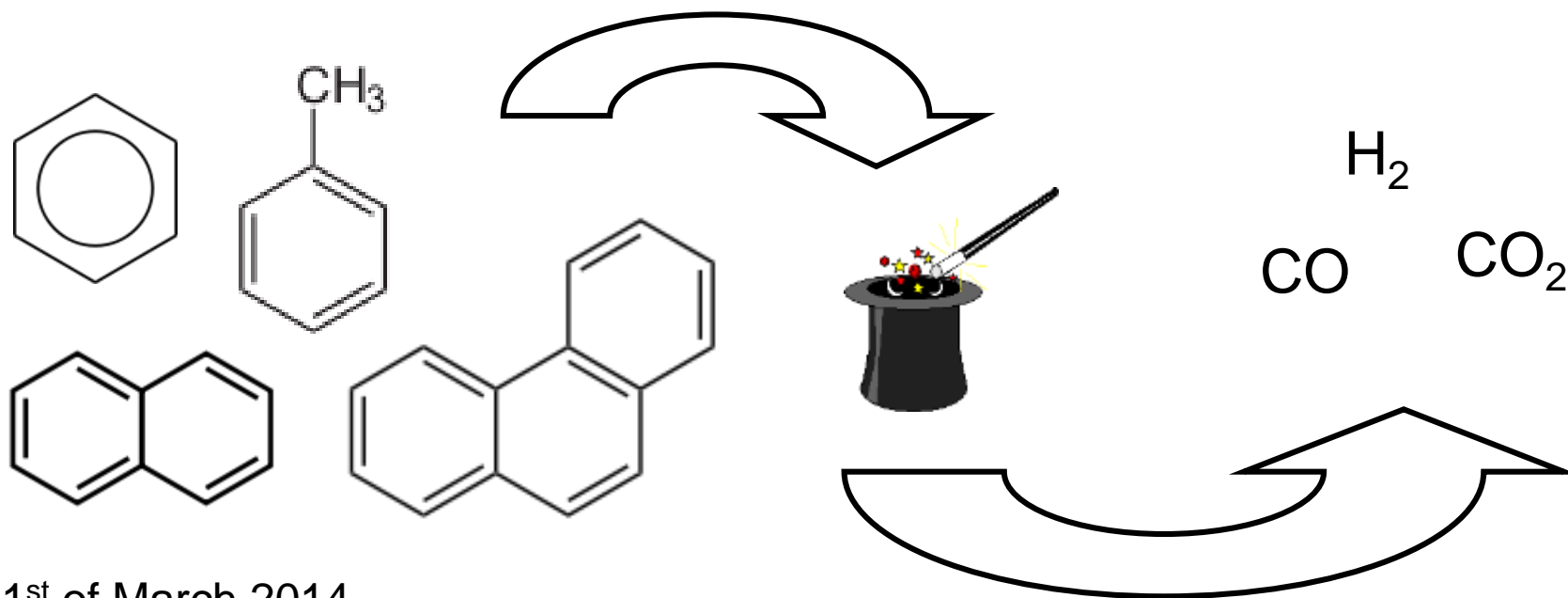

Model gas made by Fraunhofer UMSICHT

Gas Analysis Webinar

