Wrocław University of Technology

PILOT INSTALLATION FOR THERMAL PLASMA TREATMENT OF PLASTIC WASTES

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Plan of presentation

1. INTRODUCTION

(plasma in waste utilization)

2. EXPERIMENTAL

2.1 RESEARCH INSTALLATION

(installation and its elements)

2.2 ANALITIC METHODS

(measuerments and analysers)

2.3 PROCESS

(processed material and process conditions)

3. RESULTS

(results, thesis and predictions)

1. INTRODUCTION

Plasma provides highly reactive medium which includes:

- electrons
- ions
- excited molecules and atoms
- radicals

Plasma finds application in:

- gasification of solid organic materials (e.g. biomass, sewage sludge)
- decomposition of hazardous wastes (e.g. medical wastes, PCBs, toxic hydrocarbons)
- purifying process gases (after biomass gasification) from tars

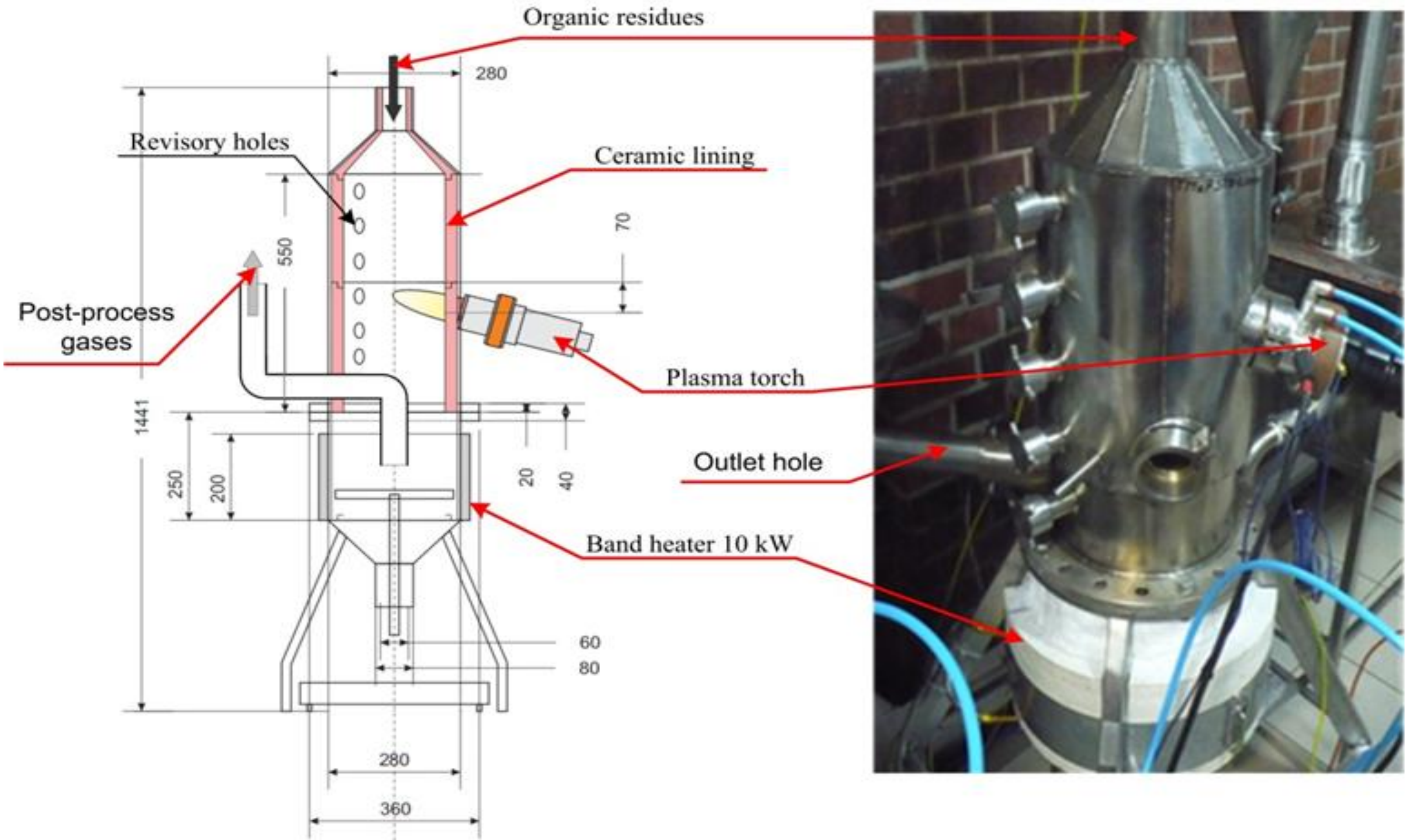
2. EXPERIMENTAL
2.1. Research installation

