

Tools for the Study of Flow Based Corrosion by Rotating Cylinder Electrodes

A Selection Guide for a Complete RCE System

This application note discusses the selection of components useful to evaluate mass transport limited corrosion under flow conditions. The RCE system components described here align with recommendations by the ASTM G5 Standard. Users should refer to Pine application note DRA10052 for a more in-depth discussion of the theory and governing equations.

Introduction

A convenient instrument for rapidly moving a metal sample with respect to a fluid is the Rotating Cylinder Electrode (RCE). This apparatus includes an electrode rotator, RCE electrode shaft, and accessories (see Figures 1-2) capable of precisely adjusting the rotation rate of a vertically oriented shaft. A special tip capable of holding a cylindrical shaped metal sample is mounted at the lower end of the shaft. The tip is fashioned primarily from chemically inert and electrically insulating materials (including polyether ether ketone, PEEK), but buried within the tip is a metal shank which provides mechanical stability and also electrical contact with the metal cylinder sample, also called a metal coupon (see Figure 1).

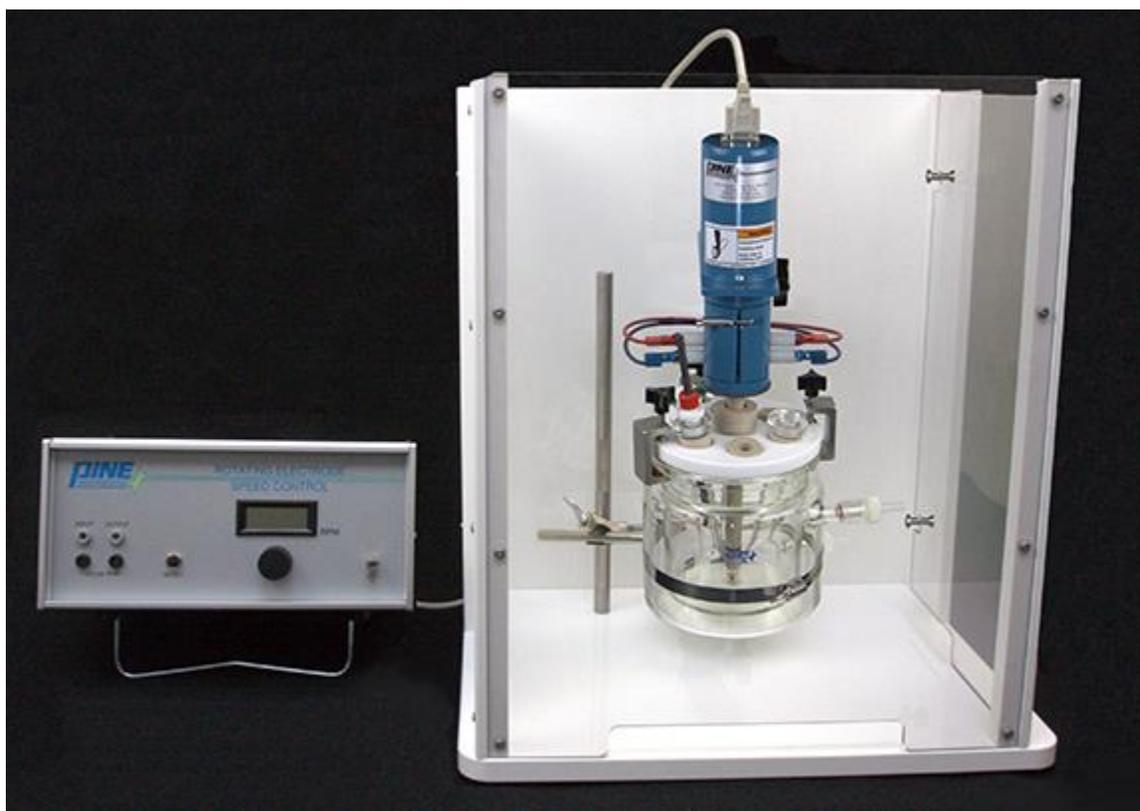


Figure 1. Typical Rotating Cylinder Setup for Corrosion Analysis.

As shown in Figure 1, the primary components of a typical RCE system include the following items:

- An analytical electrode rotator. The rotator sets the rotation rate of the RCE cylinder (coupon).
- A shaft to hold the RCE cylinder (coupon) and connect electrically through the rotator to potentiostat where corrosion rate can be measured.
- RCE cylinder inserts (coupon) that have a 3 cm² exposed area and are made from the specific metal of interest.
- An OpenTop glass cell that integrates easy access for purge gas control, insertion and positioning of other electrodes such as the counter and reference other accessories.
- A manner by which to control temperature, commonly a water jacket around the glass electrochemical cell or directly by means of a hotplate beneath the glass cell.
- A potentiostat to measure and record corrosion current.

There are many items required for a complete 15mm RCE setup. It can be challenging to know what parts should be ordered when a new setup is desired. Pine has tried to streamline the process with product bundles, Product Bundles are groups of preselected items to fulfill the needs of most RCE Corrosion scientists with a single part number. This guide mirrors the website and product selection is detailed in the flow chart provided (see: Figure 2).

