



Sealer Material Pumping Dispense Test

1 Introduction

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 provides information on material "pumping and flow" characteristics and can be used when designing a new sealer pumping, distribution and dispense system. It may also be used to check for throughput concerns on existing systems when materials are changing.

1.2 Applicability. This test procedure is used to measure the flow and pressure drop characteristics of sealer materials as tested through pumps, header, hoses and orifices typically used in production dispense systems. The data from this procedure is specific to any individual sealer formula, and may also be used as a standard to compare to any future sealer batch for density or viscosity changes.

1.3 Remarks. Data to be generated from this test procedure.

1.3.1 A pumpability worksheet (format using Microsoft Excel spreadsheet) containing all data point entries (i.e., pressure drop and flow rate) and all other collected data from the material pumpability test.

1.3.2 A graph of pump capacity showing the full range of pump flow rate output versus pump pressure output for the material tested, from zero to the maximum capability of the pump.

1.3.3 A graph of hose and header restrictors, showing the tested material flow rate through the restrictor versus pressure drop measured per meter length of the restrictor. The data points of each restrictor shall be connected on the graph, to produce a "header or hose curve" of the sealer's relevant pressure drop and flow rate behavior for each restrictor tested.

1.3.4 A graph of smaller diameter orifice restrictors, each data coordinate showing the sampled material flow rate through the restrictor orifice versus pressure drop measured per centimeter length of the restrictor. The data points of each orifice restrictor shall be connected on the graph, to produce an "orifice curve" of the sealer's pressure drop and flow rate behavior for each restrictor tested.

2 References

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

2.1 External Standards/Specifications.

ASTM D1475	ISO 3219 Z4 DIN	SAE J1524	SAE J1864
ASTM D2196			

2.2 GM Standards/Specifications.

GMW6725	GMW15979	GMW16087	GMW16680
GMW15978	GMW16070		

2.3 Additional References. None.

3 Resources

3.1 Facilities.

3.1.1 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label.

3.1.2 Alternatives. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

3.1.3 Safety. Equipment must be checked before every test, ensure that it is operating properly since this test is conducted at high pressure. Procedures for pressurizing and de-pressurizing or locking out the pumping system should be prominently posted at the test setup.

3.2 Equipment.

3.2.1 A 200 L (55 gal) Barrel Unloader Assembly. A 200 L (55 gal) elevator, follower plate, and test pump (assembled air motor and foot valve). Select the test pump, elevator and follower plate assembly which best simulates the model used in production in terms of pressure ratio, volumetric displacement and elevator/follower plate down pressure. The dimensions of internal pump parts which are subject to wear, may be recorded at the beginning of the test procedure for comparison to the re-measured parts dimensions after test to determine if there has been any pump component wear.

- One (1) side-port check (consistent with selected pump).
- One (1) outlet nipple (from side-port check): number 16 JIC male.
- One (1) pump outlet hose: 25.4 mm diameter × 3.05 m (1 in diameter × 10 ft).

Temperature conditioning of the material pathway of the test equipment will be mandatory where the test environment is not controlled to 18.3 °C (65 °F). The follower plate must have water passages incorporated into it, and temperature conditioned jackets (incorporating water tubing pathways) must also cover the external body of the foot-valve of the pump, and side-port check. The pump outlet hose must be fully temperature conditioned also.

3.2.2 Air Supply to Air Motor.

3.2.2.1 For constant air supply to the test pump, an air supply hose of 25.4 mm (1 in) minimum diameter shall be used to deliver air to the control regulator and ball valve which operate the test pump.

3.2.2.2 One (1) 25.4 mm (1 in) National Pipe Thread (NPT) Wilkerson air regulator (manually adjustable) number R30-80-000 model for setting the air motor pressures of each test sample. Alternatively, an electrically commanded "proportional valve", may be used to deliver pilot control to a larger 25.4 mm (1 in) air regulator, for remotely commanded closed-loop control of air motor pressure.

3.2.2.3 One (1) 38.1 mm (1.5 in) NPT electro-pneumatically operated ball valve, to open or close the regulated air passage to the air motor inlet.

3.2.3 Restrictor Hoses.

3.2.3.1 All restrictor hoses shall have a maximum working pressure above 344.77 bar (5000 psi). Recommend Parker 731 series hose or equivalent.

