

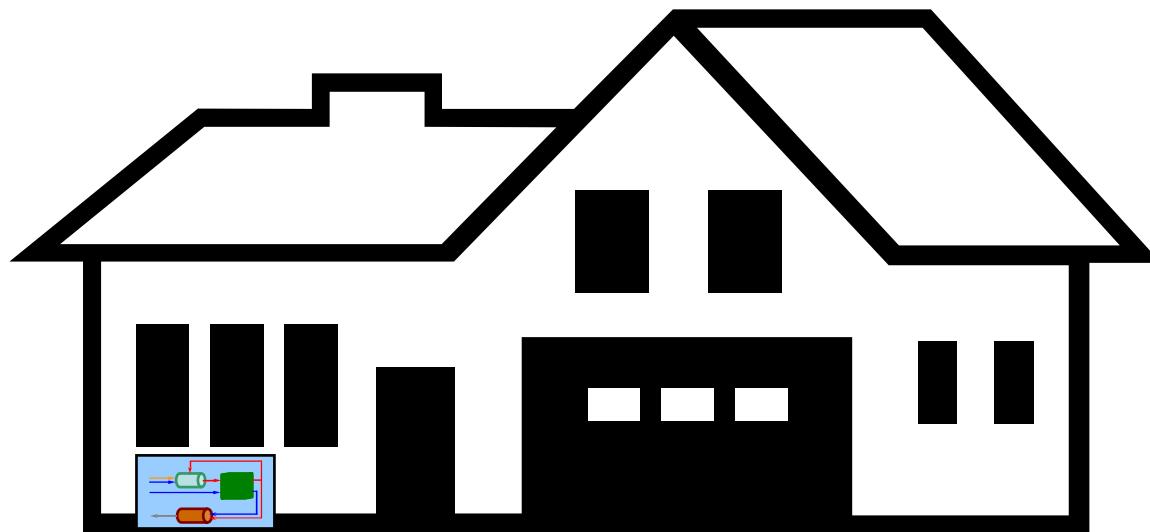
A thermo chemical model of a reforming process using hydrocarbon fuels which is included in a fuel cell system

*Sven Wenzel
Oel Wärme Institut gGmbH, Aachen*

Contents

- Application Area of the CPO-SOFC-System
- Diagram of Process
- Equilibrium calculation based on ChemSheet
- Operation area of CPO-Process
- Influence of Anode-Offgas-Recirculation
- Conclusion

Application Area of the CPO-SOFC-System



stationary fuelcell block heat and power plant

- in areas with poor infrastructure
- supply of electrical power and heat

auxiliary power unit (APU)

- generates power independent from the engine (no idle-mode)
- air conditioning while the trucks are standing

