Hydrogen Fuel Quality

Focus: Hydrogen Fuel Quality Results and Determining ISO levels

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June 9, 2010

Project ID # SCS007

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Overview

Timeline

- Project start date: 10/1/06
- Project end date: 9/30/11
- Percent complete: 70 %

Barriers

- Barriers addressed
  - I. Conflicts between Domestic and International Standards
  - N. Insufficient Technical Data to Revise Standards

Budget

- Total project funding: $1,950K
  - DOE share: 100%
  - Contractor share: 0%
- Funding received in FY09: $850K
- Funding for FY10: $450K

Partners/Collaborators

- University of Hawaii/HNEI
- University of Connecticut
- University of South Carolina
- Clemson University
- SRNL
- NIST
- NREL
- ANL

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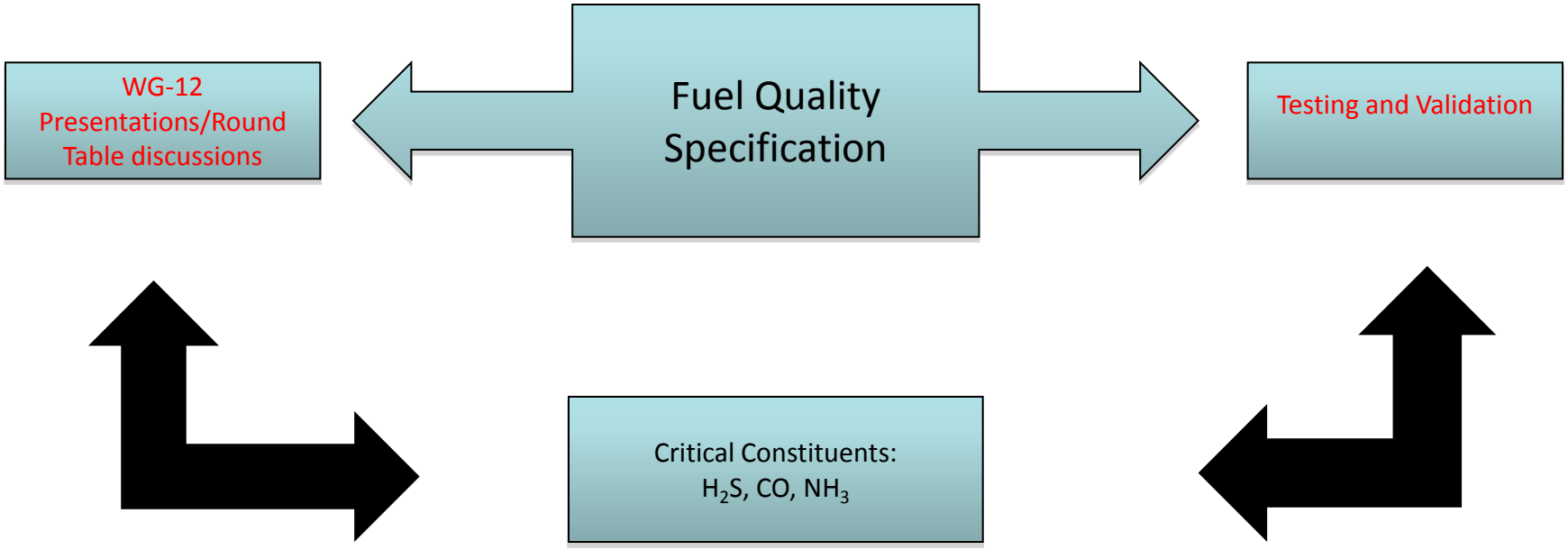
OUTLINE

- Working Group 12 Activities: LANL's Role
- Technical Approach:
  1. Experimental Set-up
  2. Testing Results/Findings: MEAs (Commercial and LANL)
  3. On-going tests
- Future Direction
  1. Testing Gaps
  2. Needed discussions

LANL's Role in WG-12



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Technical Approach

- Help determine levels of constituents for the development of an International Standard for H_2 fuel quality

- Test the critical constituents (NH_3, CO, and H_2S)
  - Tested at various conditions (Loadings, Rel. humidity, Concentrations)