3.2.3.2 Temperature conditioning of restrictor hoses is mandatory where the test environment is not controlled to 18.3 °C (65 °F). Temperature conditioning jackets must cover the total length of the restrictor hose to ensure that an 18.3 °C (65 °F) material environment is maintained.

3.2.3.3 Length and Inner Diameter of Restrictor Hoses.

- One (1) 25.4 mm inner diameter × 6.1 m (1 in inner diameter × 20 ft).
- One (1) 19.0 mm inner diameter × 3.05 m (¾ in inner diameter × 10 ft).
- One (1) 12.7 mm inner diameter × 3.05 m (1½ in inner diameter × 10 ft).
- One (1) 9.5 mm inner diameter × 3.05 m (⅜ in inner diameter × 10 ft).
- One (1) 6.35 mm inner diameter × 3.05 m (¼ in inner diameter × 10 ft).

3.2.3.4 Each restrictor hose shall have a connection means to a 25.4 mm (1 in) NPT high pressure tee at the inlet and outlet. Tee leg is required for installation of pressure transducers and pressure gauges.

3.2.4 Restrictor Orifices.

3.2.4.1 Restrictor orifices shall be stainless steel (440 hardened), with 12.7 mm (½ in) NPT male inlet threads.

3.2.4.2 Length and Inner Diameter of Restrictor Orifices.

- One (1) 6.35 mm inner diameter × 12.7 mm (0.250 in inner diameter × 0.500 in).
- One (1) 3.97 mm inner diameter × 12.7 mm (0.156 in inner diameter × 0.500 in).
- One (1) 3.17 mm inner diameter × 12.7 mm (0.125 in inner diameter × 0.500 in).
- One (1) 2.38 mm inner diameter × 12.7 mm (0.093 in inner diameter × 0.500 in).
- One (1) 1.59 mm inner diameter × 12.7 mm (0.062 in inner diameter × 0.500 in).

3.2.5 Restrictor Headers.

3.2.5.1 Restrictor headers shall be schedule 160 pipe, descaled and degreased.

3.2.5.2 Temperature conditioning of restrictor headers is mandatory where the test environment is not controlled to 18.3 °C (65 °F). To ensure effective temperature control to 18.3 °C (65 °F), the header restrictor pipe must be enclosed within a shell of water temperature conditioning bath for direct contact of the external pipe surface with the water medium ("shell and tube" design).

3.2.5.3 Length and Inner Diameter of Restrictor Headers.

- One (1) 43.1 mm inner diameter schedule 160 headers × 6.01 m (2 in inner diameter schedule 160 headers × 20 ft).
- One (1) 66.7 mm inner diameter schedule 160 headers × 6.01 m (3 in inner diameter schedule 160 headers × 20 ft).

3.2.6 Diverter Wye and Ball Valve Outlet Assembly.

3.2.6.1 One (1) quantity, 31.75 mm (1-1¼ in) NPT Schedule 160 Y-Pipe assembly, with welded 90 degree Y-legs, each 304.8 mm (12 in) long, with the root leg connectable to the 50.8 mm (2 in) and 76.2 mm (3 in) header restrictors, and the 25.4 mm (1 in) tee outlet of the hose restrictors.

3.2.6.2 Two (2) quantity 31.75 mm (1-¼ in) NPT air-actuated ball valve, each with independent electropneumatic solenoid control. The ball valves are to be installed at the outlet of the two (2) Y-legs, one (1) of which is to be a waste leg, and the other to be a sample leg.

3.2.7 Setup Diagrams.

3.2.7.1 Test equipment setup for pump and header, see Appendix A, Figure A1.

3.2.7.2 Replace header with test hoses and the orifices at the test leg of "Y" - test equipment setup for pump, header, and hose and orifice. See Appendix A, Figure A1.

3.2.7.3 Pumpability worksheet (using Microsoft Excel Spreadsheet format) with cells designated for data entry and with internal calculation formulas to generate summary data.

3.2.8 Lab Measurement Equipment.

- Two (2) pressure measuring transducers (range = 0 bar to 350 bar (5000 psi)).
- One (1) electropneumatic pump cycle sensor.
- One (1) pump cycle limit switch.
- One (1) programmable data acquisition logging device (normally a package of personal computer based software with data acquisition hardware interface). For the purposes of this specification, it shall be called the data acquisition quality (DAQ) controller.

