Development of Hydrocarbon Fuel Cells at Penn

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Premise: The fact that most FC operate only on H_2 prevents their immediate application.

1) H_2 is expensive & complex to make.

   Typically produced by steam reforming:

   $$CH_4 + H_2O = 3\,H_2 + CO$$

   or oxy-reforming:

   $$C_nH_{2n} + O_2 = nCO + nH_2$$

2) H_2 is difficult to store.
3) H_2 is potentially dangerous.
4) Reforming is inefficient (>30% loss in energy).

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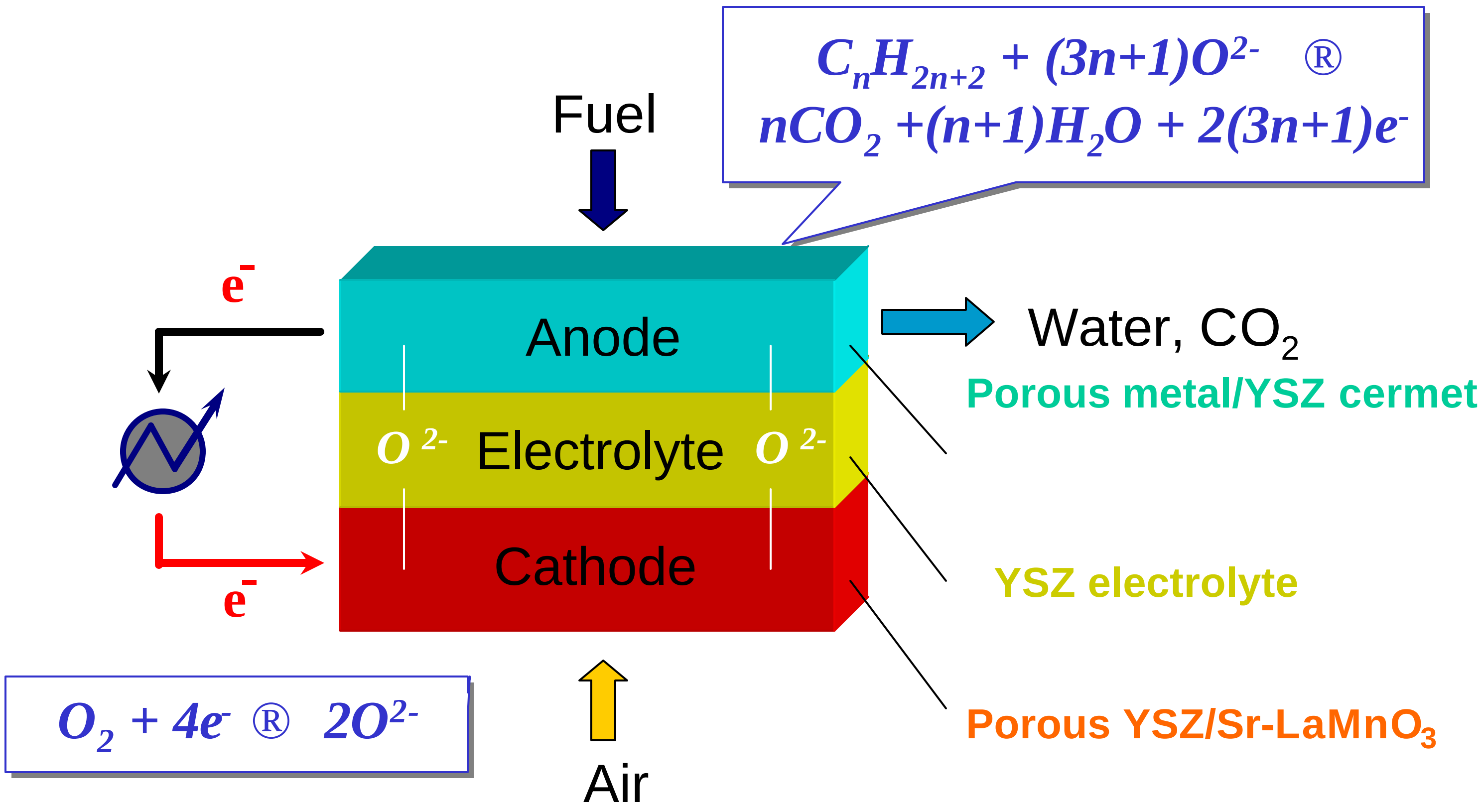
SOFCs may not require reforming, since Direct Oxidation is theoretically possible.



