Gas Sampling, Measurement and Analyses at Güssing - DFB-Biomass gasification

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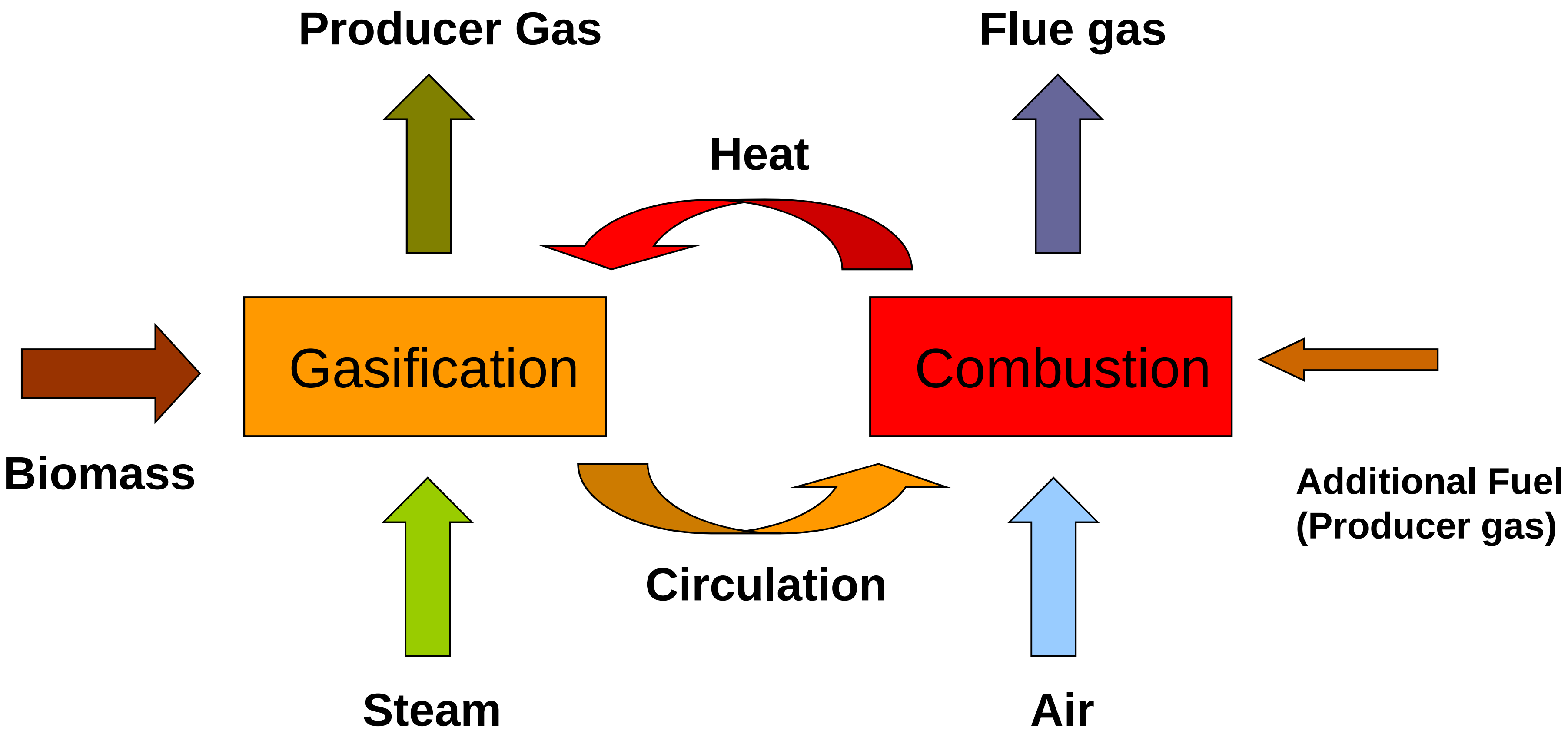
Bioenergy 2020+

Gasification Concept of Dual Fluid



- Low temperature gasification (800-900°C)
- Atmospheric pressure
- Catalytic activity of bed material and ash influences the gas qualtiy

