ARES-G2

High Sensitivity Pressure Cell (HSPC) –Concentric Cylinder

Getting Started Guide

Revision A **Issued September 2018**

Notice

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Introduction

Important: TA Instruments Manual Supplement

Please click the TA Manual Supplement link to access the following important information supplemental to this Getting Started Guide:

- TA Instruments Trademarks
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Notes, Cautions, and Warnings

This manual uses NOTES, CAUTIONS, and WARNINGS to emphasize important and critical instructions. In the body of the manual these may be found in the shaded box on the outside of the page.

NOTE: A NOTE highlights important information about equipment or procedures.

CAUTION: A CAUTION emphasizes a procedure that may damage equipment or cause loss of data if not followed correctly.

MISE EN GARDE: UNE MISE EN GARDE met l'accent sur une procédure susceptible d'endommager l'équipement ou de causer la perte des données si elle n'est pas correctement suivie.

A WARNING indicates a procedure that may be hazardous to the operator or to the environment if not followed correctly.

Un AVERTISSEMENT indique une procédure qui peut être dangereuse pour l'opérateur ou l'environnement si elle n'est pas correctement suivie.

Regulatory Compliance

Safety Standards

For Canada

CAN/CSA-C22.2 No. 61010-1 Safety requirements for electrical equipment for measurement, control, and laboratory use, Part 1: General Requirements.

CAN/CSA-C22.2 No. 61010-2-010 Particular requirements for laboratory equipment for the heating of materials.

For European Economic Area

(In accordance with Council Directive 2006/95/EC of 12 December 2006 on the harmonization of the laws of Member States relating to electrical equipment designed for use within certain voltage limits.)

EN 61010-1:2001 Safety requirements for electrical equipment for measurement, control, and laboratory use, Part 1: General Requirements + Amendments.

EN 61010-2-010:2003 Particular requirements for laboratory equipment for the heating of materials + Amendments.

For United States

UL61010-1:2004 Electrical Equipment for Laboratory Use; Part 1: General Requirements.

Electromagnetic Compatibility Standards

For Australia and New Zealand

AS/NZS CISPR11:2004 Limits and methods of measurement of electronic disturbance characteristics of industrial, scientific and medical (ISM) radio frequency equipment.

For Canada

ICES-001 Issue 4 June 2006 Interference-Causing Equipment Standard: Industrial, Scientific, and Medical Radio Frequency Generators.

For the European Economic Area

(In accordance with Council Directive 2004/108/EC of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility.)

EN61326-1:2006 Electrical equipment for measurement, control, and laboratory use-EMC requirements-Part 1: General Requirements. Emissions: Meets Class A requirements per CISPR 11. Immunity: Per Table 1 - Basic immunity test requirements.

For the United States

CFR Title 47 Telecommunication Chapter I Federal Communications Commission, Part 15 Radio frequency devices (FCC regulation pertaining to radio frequency emissions).

Safety

WARNING: The operator of this accessory is advised that if the equipment is used in a manner not specified in this manual, the protection provided by the equipment may be impaired.

AVERTISSEMENT: L'utilisateur de cet accessoire est prévenu qu'en cas d'utilisation contraire aux indications du manuel, la protection offerte par l'équipement peut être altérée.

Required Equipment

While operating this accessory, you must wear eye protection that either meets or exceeds ANSI Z87.1 standards. Additionally, wear protective clothing that has been approved for protection against the materials under test and the test temperatures.

Table of Contents

Chapter 1:

Introducing the High Sensitivity Pressure Cell

Overview

The High Sensitivity Pressure Cell (HSPC) accessory for the ARES-G2 rheometer allows for the rheological evaluation of sensitive samples using dynamic oscillatory testing while varying temperature and pressure. The High Sensitivity Pressure Cell's open chamber is designed to pressurize the cell while minimizing frictional contribution by flowing externally supplied gas across the narrow gap between the rotor shaft and the cell cap. Precise temperature control is supplied by the APS through a thin air gap to the chamber. This configuration allows for the viscoelastic characterization of samples while suppressing evaporation and boiling effects at elevated temperature and pressures with low torque sensitivity.

A conical end cylinder or optional vane rotor may be used inside the pressurized chamber for testing materials over a wide range of viscosities and particle sizes.

This document provides details on the HSPC accessory including system requirements, specifications, and instructions for installation, use, and maintenance.

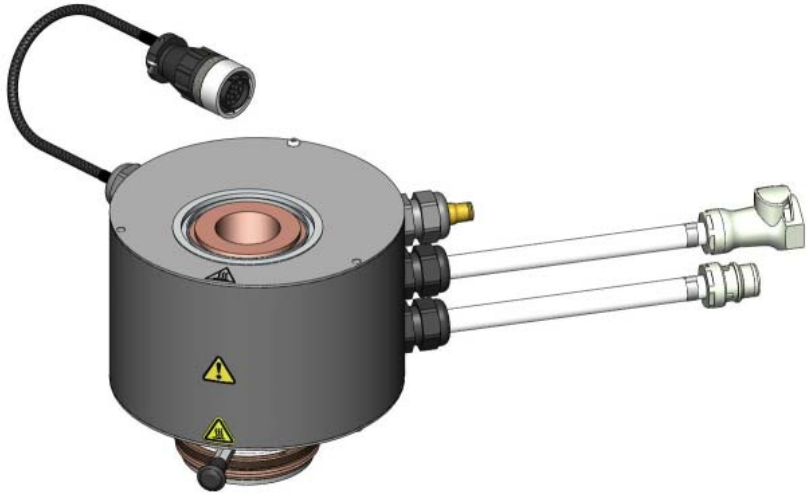


Figure 1 Advanced Peltier System (APS).

CAUTION: This accessory includes an open chamber allowing the pressurization gas, sample vapor, or the sample to escape. Reduction of pressure at elevated temperatures may result in rapid boiling and potential ejection of vapor or liquid sample. Appropriate personal protection equipment that afford adequate protection against the sample and pressurization gas under the temperature/pressure used must always be worn. The outer surfaces of the cell may become very hot or cold when used at temperatures other than ambient. When operating at these temperatures, wear personal protection equipment that afford adequate protection against the surface temperature of the High Sensitivity Pressure Cell and its fittings.

This Getting Started Guide provides instructions for installing and using the concentric cylinder High Sensitivity Pressure Cell geometry, which is designed to be used with the APS and ARES-G2. Instructions and details on the APS can be found in the ARES-G2 APS Getting Started Guide.

Pressure Cell Components

The following section describes the components included with the HPSC:

- HSPC Cup
- HSPC Pressure Cap
- HSPC Rotor Assembly
- Air Supply Manifold

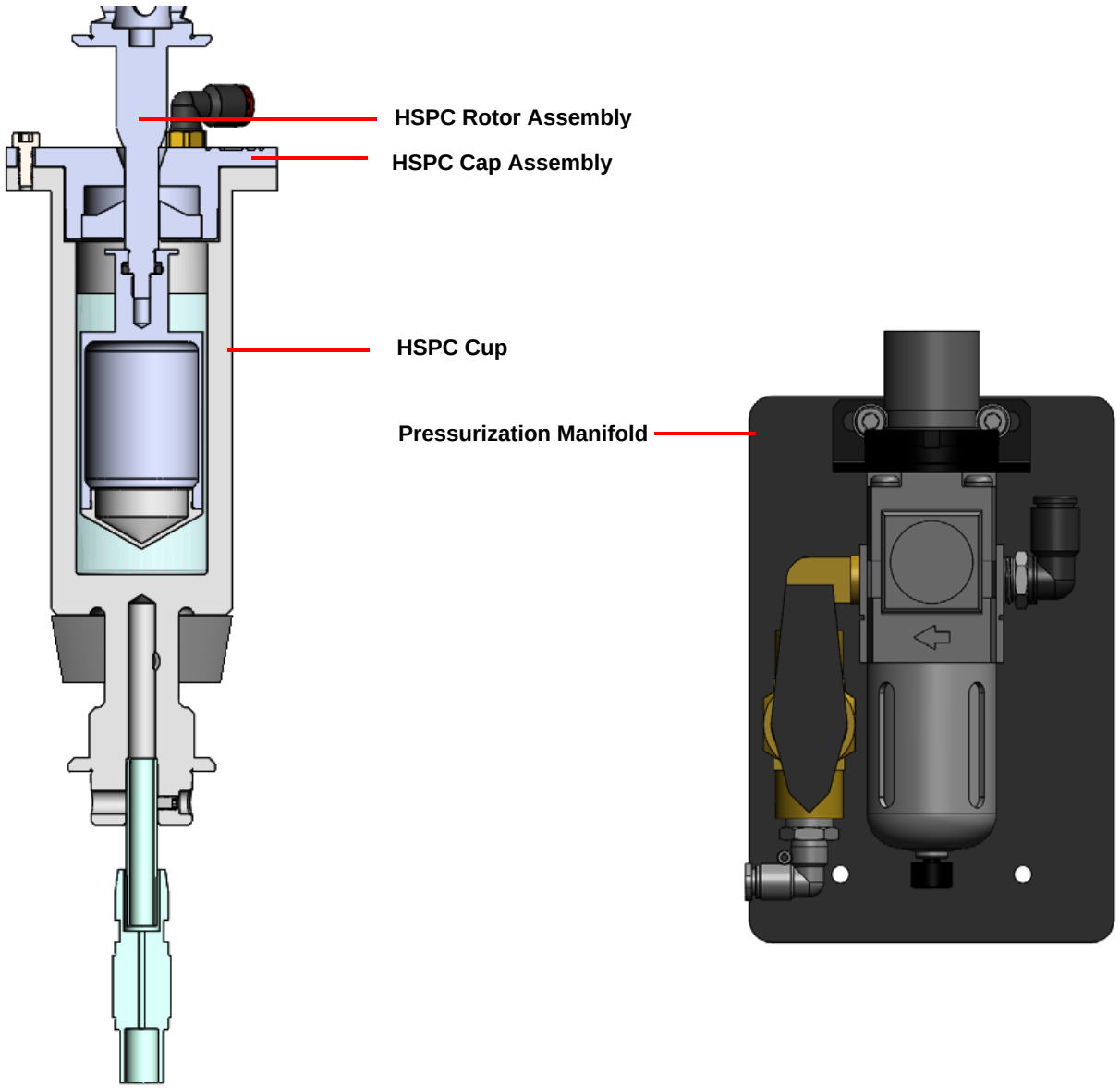


Figure 2 HPSC components.