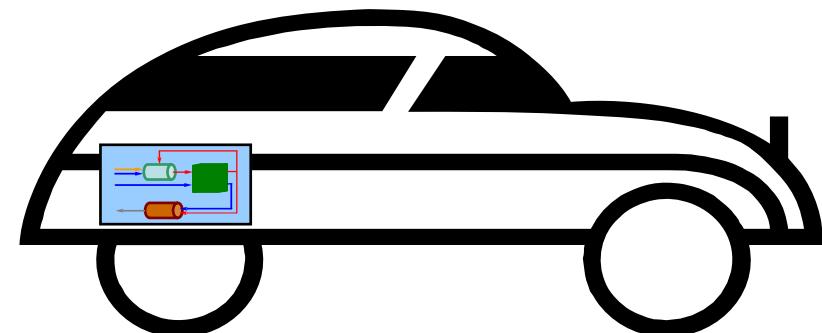
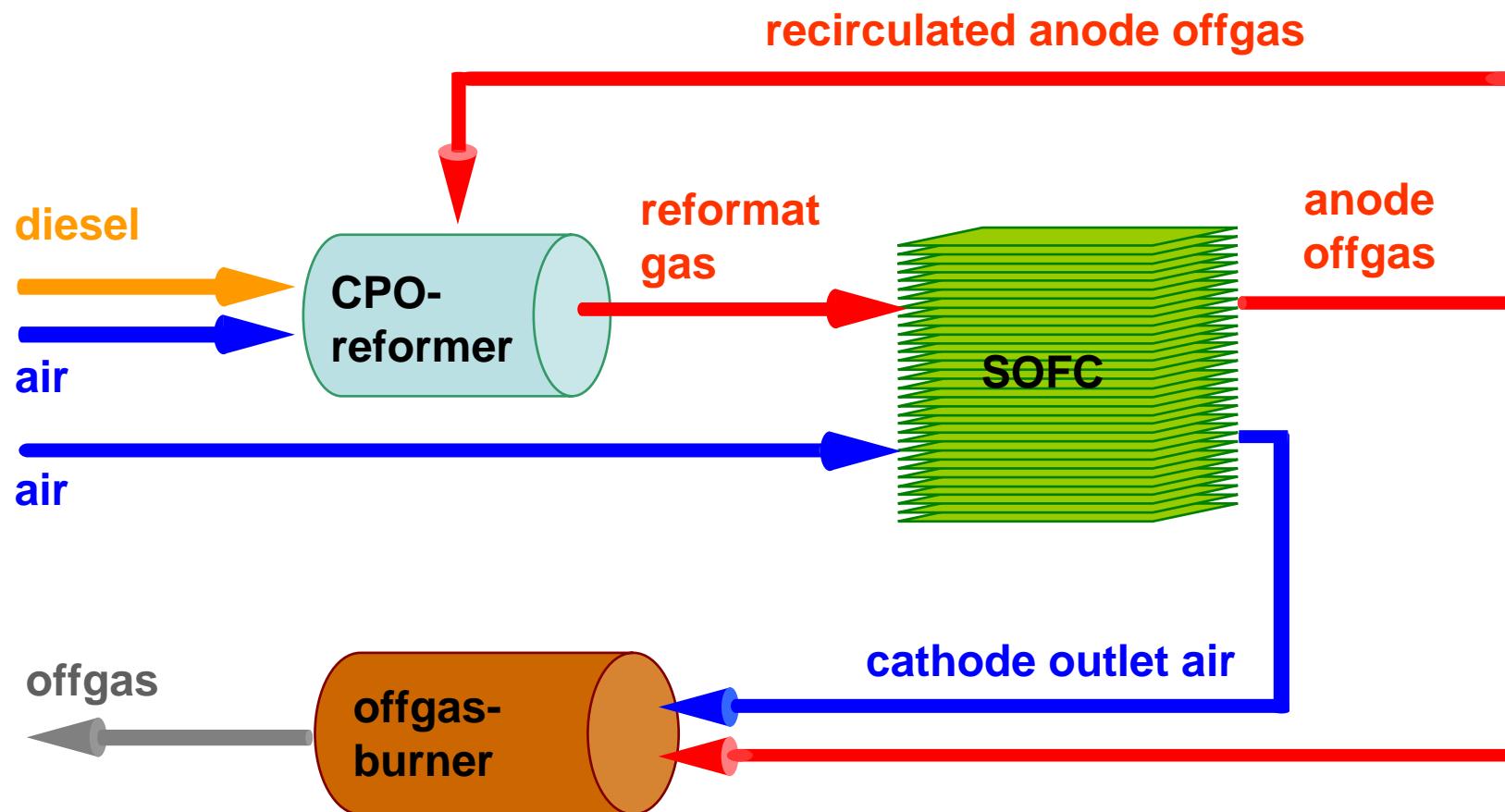


Diagram of Process



Excel Sheet

fuel

air

air

anode offgas

Prozeßbild CPO - SOFC - Anodengasbrenner	
<i>Bei Änderung des Brennstoffs muß dieser noch manuell in ChemSheet geändert werden. Das Lufterhältnis besteht sich auf CH₄ Brennstoffleistung wird automatisch bestimmt.</i>	
Temperatur [°C]	Druck [bar]
25	1
Leistung [kW]	Mischtemperatur Eingangsströme
	261,05 °C
Edukte	Stoffmenge [mol/s]
C 12,95	0,000642
H 24,38	0,000642
Enthalpiestrom [J/s]	-220,30

