Full-scale experiments at steam cracker unit

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Barbora Baranová

European union legislation

- **Clean Industrial Deal**

  replacement of 20 % of standard fossil feedstock by 2035

- **Orlen Group**

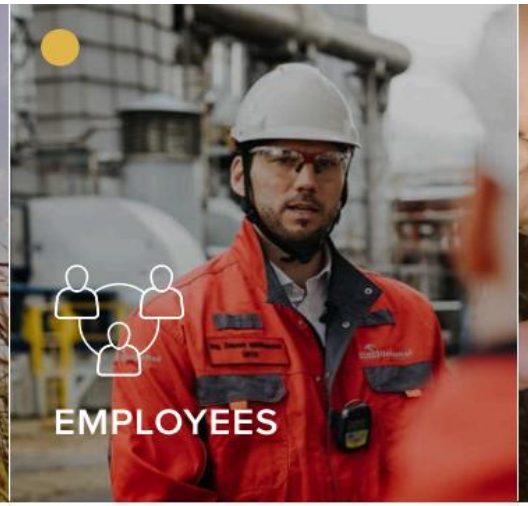
  commitment to replace 10 % fossil feedstock by 2035

The main objective

- improving long-term financial performance
- building trust with stakeholders
- boosting reputation
- being identified as a sustainable, future-proof company by investors

Action to minimise climate impact

Environment and biodiversity protection



Occupational safety and well-being

Relation with stakeholders and communities

Responsible governance

… and now technical point of view. Why is it inevitable to perform full-scale tests?

- during the March operation we observed fluctuation in S/O ratio on one pyrolysis furnace
- the reason for this phenomenon was contamination of process steam by NaOH
- consequences of this contamination: clogged MIX → forced furnace shut-down → cleaning of MIX

Pyrolysis gasoline test: Sampled regular naphta & mixed naphta PIONA analysis

- data from hot cracked gas sampling (feedstock and yields)

regular naphta

component [% wt.]	
n-alkanes	26.7
i-alkanes	33.8
olefins	3.2
naphthenes	27.2
aromatics	8.3

typical mixed naphta

component [% wt.]	
n-alkanes	23.3
i-alkanes	32.8
olefins	4.1
naphthenes	27.3
aromatics	11.3

mixed naphta – worst case

component [% wt.]	
n-alkanes	17.6
i-alkanes	28.2
olefins	3.8
naphthenes	20.5
aromatics	27.6

** Přemysl Michalička, Impact of quench tower malfunction on steam cracker yields and performance, ICCT Conference 2025*

Pyrolysis gasoline test: Cracked gas yields

component [% wt.]	
hydrogen	0.84
methane	13.35
ethylene	25.96
propylene	13.88
buta-1,3-diene	4.24
benzene	9.33
toluene	4.94
styrene	1.44
naphthalene	0.91
C_{9+} aromatics	4.61
oil	4.49

regular naphta*

GK6 heaters	
COT [°C]	830
S/O [$kg \cdot kg^{-1}$]	0.50
feed [$t \cdot h^{-1}$]	26

mixed naphta*

component [% wt.]	
hydrogen	0.66
methane	10.93
ethylene	20.60
propylene	11.15
buta-1,3-diene	3.49
benzene	14.98
toluene	7.90
styrene	2.50
naphthalene	1.94
C_{9+} aromatics	6.87
oil	6.65