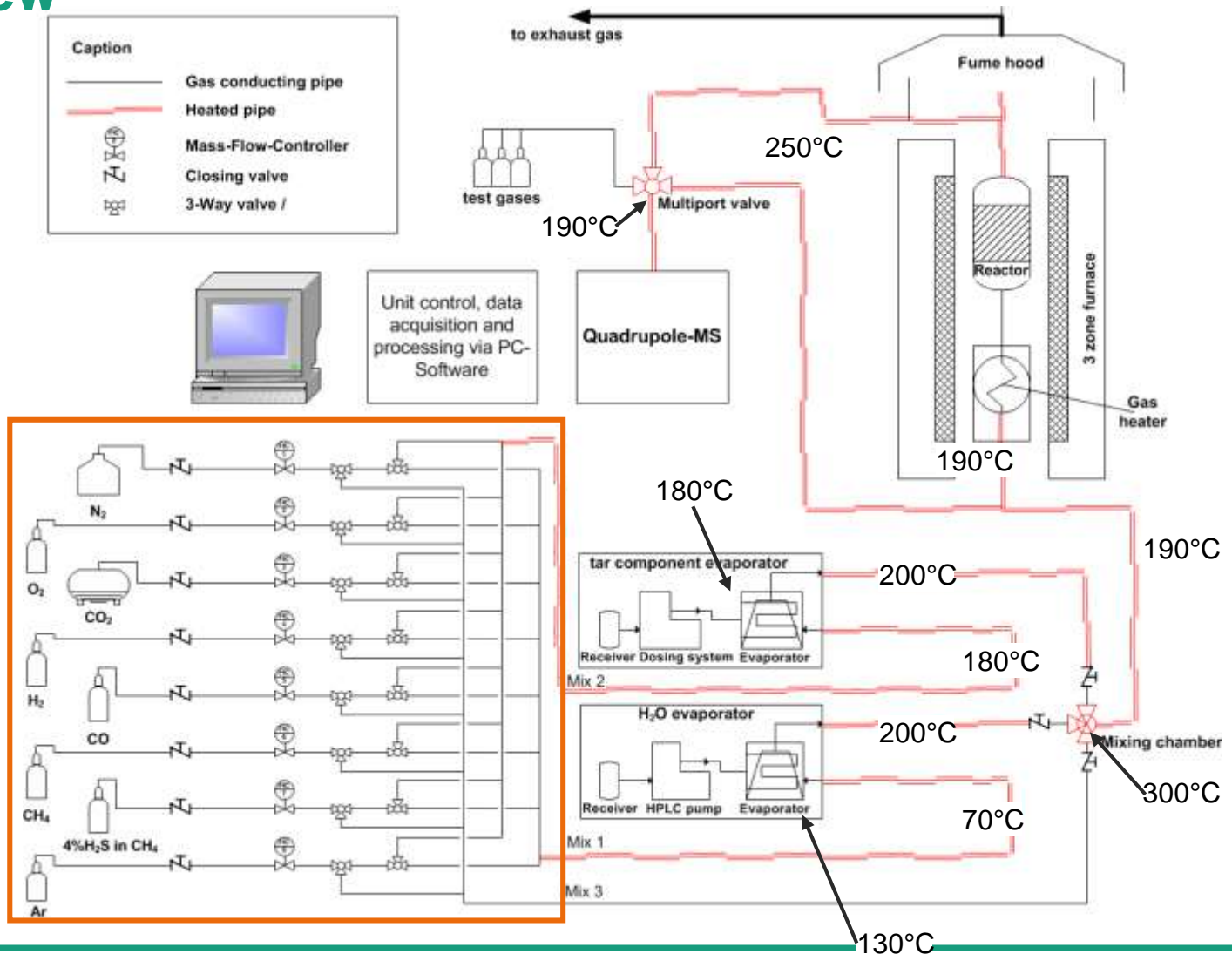
Christian Hamel – Group: Catalytic Processes