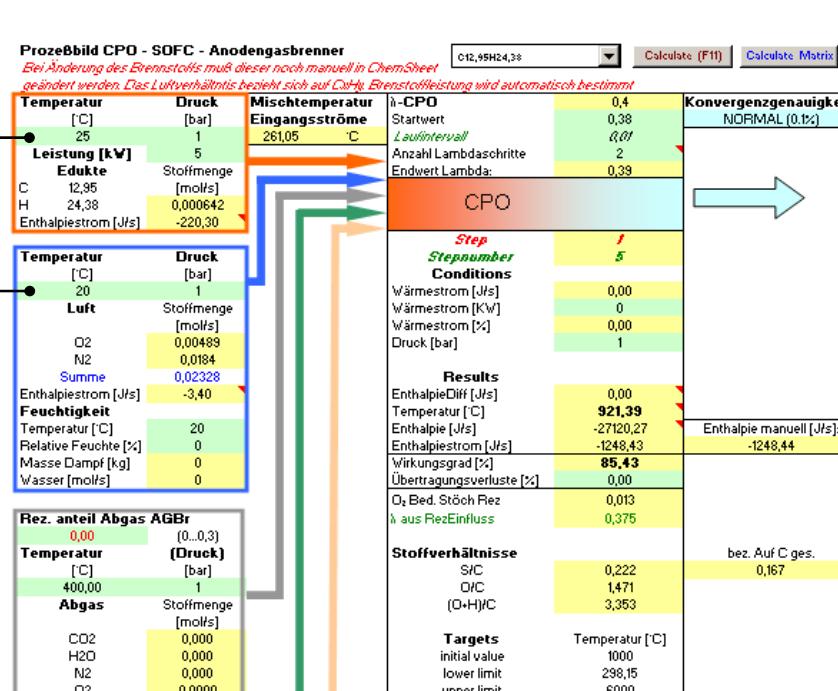
Temperatur Druck	
20	1
Luft	Stoffmenge [mol/s]
O ₂ 0,00489	0,00489
N ₂ 0,0184	0,0184
Summe	0,02328
Enthalpiestrom [J/s]	-3,40

Rez. anteil Abgas AGBr	
0,00	(0...0,3)
Temperatur [°C]	(Druck)
400,00	1
Abgas	Stoffmenge [mol/s]
CO ₂ 0,000	0,000
H ₂ O 0,000	0,000
N ₂ 0,000	0,000
O ₂ 0,0000	0,0000
NO 0,000	0,000
Summe	0,000
Enthalpiestrom [J/s]	0

Abgas AGBr	
CO ₂ 0,008	0,008
H ₂ O 0,008	0,008
N ₂ 0,092	0,092
O ₂ 0,012	0,012
NO 0,000	0,000
Summe	0,120

Störgrößen		
Temperatur [°C]	921,39	
Δ-bzgl. C	0	Stoffmenge [mol/s]
O ₂	0,000	
N ₂	0,000	
C	0,000	
CH ₄	0,000	

Abgas AGBr	
CO ₂ 0,008	0,008
H ₂ O 0,008	0,008
N ₂ 0,092	0,092
O ₂ 0,012	0,012
NO 0,000	0,000
Summe	0,120



Excel Sheet – Input Stream Fuel and Air

	pressure	fuel	air ratio initial value																											
temperature																														
power	<p>Prozeßbild CPO - SOFC - Anodengasbrenner <i>Bei Änderung des Brennstoffs muß dieser noch manuell in ChemSheet geändert werden. Das Luftverhältnis bezieht sich auf C₆H₆. Brennstoffleistung wird automatisch bestimmt</i></p> <table border="1"> <tr> <td>Temperatur [°C]</td> <td>Druck [bar]</td> <td>Mischtemperatur Eingangsströme</td> <td>i-CPO</td> </tr> <tr> <td>25</td> <td>1</td> <td>261,05 °C</td> <td>Startwert</td> </tr> <tr> <td>Leistung [kW]</td> <td>5</td> <td></td> <td>Laufintervall</td> </tr> <tr> <td>Edukte</td> <td>Stoffmenge</td> <td></td> <td>Anzahl Lambdaschritte</td> </tr> <tr> <td>C 12,95</td> <td>[mol/s]</td> <td></td> <td>2</td> </tr> <tr> <td>H 24,38</td> <td>0,000642</td> <td></td> <td>Endwert Lambda:</td> </tr> <tr> <td>Enthalpiestrom [J/s]</td> <td>-220,30</td> <td></td> <td>0,39</td> </tr> </table>	Temperatur [°C]	Druck [bar]	Mischtemperatur Eingangsströme	i-CPO	25	1	261,05 °C	Startwert	Leistung [kW]	5		Laufintervall	Edukte	Stoffmenge		Anzahl Lambdaschritte	C 12,95	[mol/s]		2	H 24,38	0,000642		Endwert Lambda:	Enthalpiestrom [J/s]	-220,30		0,39	<input type="text" value="012,95H24,38"/> <input type="button" value="Calculate"/>
Temperatur [°C]	Druck [bar]	Mischtemperatur Eingangsströme	i-CPO																											
25	1	261,05 °C	Startwert																											
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Edukte	Stoffmenge		Anzahl Lambdaschritte																											
C 12,95	[mol/s]		2																											
H 24,38	0,000642		Endwert Lambda:																											
Enthalpiestrom [J/s]	-220,30		0,39																											
			air ratio step size																											
			number of steps																											
			heat flow																											
			reaction temperature																											