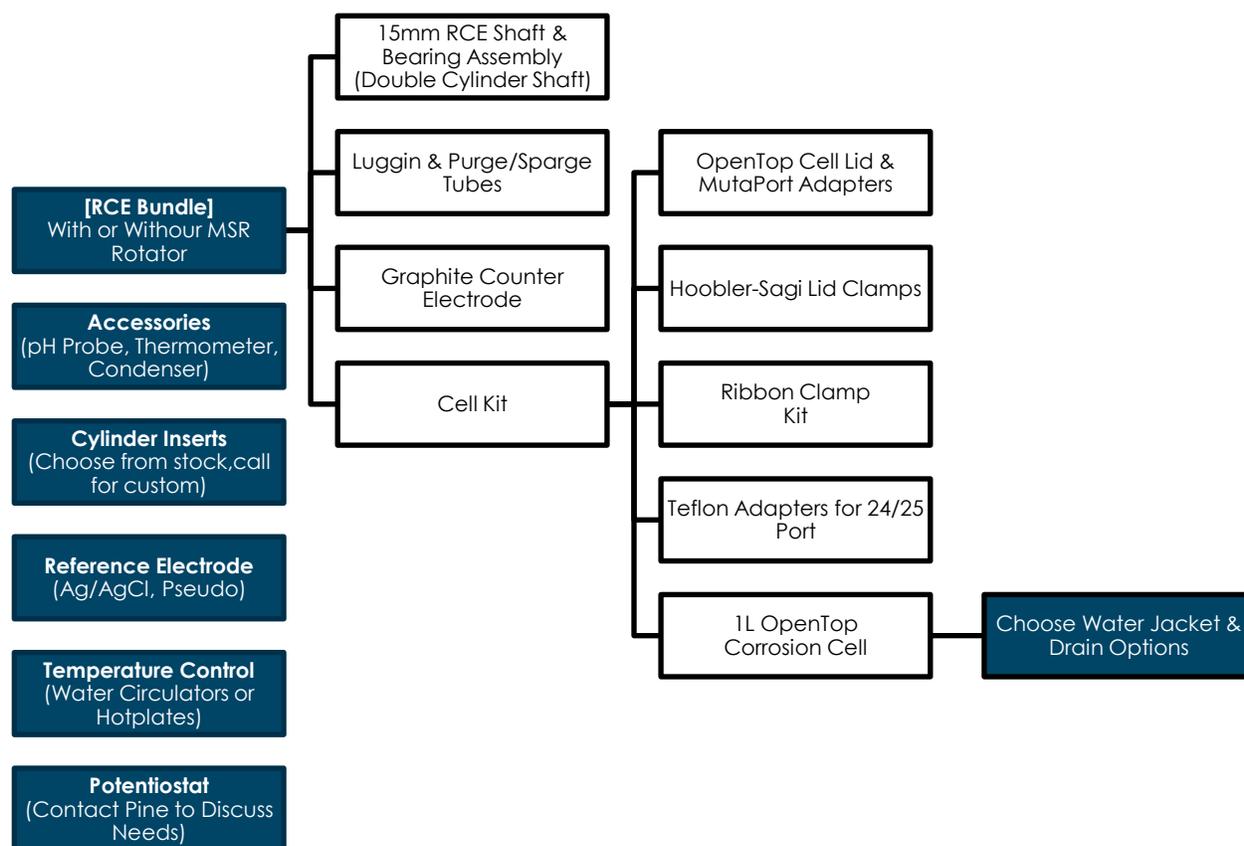


Figure 2. Flow of Products for a Complete 15mm RCE Setup. User Input Required at Shaded Boxes

15mm RCE System Bundles

To ease the complication of piecing items together to build a complete RCE system, Pine has created bundles. A bundle is a grouping of items that have been preselected to make a complete RCE setup, under a single part number. Each RCE bundle includes the basic accessories needed to perform flow based corrosion measurements at a rotating cylinder electrode. The 15mm RCE product bundles are provided on our website under Rotating Cylinder Electrodes (RCE) (see: <http://www.pineinst.com/echem>). They are also provided below in Table 1 for reference. Product bundles offer an additional discount beyond ordering the components piecewise. As described in Table 1, there are eight 15mm RCE bundles. Each bundle includes the following items:

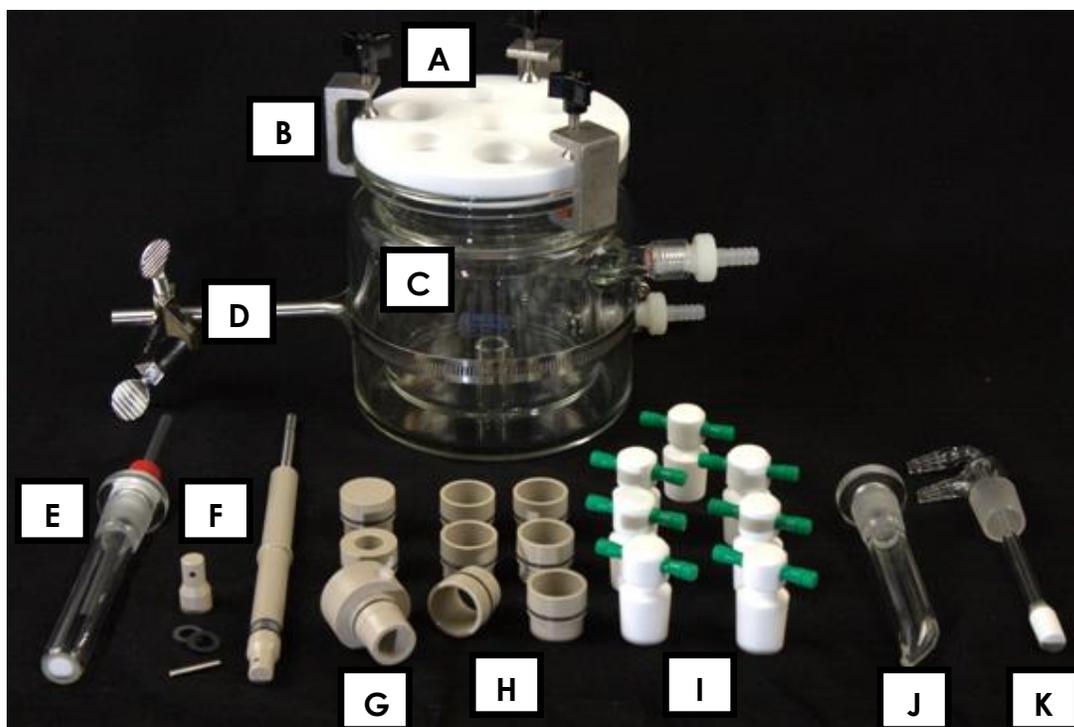
- Cell kit, contains the OpenTop cell and components (OpenTop cell lid, adapters, ribbon clamp, cell clamps, and Teflon stoppers). There are four different cell kits available (all cells are 1 Liter volume and compatible with the 15mm RCE accessories):
 - Jacketed cell with drain (Part Number AFCELL8)
 - Jacketed cell (no drain) (Part Number AFCELL8U3)
 - Basic (unjacketed) cell with drain (Part Number AFCELL8U)
 - Basic (unjacketed) cell (no drain) (Part Number AFCELL8U2)
- Hose barb/drain valve accessories are included as appropriate for the chosen cell
- 15 mm single cylinder RCE shaft with gas-purged taper plug assembly
- Graphite counter electrode
- Luggin capillary for reference electrode (reference electrode not included)
- Dual port gas purge/sparge accessory

Bundle Code	Description
[RCE15-JV]	15mm RCE Bundle – Jacketed cell with drain Includes the cell kit: AFCELL8
[RCE15-RJV]	15mm RCE Bundle – Jacketed cell with drain, includes rotator Includes the cell kit: AFCELL8
[RCE15-X]	15mm RCE Bundle – Basic cell Includes the cell kit: AFCELL8U2
[RCE15-R]	15mm RCE Bundle – Basic cell, includes rotator Includes the cell kit: AFCELL8U2
[RCE15-J]	15mm RCE Bundle – Jacketed cell Includes the cell kit: AFCELL8U3
[RCE15-RJ]	15mm RCE Bundle – Jacketed cell, includes rotator Includes the cell kit: AFCELL8U3
[RCE15-V]	15mm RCE Bundle – Basic cell with drain Includes the cell kit: AFCELL8U
[RCE15-RV]	15mm RCE Bundle – Basic cell with drain, includes rotator Includes the cell kit: AFCELL8U

Table 1. Rotating Cylinder Electrode Product Bundles.

