interferences CO_2, C_xH_y, CO



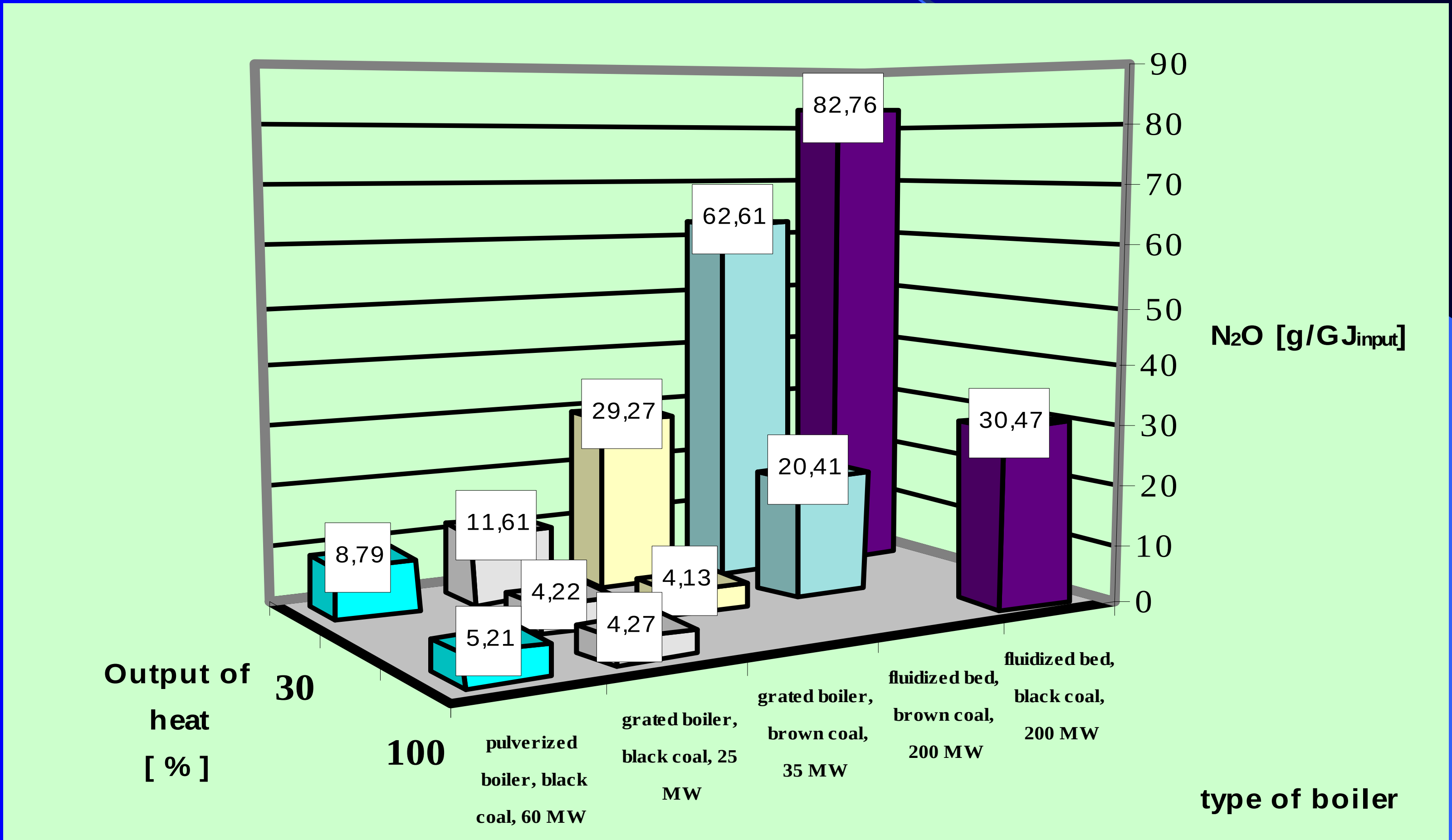
Comparison of the IR and GC analyses of N_2O



Maximal diference +/- 25 %, it is valid for content of CO when is lower than 500 ppm

Equipment for measurement

Coal combustion technologies, primary denitrification



Coal combustion technologies, secondary denitrification

SNCR – ammonia – reagent for deNO$_x$

Conversion of the reduced NO$_x$ to N_2O, 3-8%,

SCNR – urea – conversion of the reduced NO$_x$ to N_2O is 2-2,5 higher than NH_3,

Emission factor, results from measurenment in CZE	N_2O g.GJ^{-1}	NO_x g.GJ^{-1}
Combustion proces with deNO$_x$	22,8	202,7
Combustion proces without deNO$_x$	4,2	296,3

Production of N_2O from municipal solid waste

- Noticeable source of nitrous oxide
- Very little work on their characterization
- Project researching on ERC Ostrava

N_2O formation by non-catalytic denitrification processes concerning energy utilisation of Waste

Production of N_2O from municipal solid waste

Municipal solid waste

*Gutierez, Baxter, Hunter, Svoboda

Content of N – 0,1-1 mass %

SNCR – **urea** – reagent for $deNO_x$

Conversion of the reduced NO_x to N_2O, 20-30%*,

SNCR – **ammonia** – reagent for $deNO_x$

Conversion of the reduced NO_x to N_2O, 10-15%*,

SCR – type of catalyst,

Conversion of the reduced NO_x to N_2O, 3-8%*,

Production of N_2O from mobile sources

Mobile sources - cars

The following criteria of the measured cars were monitored with regard to the concentration level of nitrous oxide:

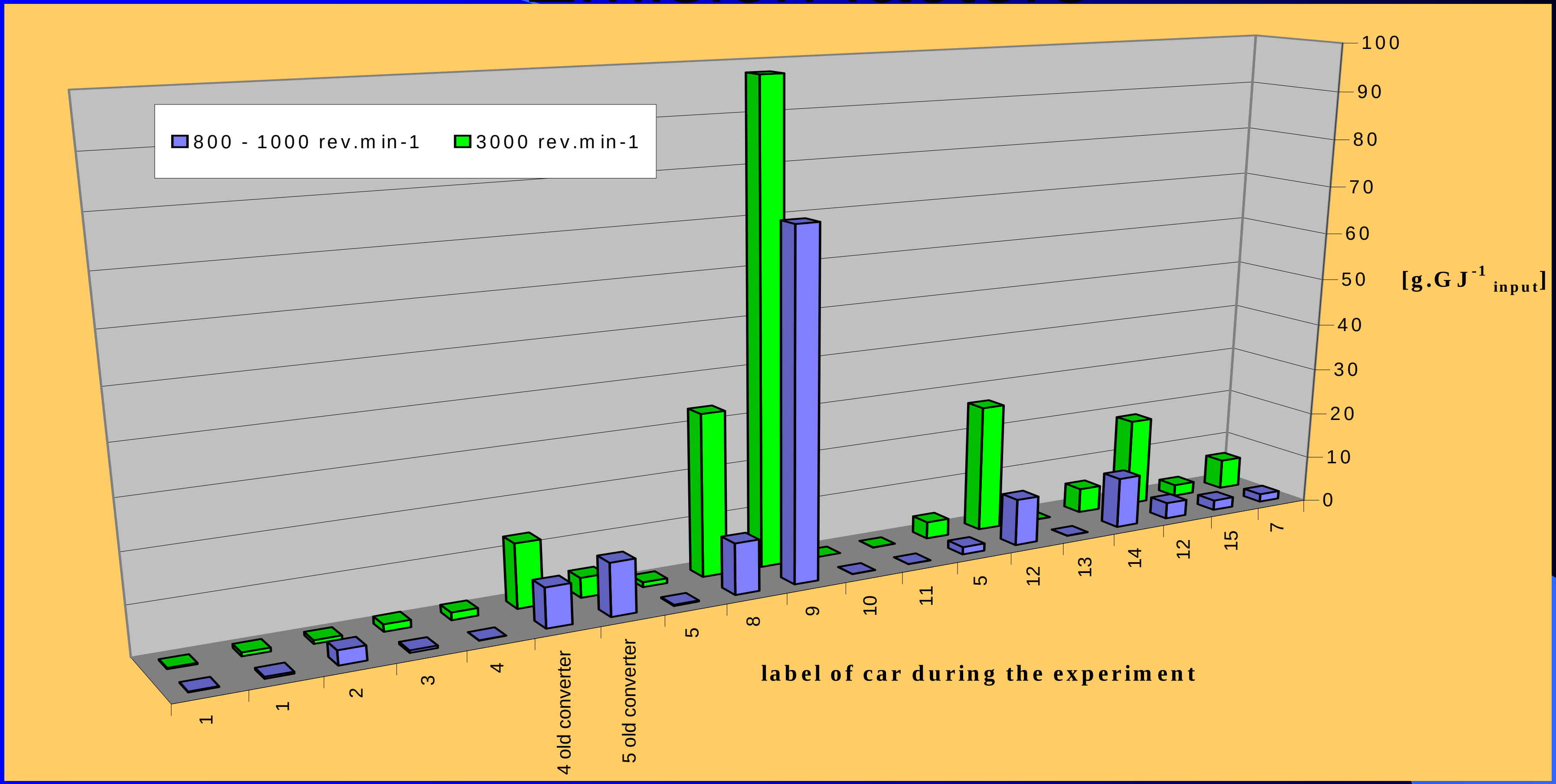
- Type of engine
- Type of fuel
- Operation output – revolutions of engine
- **With or without catalytic converter**
- **Age of catalytic converter**


MIR 9000

Catalyst for CO oxidation

Amount of CO in emission from cars is higher than 0,05%

Emision factors



1, 2, 3, 8, 9	engine without catalytic converter
4	engine with one-way catalytic converter
5, 10-14	engine with three-way catalytic converter
7, 15	diesel
12	LPG

Dependence on the age of catalytic converter

Engine with one-way converter	After running 5 000 km	After running 25 000 km
	N_2O [g.GJ^{-1}]	
900 rev.min^{-1}	0,1	17,2
3000 rev.min^{-1}	3,1	24,7

Conclusion

- Denitrification of emissions from combustion processes in energy an transport increases emission of nitrous oxide
- There are general lack of results
- EF of NO_x decrease, new denitrification units will be installed and production of N_2O will be increased ?

- The work was performed thanks to the project No. **101/05/P278** of the Grant Agency of the Czech Republic.