Balance of Plant (BoP) Components Validation for Fuel Cells

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Input from:

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Outline

- System Overview
  - Mechanization & common components
  - Materials used
  - Research Needs
- Qualification plan
  - Materials
  - System & components
  - Example code & standard

Common BOP Materials

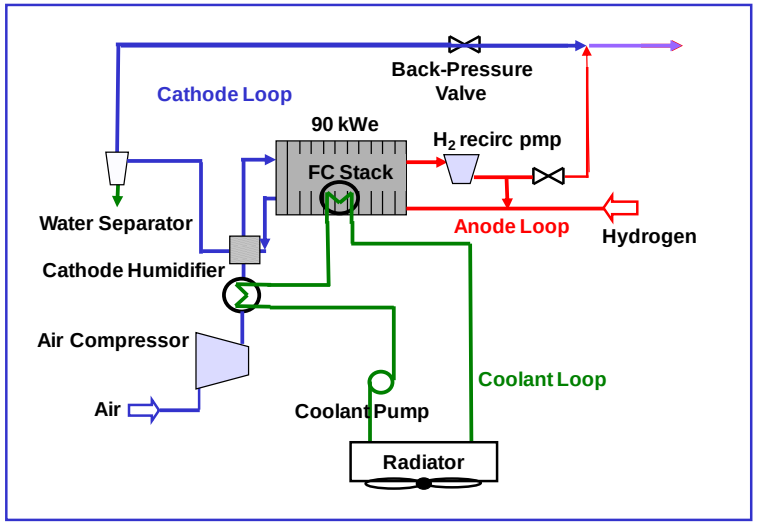
Air management	Fuel management	Stack	Integration
Compressor	Gas metering	Bipolar plates	Stack manifolds
Humidifier	Recirculation pump	Seals/sealants	Seals/sealants
Heat exchanger	Valves	Subgaskets	Conduits/hoses
Valves	Sensors	Membrane	
Sensors	Seals/sealants	Electrodes	
Seals/sealants	Conduits/hoses	Insulators and ports	
Conduits/hoses		Coolant	
		Conduits/hoses	

Most balance of plant materials fall into the following categories:

1. Structural plastics
2. Elastomers
3. Coolants
4. Assembly Aids
5. Metals

Most contaminating species are related to

1. Heat stabilizers
2. Plasticizers
3. Assembly aids
4. Solvents
5. Other



•*D.A. Masten, A.B. Bosco Handbook of Fuel Cells (eds.: W. Vielstich, A. Lamm, H.A. Gasteiger), Wiley (2003): vol. 4, chapter 53, p. 714.*

Though many BOP parts may be eliminated from the system, a few key materials will always be present.

BoP Research Needs input to DOE

Balance of Plant Technology Development

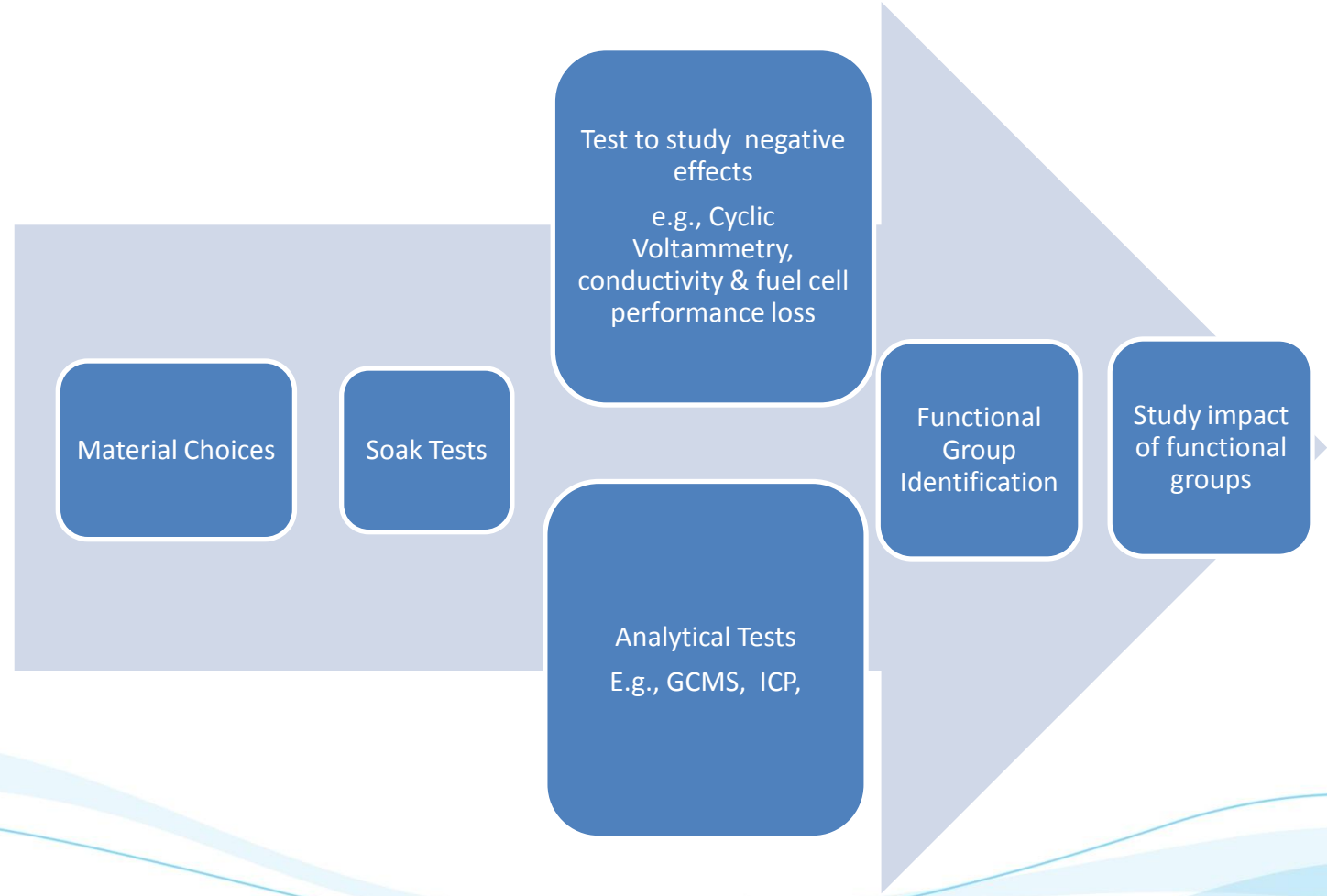
- OEMs agree than BOP cost can be reduced by system simplification enabled by development of more robust stack & MEA components, with focus on fundamental research to deliver enablers.
- Component Development
  - Some OEMs believe that development of BOP components should not be included in FOA because they are not pre-competitive.
  - Other OEMs believe that some BOP components (i.e., humidifiers, compressors, RH sensors) should be included in FOA provided appropriate targets are defined for these components by DOE.
- System Models
  - Some OEMs believe that development of analytical system & BOP models that calculate stack inlet and outlet stress factors as a function of vehicle operating conditions should be included in FOA.
  - Some OEMs believe that it is OEM responsibility to develop such models on their specific systems.