For illustration, a photo of all items included in the [RCE15-J] product bundle is shown below (see: Figure 3). The bundles are designed for the general case of most users we have encountered. Each individual component of a complete 15mm RCE Corrosion System can be replaced and ordered individually.

Should you have a specific need and do not see what you need in a bundle, please contact us. We are happy to provide custom products for your corrosion research needs. If possible, it is best to modify an existing product bundle than to create one from scratch. Our sales team is eager to learn about your research – so give us a call to customize your 15mm RCE product bundle.



Code	Description
A	Teflon OpenTop Lid
B	Hoobler-Sagi Lid Clamp (set of 3)
C	OpenTop Cell (user chooses configuration)
D	Ribbon Clamp and Cross Clamp
E	Graphite Counter Electrode (AFCTR3)
F	15mm Single Cylinder RCE Shaft (AFE9MBA)
G	Gas Purged Bearing Assembly (AC01TPA6M)
H	MutaPort Adapters for OpenTop Lid (1x cap, 1x 14/20, 6x 24/25)
I	Teflon Stoppers (set of 7)
J	Luggin Capillary Tube for Reference Electrode
K	Dual Port Gas Purge/Sparge Tube

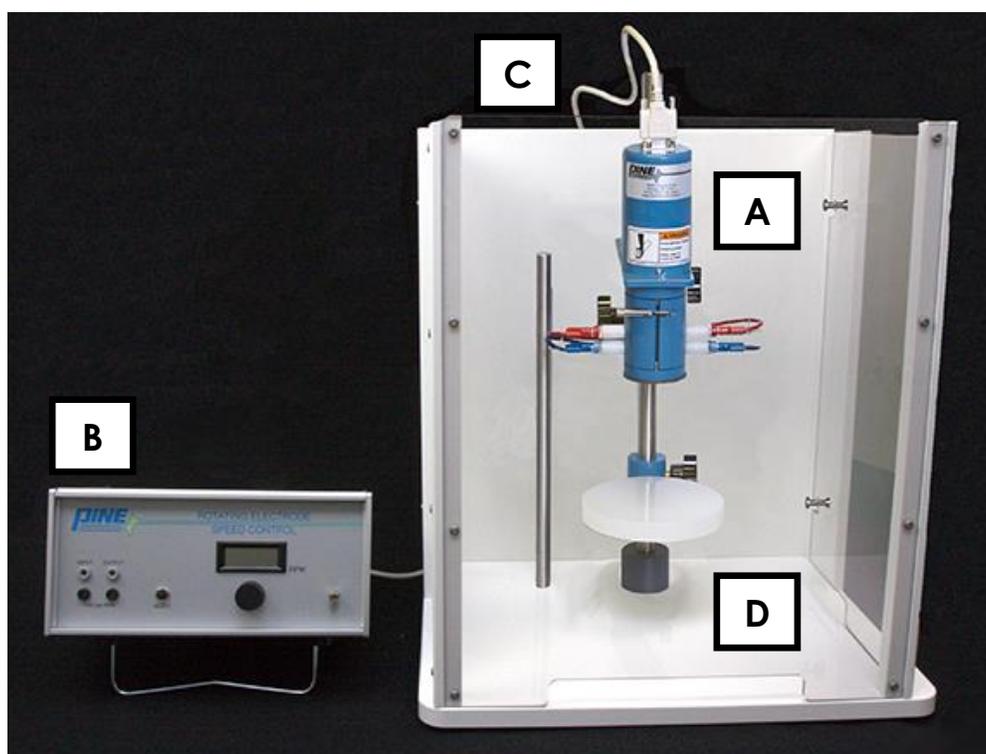
Figure 3. Components of the 15mm Rotating Cylinder Corrosion Cell.

Major RCE System Components

A. Analytical Electrode Rotator

The industry standard for electrode rotation is the Pine Research Instrumentation MSR Rotator (Part Number AFMSRCE) (See Figure 4). The MSR Rotator is a major component of an RCE system. Briefly, the MSR Rotator consists of the following primary components:

- A motor head, into which the 15mm RCE shaft is installed.
- A control box that connects to the motor head, with which rotation rate of the shaft/cylinder is controlled
- A cable to connect control box to motor head
- An AC power cable that connects to the control box
- Polymer base and enclosure, into which the motor and cell are installed on stainless steel support rods. The enclosure is secured by four metal posts on the walls.



Code	Description
A	MSR Motor
B	MSR Control Box
C	MSR Control Cable (HD15)
D	Polymer Base and Enclosure

Figure 4. MSR Electrode Rotator.

The Pine MSR is compatible with most international power standards (100 to 240 VAC, +/-10%, 50 or 60 Hz, 2 Amps), therefore users must select the appropriate AC power cord to fit the outlets in the country of use. Pine offers US and most international AC power cords (see Table 2). Consult the website for a full list of power cords. You will specify the power cord needed by its part number at the time of order (please contact us with any special cord needs if you do not find the appropriate cord for your country).

Pine Part Number	Country of Use
EWM18B7	USA, Canada, Mexico (may also be used in Brazil, Columbia, Korea, Saudi Arabia, and Taiwan)
EWM18B8EU	Continental Europe (for use throughout most of Europe, Russia, and Indonesia)
EWM18B8UK	United Kingdom (for use in the UK, Ireland, Hong Kong, Singapore, Malaysia, Kuwait, and Oman)
EWM18B8DK	Denmark
EWM18B8IT	Italy
EWM18B8CH	Switzerland
EWM18B8CN	China
EWN18B8JP	Japan
EWN18B8NZ	Australia and New Zealand
EWM18B8IN	India and South Africa
EWM18B8IL	Israel
EWM18B8AR	Argentina

Table 2. List of AC Power Cables Available from Pine Research Instrumentation.

B. Rotating Electrode Shaft for Cylinders and Bearing Assembly

An RCE shaft (Part Number AFE9MBA, see Figure 5) connects to the motor head on the 1/4" stainless steel end. A cylinder insert (coupon) installs on the opposite end, and is electrically coupled to the shaft and then to the rotator brushes. The potentiostat working electrode cell cable connects to the MSR motor. This arrangement offers flexibility in RCE cylinder configuration. The Pine RCE shaft body is made of polyether ether ketone (PEEK). PEEK has chemical compatibility in a wide variety of solvent systems and can be used safely up to 80 degrees Celsius.