Two basic elements:

1. **Reactor**
- reactor itself
- plasma torch
- band heater

2. **Separating and cooling system**
- cyclone
- cooler

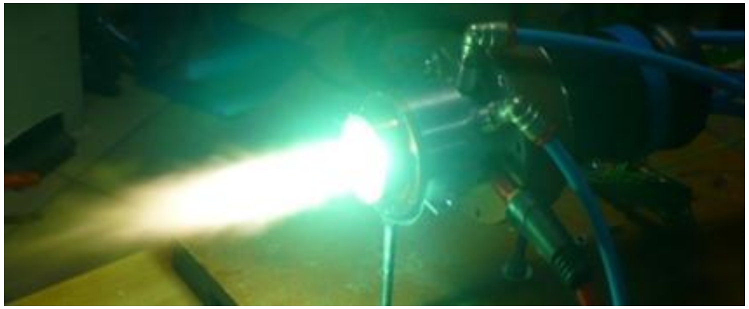
2.1 . Research installation Reactor



2.1. Research installation
Plasma torch

Arc plasma torch

- 24 kW
- cooled with water
- nitrogen and air as plasma agents

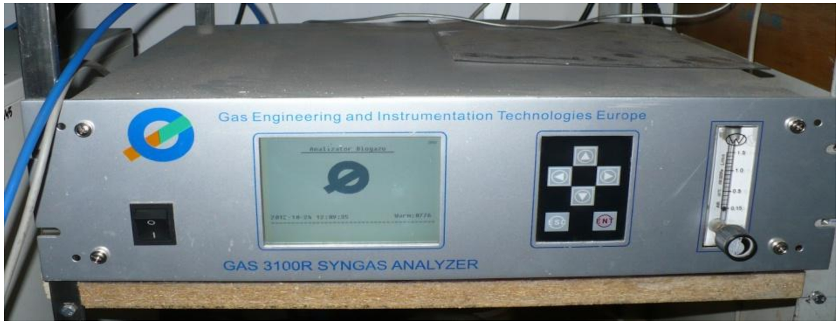


2.2. Analitic methods

Constant measurements during process

Two analyses:

- CO, CO_2, CH_4, H_2 (GAS 3000 analyser)



- Total Hydrocarbon THC (ThermoFID analyser)

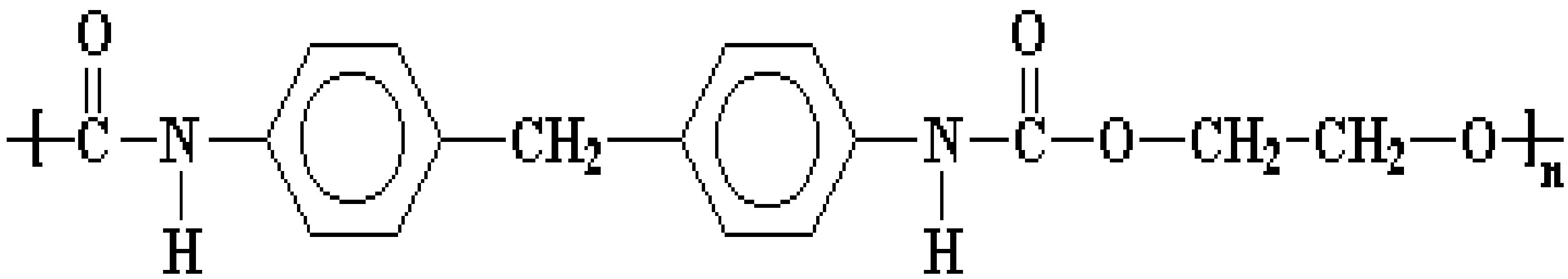
2.3. Process Material

Application of polyurethane:

- footwear
- foams
- adhesives/binders
- lacquers
- medicine (indwelling catheters, vascular access, implants)

