DESIGN OF ACTIVE STRUCTURED REACTOR FOR BIOGAS EXHAUST ABATEMENT

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BIOGAS - VALUABLE ALTERNATIVE FUEL

Potential sources[1]:

- agricultural residues
- animal waste
- food and kitchen organic waste
- forestry crops and residues
- waste water sludge
- landfill gas
- municipal organic waste
- industrial residues

Composition[2,3]

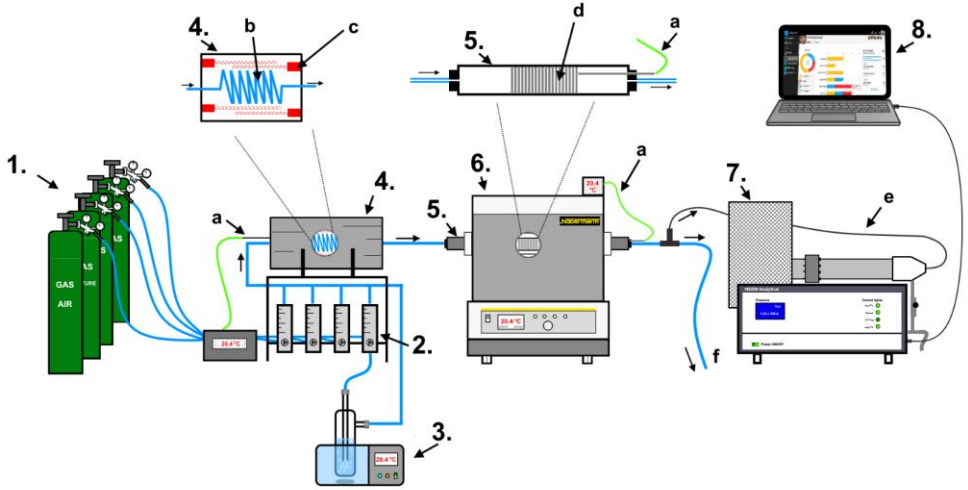
- CH_4 (50 - 75%)
- CO_2 (25 - 45%)
- H_2O (2 - 7%)
- N_2 (< 2 %)
- O_2 (< 2 %)
- H_2 (< 1 %)
- H_2S (20 – 20,000 ppm)

BIOGAS - VALUABLE ALTERNATIVE FUEL

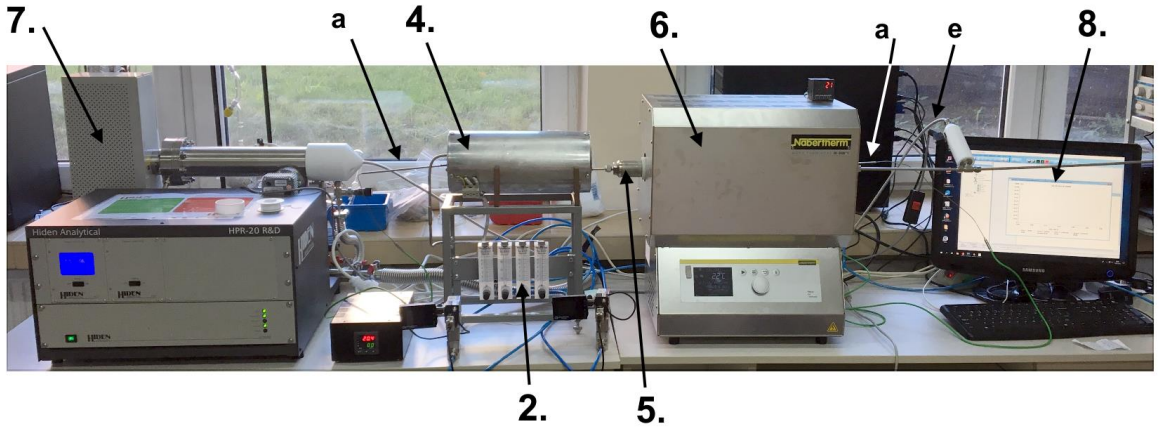
Potential usage

- production of heat and/or steam
- domestic and industrial heating, cooling and electricity
- electricity production / combined heat and power production (CHP)
- fuel for motor vehicle
- fuel cells
- chemical manufacturing
- injection into gas grid