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Flow chart of DFB for CHP

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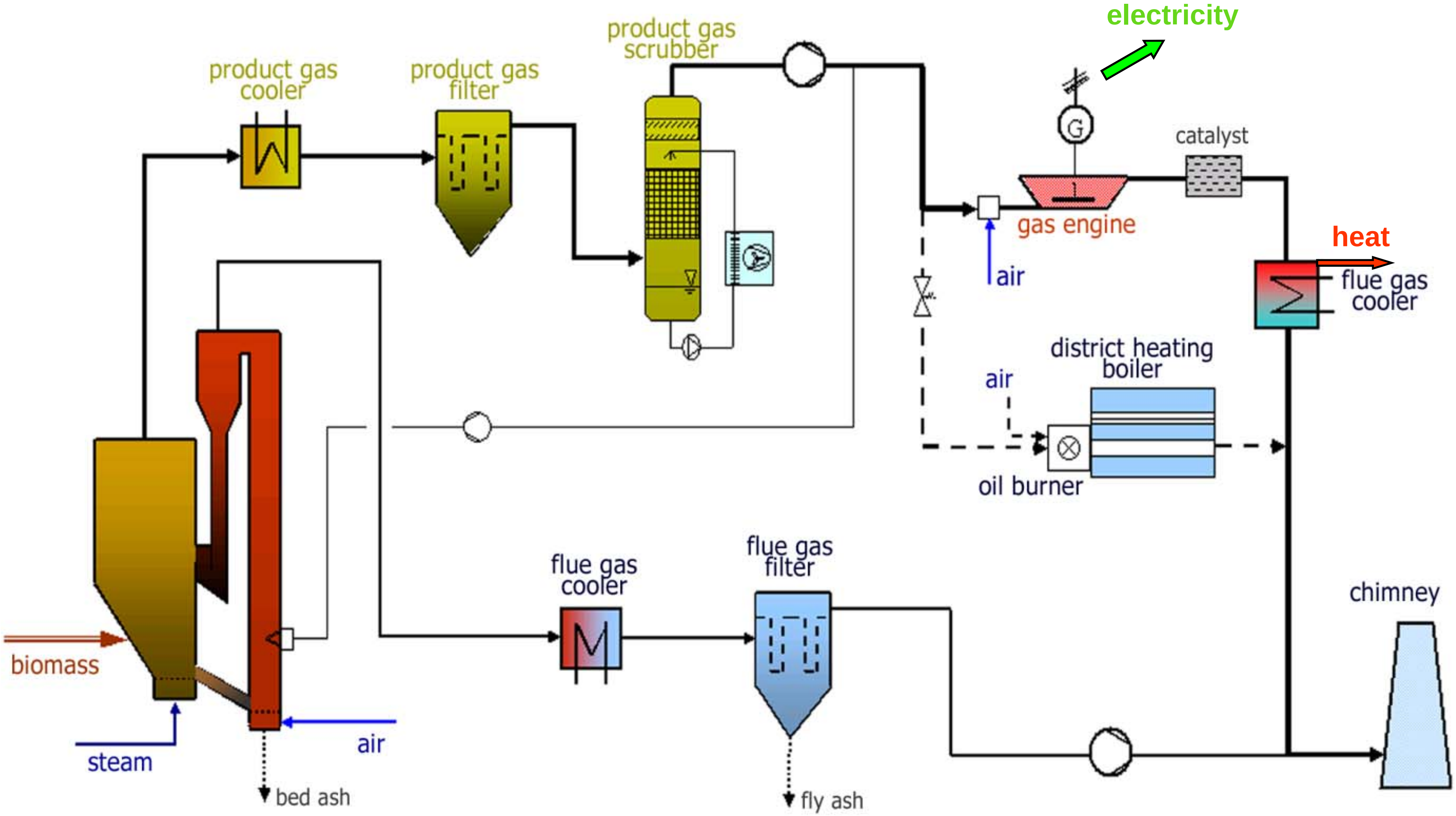
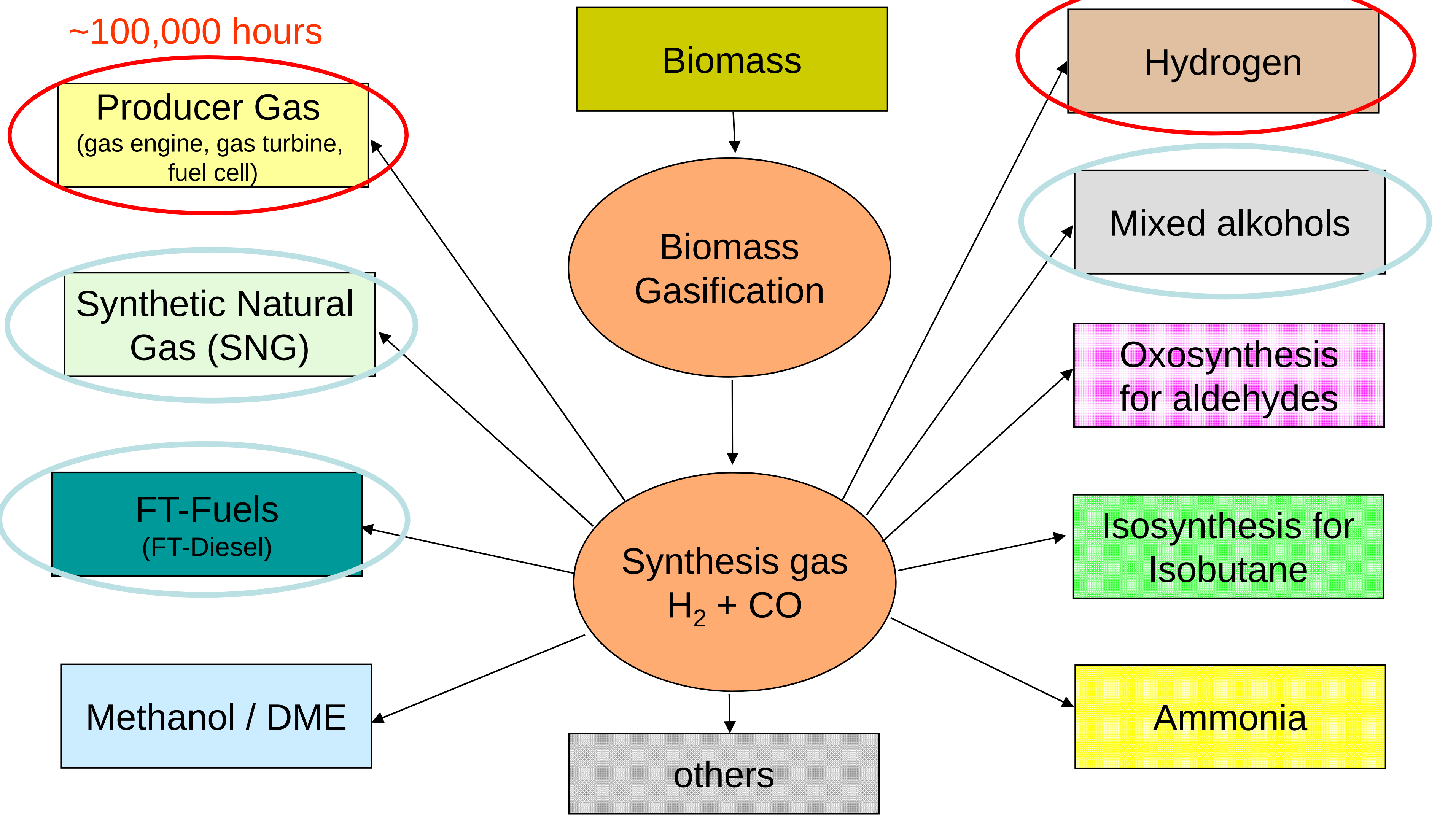