Figure 5. 15mm Single Cylinder RCE Shaft.

Due to the nature of the corrosive environment in which RCE system components are exposed, a corrosion resistant gas-purged bearing assembly (Part Number AC01TPA6M, Figure 6) interfaces the shaft to the electrochemical cell and lid. It is precision made to fit the 15mm RCE shaft body. It is made of PEEK and its bearings are ceramic to avoid corrosion of the bearing. The bearing assembly has an inset Viton rubber O-

ring to create a seal and a gas purge barb at the junction of the assembly. The tapered assembly fits standard 24/25 or 24/40 tapered joints. The central hole in the corrosion cell OpenTop (See: Figure 3) lid is a 24mm opening, designed to accommodate the bearing assembly and RCE shaft. When all other ports of the cell are closed a positive pressure can be maintained in the cell when the gas purged bearing assembly is used.



Figure 6. The 15mm OD Gas-Purged Bearing Assembly.

The bearing assembly should be installed onto the shaft before the shaft is installed into the MSR rotator (see Figure 7). Slide the tapered end over the 1/4" stainless steel 15mm RCE shaft and slide down onto the PEEK shroud of the shaft. A retaining ring on the shaft will keep the bearing assembly in place during its installation into the MSR Rotator.

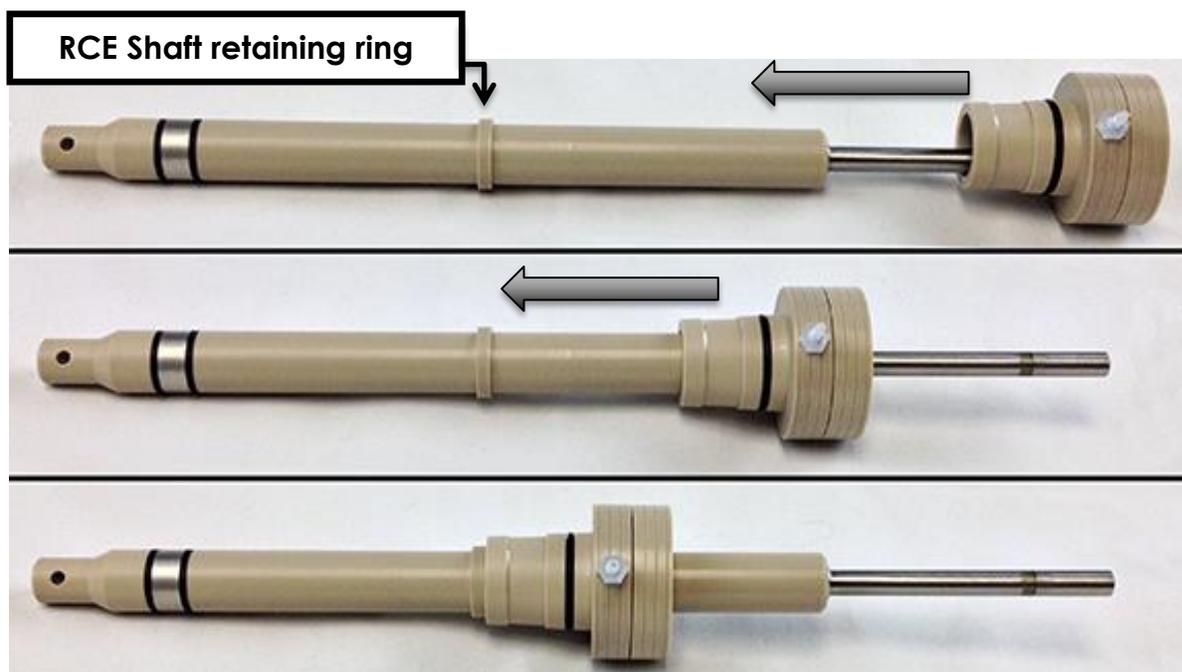


Figure 7. Installation of the Gas-Purged Bearing Assembly onto the Single Cylinder RCE Shaft.

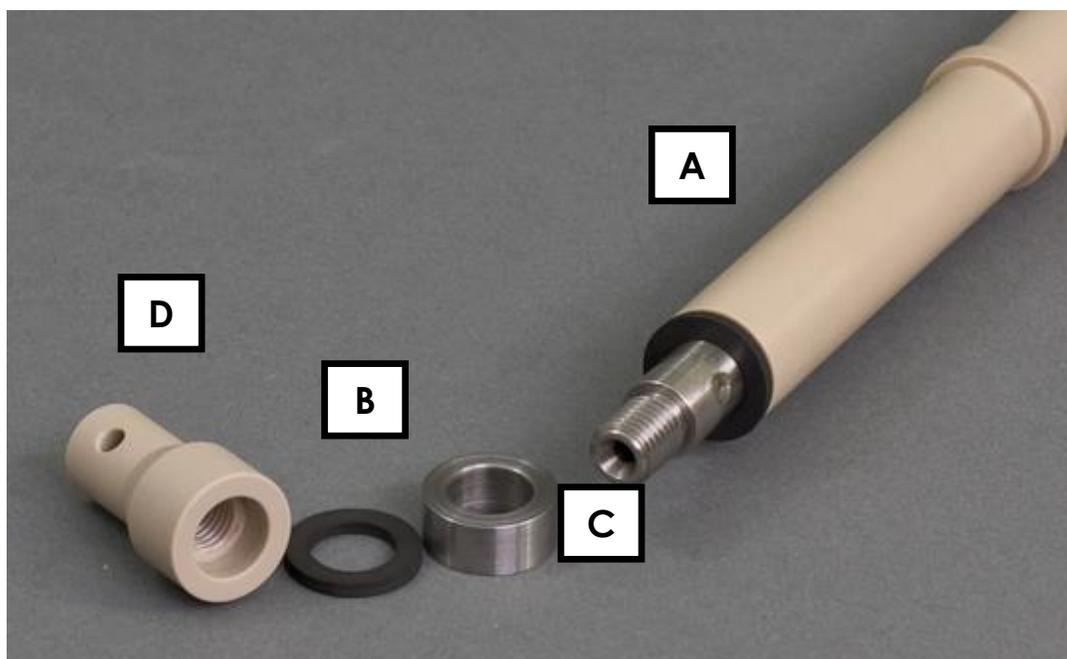
Some users have requested a shaft where two cylinders are installed, where one cylinder is used to monitor electrochemical corrosion rate (by connection to the potentiostat) while the other is strictly in place for use in weight loss experiments. Pine offers a Double Cylinder 15mm RCE shaft to suit the needs of some researchers (Part Number AFE9MBDA, see Figure 8). The 15mm RCE product bundles are sold with a single

cylinder shaft. Please inform sales at the time of inquiry if you would instead like the Double Cylinder shaft or want to add it to your existing product bundle.