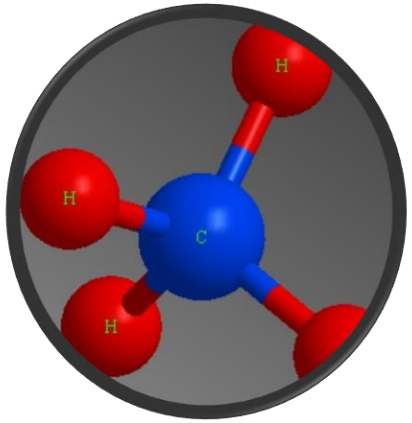
STRUCTURED CATALYTIC CONVERTERS



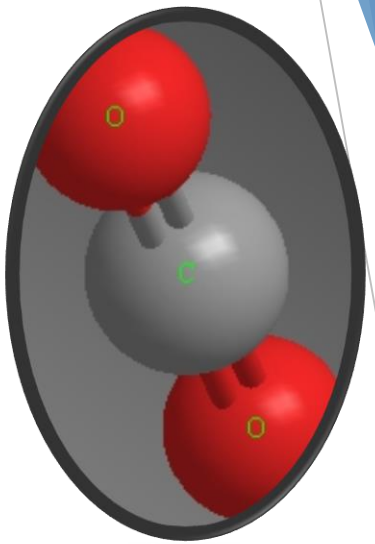
Schematic diagram and photograph of catalytic testing rig: **1** - gases cylinders, **2** - rotameters, **3** - water evaporator, **4** - pre-heater, **5** - converter, **6** - furnace, **7** - mass spectrometer, **8** - computer; **a**) thermocouple, **b**) pre-heater stainless steel coil (2 m), **c**) heating wire, **d**) wire gauzes, **e**) mass spectrometer capillary, **f**) vent.



CATALYTIC COMBUSTION – CONDITIONS



- Temperature: 100 – 500 °C
- Flow rate: 1 – 6 dm^3/min
- Catalyst: $CoPd/Al_2O_3$
- Catalyst suport: stainless steel wire gauze



hydraulic diameter, [m]	specific surface area, [m^2/m^3]	porosity
$1.71x10^{-3}$	1822.90	0.78

BIOGAS COMPOSITIONS FOR EXPERIMENTS

composition I (MIX 1)

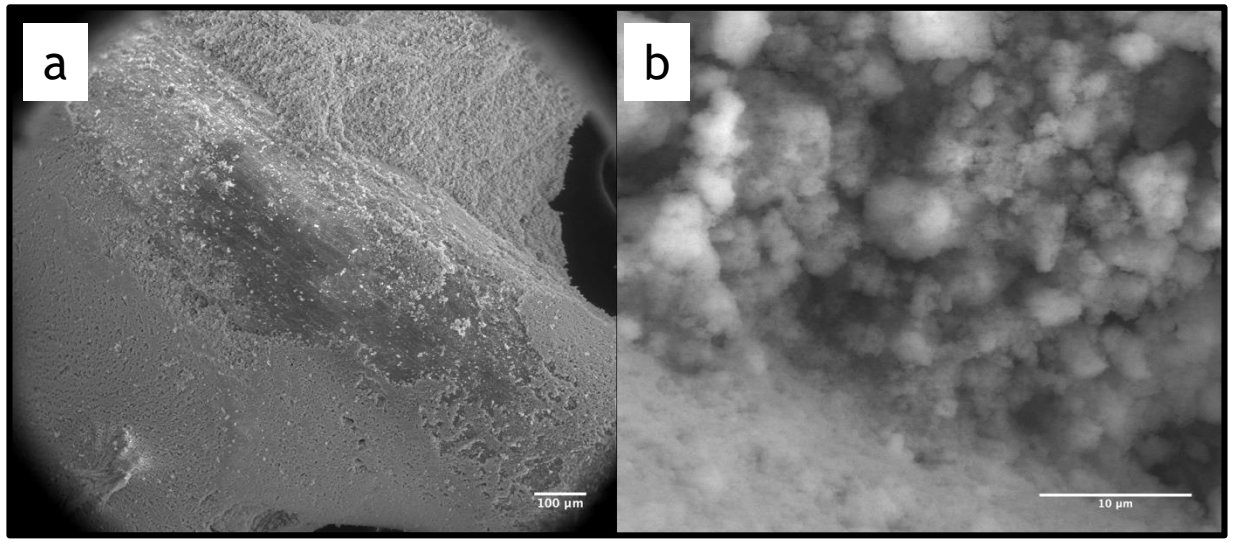
simulate biogas engine start-up or shut-down

composition II (MIX 2)