The basic concept – "Green Chemistry"

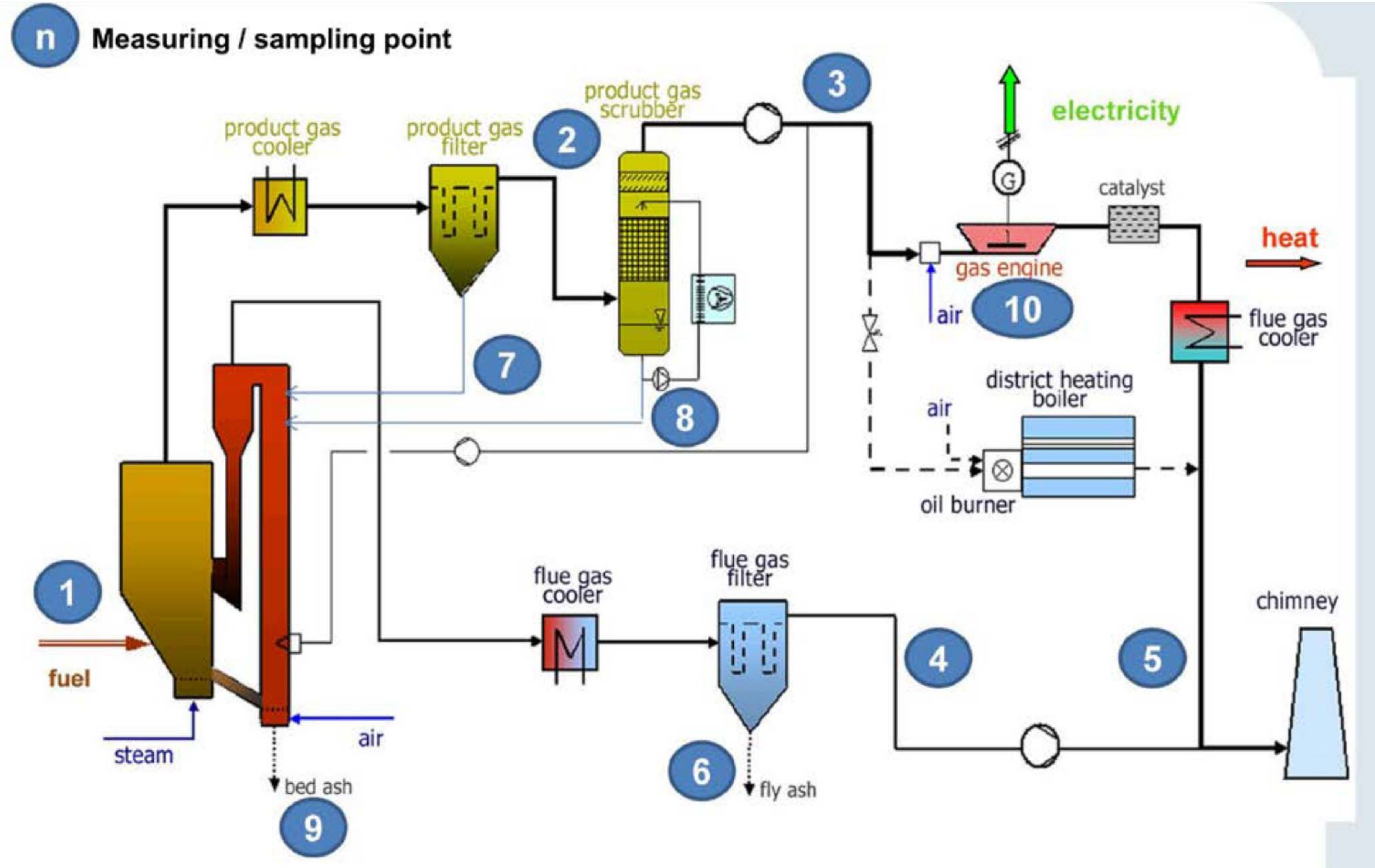


CHP standard operation

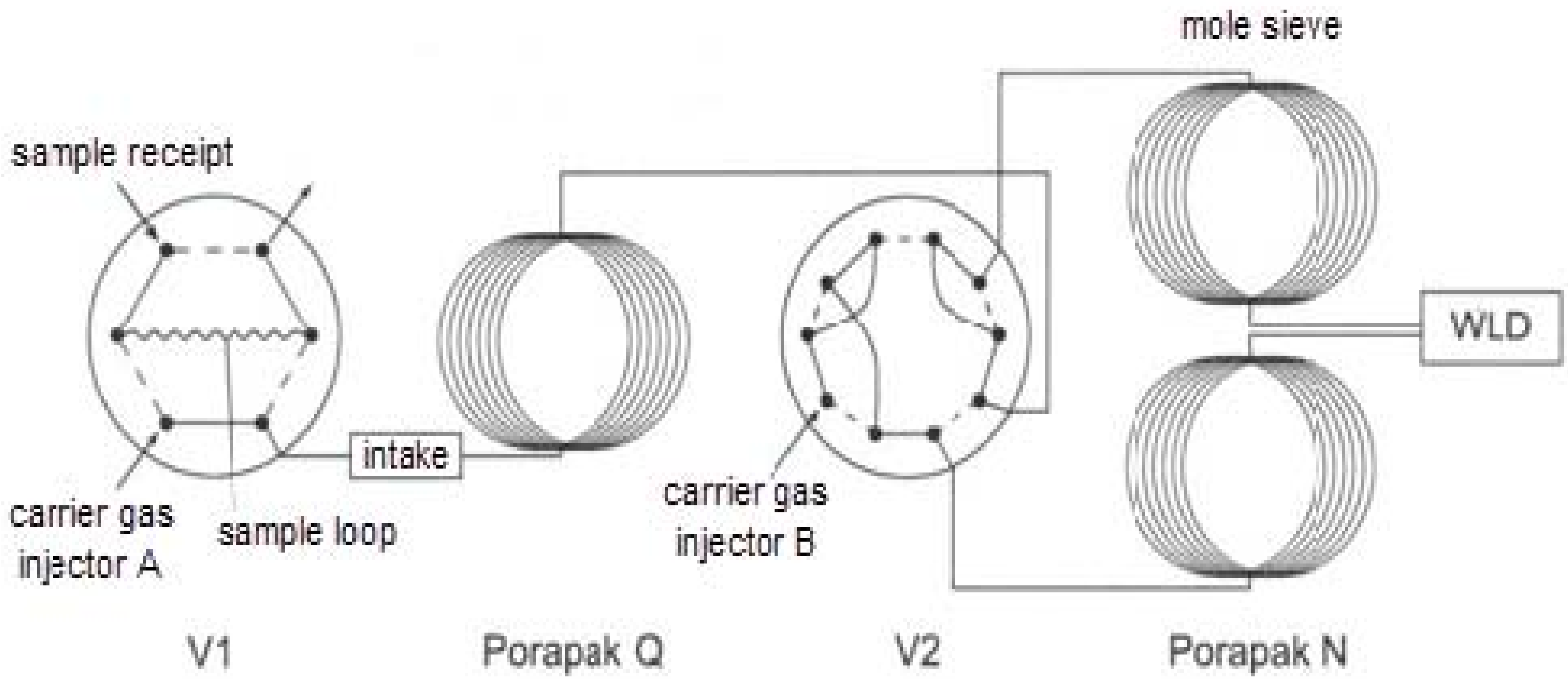
- Here fast results are necessary, so only online systems are used
- For normal operation only gas components are analysed (CO, CO_2, O_2), here typical online analysers are used (infrared, paramagnetic)
- Main difficulty is to clean the gas and to bring it into the analyser with good availability
- Analysis of the engine oil is also quite important as it shows the quality of the gas treatment