Figure 8. 15mm Double Cylinder RCE Shaft.

Cylinder inserts (sold separately) are precision metal samples that fit the 15mm Single and Double Cylinder RCE Shafts. To seal around a cylinder insert installed on the RCE shaft, flat Viton washers are used in conjunction with a threaded PEEK nut on the shaft end (See: Figure 9). A package of ten Viton washers is included with each shaft. Additional washers are available (Part Number AKE9VWASHER). Washers should be replaced regularly with every other cylinder change to minimize solution leakage and edge corrosion around the cylinders.



Code	Description
A	15 mm Single Cylinder RCE Shaft
B	Viton Washers (NOTE: To reorder a pack of 20 washers, use part number AKE9VWASHER)
C	15mm OD Metal Cylinder Insert
D	15mm RCE PEEK Nut

Figure 9. 15mm Single Cylinder Rotating Cylinder Shaft.

C. 15mm RCE Cylinder Inserts (Coupons)

Cylinder inserts, called coupon by some in the industry, install onto both the Single and Double 15mm RCE shafts. Generally, the material from which the cylinder is made represents the same material whose field corrosion is the subject of RCE research. It is critical that cylinders be of exact dimensions. When installed onto the RCE shaft there will be 3 cm² of metal surface exposed to solution.

Pine provides a mechanical drawing for 15mm RCE cylinder inserts (download from our website, also shown below in inches, see Figure 10) for users who choose to machine their own cylinder inserts. Pine can custom make cylinder inserts from any non-toxic materials, including starting material sent by the customer. Inquire with sales to initiate custom cylinder inserts.

Cylinder inserts are sold in packages of ten (10). Each package includes a certification sheet for the material used to manufacture the cylinder inserts. The cylinder inserts made by Pine (see Figure 10) are fabricated from a variety of popular steel alloys.

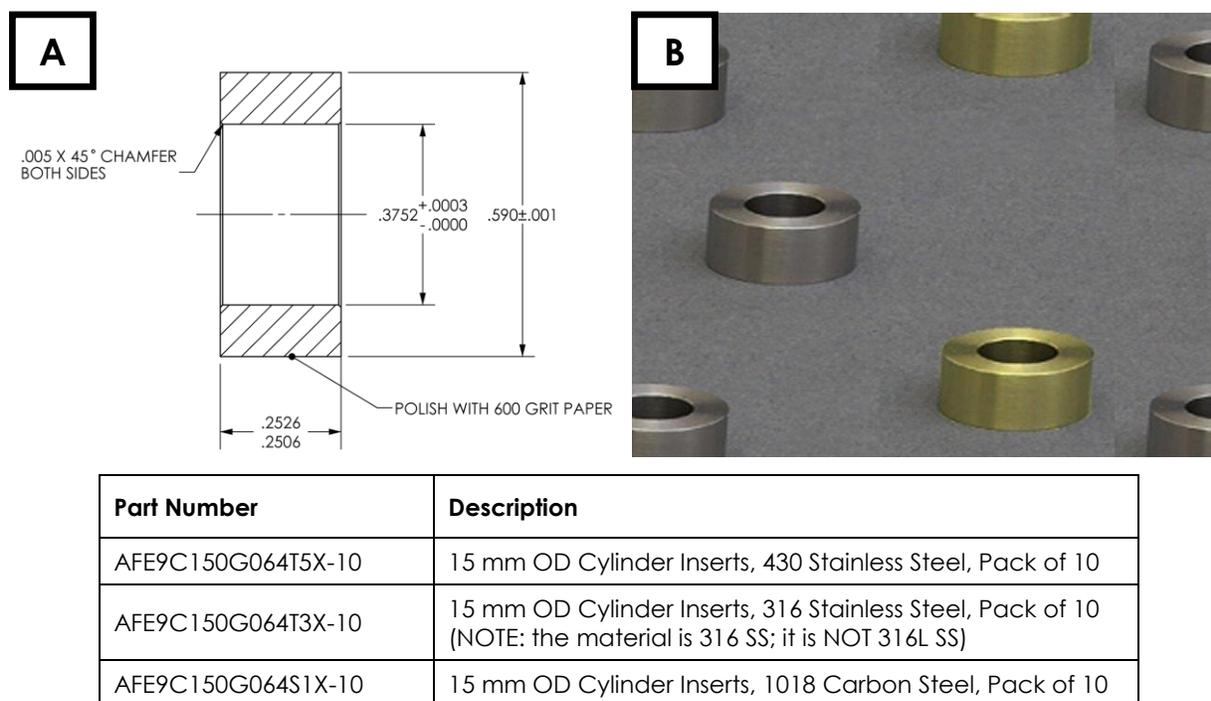


Figure 10. Mechanical Drawing of 15mm OD Cylinder Inserts (A); 15mm OD Cylinder Inserts (B).

D. OpenTop Corrosion Analysis Cell

Between experiments, users often want to clean the cell. This is difficult with standard glassware that features glass joints and other such small openings. Pine Research Instrumentation offers the OpenTop cell with their 15mm RCE Corrosion Bundles. The currently stocked OpenTop cells share the following features:

- Holds a 1 liter volume
- Fits the Teflon OpenTop lid
- Made of borosilicate glass
- Designed specifically for the 15mm RCE system shaft and MSR rotator

There are four styles of OpenTop cell, as follows:

- Jacketed cell with drain (Part Number AFCELL8)
- Jacketed cell (no drain) (Part Number AFCELL8U3)
- Basic (unjacketed) cell with drain (Part Number AFCELL8U)
- Basic (unjacketed) cell (no drain) (Part Number AFCELL8U2)

In general, the users want to control the temperature of solution inside the cell. Users can select either a water jacketed cell or a basic cell. By connecting a water-jacketed OpenTop cell to a circulating water bath, users can control the temperature of the internal solution. Threaded hose barbs are shipped with jacketed OpenTop cells. Alternatively, some users want to control heating directly using a hot plate. In this direct heating manner, a water jacket is unnecessary and users would select the Basic cell.

Some users want to drain the internal solution easily. Both the water jacketed and basic cells can have a drain installed. If the drain is present, the OpenTop cell is shipped with a drain valve. The valve extends from the base of the OpenTop cell by about 3 inches. For some users, this is undesirable, so they should select a cell without a drain. Each of the four styles of OpenTop cell will be shown in this section. Each 15mm RCE bundle includes an OpenTop cell, which is one component of the AFCELL8* part number (where * = U, U2, or U3, corresponding to different cell configurations).