HSPC Cup

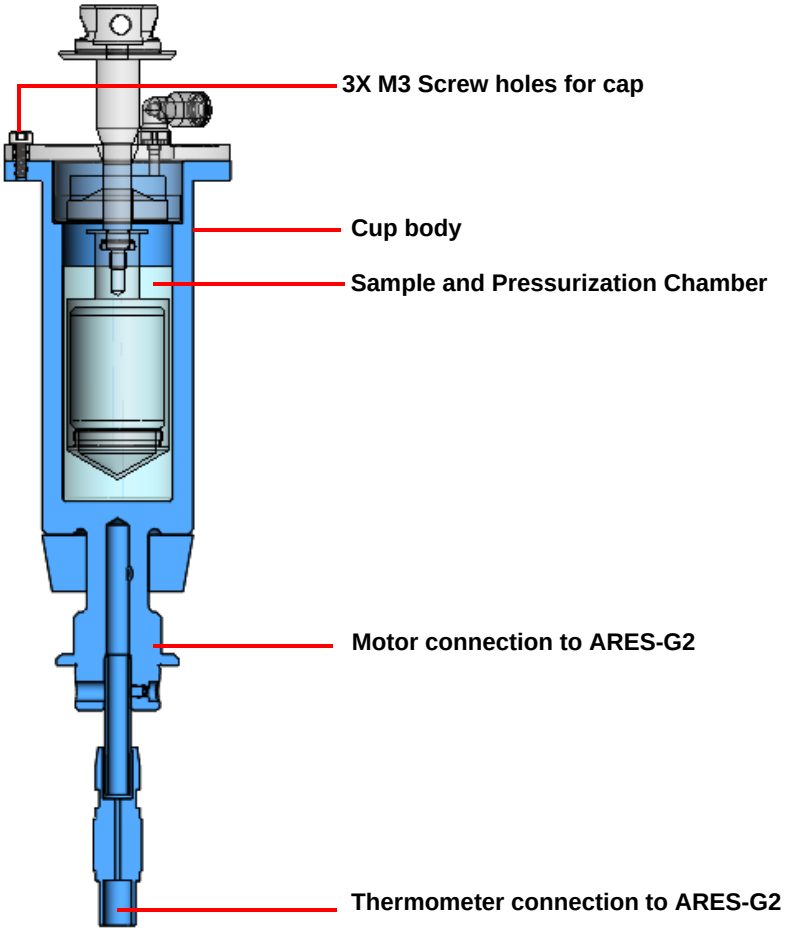


Figure 3 HPSC cup schematic diagram.

The High Sensitivity Pressure Cell Cup contains the sample fluid and acts as the rotating cylinder providing shear to the sample. It is inserted into the Advanced Peltier System (APS), which mounts onto the rheometer. Heating and cooling is transferred to the cup from the APS assembly across a narrow air gap. A platinum resistor thermometer (PRT) is embedded into the cup for precise temperature measurement. The cup is attached to the ARES-G2 via a motor connection and an electrical connection for temperature measurement. Three M3 screw holes on top of the cup allow for the mounting of the HSPC Cap after the rotor has been lowered into the cup.

An HSPC cup holder is provided in the accessory package to allow for temporary storage of the cup while it is not mounted to the ARES-G2. This cup holder should be used to prevent damage to the thermometer connection.

HSPC Pressure Cap

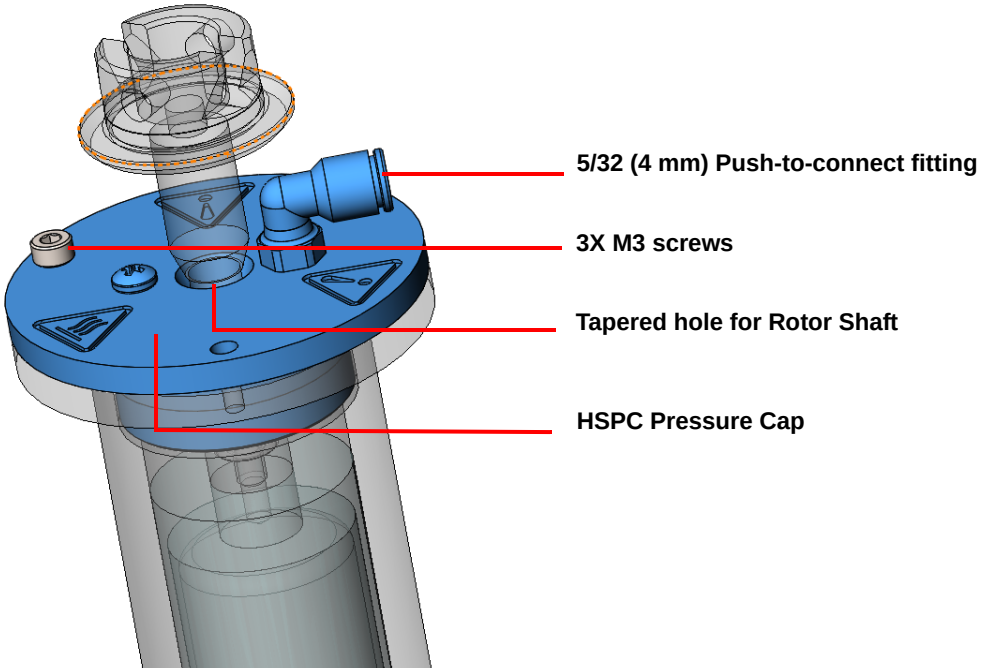


Figure 4 HSPC Pressure Cap schematic diagram.

The HSPC Pressure Cap is attached to the top of the HSPC Cup with three M3 Screws. A fitting on the cap transfers pressurized gas to the HSPC cup. The HSPC rotor shaft passes through the central hole which also serves as a pressurized air bearing. The precise gap between the rotor shaft and the cap allows for chamber pressurization without physical contact or friction between the cap and the rotor.

HSPC Rotor Assembly

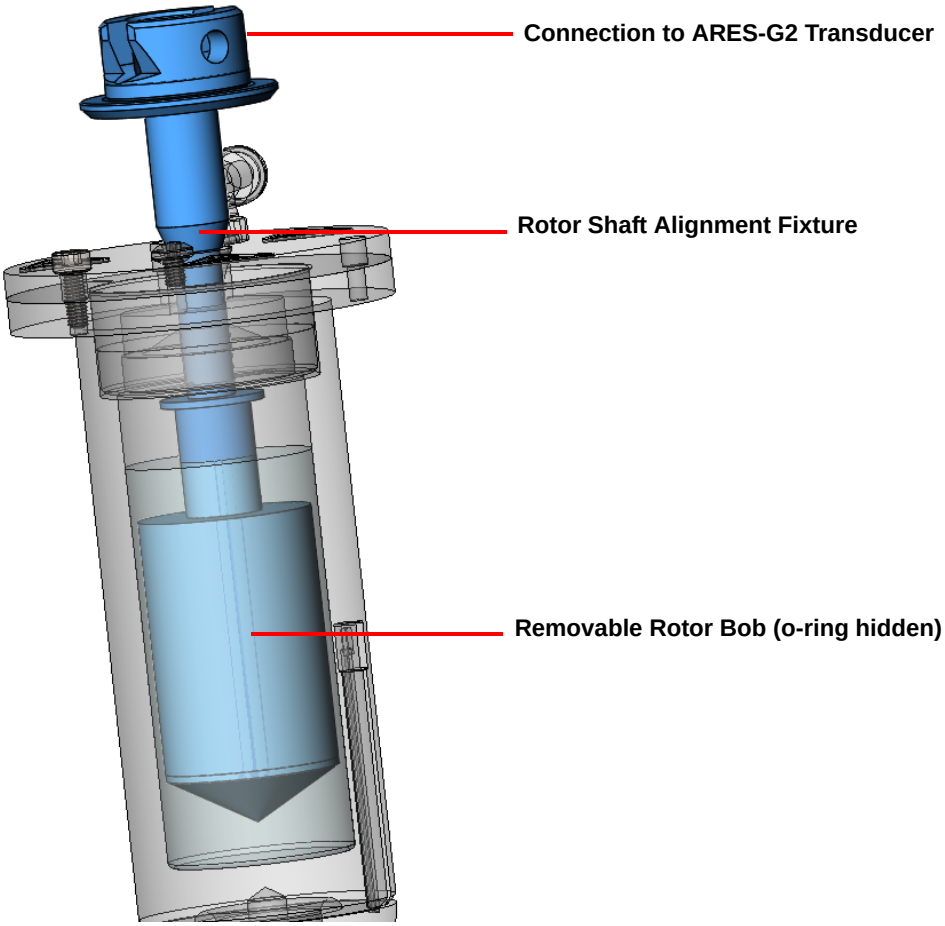


Figure 5 HSPC Rotor Assembly schematic diagram.

