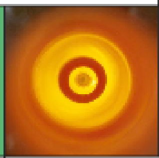
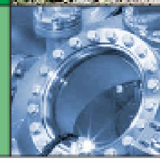
PAUL SCHERRER INSTITUT

ALLGEMEINE ENERGIE





LEM – Laboratory for Energy and Materials Cycles

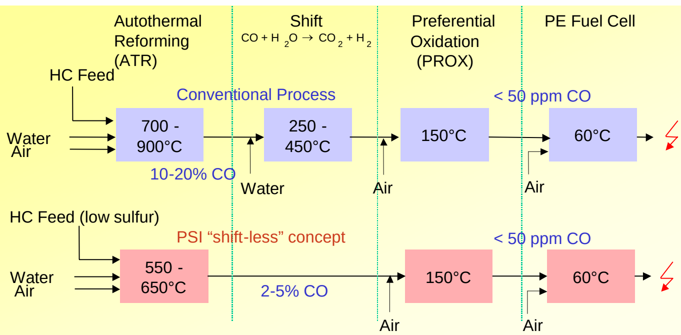
ECL – Electrochemistry Laboratory

„Shift-less" fuel processing unit to produce hydrogen from gasoline for fuel cell systems

LEM – M. Bosco, T.-B. Truong, E. De Boni, F. Vogel ECL – F. Hajbolouri, G. G. Scherer

Introduction

- One possibility to promote the commercialisation of fuel cell technology is to use H_2 gained from reforming gasoline or diesel as fuel.
- PSI's "shift-less" concept operates at lower temperatures in the reformer, producing much less CO, and is thus able to omit the shift reactors.
- To demonstrate the technical feasibility of PSI's "shift-less" concept, a lab-scale fuel processor was linked up to a PEFC.



Experimental

➢ATR

Feed: Air, Water, and Gasoline (RON = 95, S < 1 ppm)

Reactor: Fixed-bed

Catalyst: 16 g 1%Rh/CeO_2/ZrO_2

➢PROX

Feed: Reformate, Air

Reactor: Annular fixed-bed

Catalyst: 6 g 5%Ru/CeO_2/ZrO_2

➢On-line analytics

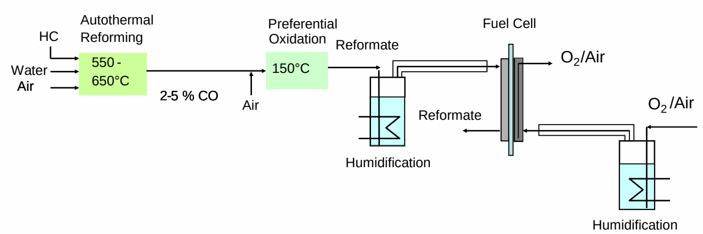
GC with two-column switching system, TCD and FID detectors

Lab-scale gasoline fuel processor

➢Fuel cell

30 cm^2 PEFC with meander flow field graphite plates

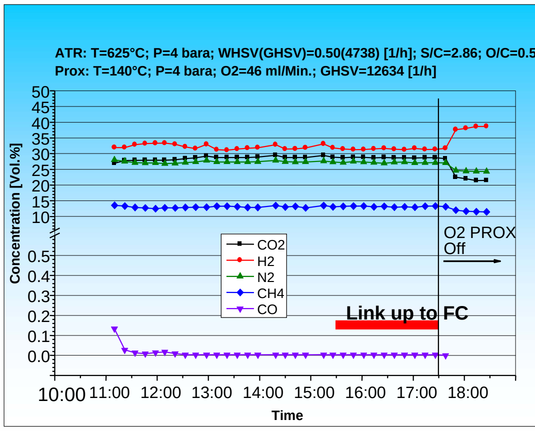
Electrolyte membrane (Nafion® 112) coating: PtRu (anode), Pt (cathode)



Schematic of the gasoline reformer-fuel cell system linkup at PSI

Results

Best operating conditions for minimizing CO concentration in the reformate gas (p = 4 bar)



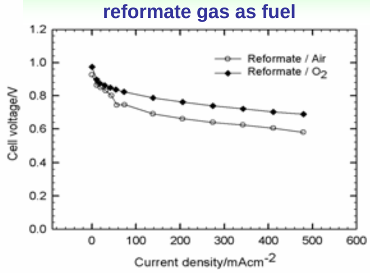
ATR conditions	
Reformer outlet temperature	610°C
S/C	2.86
O/C	0.57
WHSV	0.5 $g_{gasoline}/(g_{cat.}h)$
GHSV	4'738 h^{-1}

PROX conditions	
Inlet temperature	140°C
O_2/CO	1.24
GHSV	12'634 h^{-1}

Results (after PROX, dry)

H_2	32 Vol. %	N_2	27 Vol. %	CO Conversion	> 99.93 %
CO_2	29 Vol. %	CO	< 36 ppmv	H_2 loss	27 %
CH_4	13 Vol. %	Carbon conversion (C_2+)	100 %	H_2 yield	7.5 mol H_2/mol $C_{7.3}H_{12.6}$
				Reformate (dry)	47 L/h

Fuel cell polarization curves for reformate gas as fuel



Fuel cell conditions	
T_{cell}	60°C
$T_{hum, cathode and anode}$	35°C
λ_{fuel} / λ_{air}	1.5 / 2
$P_{anode,cathode}$	1 bar_a

Conclusions

- Reforming gasoline at lower temperatures (550-650°C) using a proprietary noble metal catalyst resulted in lower CO concentrations (2 - 5%) than conventional reformers.
- The CO content in the hydrogen-rich reformate could be reduced to < 36 ppmv in one annular fixed-bed PROX reactor.
- Operating the fuel cell with a reformate gas containing 32% of H_2 and < 36 ppmv of CO resulted in a cell voltage of 700 mV (with oxygen) at a current density of 500 mA/cm^2, which was only 40 mV less than with pure H_2.

Contact: Frédéric Vogel, Paul Scherrer Institute, OVGA/104, 5232 Villigen-PSI, Switzerland - phone: +41-(0)56-310-2135 fax: +41-(0)56-310-2199 / email: frederic.vogel@psi.ch