Water Jacketed Cell with Drain Valve (AFCELL8)

The 1 Liter OpenTop Corrosion Cell that comes with AFCELL8 (Part Number RRP122), included in the [RCE15-JV] and [RCE15-RJV] bundles, features a water jacket and drain (see Figure 11). Included with the water jacket and drain are the appropriate fittings (barbed hose connectors for the jacket and a threaded valve for the drain, see Figure 12).



Figure 11. The jacketed OpenTop 1 Liter Corrosion cell with drain.



Figure 12. Threaded Barbed Hose Connectors and Drain Valve Stem with Knob.

Unjacketed Cell with Drain (AFCELL8U)

The 1 Liter OpenTop Corrosion Cell that comes with AFCELL8U (Part Number RRP143; See: Figure 13), included in the [RCE15-V] and [RCE15-RV] bundles, is a basic cell with drain valve (See: Figure 14) that integrates with the other components of the 15mm RCE System.



Figure 13. The Basic OpenTop with Drain Valve 1 Liter Corrosion Cell.



Figure 14. Threaded Drain Valve Stem with Knob.

Basic Cell (AFCELL8U2)

The 1 Liter OpenTop Corrosion Cell that comes with AFCELL8U2 (Part Number RRP173; See: Figure 15), included in the [RCE15-X] and [RCE15-R] bundles, is a basic cell that integrates with the other components of the 15mm RCE System.



Figure 15. The Basic OpenTop 1 Liter Corrosion Cell.

Water Jacketed Cell (AFCELL8U3)

The 1 Liter OpenTop Corrosion Cell that comes with AFCELL8U3 (Part Number RPPG1210; See: Figure 16), included in the [RCE15-J] and [RCE15-RJ] bundles, features a water jacket. Included with the water jacket and is the appropriate fittings (barbed hose connectors for the jacket, see Figure 12).



Figure 16. The jacketed OpenTop 1 Liter Corrosion Cell.

E. Accessories Included with the 15mm Corrosion Cell

As shown in Figure 3, each OpenTop RCE Corrosion Cell (AFCELL8*, part of each bundle in Table 1) comes with several accessories, each of which can be ordered individually as a supplement or replacement. The items included with the purchase of a 15mm RCE Product Bundle, which includes AFCELL8*, has been provided in the tables below (See: Table 3).

(NOTE: Part numbers are given only for reference, each part is already included in the cell when purchased as part of a bundle).

F. Optional Accessories for the 15mm Corrosion Cell

Several accessories are available for the 15mm Corrosion Cell. Each has been selected or designed to fit the OpenTop Lid. As the Cell kits in the 15mm RCE product bundles contain six 24/25 MutaPort adapters, the optional accessories also fit a 24/25 port.

Part Number	Description	Quantity
AC01LID122	OpenTop Cell Lid, Teflon	1
AC01CLP1	Hoobler-Sagi Cell Clamps	3
AKCLAMP2	Ribbon Clamp and Cross Joint	1
AFCTR3	Graphite Counter Electrode Assembly	1
AFE9MBA	15mm Single Cylinder Shaft	1
AC01TPA6M	Gas-Purged Bearing Assembly	1
AC01APLUG	MutaPort Adapter, Plug	1
AC01A1420	MutaPort Adapter, 14/20 Port	1
AC01A2425	MutaPort Adapter, 24/25 Port	6
RRPG085K1	Stoppers, Teflon, 24/25	7
RRPG031	Luggin Capillary (24/25 outside, 14/20 inside)	1
RRPG034	Dual-Port Sparge/Purge Accessory	1

Table 3. Products Included in 15mm RCE Product Bundles (part of the AFCELL8* Cell Kit).

Reference Electrodes

A reference electrode IS NOT included with any part of the 15mm RCE Corrosion Product Bundle. Reference Electrodes must order it separately (see the Pine website, Reference Electrodes).

A few important notes about our reference electrodes:

- Our standard reference electrodes fit a 14/20 port. They have a 9.5 mm OD glass body.
- We cannot ship mercury containing electrodes outside the United States, sorry for any inconvenience.
- 9.5 mm Reference Electrodes are compatible with the included Luggin Capillary (RRPG030).
- Reference Electrodes ship separately from the rest of the items.

There are three ways to introduce a reference electrode into a corrosion cell.

1. Direct, by inserting the reference electrode into the cell via a 14/20 port. This approach is most appropriate when the test solution is a salt solution containing concentrated chloride salts (e.g., NaCl).
2. Semi-Indirect, by first inserting the Luggin tube (RRPG031) through a 24/25 port, followed by insertion of the reference electrode into the inner chamber of the tube through the 14/20 port. The Luggin tube helps position the tip of the reference probe close to the cylinder insert. Close proximity between the reference and working electrode can reduce the potential shift that arises from uncompensated solution resistance between the reference electrode and the working electrode (RCE cylinder). Use of a Luggin tube becomes unnecessary when the test solution is highly conductive (i.e., having a high salt concentration) and the uncompensated resistance is low enough not to cause a significant measurement error in corrosion potential.

3. Indirect, by a salt bridge. One can use a salt bridge to physically and diffusively isolate the reference electrode from bulk solution. The salt bridge offers a conductive connection between the electrochemical cell (bulk solution) and a separate beaker of the same solution. A salt bridge may be an ideal accessory to use if a reference electrode becomes unstable. Reference electrode instability is often caused by a high solution temperature or by a chemical or physical process that plugs the frit at the tip of the reference electrode.

Reference Electrode Salt Bridge Kit (AKTUBE1420)

As mentioned, the salt bridge offers an indirect manner by which to connect the reference electrode to solution in the electrochemical cell. Pine offers an easy to use salt bridge kit that users may wish to keep in the laboratory (See: Figure 17).



Figure 17. Use of the Reference Electrode Salt Bridge Kit.

Condenser with 24/25 Joint (RRPG035)



Figure 18. 15mm RCE Cell Condenser, an Optional Accessory.

Digital Thermometer with Glass Thermowell (AKTHERM1)

Figure 19. Digital Thermometer with Glass Well and 24/25 Port Adapter.