The HSPC Rotor Assembly is attached to the ARES-G2 transducer and includes a cylindrical bob which functions as the stationary cylinder in the concentric cylinder geometry. A conical feature on the rotor shaft allows for the alignment of the shaft to the cap. The Rotor Bob is removable from the shaft to allow for ease of cleaning and assembly with the HSPC Pressure Cap. Care should be taken not to damage or scratch the shaft or bob.

Air Supply Manifold

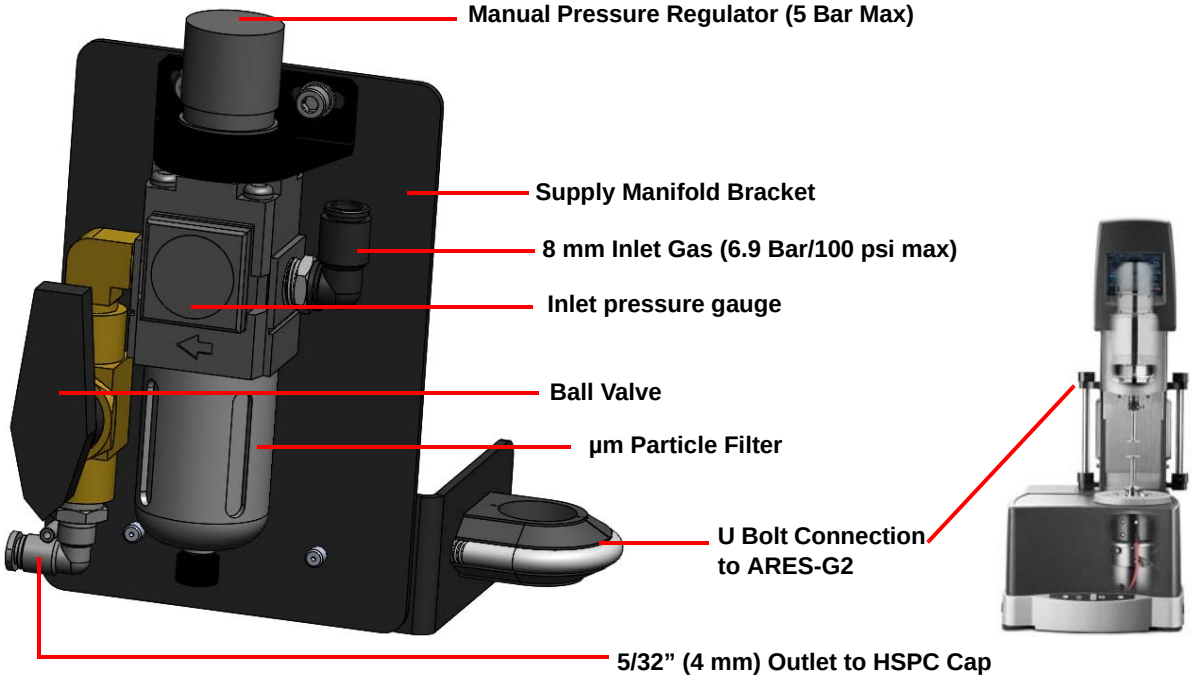


Figure 6 Air Supply Manifold schematic diagram.

The Air Supply Manifold mounts onto the left or right FCO mounting rails on the ARES-G2. The preferred location of the Air Supply Manifold is on the left FCO mounting rail. This manifold regulates and filters input gas from an external source for use as the pressurization gas to the HSPC accessory. The manifold takes an 8 mm tube at the inlet (right of the regulator) and outputs with a 5/32" (4 mm) tubing on the bottom left. The pressure is manually controlled using a regulator/filter combined unit. The ball valve is used to turn the pressure on and off.

HSPC Specifications

Table 1: HSPC Operating Specifications

Item/Area	Specification
Cup Inner Radius	13.5 mm
Rotor Outer Radius	12.5 mm
Radial Gap	1 mm
Rotor Cylinder Length	37.5 mm
Back Off Distance (Gap)	4 mm
Sample Volume	13.0 ± 0.5 mL[a]
Temperature Range	-10°C to 150°C
Minimum Chamber Pressure	0.5 bar (7.5 psi)
Maximum Chamber Pressure	5 bar (73 psi)
Torque Range	1 µN.m to 200 mN.m [a,b]
MaximumOscillation Strain	0.8 radians or 1000%
Sample Material	Sample contacting surfaces are designed to be compatible with a wide variety of samples. Stainless Steel (Grade 316), Titanium Alloy (Grade 5 - Ti 6Al 4V), and Viton (O-Rings). Ensure samples used are compatible with these materials.
Required Associated Instruments/Accessories	ARES-G2 Instrument APS Environmental System Accessory with a heating/cooling circulator

a. Measurement accuracy will be significantly affected when sample volume reduces below 10 mL due to evaporation. Typical aqueous solutions can be tested for at least 2 hours even in worst-case heating conditions. To minimize error ensure that sample volume does not significantly decrease during the testing duration.

b. Due to air flow friction, torque sensitivity will reduce with higher pressures.

Table 2: HSPC Safety Specification

Item/Area	Specification
Maximum Chamber Pressure	5 bar (73 psi)
Maximum Regulator Pressure	6.5 bar (94 psi). Do not exceed 5 bar cell pressure at any time.
Maximum Input Pressure	6.9 bar (100 psi)

Table 2: HSPC Safety Specification

Item/Area	Specification
Maximum Temperature	150°C. Do not exceed boiling temperature at operating pressure. For aqueous solutions, see table below. Refer to APS Getting Started Guide.
Minimum Temperature	–10°C. Do not freeze aqueous solutions. Refer to APS Getting Started Guide.
Maximum Volume	13.0 ± 0.5 mL Sample volume must not exceed 15 mL at operating conditions.

Table 3: HSPC Air Input Requirements

Item/Area	Specification
Pressurization Gas	Inter Gas – Air or nitrogen
Inlet Pressure	Maximum 6.9 bar (100 psi) – less may be required at lower operating pressure.
Dew Point	Non-condensing at operating conditions.
Flow Rate	At least 100 SLPM (standard liters per minute) – less may be required at low operating pressure.
Input Air Temperature	20°C–30°C

Refer to the ARES-G2 Getting Started Guide and the APS Getting Started Guide for additional requirements and specifications.

Chapter 2:

Installing and Setting Up the HSPC

Overview

The HSPC is shipped partially assembled; see below image for the layout of components in the kit container. Installation requires the APS to already be installed on the ARES-G2 Rheometer. Read and understand the following instructions entirely prior to installation.

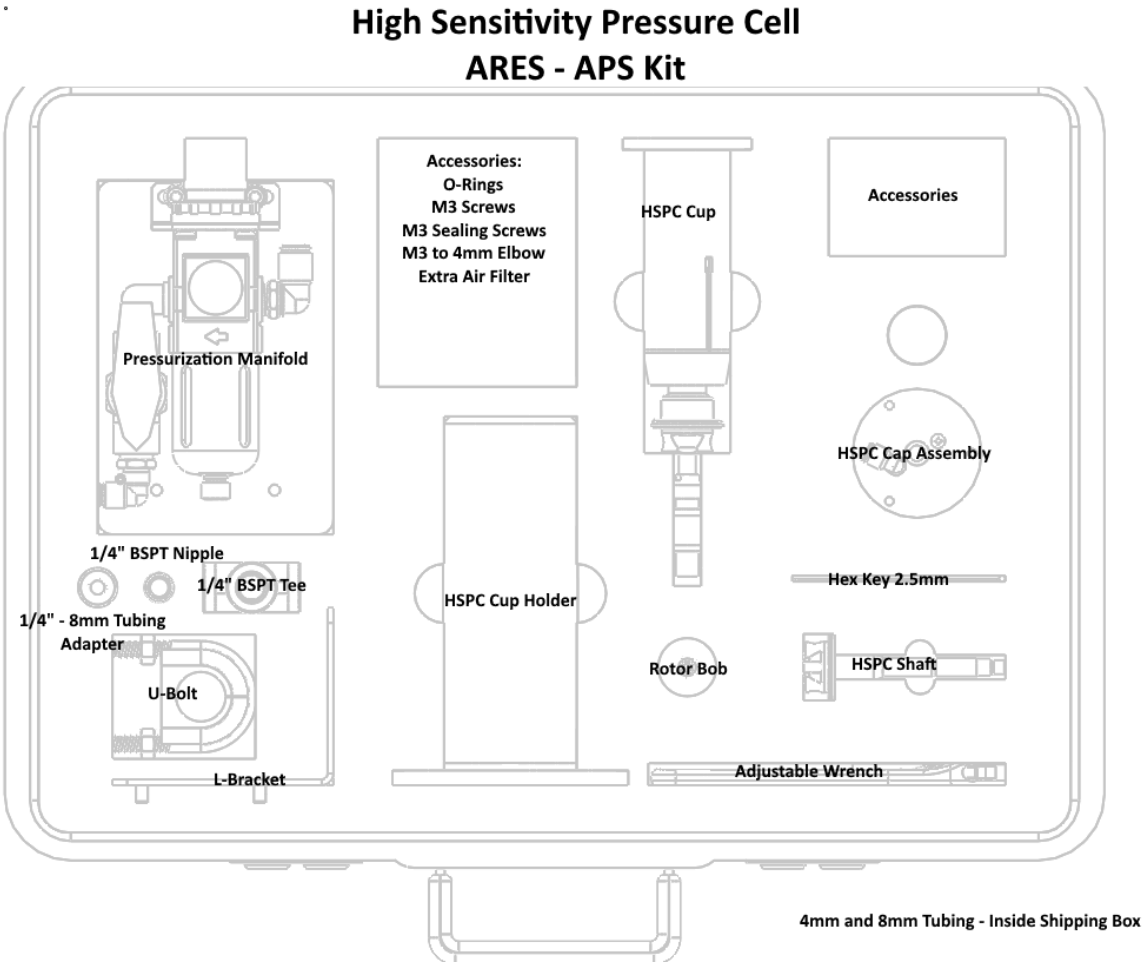


Figure 7 HSPC kit contents.