- For commissioning/optimisation of the process the following analysis are done:
  - All permanent gases in the producer gas (by GC)
  - Flue gas in combustor and gas engine (CO, NOx, SOx, PAH, …)
  - Tar and particles in gas phase (gravimetric and GC-MS), here TU Vienna uses the standard method, only a different solvent (toluene) is used
  - Hydrocarbons / tar content in solvents (e.g. tar content in RME)
  - Bed material and ashes (activiation of the bed material)

Typical analytical points for full characterisation



Typical GC configuration



Gas Composition (after gasifier)

Main Components		
H_2	% (dry)	35-45
CO	% (dry)	22-25
CH_4	% (dry)	~10
CO_2	% (dry)	20-25
H2O	%	30-50

Minor Components		
C_2H_4	% (dry)	2-3
C_2H_6	% (dry)	~0.5
C_3H_6	% (dry)	~0,4
O_2	% (dry)	< 0,1
N_2	% (dry)	0.3-3
C_6H_6	g/m³	5-10
C_7H_8	g/m³	1-2
$C_{10}H_8$	g/m³	~2
TARS (grav.)	g/m³	1-5

Possible poisons		
H_2S	mgS/Nm³	~200
COS	mgS/Nm³	~10
Mercaptans	mgS/Nm³	~30
Thiophens	mgS/Nm³	~7
HCl	ppm	~3
NH3	ppm	500-1000
Dust	g/Nm³	10-100

H_2:CO = from 1.5:1 to 2:1

Tar Composition (after gasifier)

Phenylacetylen	mg/Nm³	122	141
Styrol	mg/Nm³	1360	1575
Mesitylen	mg/Nm³	0	0
Phenol	mg/Nm³	345	515
Benzofuran	mg/Nm³	243	301
1H-Inden	mg/Nm³	2621	2243
2-Methylphenol	mg/Nm³	0	0
4-Methylphenol	mg/Nm³	0	0
2-Methylbenzofuran	mg/Nm³	0	0
2,6-Dimethylphenol	mg/Nm³	0	0
2,5 u. 2,4-Dimethylphenol	mg/Nm³	0	0
3,5-Dimethylphenol	mg/Nm³	0	0
2,3-Dimethylphenol	mg/Nm³	0	0
3,4-Dimethylphenol	mg/Nm³	0	0
2-Methoxy-4-Methylphenol	mg/Nm³	0	0
Naphtalin	mg/Nm³	5954	4892
1-Benzothiophen	mg/Nm³	0	0
Chinolin	mg/Nm³	62	103
2-Methylnaphthalin	mg/Nm³	457	534
Isochinolin	mg/Nm³	0	0
1-Methylnaphthalin	mg/Nm³	301	355
1-Indanon	mg/Nm³	0	0
Eugenol	mg/Nm³	0	0