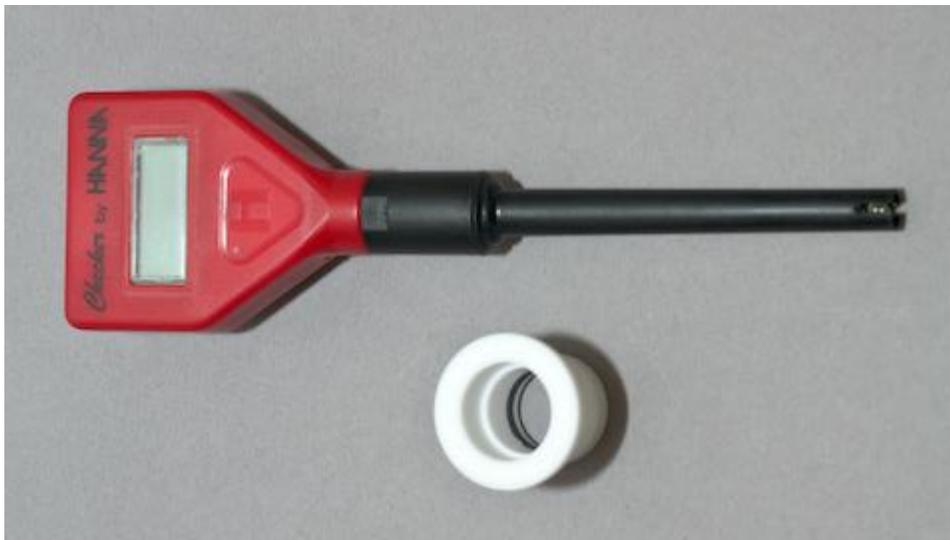
Digital pH Meter Probe with 24/25 Teflon Adapter (AKPH1)

Figure 20. Digital pH Meter Probe Fits a 24/25 Port in the OpenTop Cell Lid with 24/25 MutaPort Adapter.

Platinum Counter Electrode Assembly (AFCTR5)

Some users prefer a platinum counter electrode over a graphite counter electrode (See: Figure 21. Platinum Counter Electrode Assembly, Inserted into Glass Isolation Tube.. In general, highly corrosive conditions over long periods of time will degrade platinum. The platinum counter electrode only fits a 14/20 port – so the 14/20 MutaPort adapter must be used in the OpenTop Cell Lid.

The platinum counter electrode assembly comes with a fritted glass tube for isolation. The electrode can also be removed from the isolation tube and used directly in solution. In both configurations a 14/20 port adapter is included.



Figure 21. Platinum Counter Electrode Assembly, Inserted into Glass Isolation Tube.

Purge Kit for 1/4" Tubing (AKPURGE1)

The purge kit is useful to link a gas source (e.g. N₂ or Ar) to the Dual Port Sparge/Purge accessory included in the 15mm RCE product bundles (See: Figure 22). The three way valve is useful in regulating flow through solution (bubbling, purging) or blanketing the headspace.



Figure 22. Purge Kit Consists of Tubing for 1/4" Connectors and a Three Way Valve.

G. Thermal Control Optional Accessories

Scientists in Flow Based Corrosion Analysis often want to control the temperature of the liquid in the cell. They may want to mimic the same conditions as in their corrosive system (e.g. hot crude oil in a pipeline) and temperature is a contributing physical parameter to corrosion rate.

Two OpenTop cell types are offered from Pine; those that use a water jacket for thermal control and those that are designed to heat directly on a hot plate. Use of a circulating water back in a cell water jacket provides a uniform temperature. Despite, it is not convenient to clean a jacketed cell after a test run because the cell is attached to the circulator with hoses.

Water Circulator Kit with Remote RTD Sensor (AKAQUA40)

Pine offers four different water circulator kits for use with jacketed electrochemical cells. The circulator maintains the temperature of a fluid reservoir at a setpoint of your choosing. The recommended circulating fluid is a viscous polymer solution (see the website for further information). The fluid is circulated from the reservoir, out through hoses to the water jacket on the electrochemical cell, and then back to the reservoir. The temperature is typically monitored by a sensor located in the reservoir.

A point to consider is that each circulator kit includes a pair of chloroprene tubes (8 mm ID x 1.0 meter long) and two pairs of hose clamps to facilitate connection to the hose barb connectors on a jacketed glass cell. Chloroprene tubing is rated for use between -20°C and +120°C. For temperatures above this range, tubing made of other materials must be used.

There are several options, but the most ideal is likely the circulator with a "remote RTD sensor". The RTD sensor is Teflon coated and may be placed inside the electrochemical cell to provide more direct control of the actual temperature in the cell (See: Figure 23).

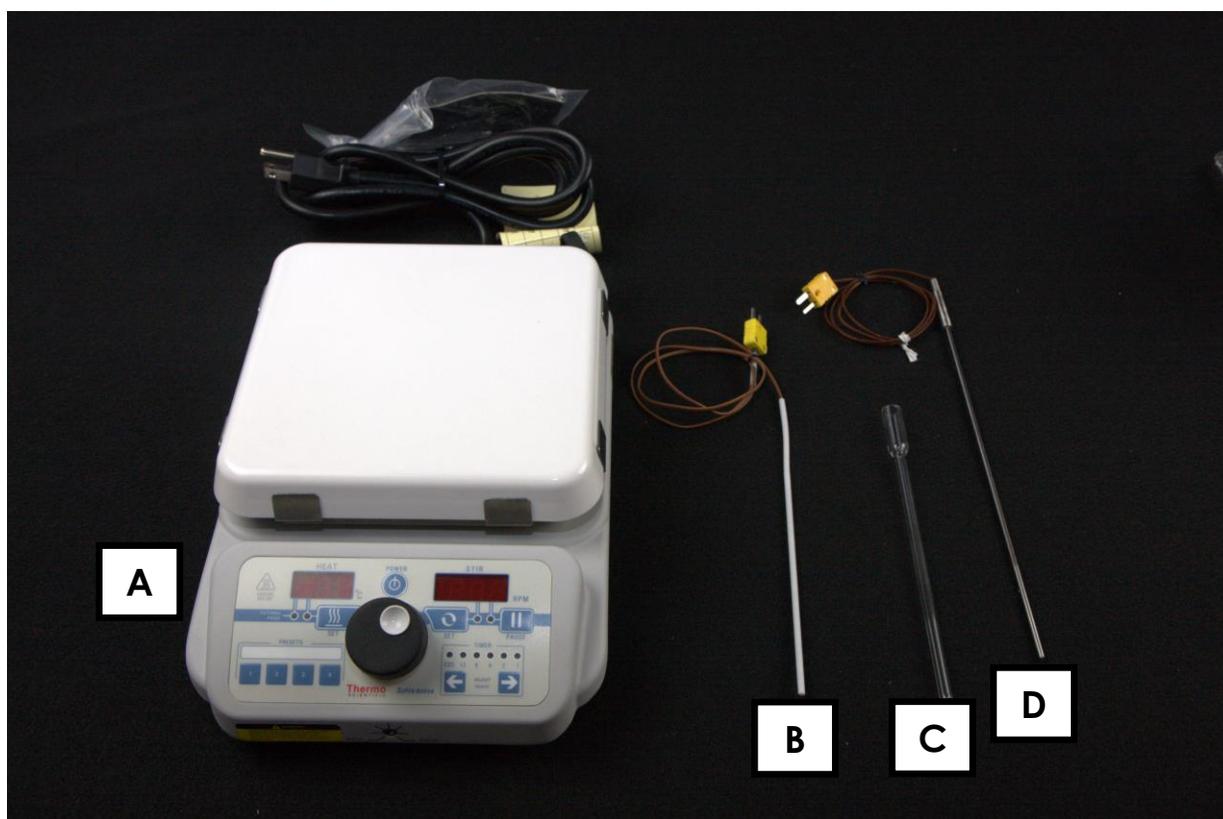


Figure 23. Circulating Water Bath with Feedback Sensor – Ideal for use with Water Jacketed Cells.