Research Needs

- Pre – Competitive
  - High Speed compact compressor expander
  - Better membranes for water vapor transfer
  - Stack health monitoring
- Competitive
  - Power electronics
  - Smart valves
  - Reliable sensors
  - Injector noise reduction
  - Coolant conductivity management

OEMs believe that most BoP components are competitive and hence should not be supported by DOE.

Material Qualification Plan

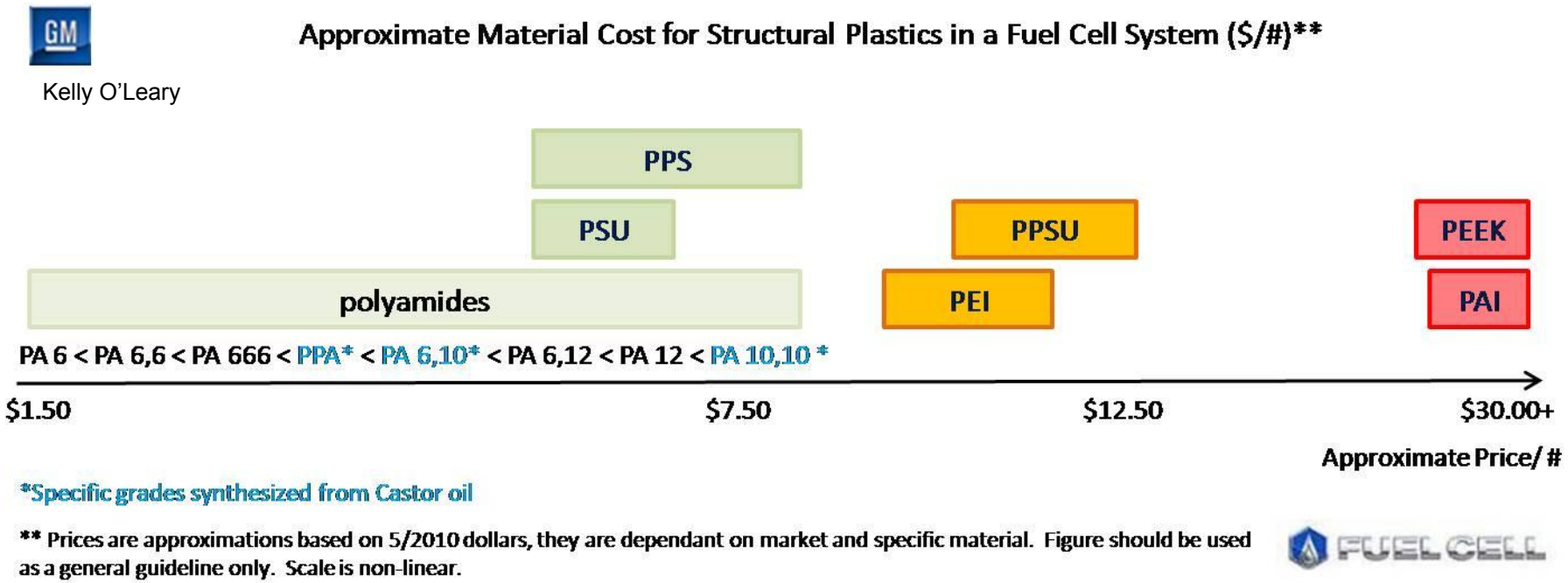


Tests planned to identify functional groups and understand impact on Fuel Cell Durability