- Present data at the Working Group 12 Meetings
  - Data was presented in FY09 at meetings held in Berlin, Germany…Seoul, Korea…San Francisco, CA.
  - Open discussions with the members of TC197/WG-12 members

Testing Parameters/Set-up

- Fuel Cell: 50 cm^2 Active Area
- Gas Diffusion Media: SGL 24 BC
- Calibrated MKS flow controllers
- Certified Impurities introduced via by passing humidifiers after matching the back pressure
- Electrolysis-grade H2/Air(oiless-compressor)
- *Focus Impurities: H_2S and Mixtures of H_2S, NH_3 and CO at both ISO levels*

ISO Fuel Specification (previous versus current levels)

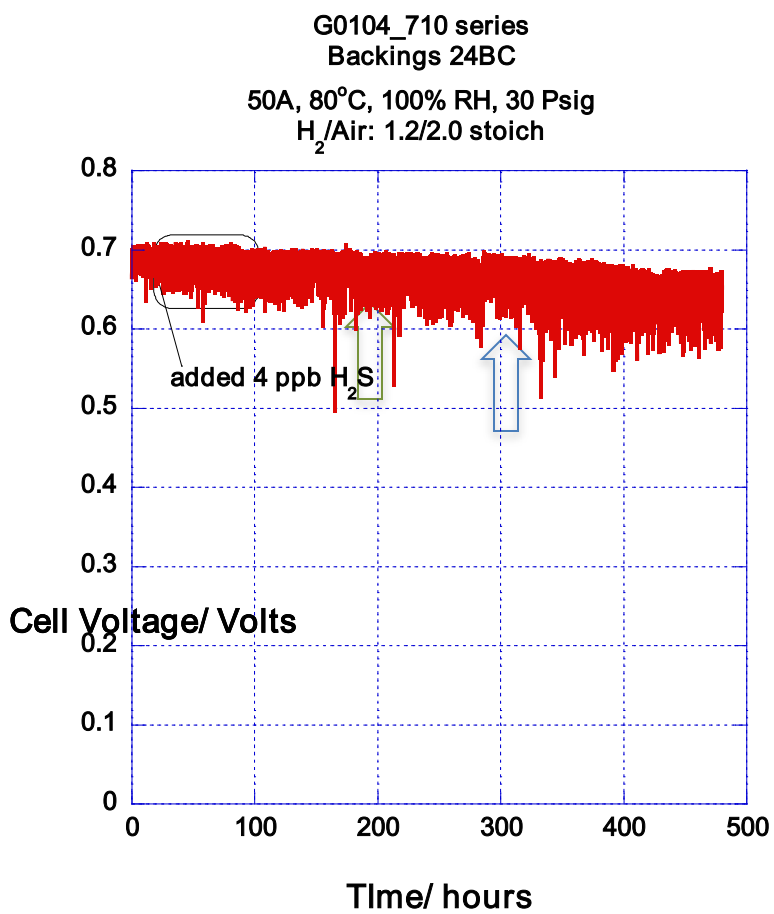
Previous Levels	Current levels
NH_3: 0.1 ppm	NH_3: 0.1 ppm
H_2S: 0.004 ppm	H_2S: 0.001 ppm
CO: 0.2 ppm	CO: 0.1 ppm

Initial levels in the fuel specification were determined by *detection limits.*

Parallel Efforts by WG-12:

- Determine the impact on FC experimental, using the specified contaminant levels
- Improve analytical capabilities to detect below the given limits

H_2S Gore Standard MEAs



G0104_710 series
Backings: 24BC, 75 in-lbs
50A, 100% RH, P:30 psig, H_2/Air: 1.2/2.0

Slower poisoning onset
Higher operating Voltage
- good for H_2S tolerance
- *4 ppb H_2S for short term may be tolerable*

But if accumulation occurs these result will differ, the decay rates increases with time. (i.e. 0-100h, 100-200h, 200-300h)