simulate dry reacting mixture

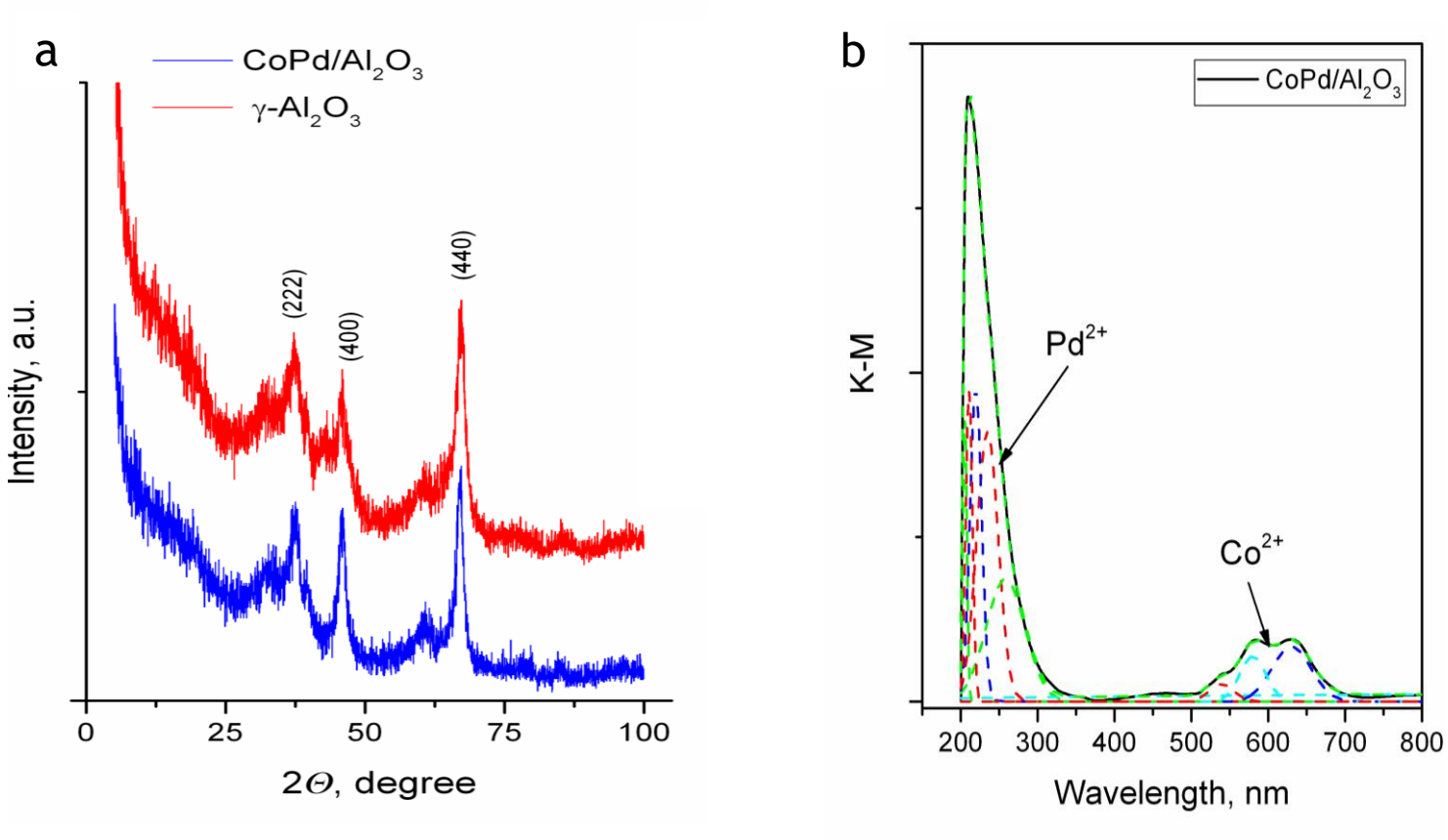
Compound	Unit	MIX 1	MIX 2
CH_4,*	vol%	0.40	0.40
O_2	vol%	8.00	8.00
CO	vol%	0.05	0.05
CO_2	vol%	7.00	7.00
NO	ppm	200.0	200.0
NO_x	ppm	240.0	240.0
NH_3	ppm	-	2500
N_2		balance	balance