Project funded by DOE in collaboration with NREL

Examples of Possible Structural Plastics for Fuel Cell use

Kelly O'Leary



Data gathered as part of DOE project No. DE-AC36-08-GO28308

Materials with a wide range in cost are being considered for Fuel Cell systems.

Example of Specification Flow

Vehicle Technical Specification (VTS)

Efficiency → ~ 50 mpg
Durability→ B10 of x hours
Top Speed → 100 MPH
Acceleration → 8 s for
IVM to 60 MPH

Sub system Technical Specification (SSTS)

Efficiency → x% for ¼ power
Durability→ B5 of x hours
Max Power → 80 kW

Component Technical Specification (CTS)

Torque → e.g., 1 NM
Durability→ B1 of x hours
Max Power → e.g., < 5 W

Component requirements are based on product requirements

Validation Codes

- Most BOP components are similar to components in a regular Internal Combustion Engine (ICE)
- Specifications for validation or derived from GM internal standards e.g., GMW3172
- GM Worldwide (GMW) standards are based on ASTM, ISO standards e.g.,
  - ASTM D4728
  - IEC 60068-2-1, IEC 60068-2-14, IEC 60068-2-27, IEC 60068-2-29, IEC 60068-2-30, IEC 60068-2-38, IEC 60068-2-52, IEC 60068-2-64, IEC 60068-2-78
  - ISO 8820, ISO 12103-1, ISO 16750-2, ISO 16750-3, ISO 16750-

Example: Thermal Cycling for Fatigue

9.3.1.4 Thermal Cycle Profile Used During All Vibration Tests. Vehicle vibration stress can occur together with extremely low or high temperatures; therefore, a simultaneous temperature cycle profile as shown below shall be applied repetitively during the vibration tests.

Figure 22: Thermal Cycle Profile Used During All Vibration Tests

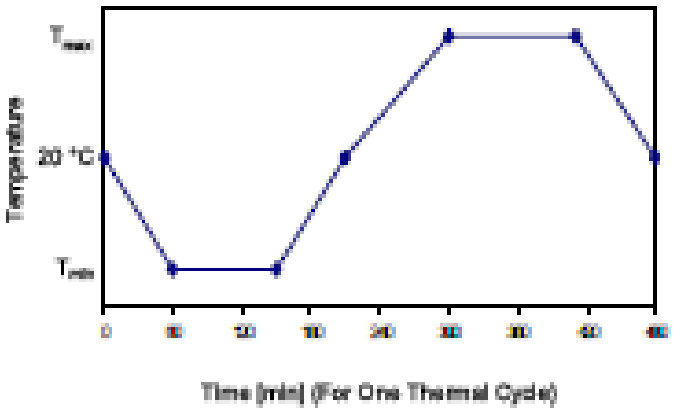
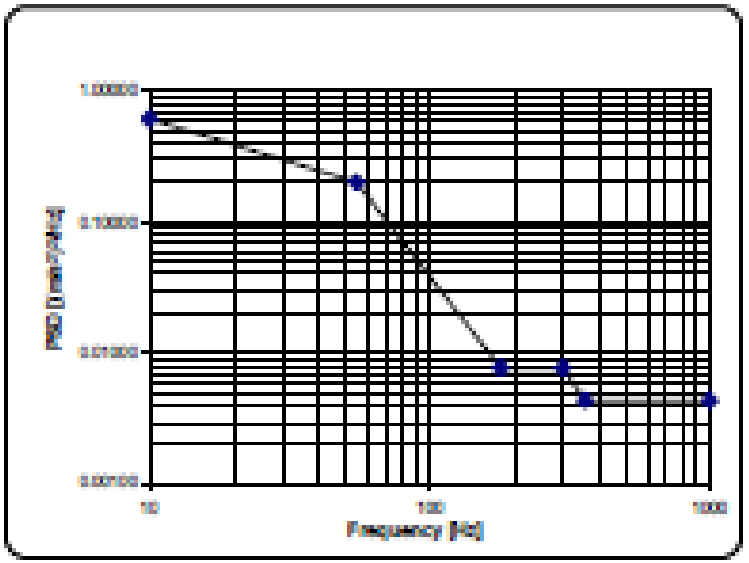


Figure 23: Post Thermal Fatigue Vibration Profile



Effective Acceleration = 4.9 m/s^2 = 0.5 G_{RMS}

Closing Thoughts

- Balance of plant (BoP) components within fuel cell systems are validated using GM internal standards.
- Impact of component interactions and contamination need to be studied as a part of product validation.
- Code and standard needed for hydrogen refueling and infrastructure.