21st of March 2014

Test system

Overview



Test system

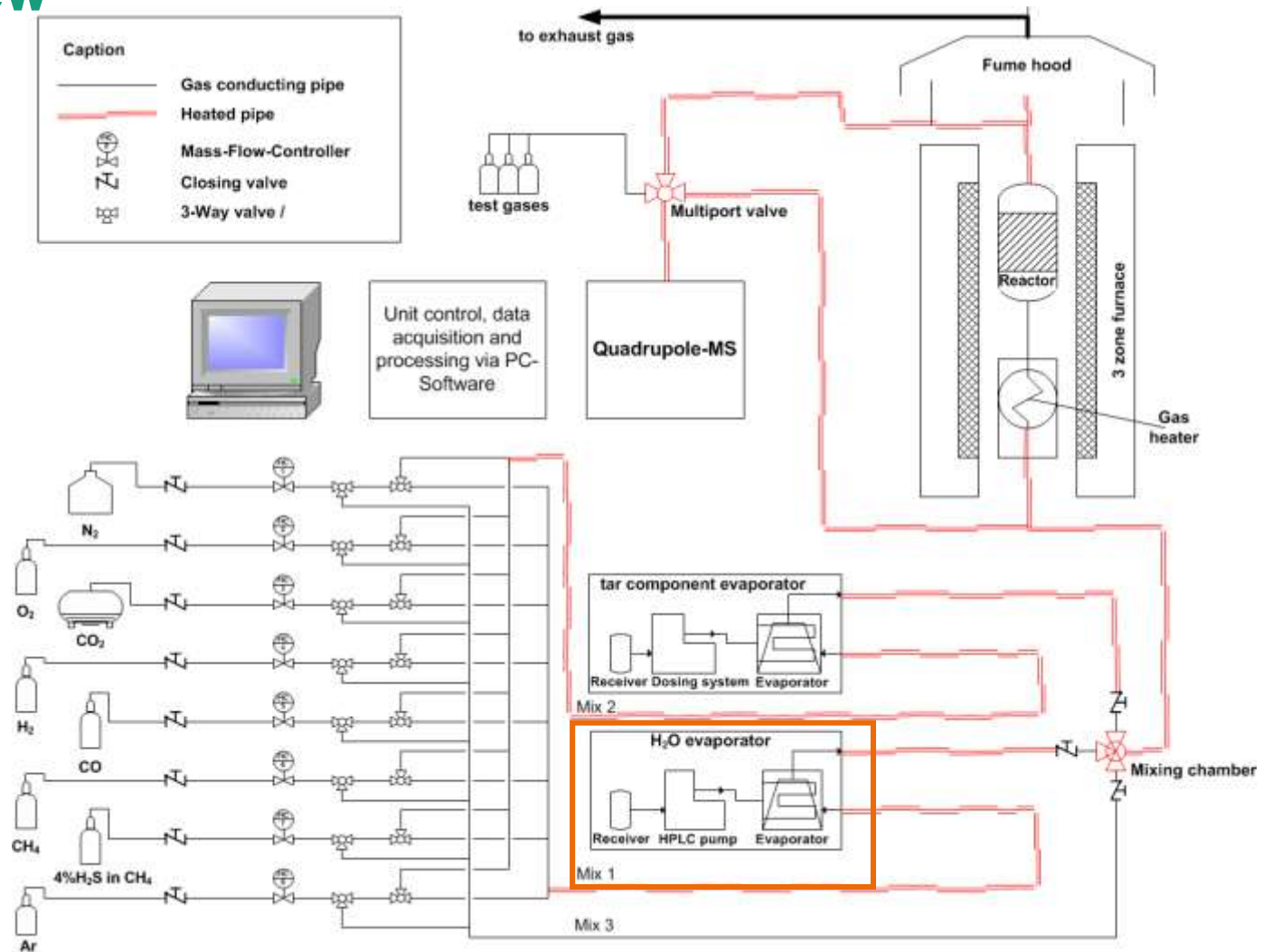
Main gas mixture



- Gas dosing and mixing with 8 separate MFCs for
 - N_2
 - O_2
 - CO_2
 - H_2
 - CO
 - CH_4
 - 4 % H_2S in CH_4
 - Ar
 - 3 separate gas compositions
 - to H_2O evaporator → “Mix 1”
 - to tar evaporator → “Mix 2”
 - Bypass → “Mix 3”
- ➔ High flexibility in gas composition
- ➔ MFCs controlled via automation software