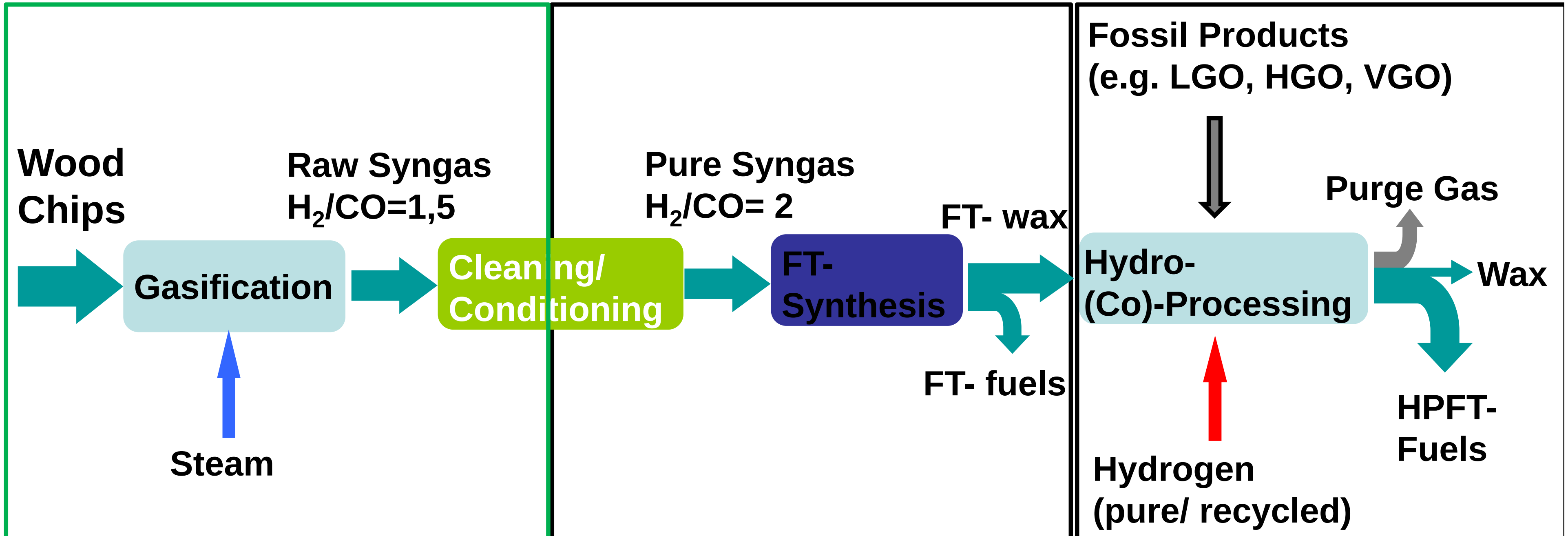
Indol	mg/Nm³	58	112
Biphenyl	mg/Nm³	222	290
Isoeugenol	mg/Nm³	0	0
Acenaphtylen	mg/Nm³	1769	2268
Acenaphten	mg/Nm³	56	70
Dibenzofuran	mg/Nm³	145	176
Flouren	mg/Nm³	435	633
Dibenzothiophen	mg/Nm³	0	0
Anthracen	mg/Nm³	1209	1342
Phenanthren	mg/Nm³	271	330
Carbazol	mg/Nm³	0	0
4,5-Methylphenanthren	mg/Nm³	111	161
9-Methylanthracen	mg/Nm³	0	0
Flouranthen	mg/Nm³	284	329
Pyren	mg/Nm³	301	358
Benzo[a]anthracen	mg/Nm³	112	119
Chrysen	mg/Nm³	180	199
Benzo[b]flouranthen	mg/Nm³	0	31
Benzo[k]flouranthen	mg/Nm³	0	38
Benzo[a]pyren	mg/Nm³	8	84
Benzo[g,h,i]perylen	mg/Nm³	0	0
Dibenz[a,h]anthracen	mg/Nm³	0	0
Indeno[1,2,3-cd]pyren	mg/Nm³	0	0

Analytics in synthesis applications, as example FT is used:

*Bio*FiT
BIOMASS-TO-FISCHER-TROPSCH

$$nCO + 2nH_2 = nCH_2 + nH_2O$$

Schema of FT

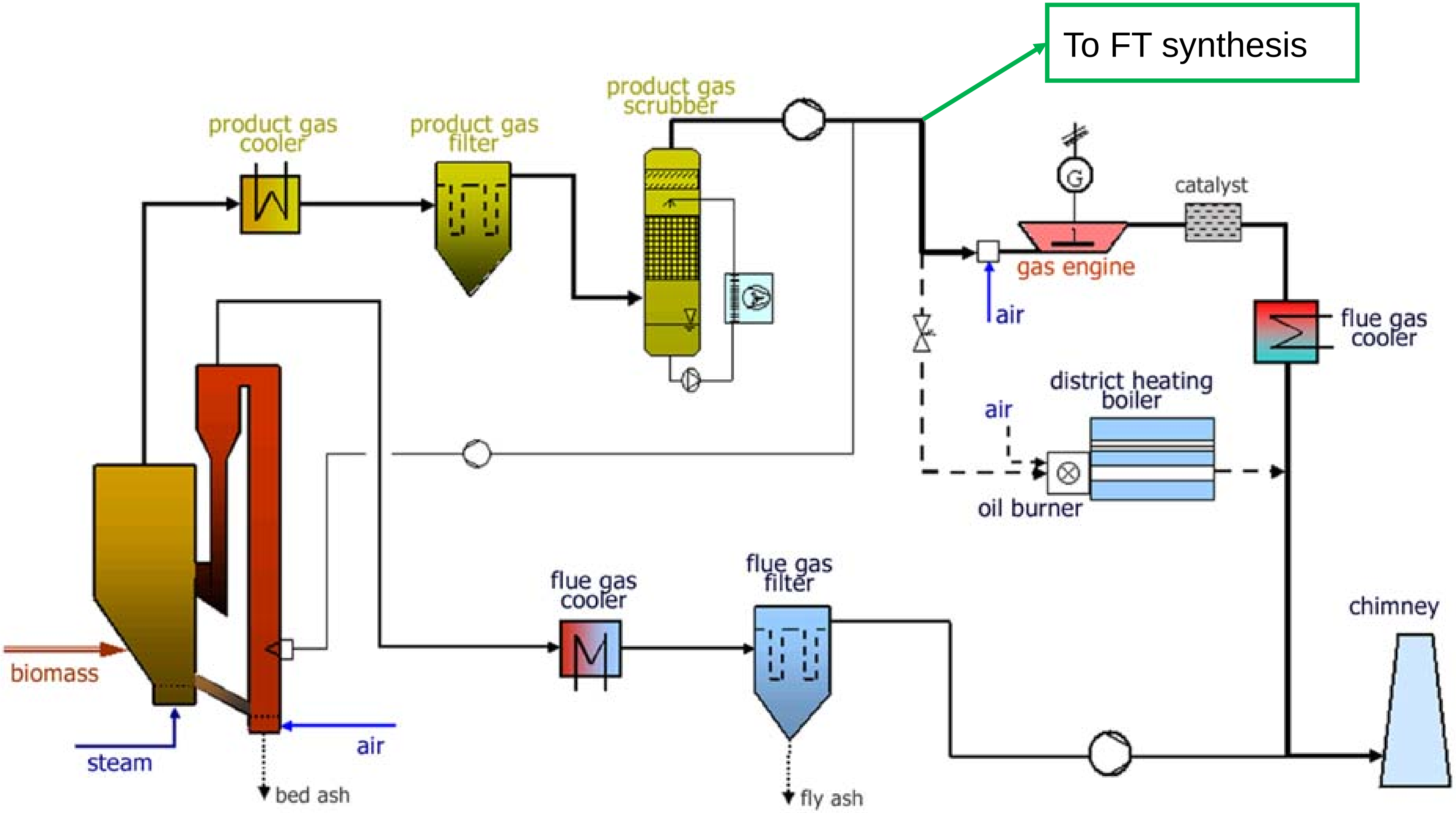


Long term experience in Güssing with wood R&D on other feedstock's	Long term experience in lab scale upscaling to 1 barrel/day	Actual done by refinery R&D for integration on the long term

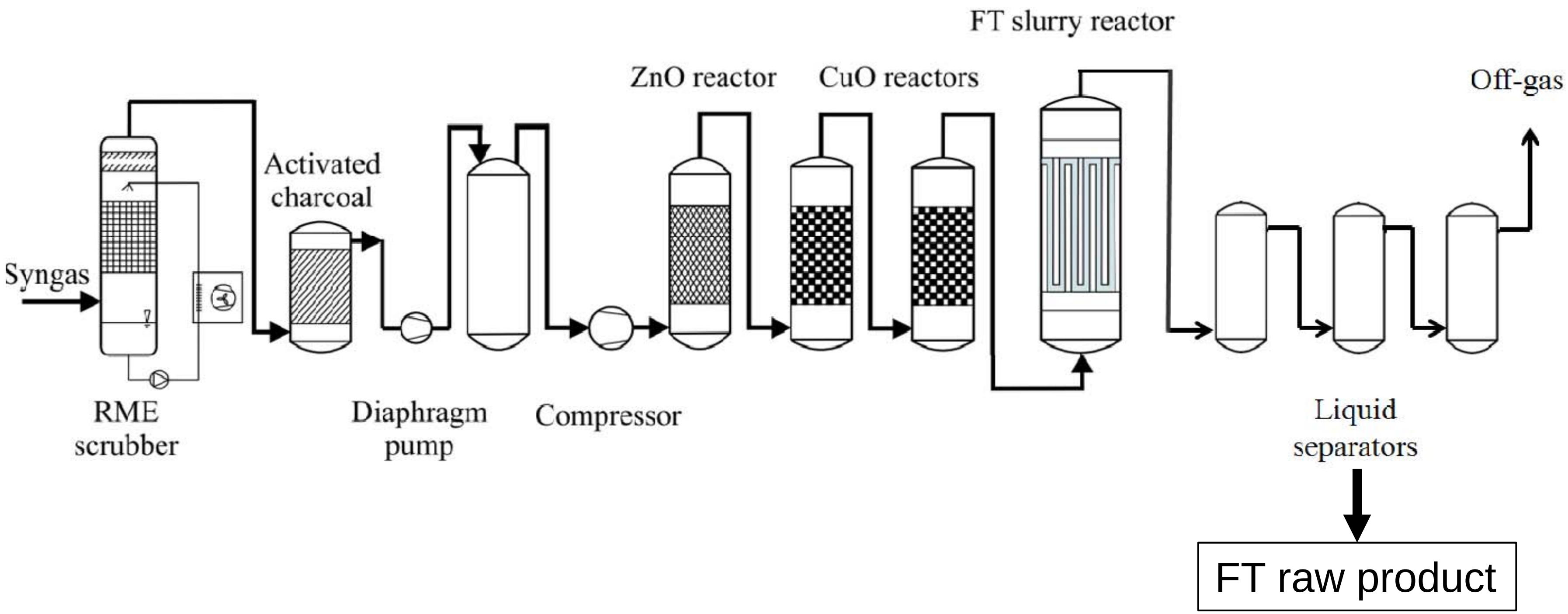
Same analytics as in CHP are used

Focus on catalyst poisons, like S, Cl or metalls

Technology and analytics from refineries are used


To FT synthesis
product gas scrubber
product gas cooler
product gas filter
catalyst
gas engine
air
flue gas cooler
district heating boiler
air
oil burner
flue gas cooler
flue gas filter
chimney
biomass
steam
air
bed ash
fly ash