SEM CHARACTERIZATION



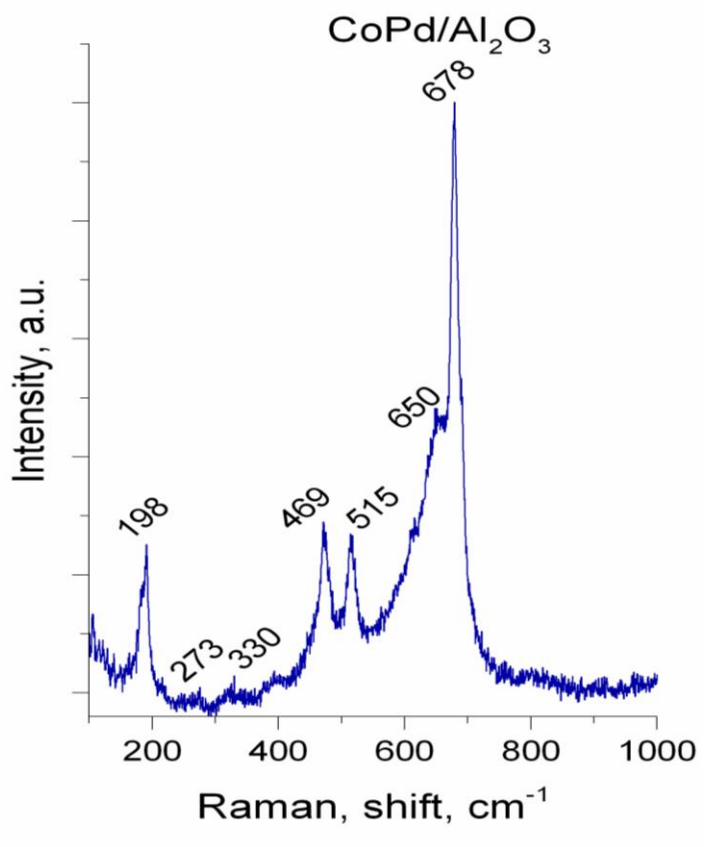
SEM pictures of prepared wire gauze supported structured catalysts
a) scale 100 µm, b) scale 10 µm

SPECTROSCOPIC CHARACTERIZATION



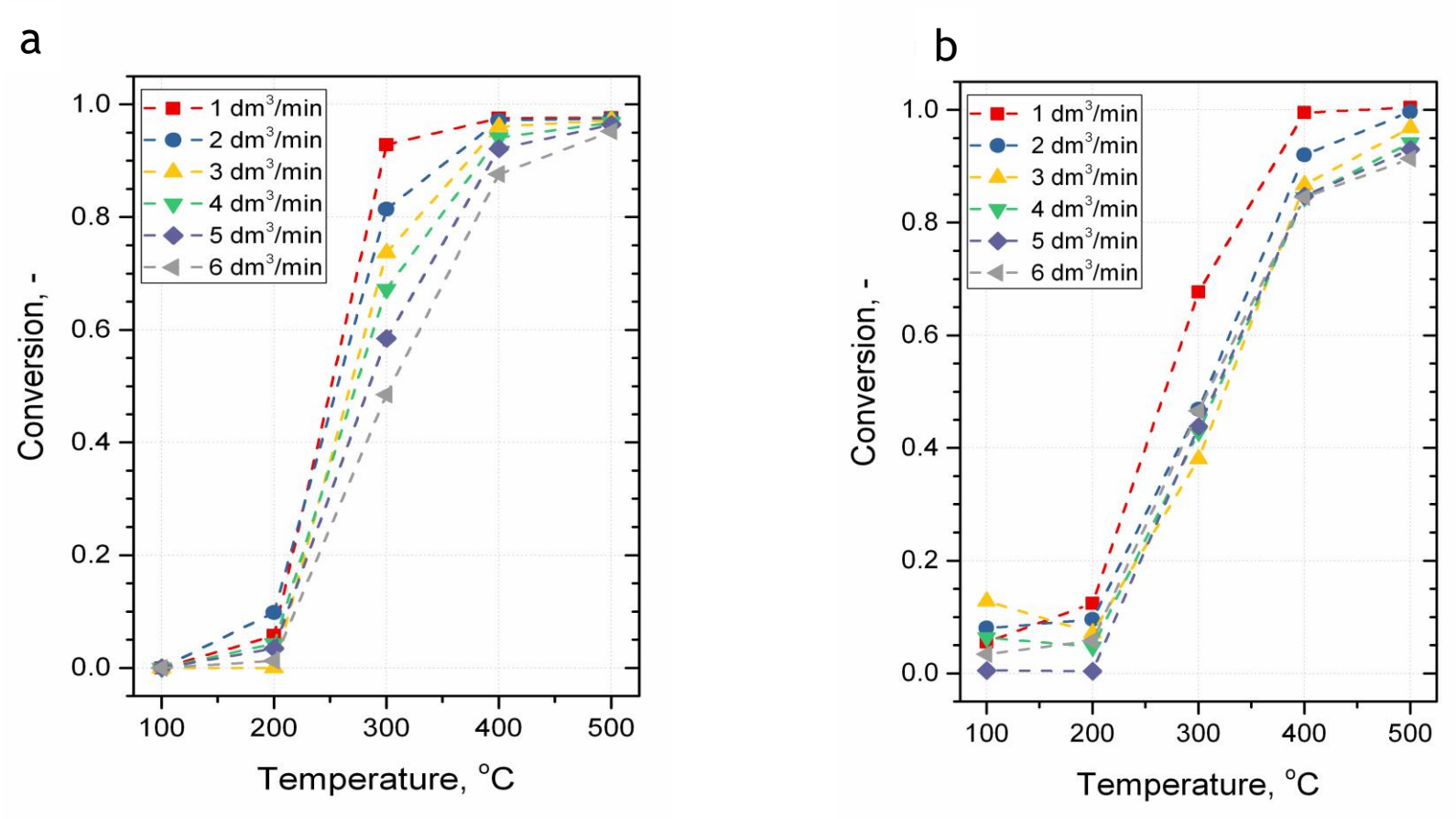
Results for tested catalysts a) XRD diffractogram, b) UV-Vis spectrum