Test system

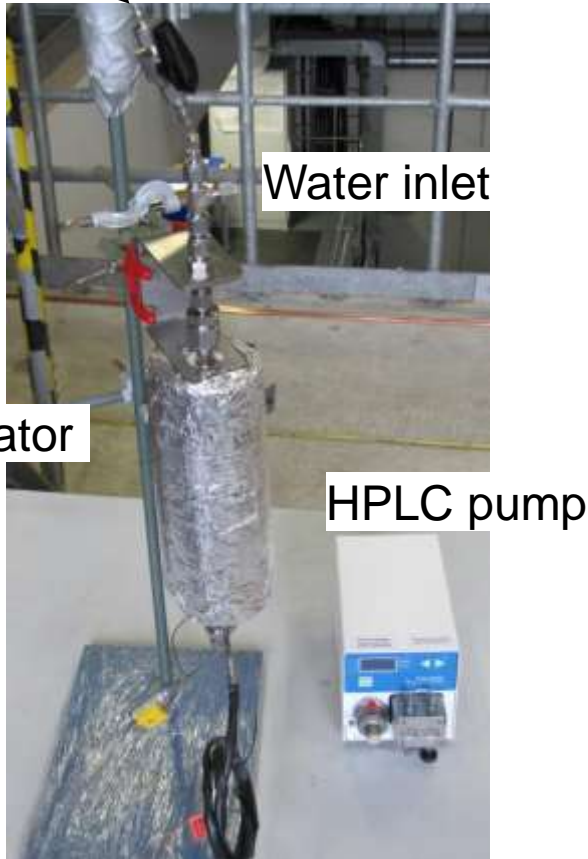
Overview



Test system

Water evaporator

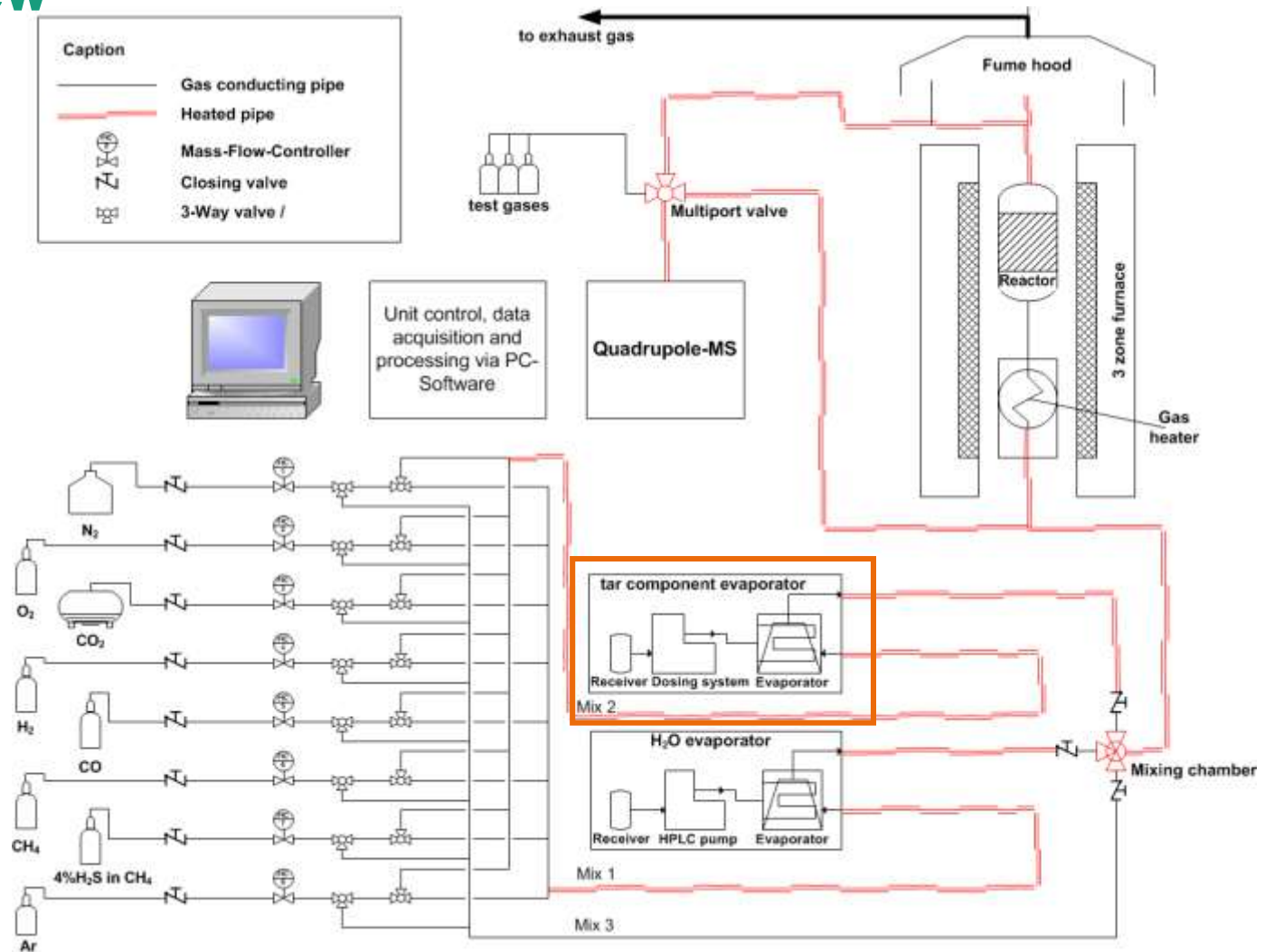
Carrier gas



- Carrier gas based system
- HPLC Pump (Knauer S100) for precise dosing of H₂O
 - ➔ 0,1 – 10 g/min H₂O
- High levels of H₂O possible
- Integrated in automation software