2.3. Process Material cont'd

Polyurethane structure



2.3. Process Material cont'd

Particle size < 500 μm

Chemical composition and HHV

HHV [MJ/kg]	C[a] [%]	H[a] [%]	N[a] [%]	O[a] [%]
27,3	67,8	6,2	2,3	23,7

2.3. Process
Process conditions

Plasma torch gas input		Average temperature in the reactor	Outlet gas temperature	Plasma torch power	Polyurethane input
Air	N_2				
[l/min]	[l/min]	[°C]	[°C]	[kW]	[kg/h]
0	214,5	713	625	24	2,0
60	152,0	827	700		
100	111,3	843	720		
130	85,3	860	776		
160	54,1	887	775		
211,3	0,0	983	845		
251,3	0,0	1070	911		

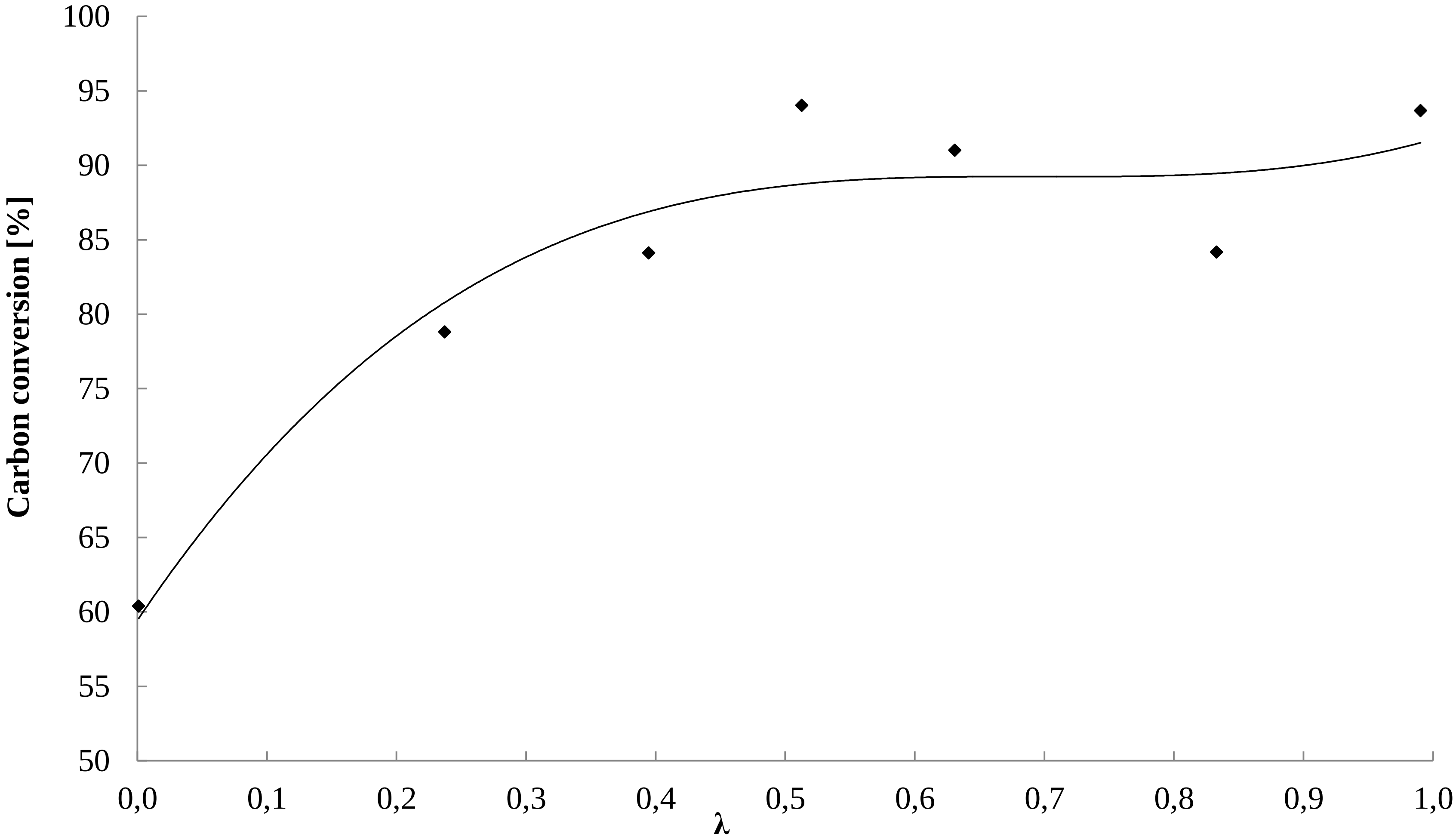
3. Results
Products

Products obtained:

- Mostly gaseous product (CO, CO_2, CH_4, H_2 + other light hydrocarbons)
- Small amounts of solid products (soot, carbonized polyurethane) inside cooler and carried out with gas stream
- Small amounts of liquid products (tar) adsorbed on solid products

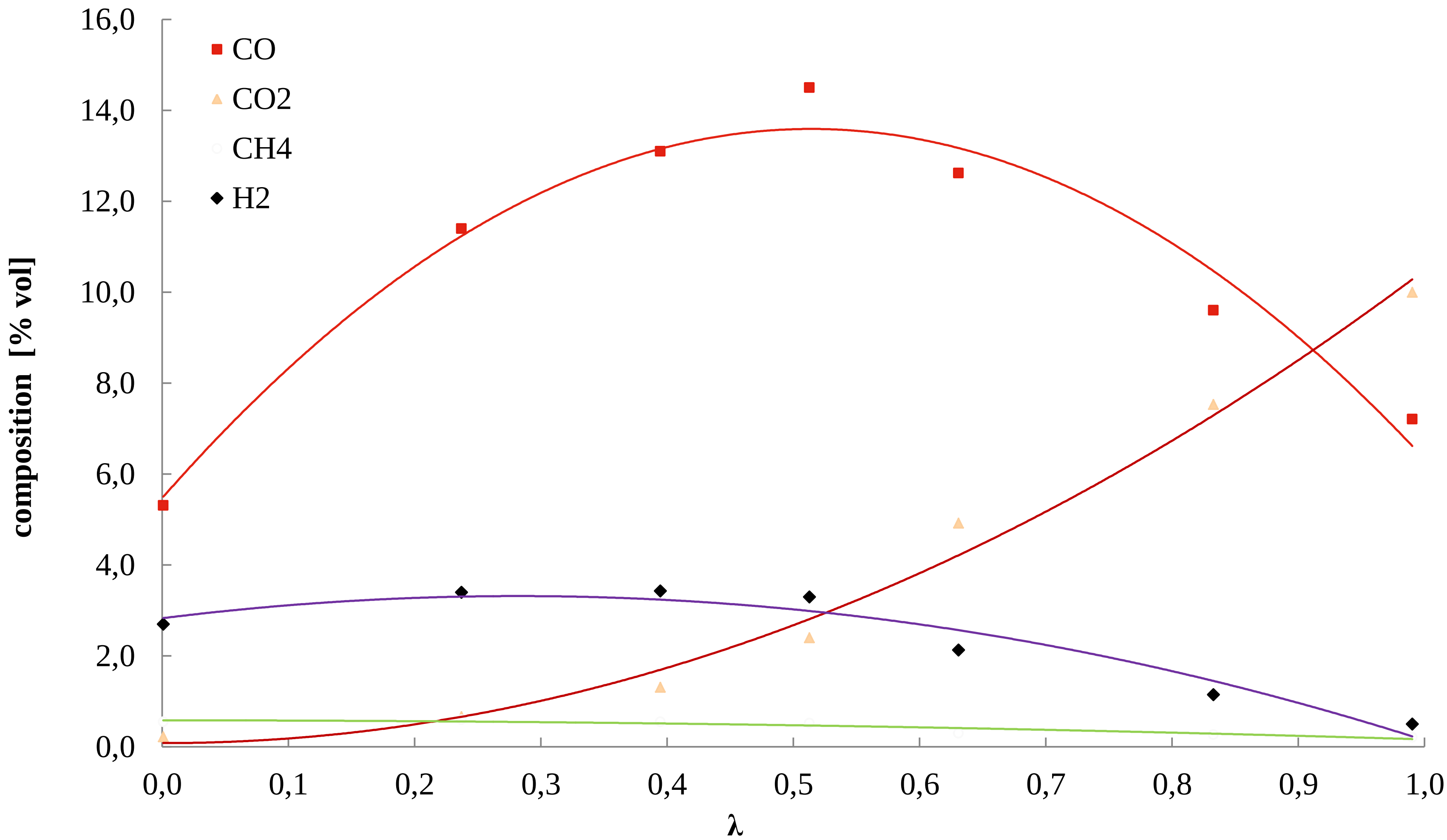
3. Results

Carbon conversion as a function of λ coefficient



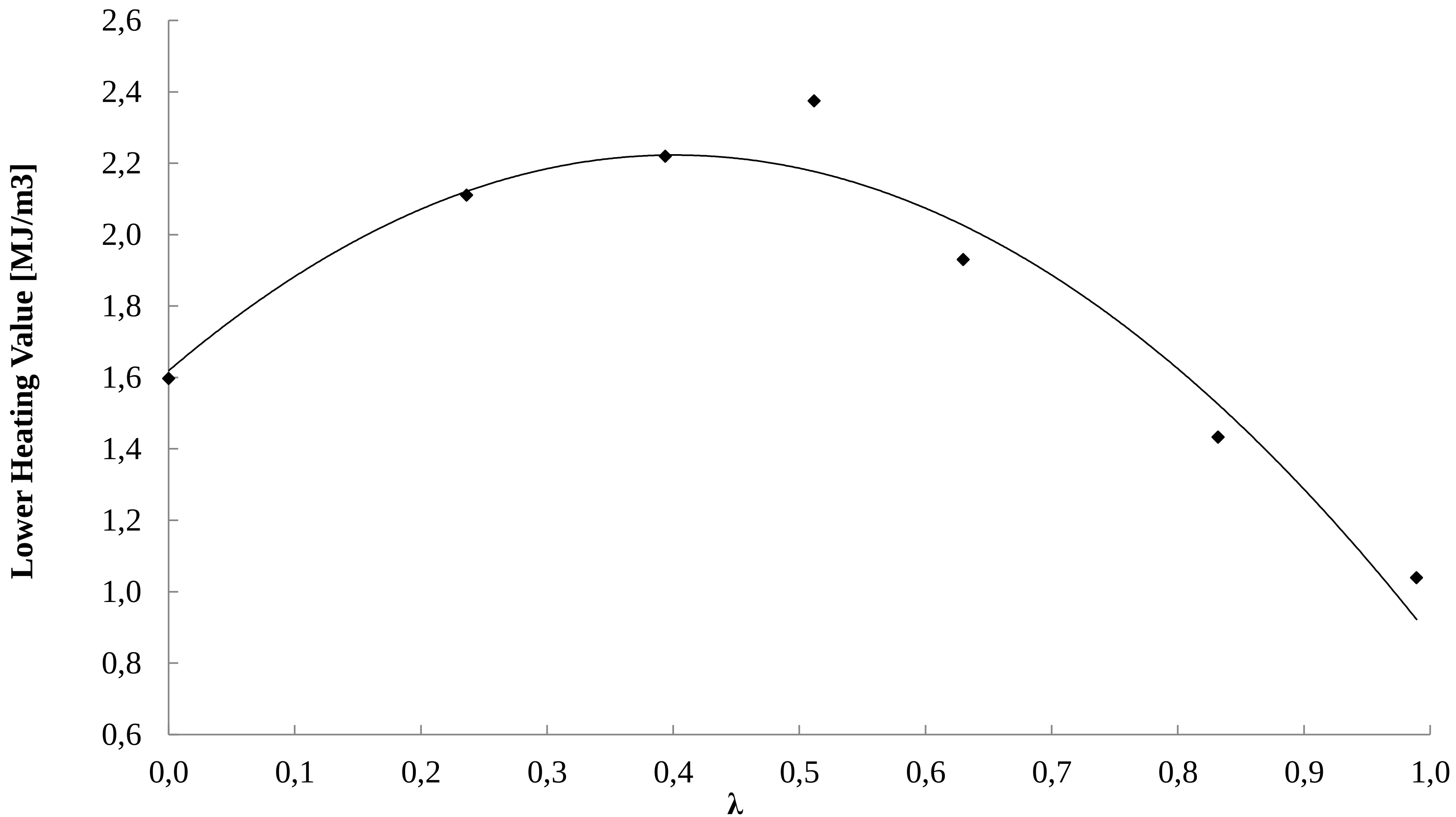
3. Results

Composition of product gas as a function of λ coefficient



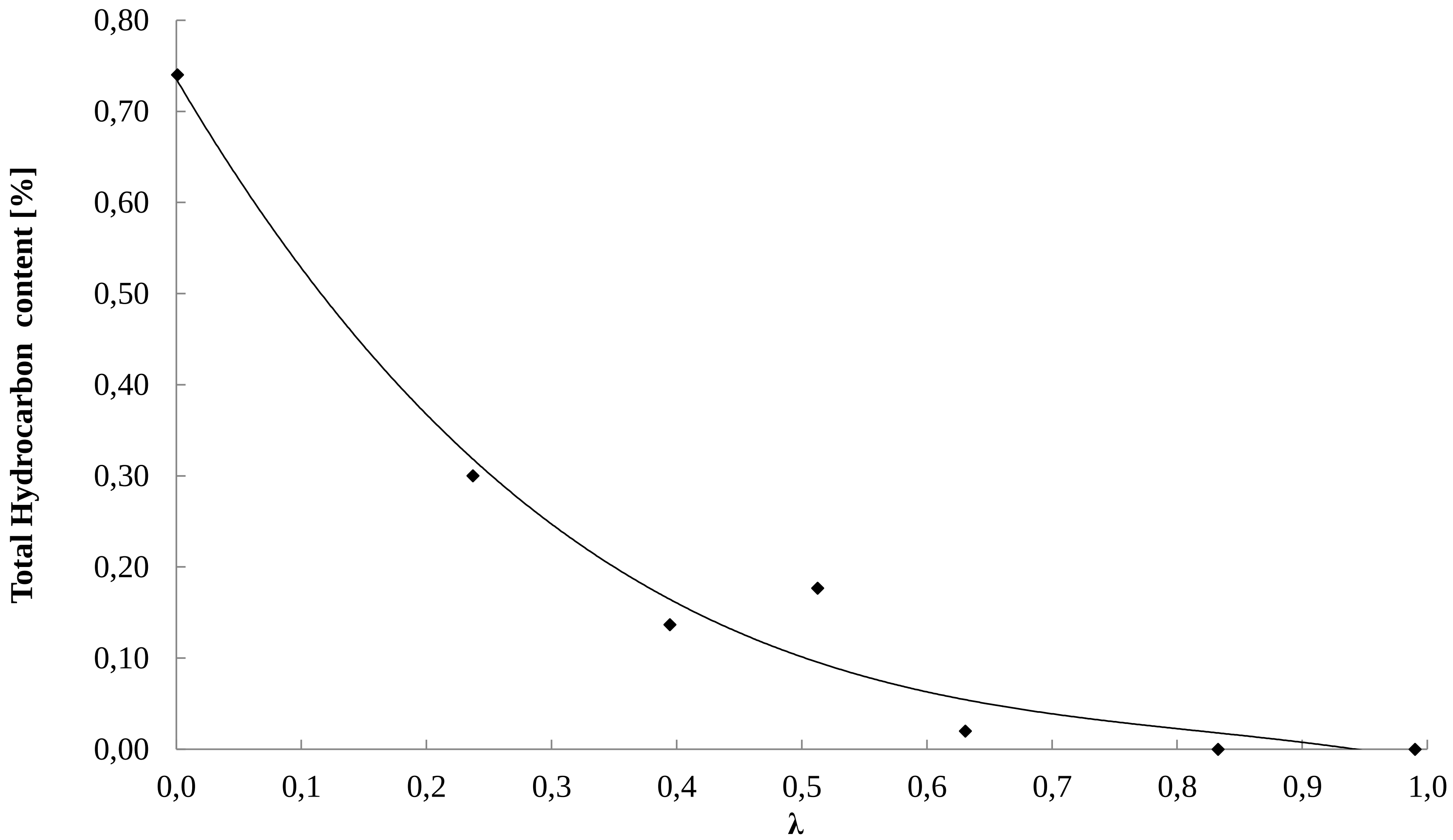
3. Results

Lower Heating Value of product gas as a function of λ coefficient