SPECTROSCOPIC CHARACTERIZATION



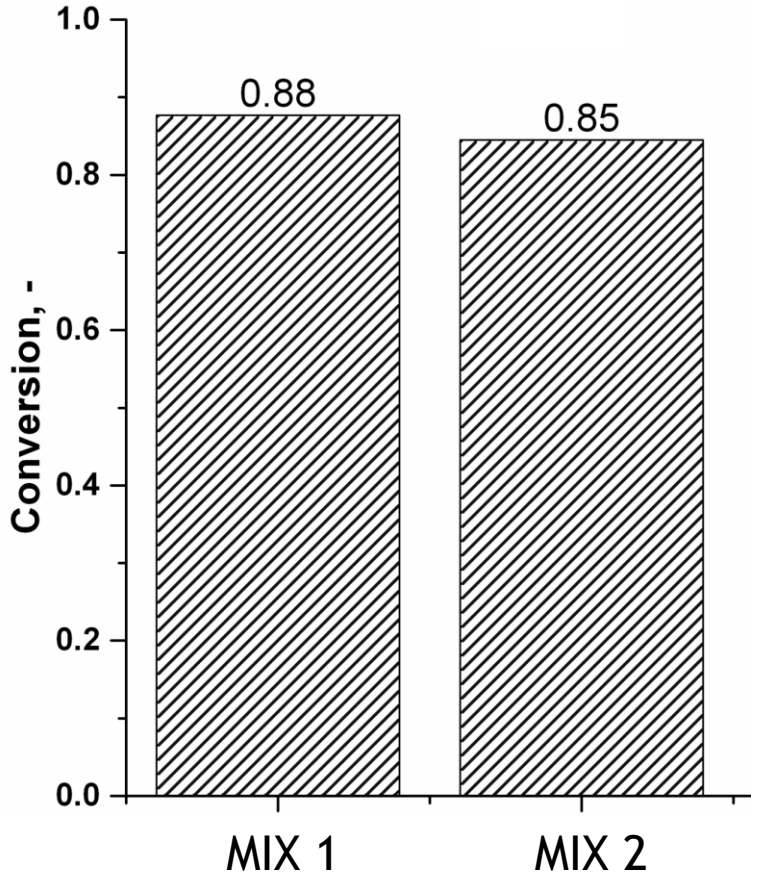
Raman spectrum for tested catalyst

CATALYTIC ACTIVITY EVALUATION



Catalytic activity for tested catalyst for different flow conditions
a) MIX 1, b) MIX 2

CATALYTIC ACTIVITY EVALUATION



Conversion at 400°C for 6 dm^3/min at different exhaust compositions

CONCLUSIONS

- Stainless steel wire mesh can be used as a support for CoPd/γ-Al_2O_3 catalysts in methane combustion
- The T50% for the 1 dm^3/min is achieved for ca. 250°C, moves to the higher temperatures with the increasing of the gas exhaust flowrates. The almost complete conversion is achieved for all considered flowrates at 500°C
- For more complex gas composition (composition II), the T50% moves towards the higher temperatures ca. 300°C for flowrates 2 - 6 dm^3/min. The conversion at 500°C varies between 90% and 100%, with the lowest catalytic activity for the shortest residence time.

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