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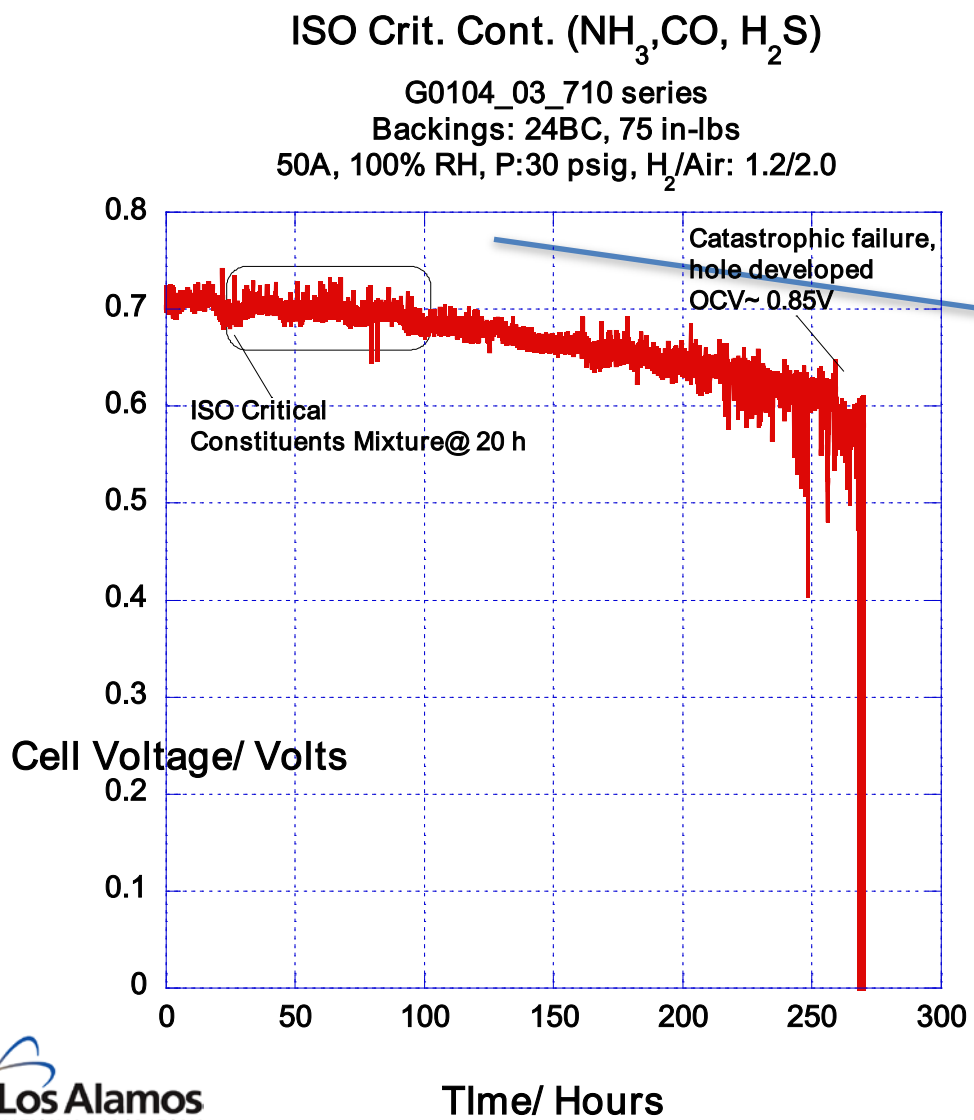
MEAs ISO Mixture



Slower poisoning onset

Higher operating Voltage

- good for H_2S tolerance

Thinner membrane

- bad for NH_3 tolerance
- durability issues?
- S crossover?