Test system

Overview



Test system

Organic component evaporator

Dosing system



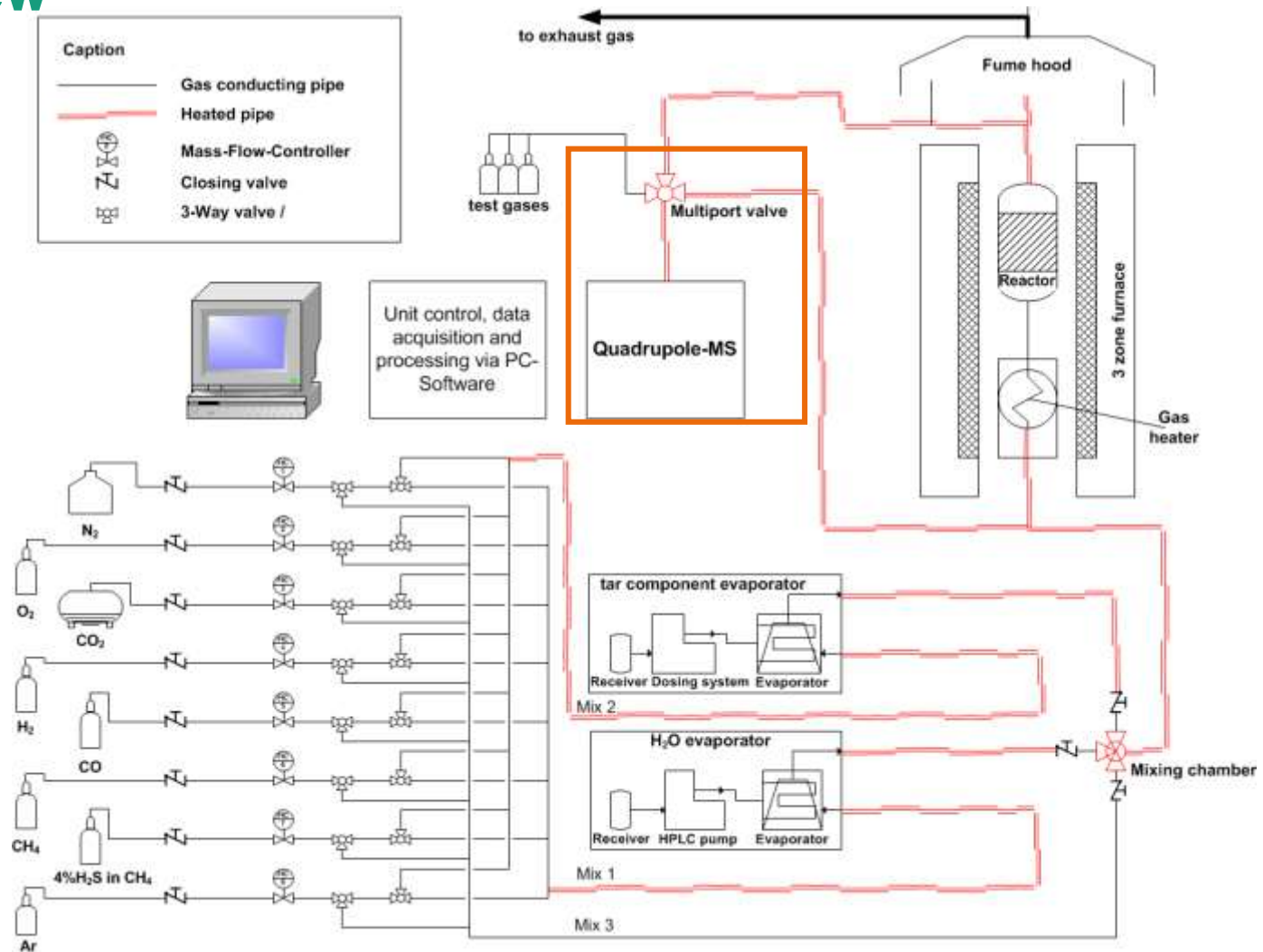
Evaporator

Receiver vessel

- Carrier gas based system
- 2-syringe dosing system MMT MDSP3f
- Dosing of almost any kind of liquid substances
- Usage of different syringe sizes allows variation of minimum and maximum volume flows
- Controlled with separate software of the MMT

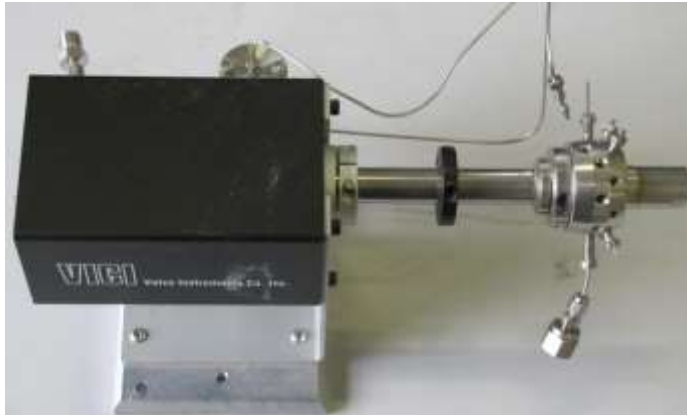
Test system

Overview



Test system

Analytical system



Multiport valve

Mass spectrometer

- Heated Vici Valco 8-port valve
- Mass spectrometer with electron impact ionization
- Direct inlet (no condensation)
- Controlled via complex yet versatile software
- Large measurement range
 - ➔ Lower boundary: ca. 1ppm
 - ➔ Upper boundary: range of main gas components
- Quasi continuous measurement
 - ➔ Every 10-15 seconds
 - ➔ Changes in gas composition can be seen within that time frame

Gas composition

Variability

1. Main gas components

	Vol-flow (g) [NI/min]	wet [Vol-%]	dry [Vol-%]
Hydrogen	0,52	25,8%	38,8%
Carbon monoxide	0,33	16,3%	24,6%
Carbon dioxide	0,28	13,9%	20,9%
Methane	0,14	7,0%	10,3%
Argon	0,07	3,5%	5,2%
Water	0,68	33,5%	
Total	2,02	100,0%	100,0%