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Conventional SOFC made from Ni; Ni is not stable in dry hydrocarbons

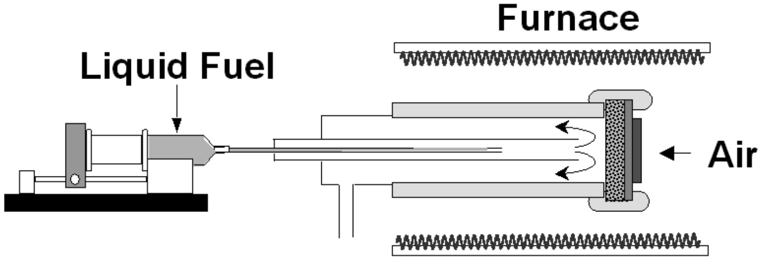
Ni/YSZ exposed to H_2 for 3 hrs, 800ºC

Ni/YSZ exposed to methane for 3 hrs, 800ºC

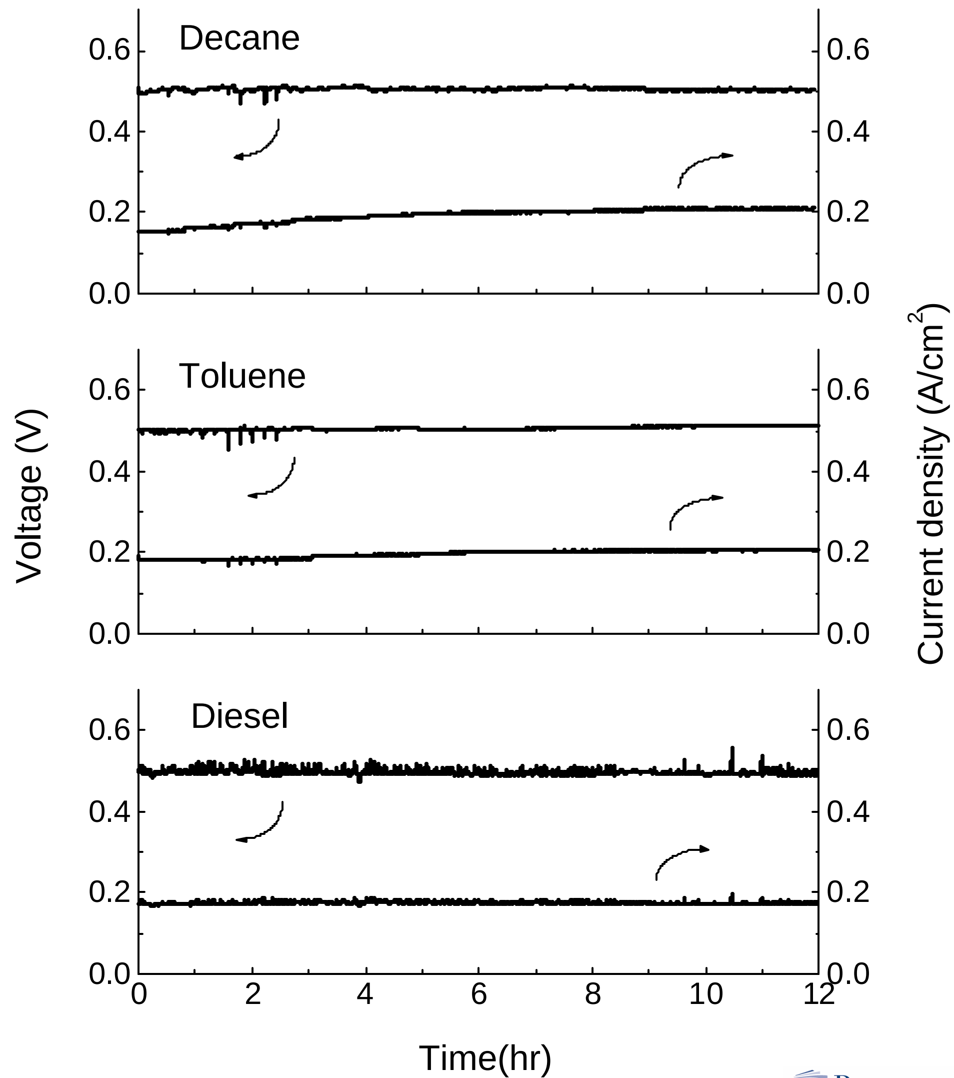
Ni/YSZ exposed to toluene for 3 hrs, 700ºC

Cu-cermets are stable in a wide variety of fuels:

700ºC



Note: No O_2 or H_2O added with the fuel. Some N_2 was added to maintain flow at low fuel utilization.



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At Penn,

- We have developed a novel anode based on copper for direct oxidation of hydrocarbon fuels.
- The Cu-based cermets appear to be very resistant to coking and are relatively sulfur tolerant.
- The design is inexpensive, contains no precious metals, and is easy to fabricate.
- The design breaks new ground and will allow much future development.

http://www.franklinfuelcells.com/

http://www.seas.upenn.edu/cbe/Fuel_Cell_index.htm