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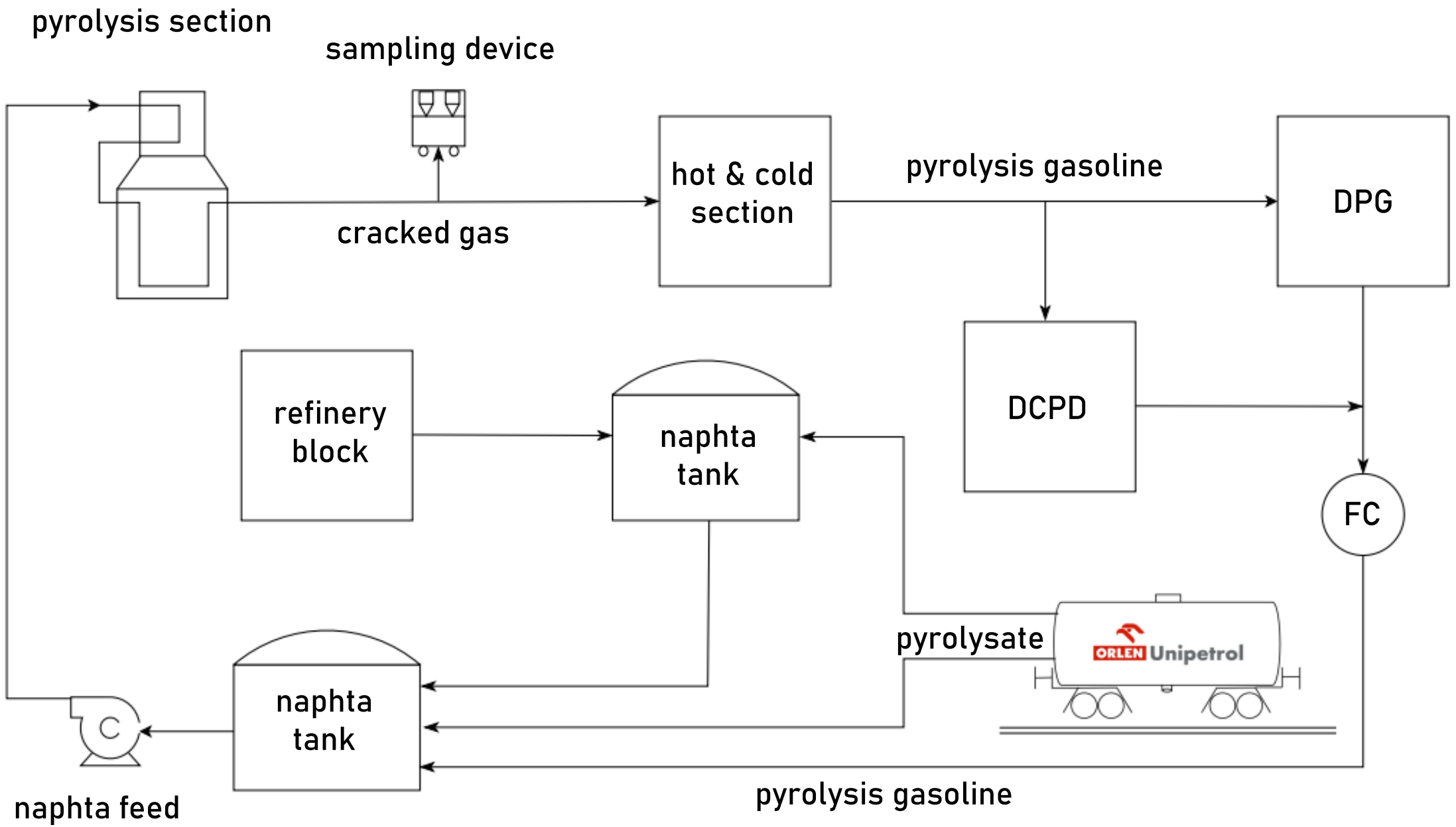
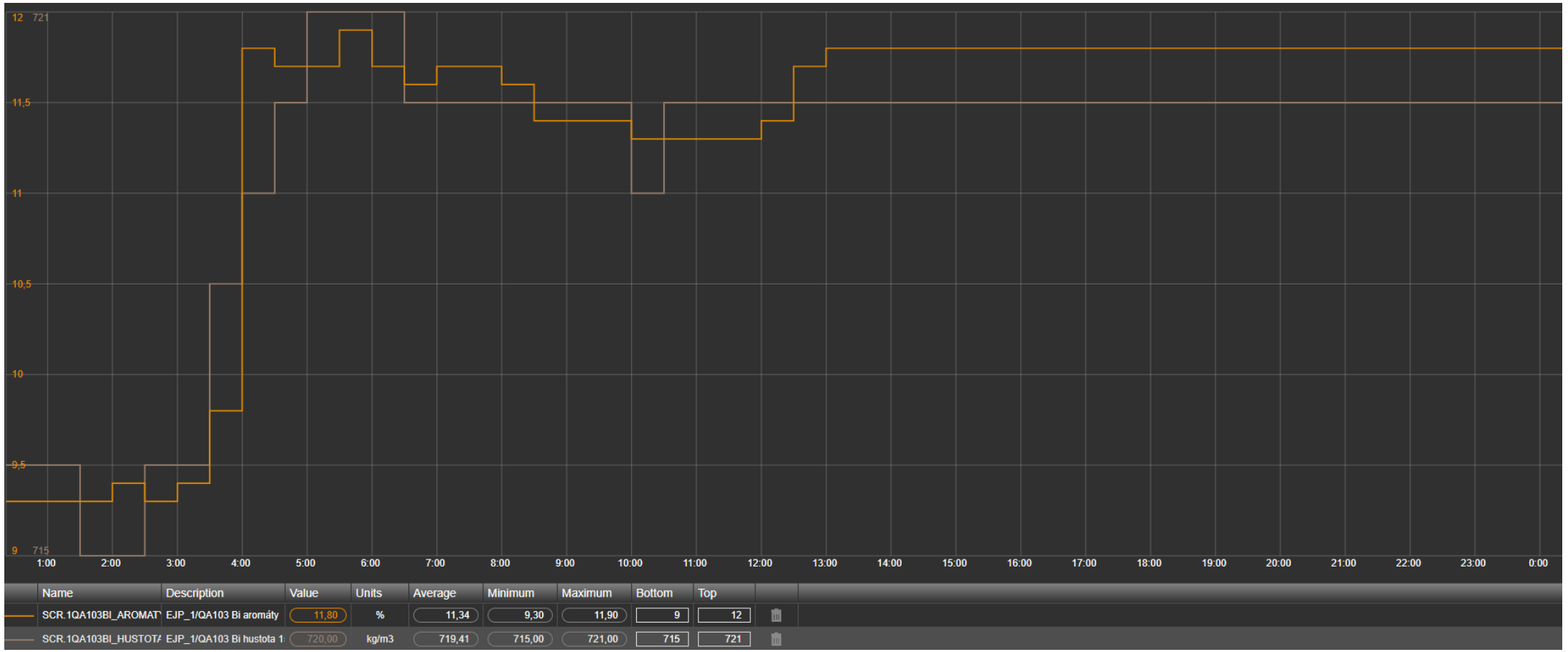