Notice the decay rates: 0-100h versus 100- 200h

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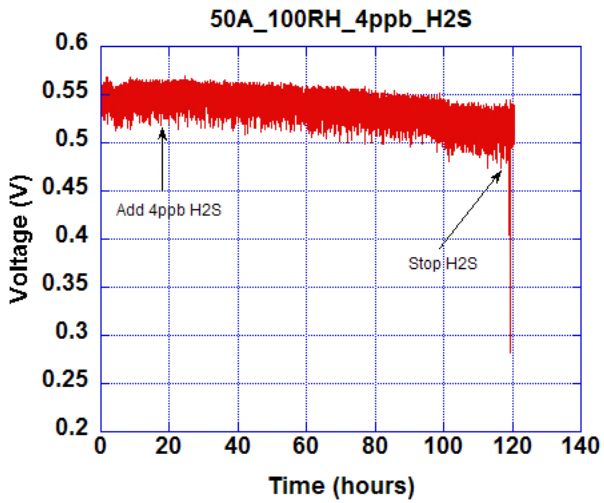
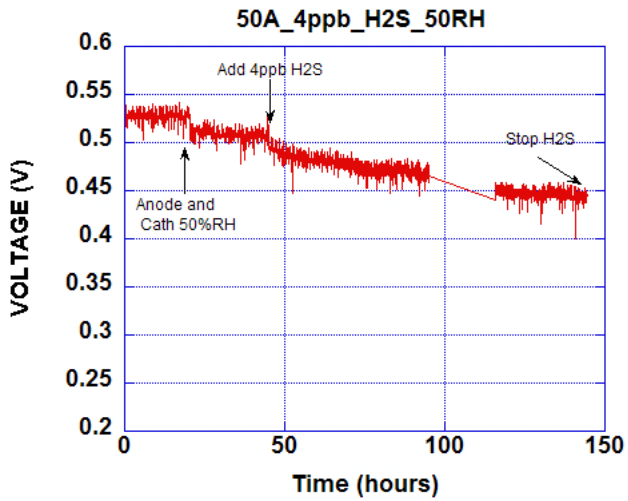
H_2S at ISO levels
- isolated and combined shorter duration





- Results shown reflect 4 ppb H_2S at 100% RH and 50% RH, 80C, 30 psig
- After 100 hrs of exposure FC at 100% RH decrease ~30 mV, while the cell operating at 50% RH decreased by >50mV

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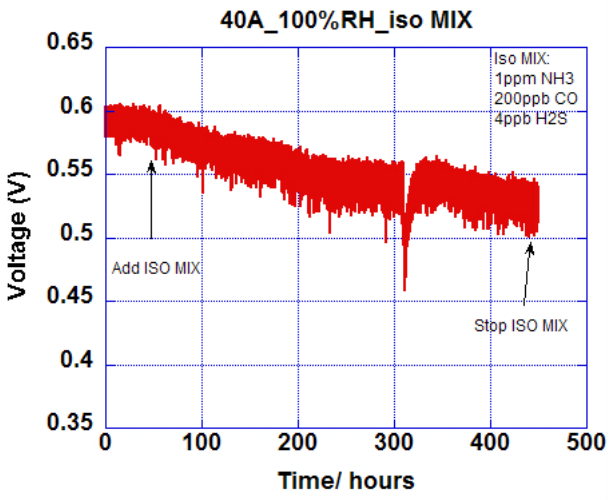
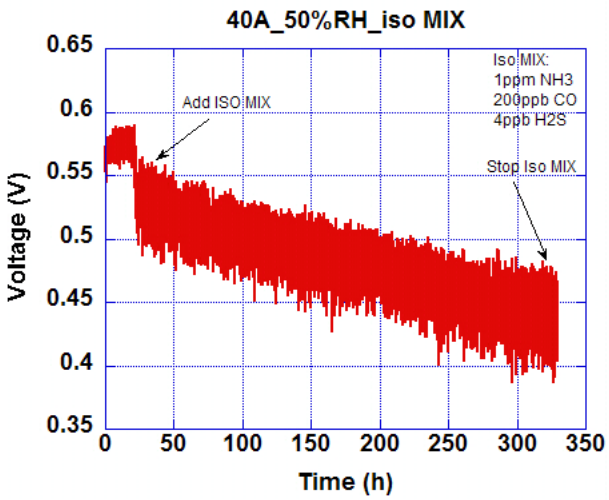
H_2S at ISO levels
- isolated and combined





- Results shown reflect ISO mix with NH3, CO, and H2S at 100% RH and 50% RH, 80C, 30 psig

- After 300 hrs of exposure FC at 100% RH decrease ~ 50 mV, while the cell operating at 50% RH decreased by ~ 100mV

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Testing Gaps/Challenges:

What tests remain to better determine the fuel specification?