➔ Approximately Güssing gas composition

2. Model tar components

- Benzene (ca. 1500 ppmv)
- Naphthalene (ca. 370 ppmv)
- Toluene
- Phenole
- Phenanthrene

} → Possible for further tests

3. Poisons

- H₂S (150 ppmv)

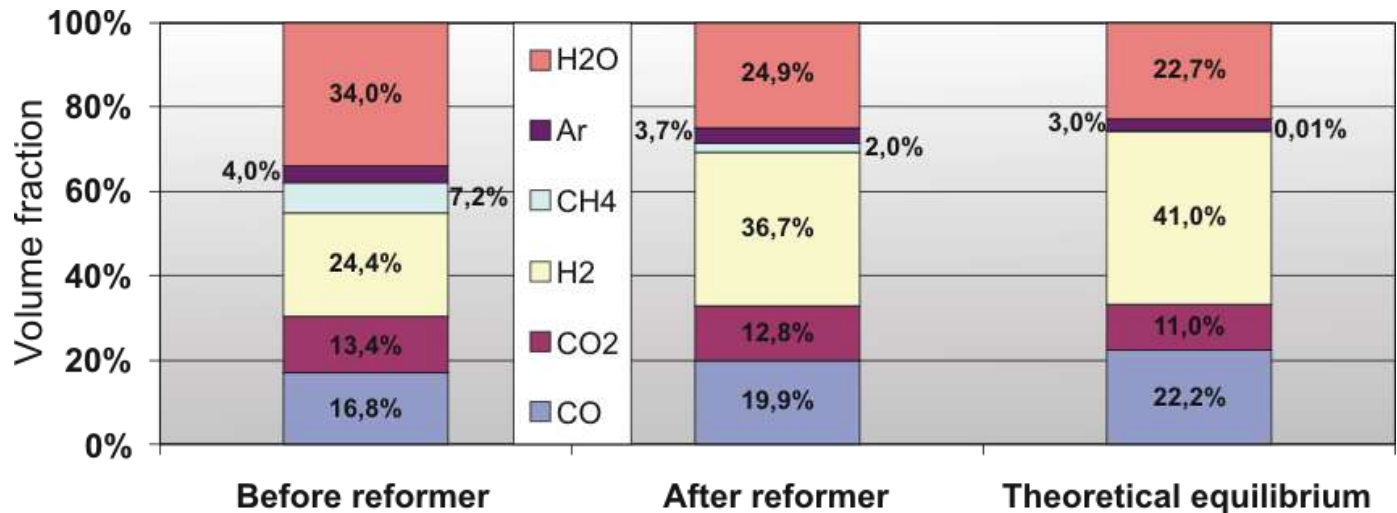
Gas composition

Example for results

	CO	CO2	H2	CH4	Ar	H2O	C6H6	C10H8		C	H	O	Ar
Before reformer [Vol-% feucht] ppmv	16,8%	13,4%	24,4%	7,2%	4,0%	34,0%	1454	389		35,00	132,87	70,28	3,65
[mmol/min]	15,23	12,13	22,11	6,50	3,65	30,79	0,13	0,04	90,58				
After reformer [Vol-% feucht] ppmv	19,9%	12,8%	36,7%	2,0%	3,7%	24,9%	32	2		34,56	130,72	70,13	3,65
[mmol/min]	19,79	12,76	36,55	1,99	3,65	24,82	0,00	0,00	99,56				
Conversion / Comparison				69,4%			97,6%	99,3%	9,9%	-1,3%	-1,6%	-0,2%	0,0%