pyrolysis section
sampling device
cracked gas
hot & cold section
pyrolysis gasoline
DPG
DCPD
refinery block
naphta tank
FC
pyrolysate
ORLEN Unipetrol
naphta tank
naphta feed
pyrolysis gasoline

Pyrolysis gasoline test: result

- density increase 715 kg/m^3 → 721 kg/m^3
- increase in aromatics concentration 9.30 % wt. → 11.90 % wt.



Gunvor: Comparison of yields

component [% wt.]	
methane	9.88
ethane	1.92
ethylene	27.14
propane	0.23
propylene	11.55
acetylene	1.15
propadiene	0.28
sum C4	9.07
benzene	7.81
toluene	4.91
non-identified (FID2) +(FID3)	8.06 14.92
oils (FID1)	3.08

mixed naphta (10 % wt.)

naphta + PO (10 % wt.)

component [% wt.]	
methane	8.79
ethane	1.81
ethylene	25.56
propane	0.24
propylene	11.63
acetylene	1.03
propadiene	0.23
sum C4	9.34
benzene	6.54
toluene	4.44
non-identified (FID2) +(FID3)	10.67 16.19
oils (FID1)	3.52

** data obtained from Micropyrolysis Unit, Orlen Unipetrol, Litvínov*

Conclusion

- perform the maximum possible test-runs with mixed naphta feed
- maximize the lesson-learnt – precise evaluation and comparison of a model feedstock vs. pyrolysis oil from recycled plastics

Thank you for your attention!

Barbora.Baranova@orlenunipetrol.cz