Preparing the Instrument

Preparing the instrument includes the following procedures:

- Installing the Advanced Peltier System (APS)

Installing the Advanced Peltier System (APS)

Follow instructions in the ARES-G2 Advanced Peltier System Getting Started Guide to install the APS to the ARES-G2. Follow instructions listed for concentric cylinder installation but do not install the PRT, the cup geometry, or the shaft/bob geometries. The installation steps below describe the installation of the HSPC geometries to the already installed APS. Ensure that the environment system and motor is turned off and the APS is at room temperature prior to proceeding.

CAUTION: Always ensure that the ARES-G2 motor is turned off prior to installing or uninstalling any accessory. A hazardous situation may occur if the motor is activated during installation.

CAUTION: Always ensure that the ARES-G2 environmental system and accessories are turned off and have reached a safe handling temperature prior to installing or uninstalling any accessory. A hazardous situation may occur if the environmental system is activated or is at a harmful temperature during installation.

Installing the HSPC Accessory

Installing the HSPC Accessory includes the following procedures:

- Installing the Air Supply Manifold
- Installing the HSPC Cup
- Installing the HSPC Rotor Shaft

Installing the Air Supply Manifold

The Air Supply Manifold is installed on the FCO mounting rail of the ARES-G2. In a typical installation, the HSPC manifold is mounted on the left rail on the left side of the ARES-G2. However, it can be mounted on the right rail if needed.

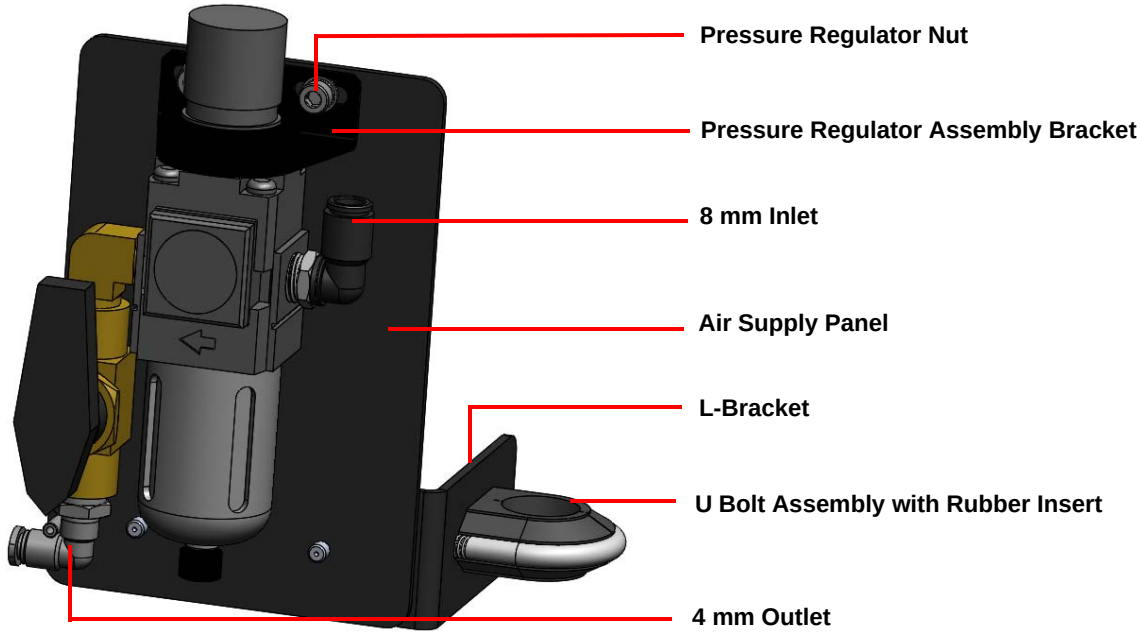


Figure 8 Air Supply Manifold components.

1 Secure the L-Bracket and U-Bolt assembly to the top of the left FCO mount rail. The U-Bolt and Rubber Insert is removable to ease installation without modification to the rail. The U-Bolt is secured with two nuts with nylon inserts. If mounting on the right FCO mount rail, follow these instructions except the L-Bracket will be on the right rail and the U-Bolt is to the left of the Regulator.

2 Attach the Air Supply Panel to the L-Bracket with the two supplied nuts. The panel should be parallel to the front face of the ARES-G2.

3 If it is not already attached, attach the Pressure Regulator Assembly to the Air Supply Panel with the two supplied screws. Make sure that the Pressure Regulator gauge is facing towards the front of the ARES-G2. Finger-tighten the large nut holding the Pressure Regulator to the bracket. The arrow on the front of the regulator should point to the left, indicating flow direction.

4 **To attach the HSPC to an air supply source**: Install the universal ¼" threaded 8 mm push-to-connect adapter to your supply air source. This fitting is designed to mate with NPT, NPTF, BSPT, and BSPP ¼" threads.

To attach the HSPC to the existing ARES air source:

a Follow the ARES-G2 Getting Started Guide instructions to prepare and turn off air supply to the ARES-G2.

b Turn off the supply air.

c Remove the Input air hose from the Inlet side of the ARES-G2 filter/dryer/regulator. Install the

supplied Tee on the inlet side of the ARES-G2 filter/dryer/regulator between the Quick-Connect Inlet and the left mounting bracket as shown in the image below.

d Install the universal ¼" threaded 8 mm push-to-connect adapter to the Tee. Use Teflon thread sealing tape as needed. Note that all three female threads on this Tee are British Standard Pipe Thread ¼" (BSPT). The Tee is designed to fit in the ARES-G2 Filter/Dryer/Regulator and the supplied 8 mm push-to-connect adapter, but it should not be used to connect to NPT threads. Do not overtighten.

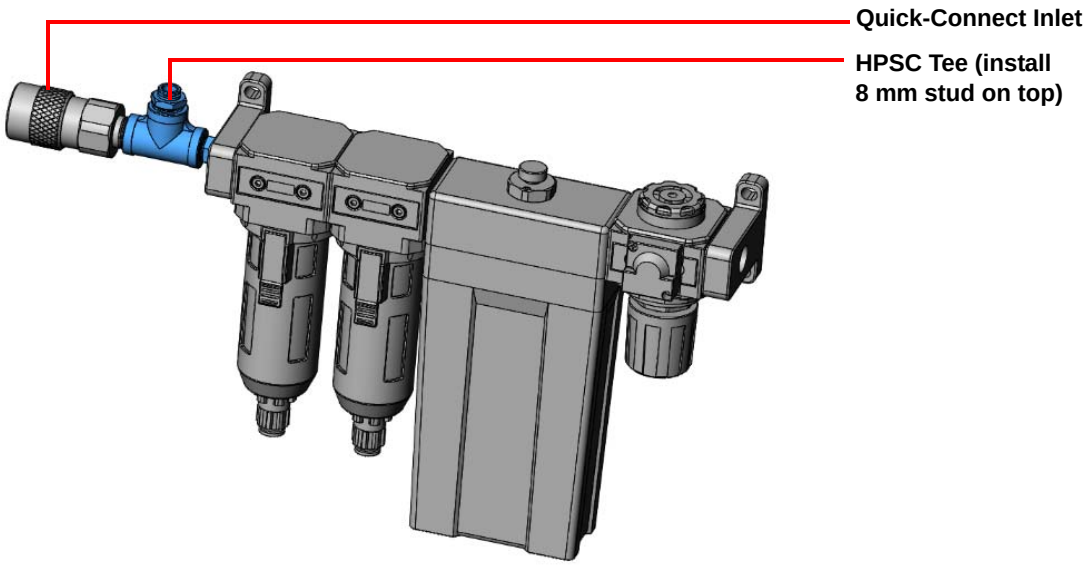


Figure 9 ARES-G2 Filter/Dryer/Regulator.

5 Rotate the HSPC Pressure Regulator Assembly ball valve to the **OFF** position (knob perpendicular to the flow direction). Attach the supplied 8 mm tubing between the 8 mm stud (step 4) to the Pressure Regulator Assembly. Route, shorten, and secure the tubing as needed. Reattach the supply air source and check for leaks. If the ARES-G2 was disconnected from the air source, follow ARES-G2 installation instructions for reconnecting the air source.