3.2.8.1 Must be capable of simultaneously logging analog voltage inputs from two pressure transducer channels, plus one (1) digital input channel for pump cycle sensor.

3.2.8.2 Must be capable of real time sensing of digital input data (from pump cycle counter), and programmed to trigger digital output signals to automatically operate the air motor ball valve and the wye outlet waste leg and sample leg ball valves.

3.2.8.3 Must be capable to download measured data to a Microsoft Excel Spreadsheet. May be programmed to automatically populate dispense sample data directly into the designated cells of the pumpability worksheet.

3.2.8.4 Must be able to acquire digital and analog data on all channels at a sample rate of at least 40 samples per second.

3.2.8.5 One (1) electric control panel to integrate the DAQ controller interface for pump cycle sensor, air motor, and Y-outlet ball valve controls.

3.2.8.6 One (1) scale or balance with 0.0 kg to 5 kg, measurement accuracy to 0.1 g.

3.3 Test Vehicle/Test Piece. Sealer materials used in production dispense systems.

3.4 Test Time.

Calendar time: 5.0 days

Test time: 40.0 hours

Coordination time: 8.0 hours

3.5 Test Required Information. See 5.3.

3.6 Personnel/Skills. Persons performing this test are required to use proper protective equipment, eye protection with side shields and gloves to prevent contact with test materials. Operators should be trained in operating this equipment and conducting this test.

4 Procedure

4.1 Preparation. Not applicable.

4.2 Conditions. Not applicable.

4.2.1 Environmental Conditions. See 4.3.1.5.

4.2.2 Test Conditions. Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

4.3 Instructions. Dispense test procedure.

4.3.1 Material to be Provided for Test.

4.3.1.1 A full 200 L (55 gal) drum of material (minimum 189 L (50 gal)) is required for this testing procedure.

4.3.1.2 One (1) additional empty drum shall also be supplied to recover the dispensed sample material.

4.3.2 Material Viscosity. Viscosity of the unpumped test material (drawn from the drum) will be measured by castor-severs press-flow viscosity method (SAE J1524), brookfield viscometer method (ASTM D2196) and rheometric method (ISO 3219 Z4 DIN). Standard viscosity sample testing temperature is $25\text{ }^{\circ}\text{C} \pm 0.5\text{ }^{\circ}\text{C}$, however the press-flow orifice and sample cylinder pressure, and brookfield spindle and rotations per minute, shall be as specified in the GM sealer specifications (i.e., GMW6725, GMW16070, GMW16087, GMW15978, GMW15979 and GMW16680) for the material tested.

4.3.3 Material Density. The density/specific gravity (ASTM D1475) of the test material shall be measured from a gardco series 300 weight per gallon cup.

4.3.4 Material Separation. A material separation test must be conducted to measure whether any material liquids/solids will separate in the subject test sample after 72 h at 206.85 bar (3000 psi). Reference SAE J1864 for separation (Sep)-check test equipment, procedure, and reporting.

4.3.5 Test Environment Temperature. The facility that contains the test equipment and material to be tested must be maintained at a temperature of $18.3\text{ }^{\circ}\text{C}$ ($65\text{ }^{\circ}\text{F}$). If the material is to be tested in an uncontrolled environment, then the material pathway of the test equipment must be temperature conditioned (to a set-point of $18.3\text{ }^{\circ}\text{C}$) in a continuous unbroken manner from the material inlet of the pump follower plate and throughout the pump, 25.4 mm $\times$ 3048 mm (1 in $\times$ 10 ft) supply hose, the header or hose restrictor, and through the material sample outlet of the 31.75 mm (1 in to 1 $\frac{1}{4}$ in) diverter "Y".

4.3.5.1 If an $18.3\text{ }^{\circ}\text{C}$ ($65\text{ }^{\circ}\text{F}$) controlled temperature room is used, then the material must reside in the room long enough to have stabilized at a measured $18.3\text{ }^{\circ}\text{C}$ ($65\text{ }^{\circ}\text{F}$) (usually 72 h). It must be verified that material throughout the barrel has reached $18.3\text{ }^{\circ}\text{C}$ ($65\text{ }^{\circ}\text{F}$) before flow data may be taken.

