



Component Conductivity Assessment: Flow Test In Ethylene Glycol Based Fuel Cell Coolant

1 Scope

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. This test covers the operation procedure for fuel cell cooling loop components in a test bench for evaluating the effects of corrosion products and leachants of components in contact with fuel cell coolant on the coolant conductivity under controlled laboratory conditions.

The performance requirements for the components are defined by additional specifications.

1.2 Foreword. Cooling system components considered for use in various fuel cell applications come in contact with low conductive fuel cell coolants. There is concern around contaminating the coolant with corrosion products, leachants, and residues from machining and manufacturing, which have the potential of increasing the coolant electrical conductivity.

This test procedure will generally distinguish between components that contribute detrimentally to the conductivity of the fuel cell coolant.

However, the results of this test cannot stand alone in determining if the component is appropriate for use within the fuel cell coolant loop.

1.3 Applicability. This test procedure is applicable for any components in contact with the low conductive coolant within the fuel cell coolant loop.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

None

2.3 Additional References.

Fuel Cell Propulsion System (FCPS) Subsystem Technical Specification (SSTS)

Vehicle Technical Specification (VTS)

3 Resources

3.1 Facilities.

3.1.1 Major Facility. Engineering Test Laboratory.

3.1.2 Minor Facility. Thermal Subsystem Test Cell.

3.2 Equipment. Coolant Loop Setup (see Figure 1) must incorporate the following features (including all components):

3.2.1 Closed Loop System.

3.2.1.1 All installed components must be in accordance to the approved material list for fuel cell coolant systems.

GM Confidential

© Copyright 2012 General Motors Company All Rights Reserved

December 2012

Originating Department: North American Engineering Standards

Page 1 of 7

- 3.2.1.2 Suitable to achieve a stable minimal operating test temperature.
- 3.2.1.3 Shall always supply a total test coolant volume.
- 3.2.1.4 Shall support a bypass capability for the installed test object.
- 3.2.1.5 Shall support a non-permanent cleaning path to clean the setup after the measurement.
- 3.2.1.6 Shall supply a drainage path to drain the complete coolant volume.
- 3.2.1.7 Shall suit a control unit to condition cycled coolant in terms of flow rate and temperature, supervise and capture set points and sensor readings.
- 3.2.1.8 Shall support an emergency shutdown to bring the test setup into a safe state.
- 3.2.1.9 Must be capable to run 24 h, seven (7) days per week without operator supervision.
- 3.2.1.10 Avoid air accumulation in complete test bench.
- 3.2.1.11 Should supply a thermal insulation to achieve temperature set point if required.
- 3.2.1.12 Optional: Chiller to cool down test setup to room temperature after hot test.

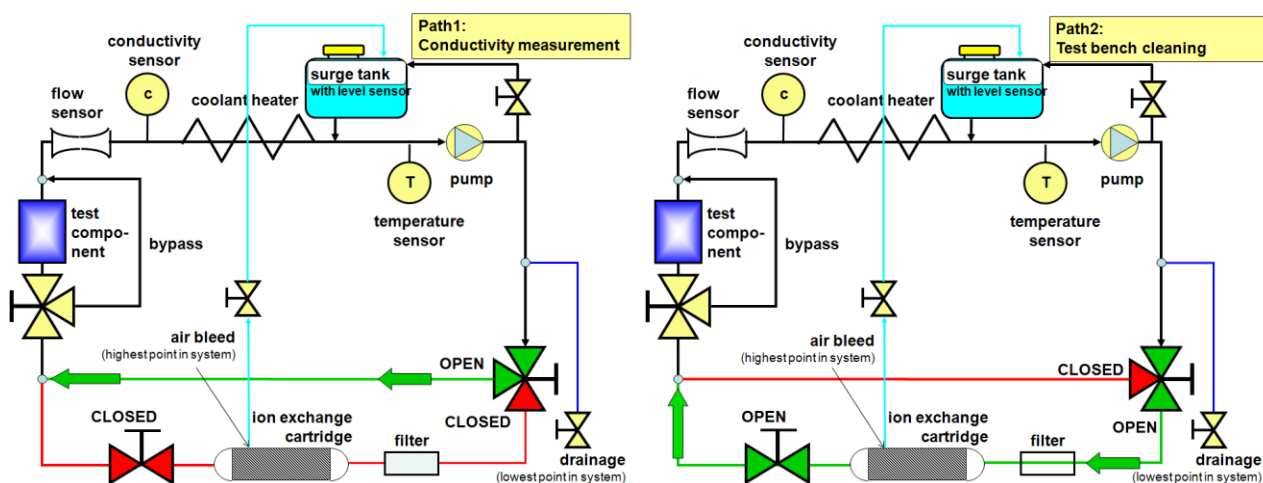


Figure 1: Coolant Loop Bench Mechanization

Note:

Test coolant volume: 6 L $\pm$ 0.5 L (include test object)
 Test flow rate: 20 L/minute $\pm$ 1 L/minute
 Test temperature: 90 °C $\pm$ 1 °C

3.2.2 Controls Unit. Unit must incorporate the following features:

- 3.2.2.1 Control and supervise pump speed to supply a test flow rate.
- 3.2.2.2 Control and supervise heater to supply a minimum coolant test temperature.
- 3.2.2.3 Supervise coolant tank level and coolant temperature.
- 3.2.2.4 Shall support an emergency shutdown to bring the test setup into a safe state.
- 3.2.2.5 Should supply a data acquisition capability for all set points and sensor readings with a period time of $\leq$ 1 s, but shall be faster than 60 s.