Excel Sheet – Products Rformat

quantity of materials

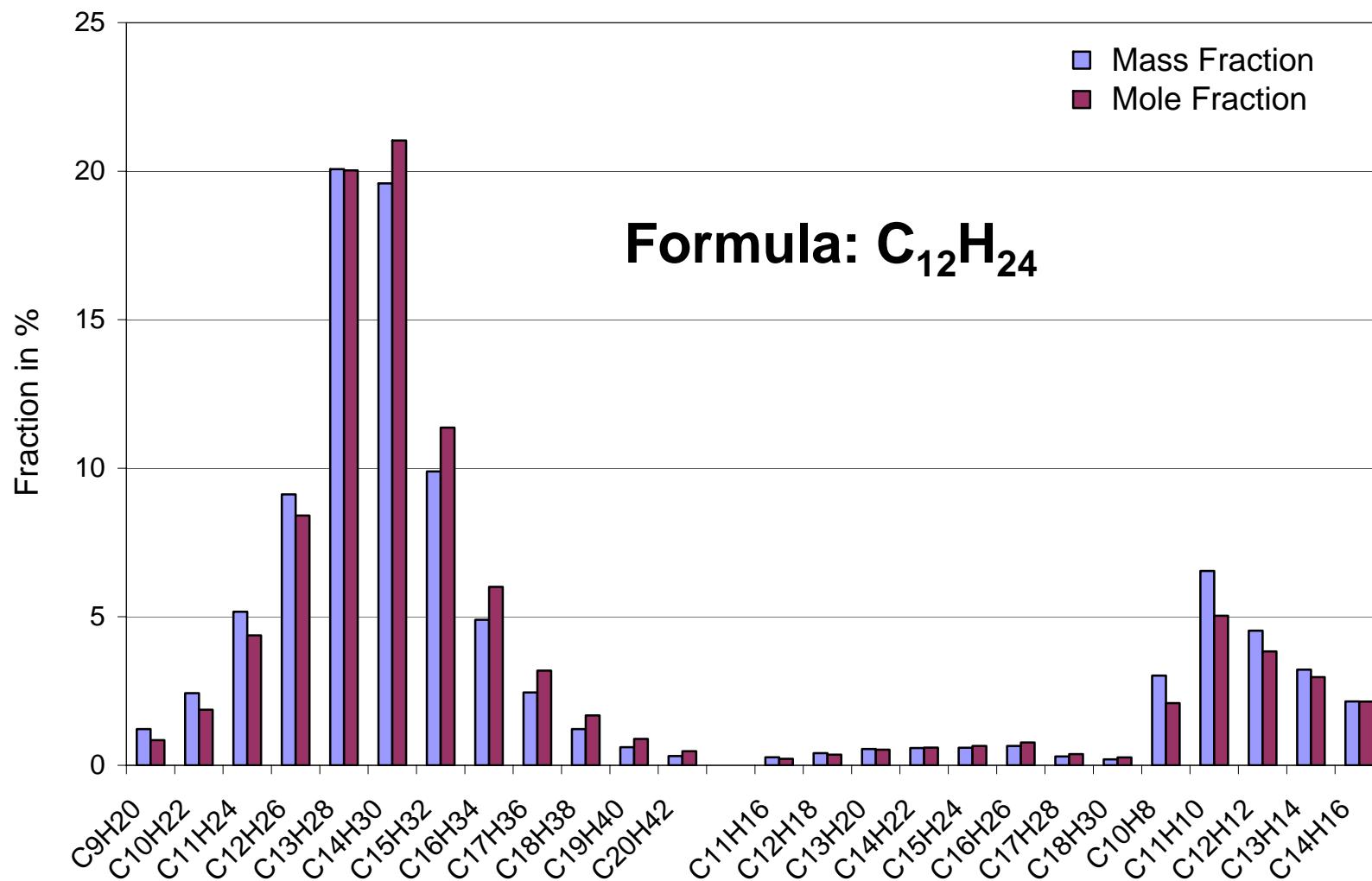
Produkte	Stoffmenge [mol/s]	Ausgabe
		Eingabe bedingt (über Drop-D
		Eingabe
CPO		
H2	7,603E-03	entered
H2O	2,828E-03	entered
CO	8,698E-03	entered
CO2	2,385E-03	entered
CH4	2,943E-07	entered
C2H2	1,535E-13	entered
C	0,000E+00	abgelagert
N2	2,452E-02	entered
O2	8,1021E-19	entered
NO	6,4906E-14	entered
CxHy	0,0000E+00	entered
Summe	0,0460	