4.3.6 Final Material and Equipment Preparations.

4.3.6.1 Remove lid from test material barrel, and fill three (3) 354.8824 cc (12 oz) semco tubes with unpumped material (vacuum fill method recommended). Cap and label the material tubes (material number, lot number, and date) and reserve for density, sep-check, and castor-severs press-flow viscosity testing (SAE J1524).

4.3.6.2 Administer the density test (ASTM D1475), castor-severs press-flow viscosity test (SAE J1524), brookfield viscometer test (ASTM D2196) and rheometric test (ISO 3219 Z4 DIN).

4.3.6.2.1 After the density testing, enter the values for specific gravity in gram/cubic centimeter (g/cc), or (lb/gal) into the designated cells of the pumpability worksheet.

4.3.6.2.2 After the castor-severs test, enter the press-flow seconds (with orifice and pressure parameters) in the designated cell of the pumpability worksheet.

4.3.6.2.3 Prepare and administer the 72 h sep-check test (the 72 h testing period will be concurrent with pumpability testing).

4.3.6.2.4 Enter all pumpability test serial number, material number, lot number, and date into designated cells of the pumpability worksheet. See Appendix A, Table A1 for example setup.

4.3.6.3 Connect the pump supply 25.4 mm inner diameter × 3.05 m (1 in inner diameter × 10 ft) material hose to the 66.7 mm inner diameter × 6.01 m (3 in inner diameter × 20 ft) restrictor header inlet. Connect the diverter "Y" assembly to the restrictor header outlet.

4.3.6.3.1 Install two (2) pressure transducers at header inlet and outlet.

4.3.6.3.2 Apply air to unloader and pump air motor controls, and diverter "Y".

4.3.6.3.3 Turn on temperature conditioning system (set point = 18.3 °C (65 °F)).

4.3.6.3.4 Connect all cables from electric control panel (transducers, pump sensor, ball valve solenoids, and DAQ controller system). Power up control panel and DAQ controller system.

4.3.6.4 Place test material drum under the 200 L (55 gal) follower plate in the unloader elevator, then lower pump and flower plate into the drum. Place and empty 200 L (55 gal) waste drum under the waste leg of the diverter "Y".

4.3.6.5 Manually operate pump at low pressure 1 bar (10 psi to 20 psi) air motor pressure so that material slowly fills the test system, and flows out of the waste leg of the diverter "Y". Allow 3.785412 L (1 gal) or so of the material to accumulate in the waste barrel, and then shut off pump air motor to allow material pressure in the restrictor header to deplete to zero pound per square inch gauge.

4.3.6.6 Final Calibration of Pressure Transducers. Both transducers must be in good working order and pre-validated for reliable linearity. After installation into the restrictor header inlet and outlet, however, a further check and pressure output correction should be made to match the two (2) transducer pressure outputs to the extent possible.

4.3.6.6.1 Match transducer outputs for zero pound per square inch gauge (zero offset). While observing the transducer output on the DAQ controller data logger screen, either manually adjust the zero potentiometers on the transducer bodies, or electronically offset the zero errors in the DAQ controller user software, until 0.00 bar (0.00 psi) is identically displayed for both transducer pressure data lines.

4.3.6.6.2 Raise material pressure in the header to 140 bar (2030 psi) static gauge pressure, and assure that transducer outputs also equal 140 bar (2030 psi) gauge pressure. Apply a gain factor (can be set in the DAQ controller user software), until the pressure value from the transducers both display 140 bar (2030 psi) in the DAQ controller pressure data display lines.

4.3.7 Position (and level) the gram-weight scale under the outlet of the sample leg of the diverter "Y". Power up and calibrate.

4.3.8 Depressurize the pump and header system after the calibration is completed (turn off air motor and open waste leg of diverter "Y"). Double check to verify that material inside header is measured to have a temperature of 18.3 °C (65 °F).

4.3.9 Header Restrictor Pumpability Test.

4.3.9.1 The 76.2 mm inner diameter × 6.1 m (3 in × 20 ft) header restrictor is already installed and purged. Close both the waste leg and the sample leg of diverter "Y".

4.3.9.2 Put an empty sample cup on the plate of the scale, and tare.