CAUTION: Instructions are provided in the ARES-G2 Getting Started Guide on how to turn off the air to the ARES-G2 system safely. If you are shutting off the ARES air source to attach the HSPC input line to the ARES-G2 Filter/Dryer/Regulator, follow the instructions in the ARES-G2 Getting Started Guide precisely to prevent damage to the air bearings in the ARES-G2 instrument. Alternatively, you can follow the instructions above to attach the HSPC to a separate source line (1/4" Universal Thread to 8 mm push-to-connect adapter provided).

6 Attach 5/32" or 4 mm tubing to the Pressure Regulator Assembly outlet. Cut the length of the tubing to approximately 8" longer than needed to reach center of APS.

Installing the HSPC Cup

1 Raise the ARES-G2 head to maximum height. If needed, remove all geometries and PRTs from the APS. Ensure the motor is deactivated. Loosen the anvil thumbscrew on the motor anvil.

2 Place the HSPC Cup into the APS, taking care not to damage the PRT sensor shaft or the APS walls. While holding the motor shaft to prevent rotation, rotate the cup until it drops and seats fully into the APS. This engages the PRT connection and the motor mounting preventing relative rotation of the cup and the motor shaft.

3 While gently pushing the HSPC Cup down, tighten the anvil thumbscrew with the torque screwdriver supplied with the APS. The HSPC cup is now installed.

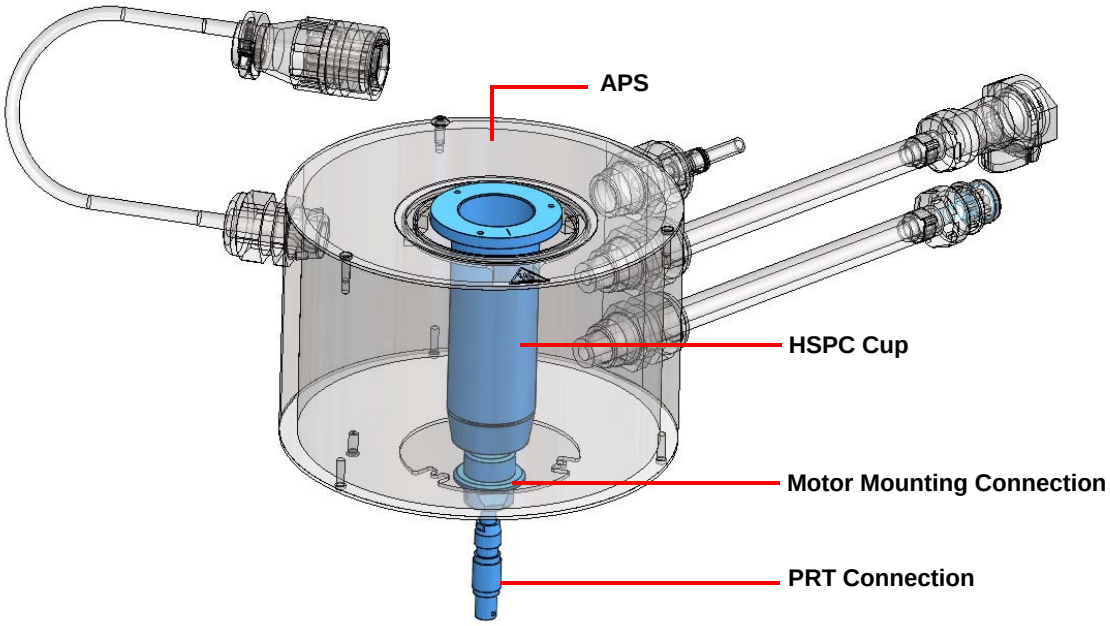
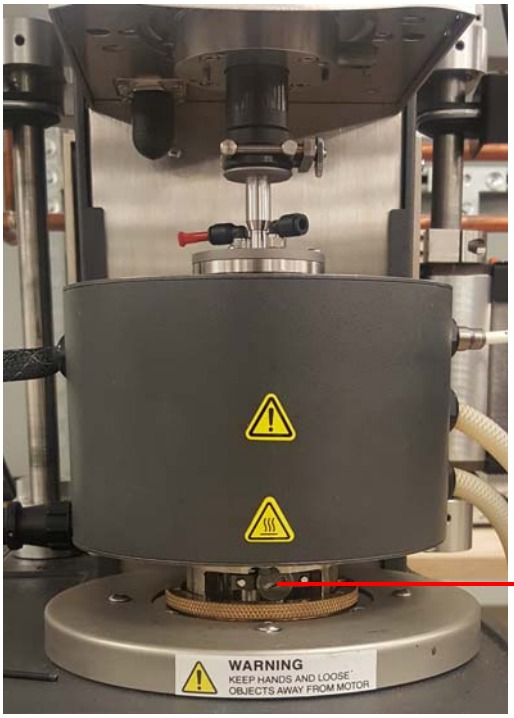


Figure 10 HSPC Cup installed on ACS.


WARNING
KEEP HANDS AND LOOSE OBJECTS AWAY FROM MOTOR
Motor Anvil Thumbscrew

Installing the HSPC Rotor Shaft

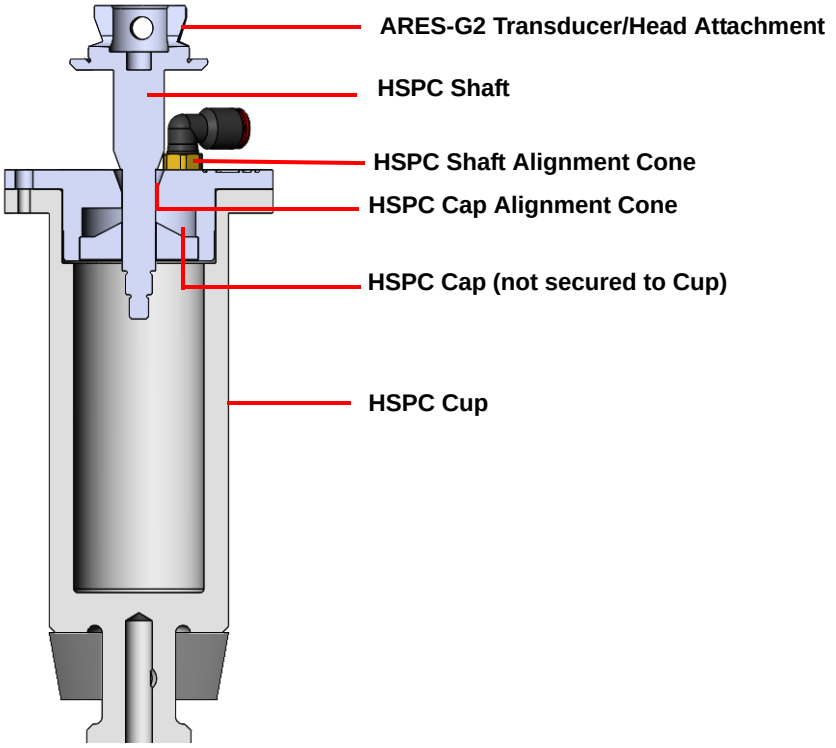


Figure 11

1 Place HSPC Rotor into the upper tool mount. Rotate until the angled surfaces at the ARES attachment point face the thumbscrew. Hand-tighten the thumb screw to secure. Do not attach the Rotor/Bob.

2 Place the HSPC Cap onto the Cup. Do not attach screws.

3 Lower ARES-G2 head slowly until the Shaft Alignment surface is approximately 4 mm above the Cap alignment surface.

CAUTION: Pinch hazard exists when lowering the ARES-G2 head. Do not place fingers or tools within the working area while lowering the head.

4 Open TRIOS and select the HSPC geometry. Select the **Axial Force** icom in the Gap setting and initiate the “zero fixture” function with an axial force of 10 N to zero the HSPC gap.

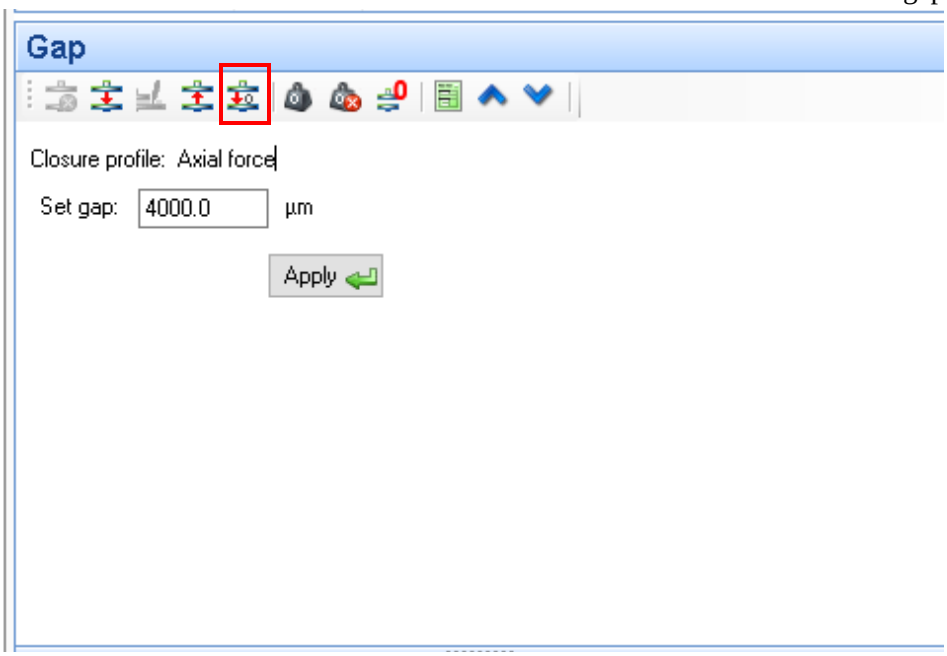


Figure 12 Zero Fixture.