Aktivität

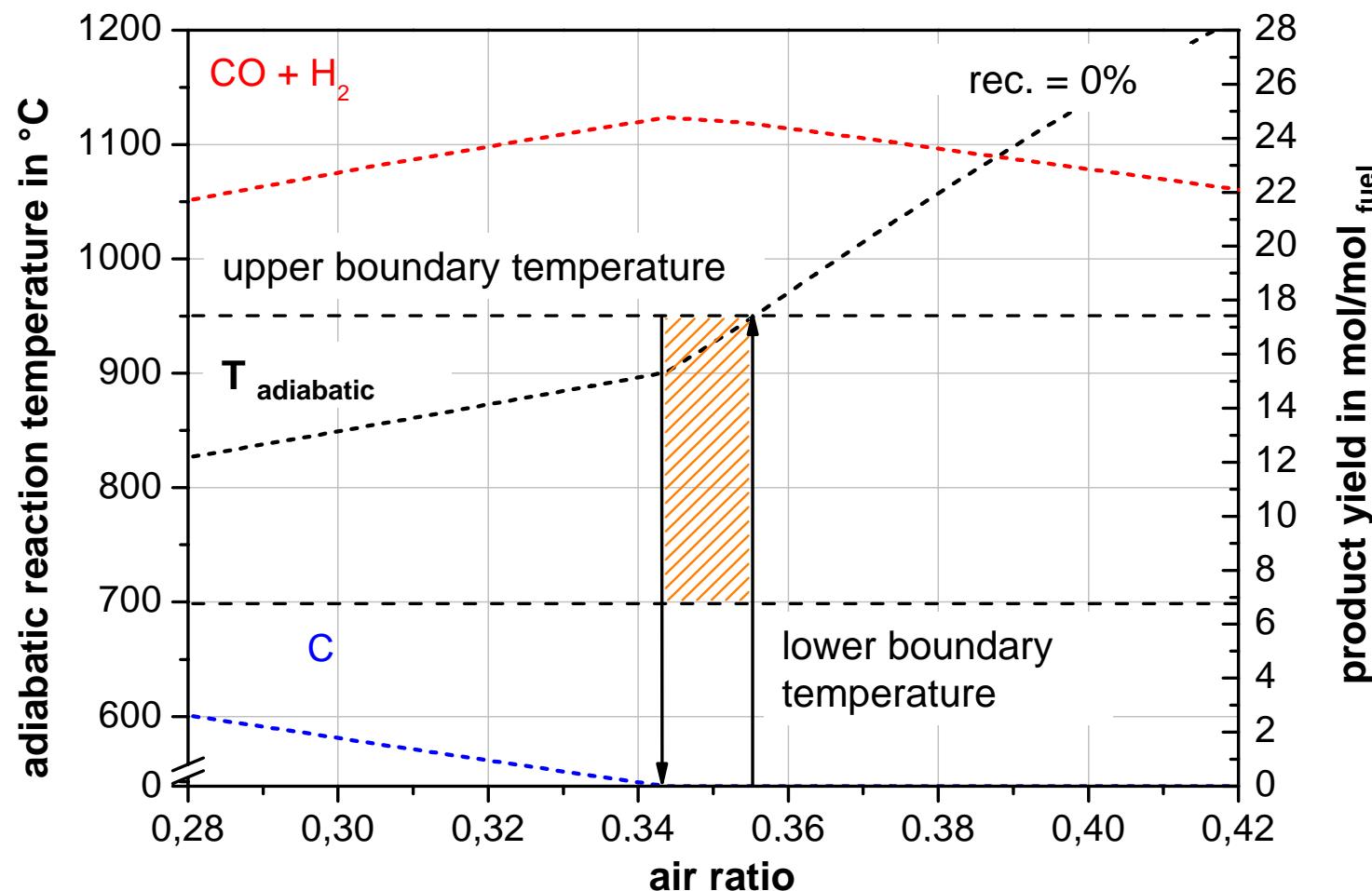
activity