1. Testing Critical Constituents at reduced levels.
2. Reduce anode loading: 0.05 mg Pt/cm^2(DOE's 2015 target)
3. Short term tests: typical vehicle operation ≈ 5-10hrs
4. Start/stop FC operation
5. Aged studies

With respect to the critical constituents:

1. Test are underway. Preliminary results are included.
2. Lower Pt loadings may increase performance losses via surface poisoning and/or within the catalyst layer.
3. Short term tests may help reduce the build-up of adsorbates and/or cation uptake
4. Shut down may be to some extent be helpful as a recovering strategy (introduction of air to remove excess H_2)
5. Aged fuel cells may inhibit particle growth and/or ionomer loss (similar to lowering Pt loading)

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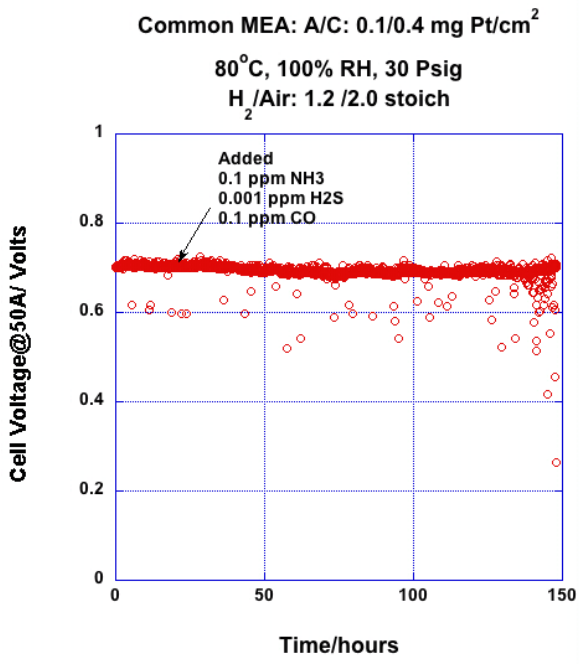
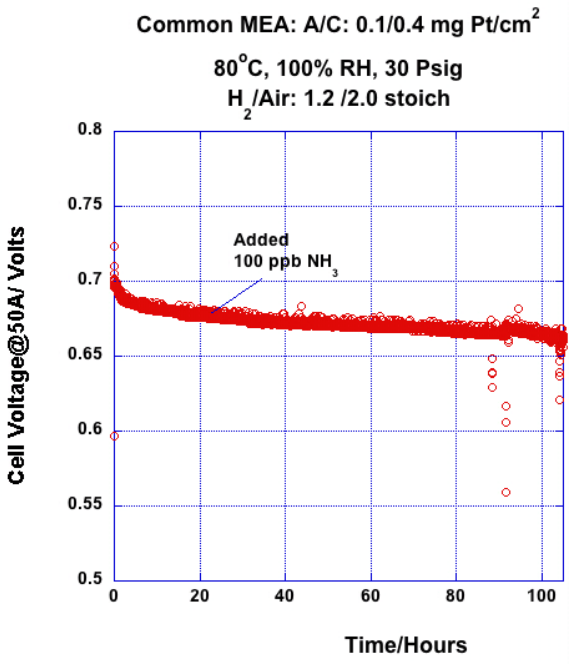
On Going Efforts: Modified Levels