NOTE: The HSPC fixture zero is based on the shaft alignment feature engagement rather than the rotor engagement. The shaft alignment feature is designed to place the rotor in the appropriate location at its operational gap (4 mm).

CAUTION: Pinch hazard exists when lowering the ARES-G2 head. Do not place fingers or tools within the working area while lowering the head.

5 Raise the ARES-G2 head to its highest position and remove Cap and the Shaft from the ARES-G2. Leave the Cup in place.

6 Insert the o-ring into the Bob and assemble the HSPC Shaft, HSPC Cap, and Bob as shown in the image below. Take care not to scratch or bend the shaft and Cap. Attach Shaft Assembly to ARES-G2 Head.

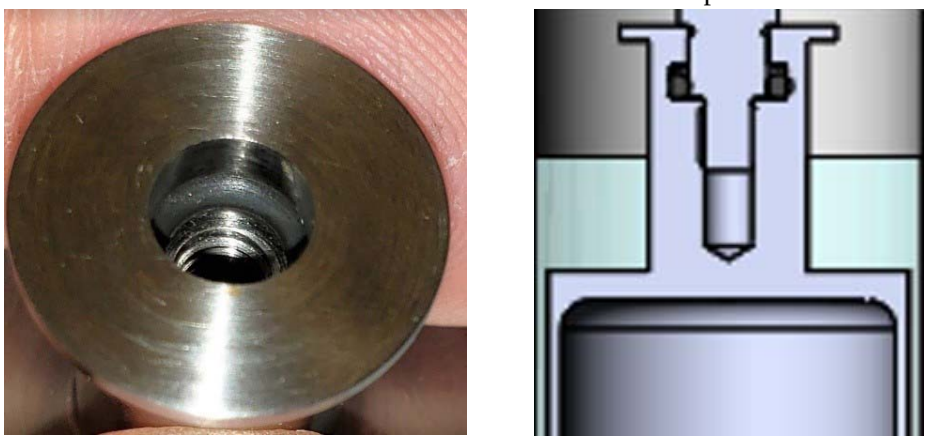


Figure 13 Insert the o-ring into the groove at the shaft/bob interface.

NOTE: The HSPC Cap is provided with an M3 Swivel Fitting and an additional M3 Sealing Screw already attached. If they have been removed for cleaning, ensure that both are reattached and tightened to prevent leakage. Do not exceed 0.7 Nm.

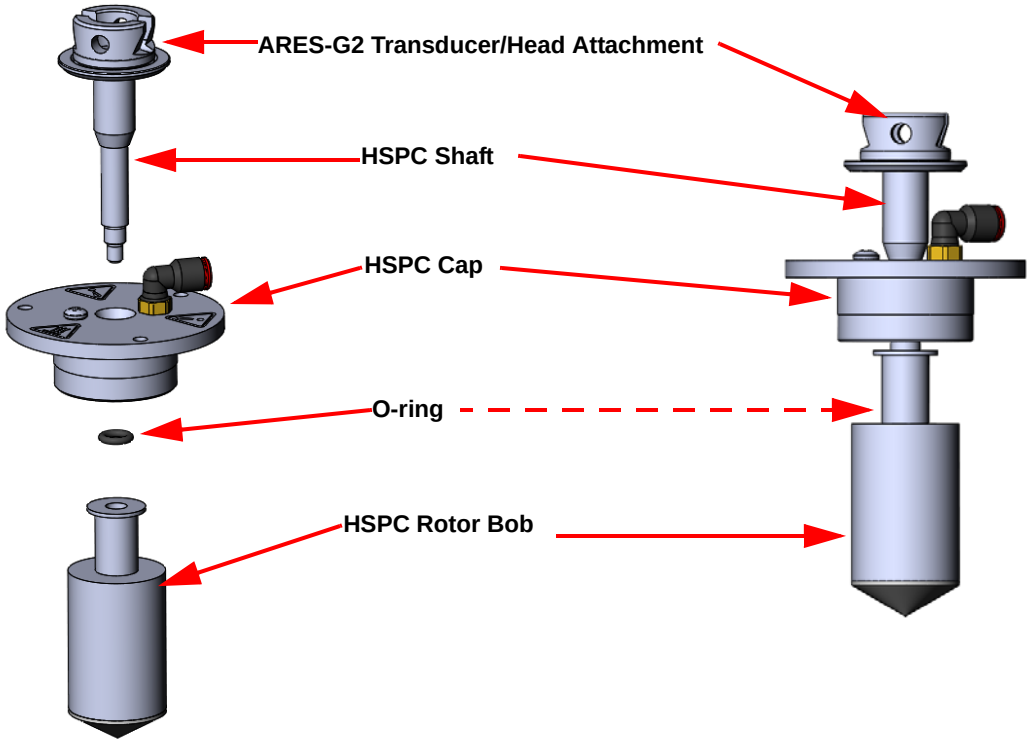


Figure 14

The HSPC is now installed onto the ARES-G2. The instructions in Chapter 3 should be performed when ready to load the sample and initiate testing.

Chapter 3:

Operating and Maintaining the HSPC

This chapter briefly describes the operation and maintenance of the HSPC Accessory.

Test Setup

CAUTION: Always make sure that the ARES-G2 motor is turned off prior to installing or uninstalling any accessory. A hazardous situation may occur if the motor is activated during installation.

CAUTION: Always verify that the ARES-G2 environmental system is turned off and has reached a safe handling temperature prior to installing or uninstalling any accessory. A hazardous situation may occur if the environmental system is activated or is at a harmful temperature during installation.

1 Load 13.0 ± 0.5 mL of sample into the HSPC Cup. Take care not to contaminate the top of the cup or apply side loads to the shaft.

CAUTION: Do not overfill the HSPC Cup. Liquid sample volume should never exceed 15mL during preparation or during testing. The sample must never contact the shaft. This may result in irreversible contamination of the HSPC cap and may result in ejection of the sample from the HSPC cap.

CAUTION: HSPC utilizes 316 Grade Stainless Steel, Grade 5 Titanium, and Viton for wetted components. These materials are chosen to be compatible with a wide range of materials. Ensure that your sample is compatible with these materials in the testing concentration, pressure, and temperature before using the accessory.

2 Rotate the cup so the 4mm inlet fitting faces the Air Panel Supply tube and engage the motor.

Figure 15

3 Slowly lower the ARES-G2 head until the cap is seated onto the cup (Gap approximately 4mm). Take care not to allow any side loading of the shaft.

CAUTION: Pinch hazard exists when lowering the ARES-G2 head. Do not place fingers or tools within the working area while lowering the head.

4 Place 3X M3 socket cap screws through the cap into the cup. Rotate the cup as needed to align the holes. Start the threads by hand but do not tighten.

5 Lower the ARES-G2 head slowly until the gap is between 0.25 and 0.7mm. Set Normal Transducer Mode to **Spring Mode**.

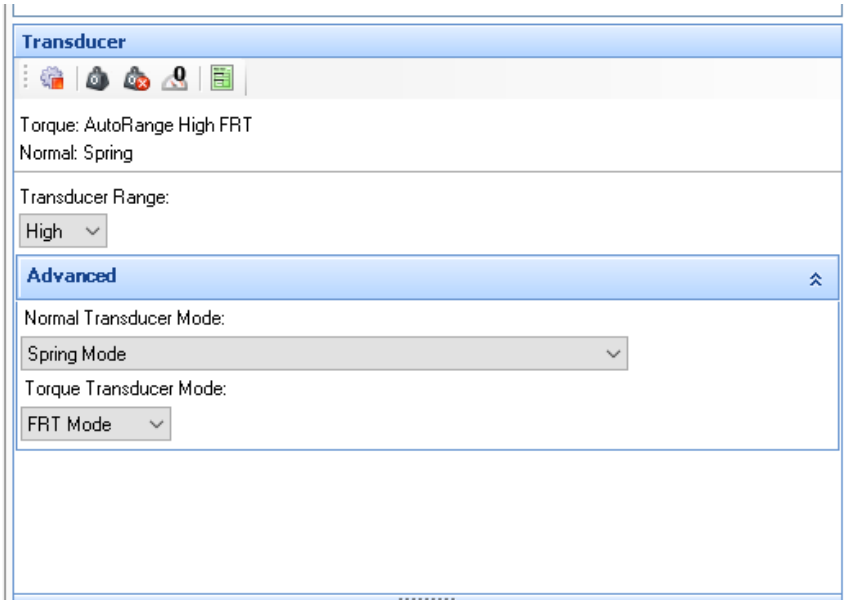


Figure 16 Choose Spring Mode for Normal Transducer Mode.