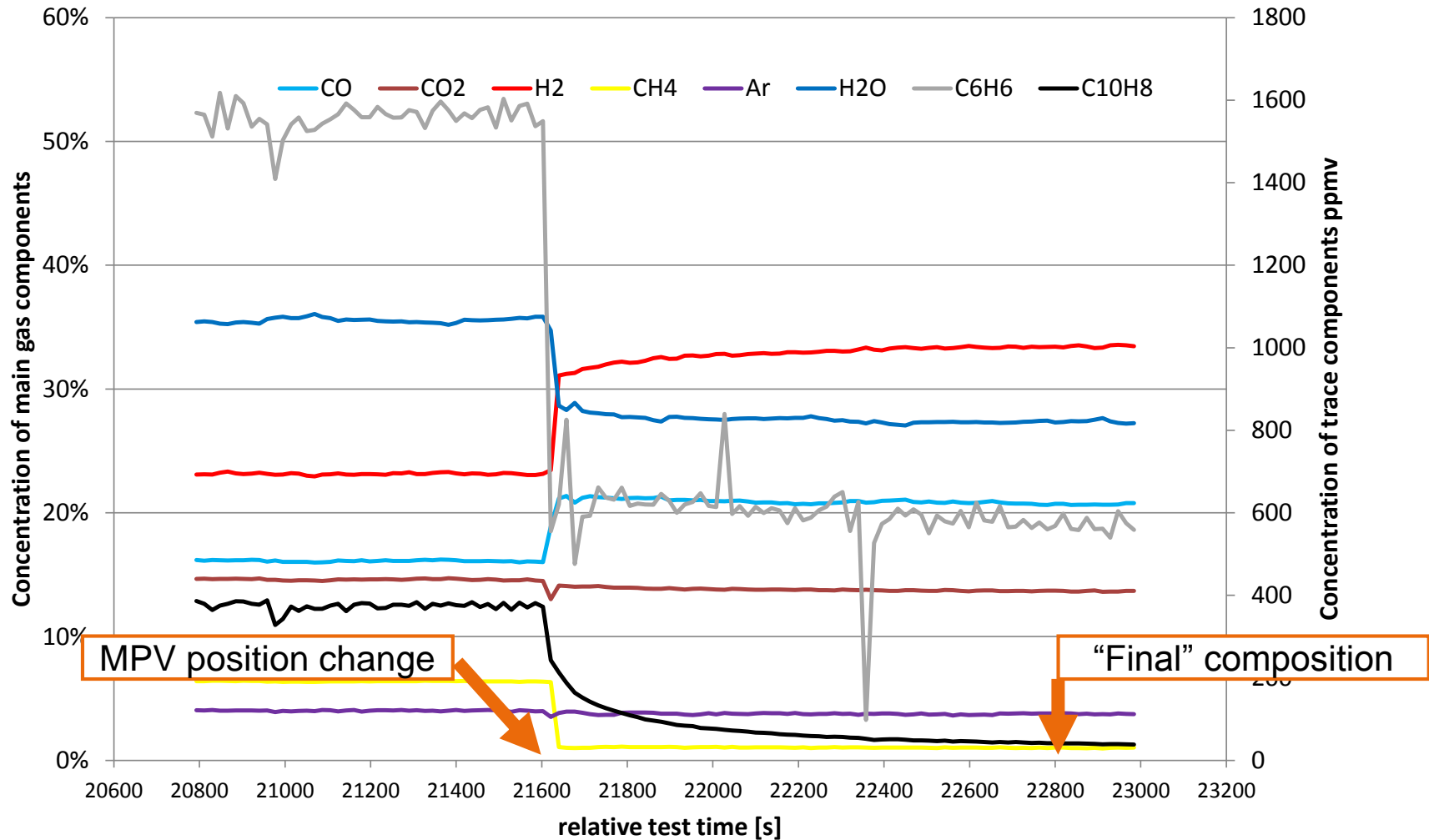
Conversion rates
Change in volume

- Tar components have virtually vanished at equilibrium
- Tar components play no significant role in mole balance
- Mole balance error in most cases below 5%



Gas composition

Example for results



Thank you!