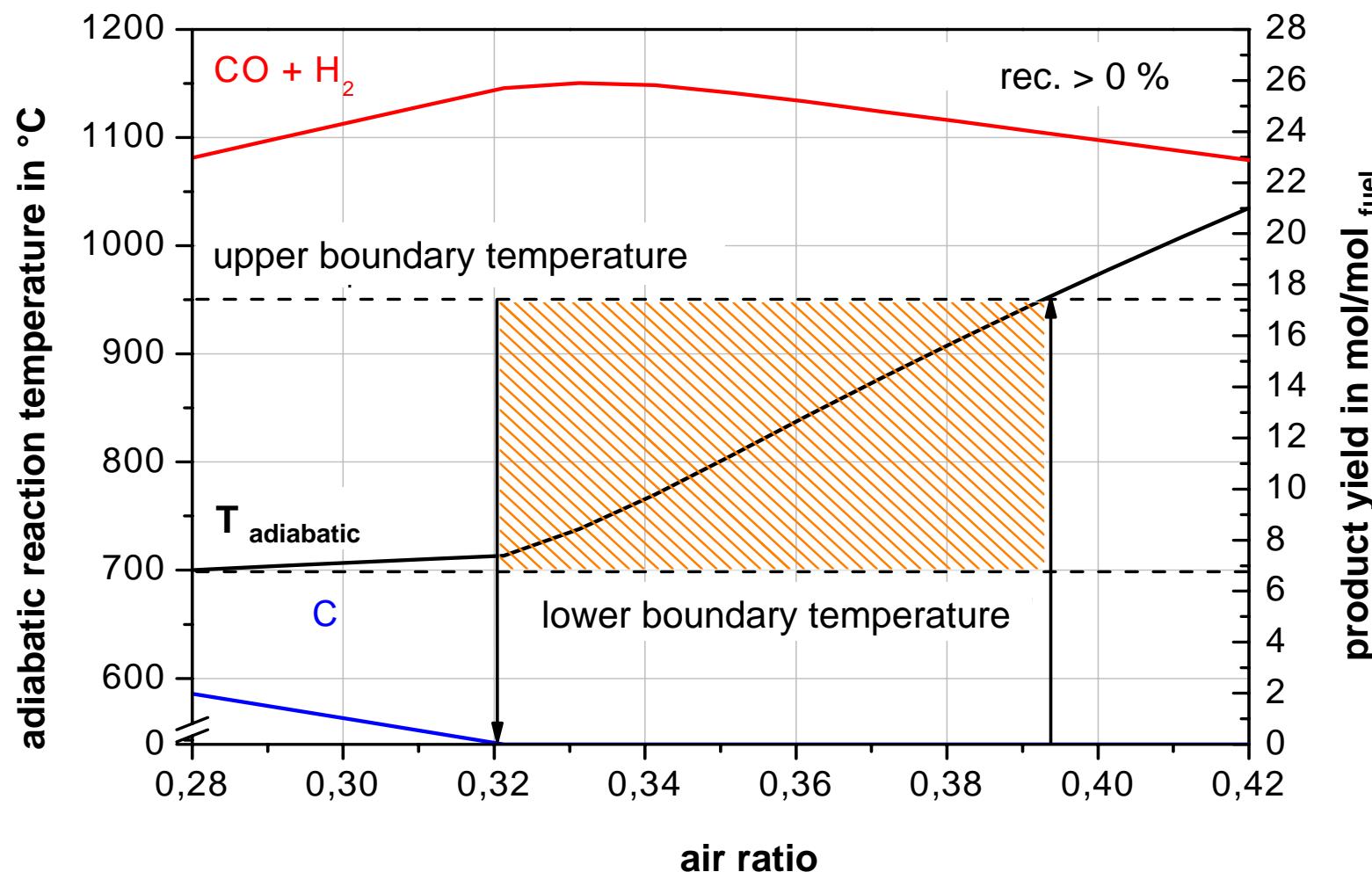
Model Fuel (according to Amphlett) for Material Data Bank