6 Click the **Axial Force Transducer** icon in TRIOS.

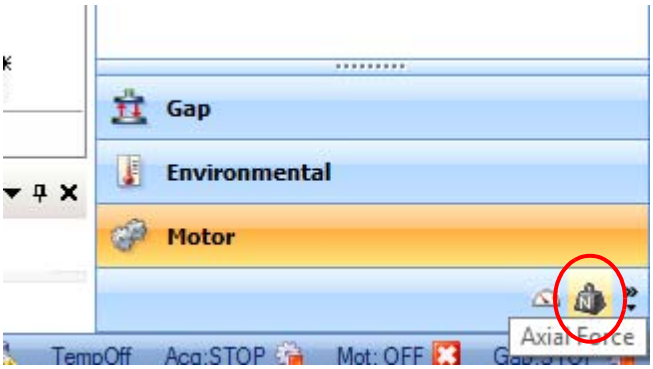


Figure 17 Click the Axial Force icon to open the Axial Force Transducer window.

7 Choose **Compression**. Set **19 N** for Axial Force, **0.1 N** for Sensitivity, and **1 mm** maximum gap change (up and down). Click **Apply**. If the load does not reach 19 N, click **Apply** again.

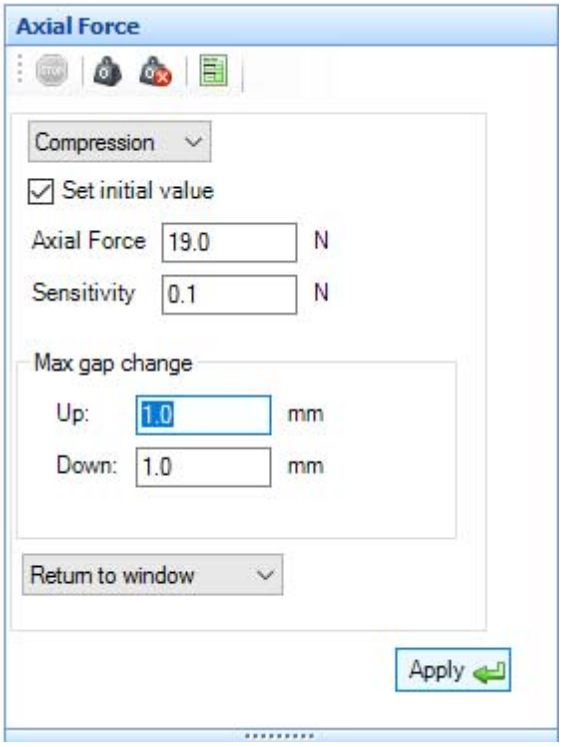
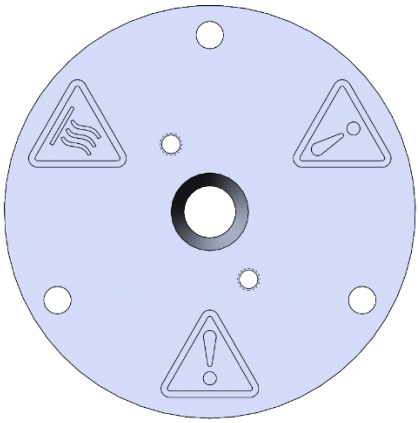


Figure 18 Axial Force settings.

CAUTION: Pinch hazard exists when lowering the ARES-G2 head. Do not place fingers or tools within the working area while lowering the head.

8 Finger tighten the three M3 screws in sequence. Use the supplied 2.5 mm Allen key to lightly tighten the screws. Repeat with increasing tightness, using care to not overtighten the screws. See table and diagram below for guidance.



Screw #	Torque (approx.)
1	Finger Tighten

Screw #	Torque (approx.)
2	Finger Tighten
3	Finger Tighten
1	Allen Key - Light
2	Allen Key - Light
3	Allen Key - Light
1	Allen Key - Medium
2	Allen Key - Medium
3	Allen Key - Medium
1	Allen Key - Medium
2	Allen Key - Medium
3	Allen Key - Medium

NOTE: The three screws will reduce, but not eliminate, gas loss through the interface between the cap and the cup. A small amount of gas, sample, or condensate may escape at this interface. To improve sealing, a small amount of appropriate vacuum grease (for example, Dow Corning High Vacuum Grease) can be applied between the cap and cup. Do not allow the grease to contact other surfaces. Do not use adhesives. If applying grease, repeat tightening sequence of M3 screws after waiting 5 minutes to allow the grease to flow.

Compatible vacuum grease may be applied to this interface (shown in orange) to improve sealing. Do not apply or contaminate any other surface with grease. Do not use adhesives. \

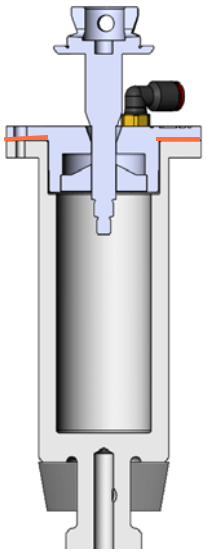


Figure 19

CAUTION: The outer surfaces of the cell may become very hot or cold when used at temperatures other than ambient. When operating at these temperatures, wear personal protection equipment

that afford adequate protection against the surface temperature of the High Sensitivity Pressure Cell and its fittings.

CAUTION: Inspect all screws and threads prior to installation. Replace if any damage is observed or suspected. These three M3 screws are designed to contain the pressure within the cell. Failure of these screws may result in a hazardous situation. Always wear PPE appropriate for your sample at the testing pressures and temperatures.

9 Raise the ARES-G2 head to a gap of 4 mm.

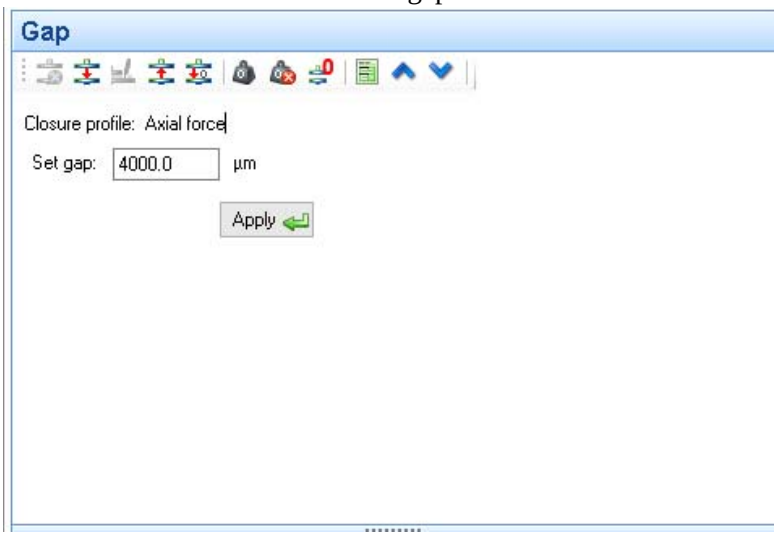


Figure 20

10 Tare the normal force.

Figure 21

11 Connect the 4 mm tube from the Air Supply Panel outlet to the ARES Cap. Orient the fittings and cut the tubing to minimize load applied to the HSPC cap. See image below for recommended orientation when the manifold is attached to the left. Ensure that the tubing is long enough to allow for oscillation

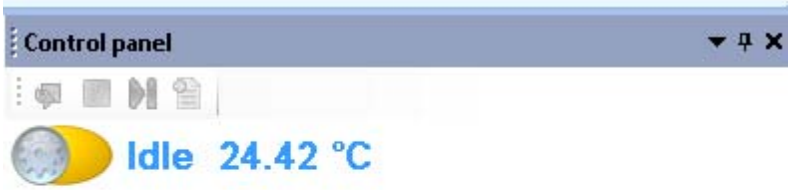
motion of the cup.

Figure 22

CAUTION: The ARES-G2 must be powered on and have gone through its startup sequence prior to connection of the 4mm tube to the cap. Only connect the 4 mm tubing after the startup sequence is completed and disconnect the 4mm tubing after testing is completed and safe temperatures are achieved. The startup sequence requires free rotation of the cup, therefore the 4 mm tubing cannot be attached during this sequence. Excessive rotation of the cup while this tube is connected will result in damage to the accessory and instrument.

12 Unlock the Pressure Regulator by pulling up on the knob (orange band will slow). Set the Pressure Regulator to 0 bar/0 psi (rotate counter clockwise until stop). Open the Ball Valve. While observing the sample pressure in TRIOS, rotate the pressure regulator clockwise until pressure reading in TRIOS reaches desired pressure. Typically, this pressure should be at least 0.5 bar above the vapor pressure of your sample at the maximum testing temperature. See the image below for vapor pressure table for water. Press pressure regulator handle down to lock (orange band will be hidden). This pressure cell is designed to operate within a range of 0.5 to 5.0 bar. Do not exceed 5 bar (Gauge Pressure) and do not operate at

below 0.5 bar.



Signals	Value	Units
Torque	-1.090	µN.m
Axial Force	0.5491	N
Temperature	24.42	°C
Set Temperature	25.00	°C
Gap	1.4e5	µm
Displacement	-192.4	rad
Velocity	-1.378e-7	rad/s
Viscosity	-14630	Pa.s
Pressure	0.145738	bar

Figure 23

If Pressure is not shown in the Signals table, right click the table to select Pressure. Units can be adjusted in the TRIOS options settings. Note that this measurement is relative to the pressure in the chamber when the normal force has been tared (step 8).