3.2.3 Emergency Shutdown. Must automatically shutdown test setup in case of the following circumstances:

- 3.2.3.1 Coolant level low.
- 3.2.3.2 Coolant temperature > Maximum excursion temperature specified in Vehicle Technical Specification (VTS).
- 3.2.3.3 Coolant flow rate $\leq$ 5 L/minute for more than 10 s.

3.2.4 Power Supply.

- 3.2.4.1 Grid connection, 110 V/220 V.

GM Confidential

© Copyright 2012 General Motors Company All Rights Reserved

December 2012

Page 2 of 7

3.2.4.2 Power supply, 12 V, 8 A.

3.2.5 Measurement Path.

3.2.5.1 Coolant Surge Tank. It must incorporate the following features:

3.2.5.1.1 Suits a coolant volume of > 3 L.

3.2.5.1.2 Suits one ventilation line connection.

3.2.5.1.3 Suits one surge tank degassing line connection.

3.2.5.1.4 Suits one return line connection.

3.2.5.1.5 Suits a coolant level detection.

3.2.5.2 Temperature sensor. Shall have a measurement range between 0 °C and 120 °C with an accuracy of ± 1 °C.

3.2.5.3 Coolant Pump. Shall be capable of supplying a coolant flow rate of 20 L/minute at a pressure drop of 60 kPa through 80 kPa.

3.2.5.4 Surge Tank Degassing Valve. Degassing during test preparation and to ensure coolant circulation through surge tank during normal operation with a defined flow rate.

3.2.5.5 Three (3) Way Valve Ion Exchange Cartridge. Switch between conductivity measurement and test bench cleaning operation.

3.2.5.6 Three (3) Way Valve Test Object. Switch between bypass (coolant warm up or cleaning) and conductivity measurement with test object.

3.2.5.7 Test Object/Component Mount. It must incorporate the following features:

3.2.5.7.1 Flexibility to suit all kind of test objects. Necessity of handmade mounts/adapters very likely.

3.2.5.7.2 Shall be placed in a way that even large and heavy test objects can be hooked up to the setup.

3.2.5.7.3 Test objects shall be placed on a coolant catch basin.

3.2.5.7.4 Pipe between component outlet and component bypass T-junction shall be accessible and long enough to apply a hose clamp during warm up.

3.2.5.8 Flow Sensor. Shall have a measurement range between 0 L/minute and 30 L/minute with an accuracy of ± 1 L/minute.

3.2.5.9 Conductivity sensor. Shall have a measurement range between 0 $\mu\text{S}/\text{cm}$ and 100 $\mu\text{S}/\text{cm}$ and an accuracy of ± 1 $\mu\text{S}/\text{cm}$, where $\mu\text{S}/\text{cm}$ is the measurement for specific conductivity.

3.2.5.10 Coolant Heater. Shall be able to control to the test temperature at nominal test flow rate.

3.2.5.11 Coolant Loop Pipes. Should have a minimum diameter of 1.9 cm (0.75 in).

3.2.6 Cleaning Path.

3.2.6.1 Filter. Shall supply a filter mesh size of < 150 μm mesh width.

3.2.6.2 Ion Exchange Cartridge. It must incorporate the following features:

3.2.6.2.1 Ion exchange resin shall be approved for fuel cell systems and will be supplied by ion exchange cartridge design release engineer (DRE).

3.2.6.2.2 Shall supply a mesh size of < 150 μm mesh width to hold resin in place.

3.2.6.2.3 Minimum amount of 30 g ion exchange resin required.

3.2.6.2.4 Shall be able to reduce coolant conductivity to < 4 $\mu\text{S}/\text{cm}$ at 25 °C.

3.2.6.2.5 Shall be easily accessible and serviceable (resin exchange).

3.2.6.3 Ion Exchange Cartridge Valve. Prevent coolant flow through ion exchange cartridge during measurement operation (Open/Close function).

3.2.6.4 Bleed Line Valve of Ion Exchange Cartridge. Degassing of ion exchange cartridge during cleaning operation (Open/Close function).

3.2.7 Drainage path.

3.2.7.1 Drain Line Valve. Drainage of bench setup. Shall be located at the lowest point of the bench setup (Open/Close function).

GM Confidential

© Copyright 2012 General Motors Company All Rights Reserved

December 2012

Page 3 of 7