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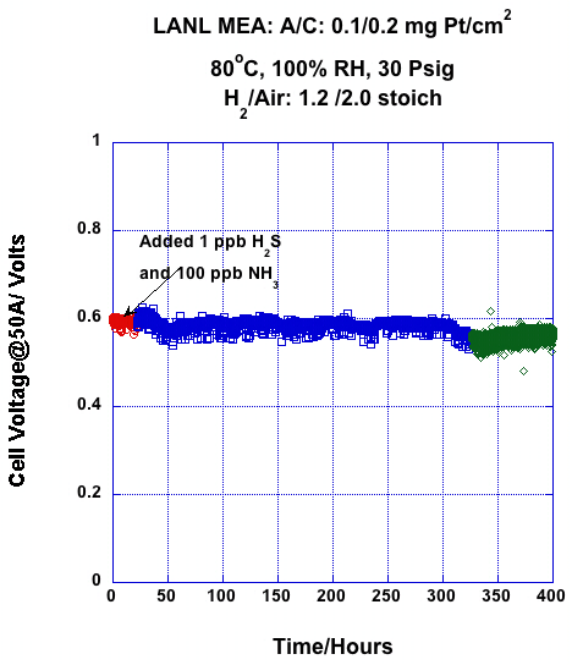
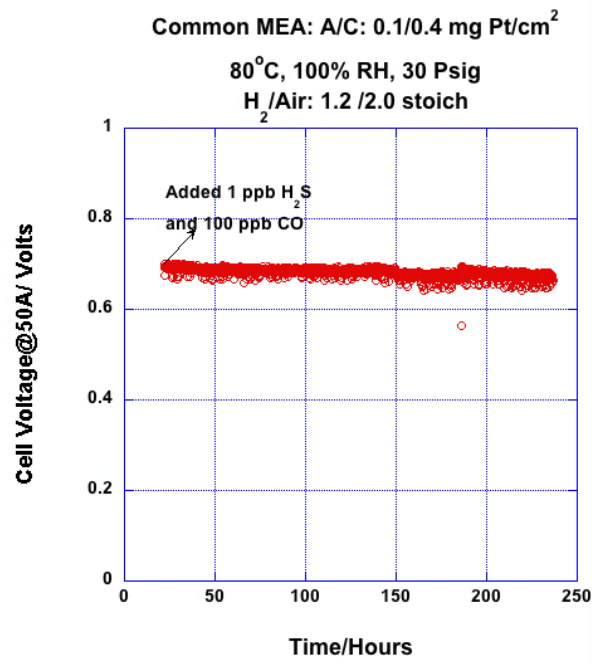
On-Going Efforts: Modified Levels





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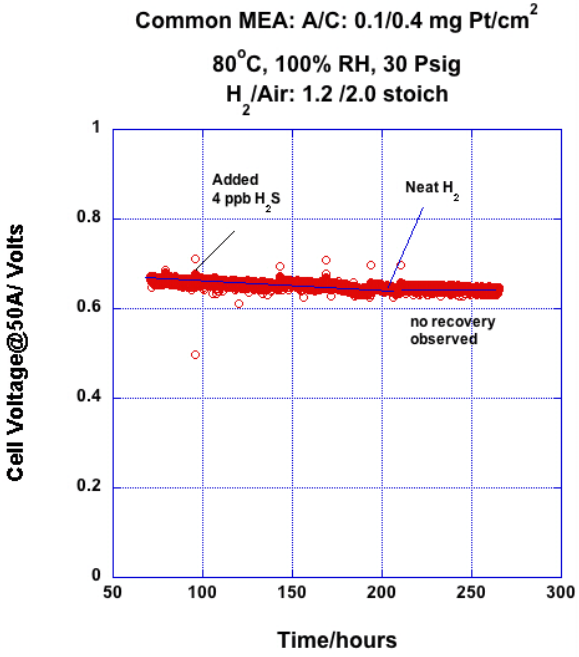
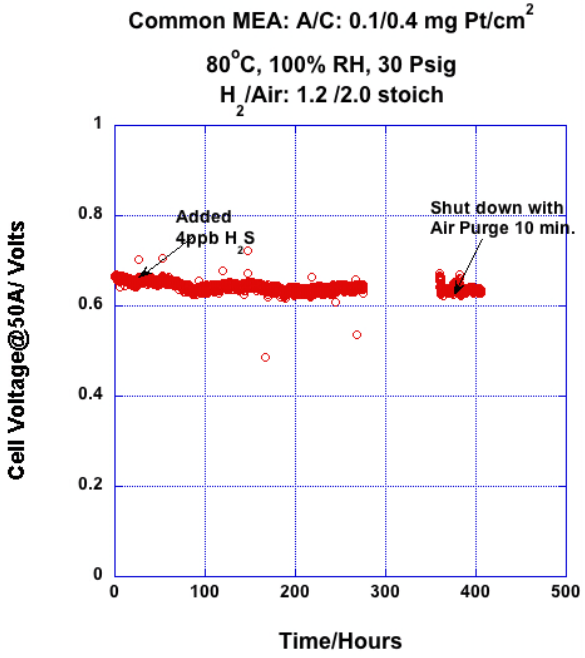
H_2S: Impact of Shut-down?





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Conclusions

- Significant efforts have been made by the Working Group 12 both by experimenters and analytical methods developers.
- The ISO specifications has been changed and tests are currently underway to investigate the impact of the reduced contaminant levels.