CAUTION: Pressure observed on the pressure regulator may be slightly different from the chamber pressure (TRIOS). This is normal but do not exceed 6.5Bar on the pressure regulator or 5Bar in the chamber. Air flow through the chamber generates noise and may cause small amounts of sample vapor or particulates to escape. Always wear appropriate PPE for your sample and testing conditions. Hearing protection PPE is recommended for prolonged use.

CAUTION: Rapid depressurization should be avoided when samples are heated to above atmospheric pressure boiling points. Reduction in pressure may result in rapid boiling or vaporization of the sample when at elevated temperatures. This may result in rapid expansion and ejection of the sample from the chamber. Appropriate PPE must be worn at all times.

CAUTION: The HSPC is designed to allow pressurization gas to escape from the air gap, care must be taken that this gap is not obstructed. The pressure regulator features a relief function if over pressurized. Damage to the filter/regulator may occur if it is exposed to sample or sample vapors. If this happens, discard and replace filter regulator.

CAUTION: The outer surfaces of the cell may become very hot or cold when used at temperatures other than ambient. When operating at these temperatures, wear personal protection equipment that afford adequate protection against the surface temperature of the High Sensitivity Pressure Cell and its fittings.

Running an Experiment

1 Ensure that appropriate pressurization is achieved (see step 10 above). To prevent rapid boiling, maintain pressure above the vapor pressure of the sample at the maximum testing temperature. Refer to the vapor pressure table below for typical aqueous solutions. Ensure that the APS circulator is and set to an appropriate temperature. Turn on the ARES G2 motor and environment control and set the starting testing temperature in the TRIOS software.

NOTE: Small changes to the pressure regulator may be necessary to maintain chamber pressure during heating or cooling tests. Variability of up to 5% may occur. Adjust the pressure as necessary but do not to reduce pressure below the vapor pressure at the testing temperature or increase it beyond 5 bar limit.

NOTE: Due to the air flow, the HSPC may take longer than typical for temperature stabilization at extreme temperatures and at higher pressures.

CAUTION: Do not freeze aqueous solutions. This will overload the torque transducer and may cause irreversible damage to the accessory.

CAUTION: The outer surfaces of the cell may become very hot or cold when used at temperatures other than ambient. When operating at these temperatures, wear personal protection equipment that afford adequate protection against the surface temperature of the High Sensitivity Pressure Cell and its fittings.

NOTE: Refer to the APS Getting Started Guide for appropriate coolant temperature to reach high and low testing temperatures. A typical coolant temperature of 25°C will allow for testing between 0°C and 100°C. Higher coolant temperature is needed to reach greater than 100°C and lower coolant temperature is needed to reach lower than 0°C. Heating and cooling rates and limits are affected by gas flow rate, pressurization gas temperature, coolant temperature, environmental conditions, and sample properties. Refer to the table below for typical temperature range.

Testing Pressure (Air)	Minimum Temperature	Maximum Temperature
0.5 bar	-10°C	150°C
5 bar	-10°C	140–150°C
Coolant Temperature Setting	0°C[a]	65°C[a]

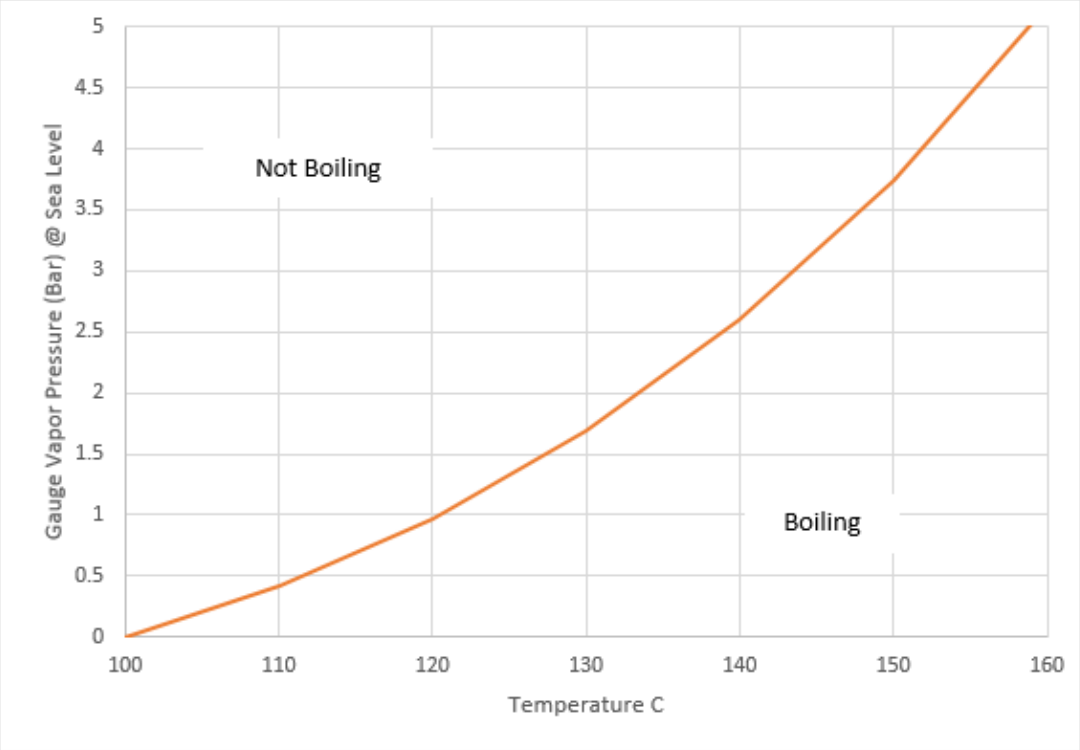
a. With TCube Edge circulator – P/N 404500.901

CAUTION: Pressurization, heating, and supply of oxygen containing air may create a potentially hazardous condition for volatile samples. Take extreme caution with samples which may be volatile or flammable under test conditions. The HSPC is not designed to contain explosive or flammable samples.

8 Program the test procedure. Refer to ARES Getting Started Guide and TRIOS Online help for details.

9 Run the experiment.

10 After testing is completed, allow the sample to reach room temperature prior to depressurization. Slowly reduce pressure by unlocking the regulator and rotating counter clockwise until pressure is at 0 bar and lock. Rotate ball valve to **OFF** (handle perpendicular to flow direction). Disconnect the 4 mm tubing from the HSPC cap fitting.



Vapor Pressure Table for Water. Maintain pressure at least 0.5 bar higher than the Vapor Pressure at testing temperature to minimize boiling and vaporization.

Disassembly

1 Verify that pressure is reduced to 0 bar and the temperature has reached and stabilized to a safe temperature. Verify that the 4mm tubing has been removed from the HSPC cap fitting. Turn off the ARES Motor and ARES Environmental Control.

2 Remove the 3X M3 screws holding the cap to the cup.

3 Release the HSPC Shaft Assembly from the ARES transducer by unscrewing the thumb screw. Raise the ARES-G2 head to its maximum position.

4 Carefully remove the HSPC Shaft Assembly with the HSPC Cap from the HSPC Cup. Never apply side loads to the cap when it is attached to the Shaft and Bob as this will damage the shaft, bob, and cap.

5 Unscrew the Bob Rotor from the Shaft and clean with detergent and water or other cleaner suitable for the sample type. Clean the Rotor Shaft and remove the cap. Make sure that the cap does not contact the sample or sample residuals. Clean and dry the cap as necessary.

CAUTION: When cleaning the Rotor Assembly and Cap, do not allow sample to enter the hole of the HSPC cap. Residue will cause friction in the air bearing. If this occurs, remove all fittings from the Cap and soak the cap in solvent suitable to dissolve the residue. Rinse cap with clean solvent, water, or cleaner until no residue remains. A cotton swab or lint free tissue can be inserted through the hole for cleaning. A solvent which does not leave any residual may also be used (eg. Isopropyl Alcohol). Ensure this is completely dry prior to reuse. The cap cannot be disassembled.

CAUTION: When handling the Rotor Assembly and Cap, do not apply any sideways load on the shaft and do not allow the cap to apply sideways load to the shaft. Doing so may cause surface damage or bending of the shaft. This will cause rubbing or friction in the air bearing.

6 Remove the cup by releasing the cup from the lower motor mount. Dispose of remaining sample as appropriate and clean with a solvent and water or other suitable cleaner for the sample type. Do not allow cleaner to touch the outside of the cup. Take extra care not to damage the PRT shaft. HSPC Cup can be placed into the HSPC Cup Holder for temporary storage. This will hold the cup in upright position while preventing damage to the PRT shaft.

7 Dry all surfaces parts prior to storage. HSPC Shaft should be placed back into its protective yellow sleeve to prevent scratches prior to storage.

Maintenance

Inspect the M3 screws and M3 Fittings on the HSPC Cap for damage and replace as needed. O-Rings should be replaced periodically and when physical or chemical damage is observed or suspected.

Replace the 5um Filter in the pressure regulator at least once per year or when excessive pressure loss is observed. More frequent replacement may be needed if source air is not clean.

Inspect the end of the tubing each time it is removed from the push to connect fitting. Cut the damaged end or replace if damage is observed.

Replacement Parts

The table below lists the replacement parts available for the HSPC.

Table 4: Replacement Parts for HSPC

Part Number	Description
402814.901	Accessory - Replacement Kit HSPC. Includes: M3 Screws M3 Fittings M3 Sealing Screws Viton O-Rings
201141.002	SMC Filter Replacement - AF20P-060S