FT lab scale plant



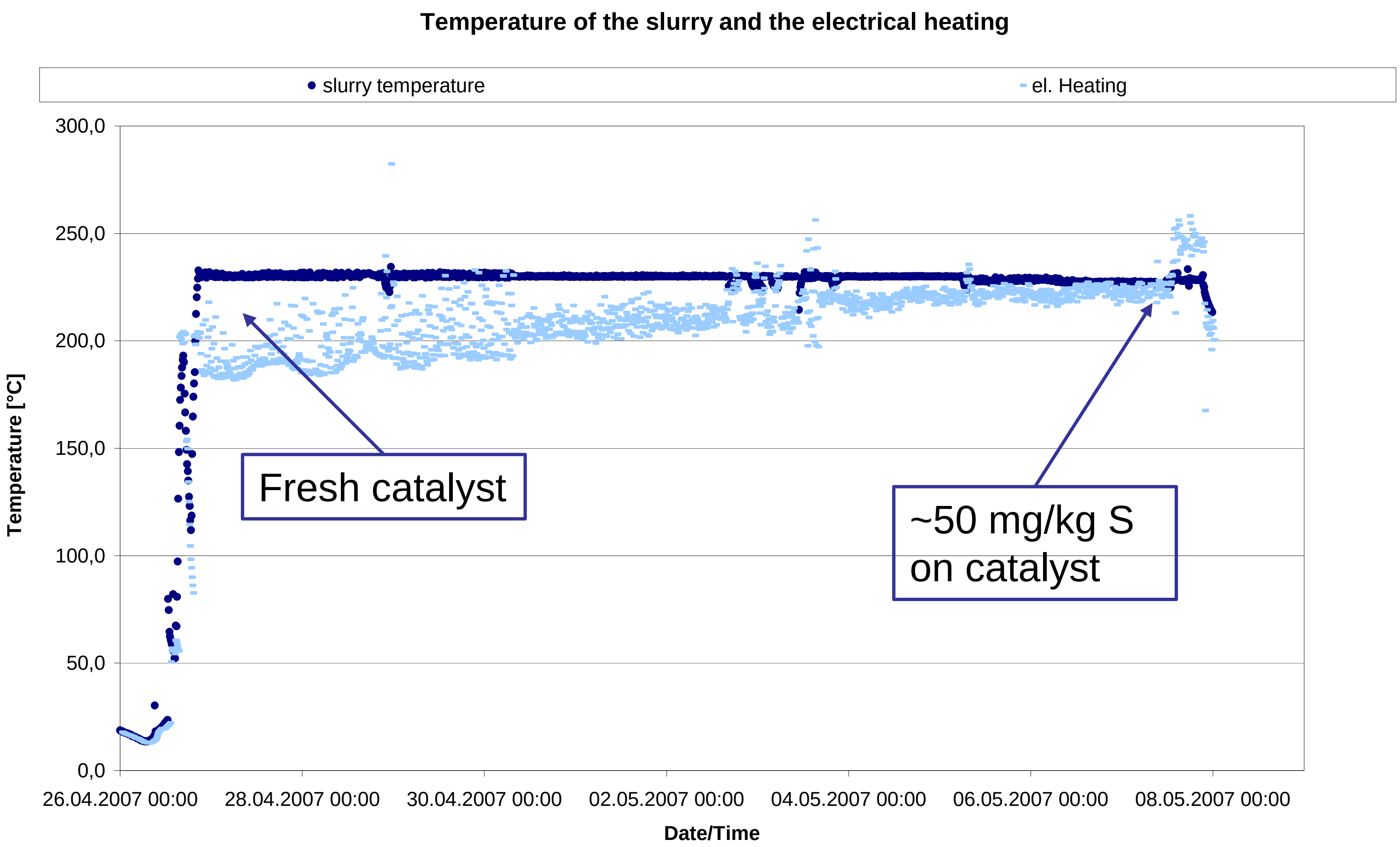
5-10kg/day of FT raw product

Slurry reactor, because of excellent heat transfer and easy scaling up

Gas treatment removes Sulphur to below 10ppb

Fully automatic

Post mortem analysis



Analytics

- Sulphur
  - In the gas phase by GC-SCD,
  - sampling is done by Tedlar bags
- Chlorine, Ammonia, HCN
  - Sampling in liquids (e.g. H2SO4),
  - analysis by IC
- BTX, Naphthalene
  - Sampling by Tedlar bags or online
  - Analysed by GC
- Metalls, Carbonyls
  - Done by external organisations

Conclusion

- Analytics for standard CHP are established and work well
- They are only too expansive and/or to much maintenance is necessary

- Species analysed for synthesis gas are different than CHP (focus more on inorganic)
- Analytics for synthesis applications are more difficult, as the range from **ppm** is changed to **ppb**
- In addition to the analytics long term tests in pilot scale are really necessary, because you do not know, if you miss one catalyst poison

More Information

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