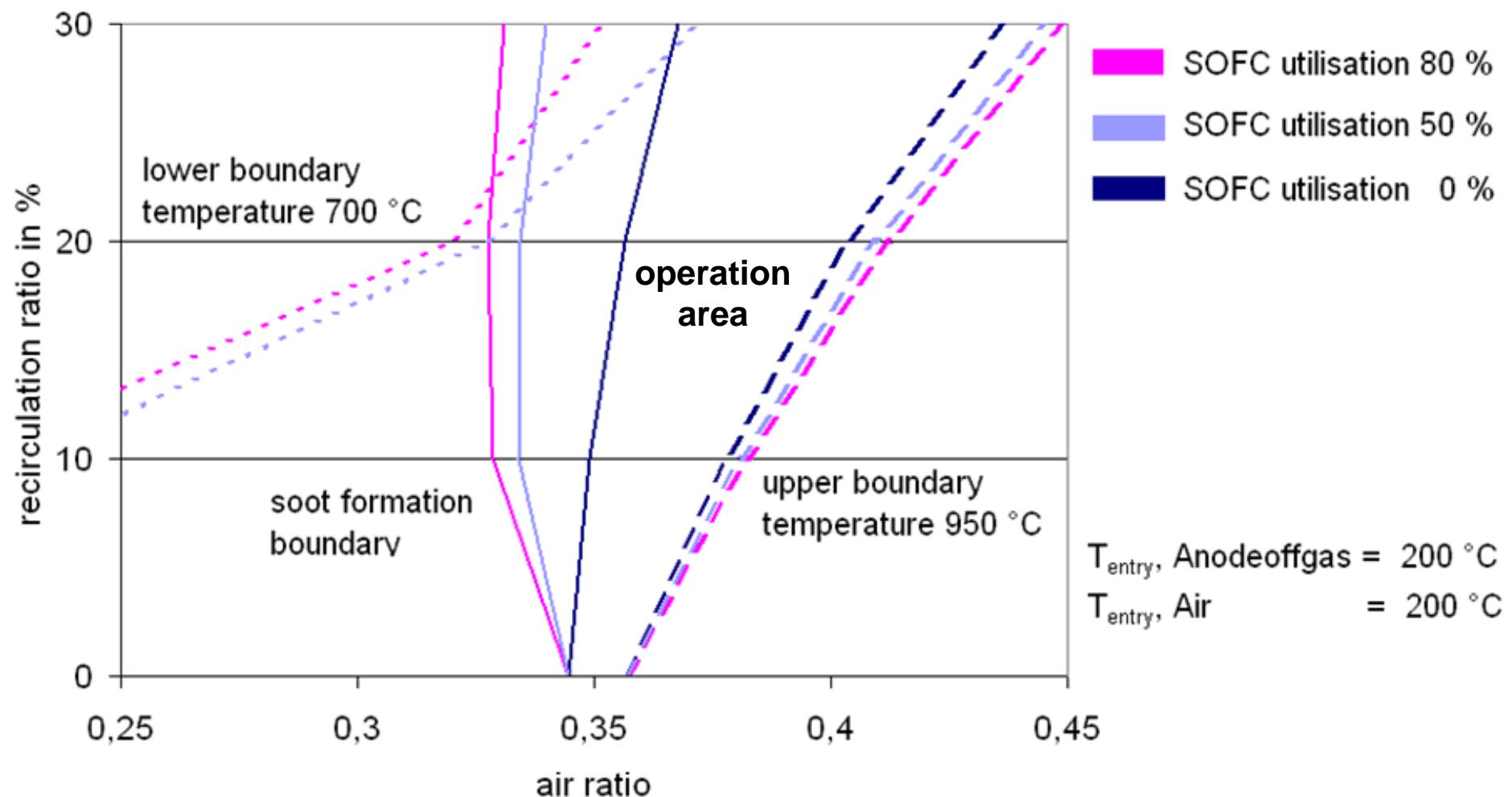
Operation Area of CPO-Process



Operation Area of CPO-Process with Anode-Offgas Recirculation



Operation Area Depending on Recirculation Ratio and SOFC-Utilisation



Conclusion

- catalytic partial oxidation is possible for stationary and mobile applications
- restricted operation area of CPO-process between soot-formation and boundary temperature of catalyst
- the equilibrium calculation based on ChemSheet shows the potential of recirculation of anode-offgas
- increase in the part of recirculated anode-offgas enlarges the operation area of CPO-process