3. Results

Total Hydrocarbon content as a function of λ coefficient



3. Results
Conclusions

λ	CO	CO_2	CH_4	H_2	THC	$LHV_{prod\text{-}gas}$	C conversion
	%	%	%	%	%	MJ/m^3	%
0,000	5,31	0,22	0,55	2,70	0,740	1,83	60,4
0,236	11,40	0,66	0,60	3,40	0,300	2,29	78,8
0,394	13,10	1,31	0,55	3,43	0,137	2,34	84,1
0,512	14,50	2,40	0,52	3,30	0,177	2,53	94,0
0,630	12,62	4,92	0,30	2,13	0,020	1,95	91,0
0,832	9,60	7,53	0,27	1,15	0,000	1,43	84,2
0,989	7,21	10,000	0,210	0,500	0,000	1,04	93,7

3. Results
Conclusions cont'd

- Low calorific gas can be obtained from gasification of PU
- Best results for excess air coefficient near 0,5
- Aromatic structure causes obtaining soot and tars
- De-dusting devices needed
- Increased temperature (by better insulation or additional plasma torch) seems to be possible solution

4. Acknowledgements

Installation was built within the confines of realization Research Project called „*Application of the plasma technique to biomass and waste gasification for fluid fuel production*” funded by the National Centre for Research and Development (contract No. NR06-0003-10/2010).

Thank you for your attention.