Hotplate Kit with Thermocouple Feedback (AKHEATER1 or AKHEATER2)

For users that prefer to heat the contents of their cell directly, they should choose an unjacketed OpenTop Cell. Heating with a hotplate tends to provide a non-uniform temperature gradient; however, the rotating shaft (with turbulent flow) will disrupt the temperature gradient and enhance the temperature gradient uniformity.

The hotplate is available in two electrical configurations: 110V (AKHEATER1) and 220V (AKHEATER2). The hotplate kit includes two 8" temperature probe thermocouples, a glass thermowell, and a 7mm to 24/25 Teflon adapter (See: Figure 24). Be sure to select the product whose electrical configuration is matched to the voltage source in your country. The hotplates have a ceramic top and maximum surface temperature of +300°C. It is recommended to use the included thermowell and add either water or high boiling-point oil in order to achieve good thermal contact.



Code	Description
A	Digital Hotplate (in either 110V or 220V configurations)
B	Teflon Coated Thermocouple Probe for Temperature Feedback (temperature limit is +190°C)
C	Glass Thermowell for Thermocouple Probes
D	Stainless Steel Thermocouple Probe for Temperature Feedback (temperature limit is +380°C)

Figure 24. Hotplate with Thermocouple Probe Feedback Sensors.

The cell is flat bottomed and seats onto a hotplate. The MSR Rotator base is large enough to accommodate our recommended hotplate (See: Figure 25) with sufficient clearance above to install the cell and RCE accessories.

The thermocouple connects to the rear of the hotplate, at the yellow two prong (anode/cathode) connector (See: Figure 26). By using the thermocouple feedback sensor probes in the electrochemical cell, the hotplate can more accurately control the temperature of the heating element relative to its setpoint and the actual solution temperature in the cell.



Figure 25. Use of the Hotplate and Thermocouple Feedback with an AFCELL8U2 under the MSR Rotator.

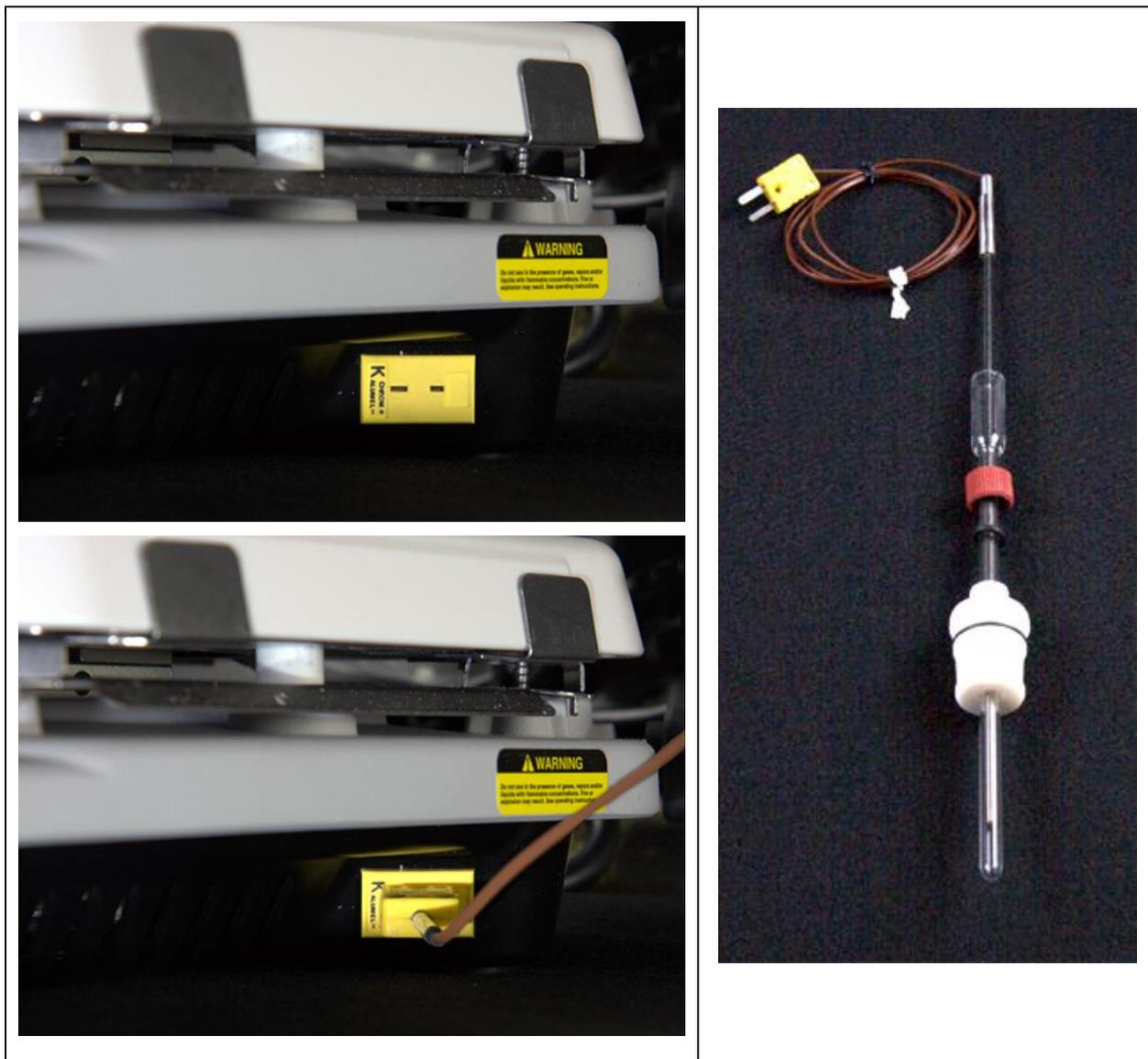


Figure 26. Connect the Thermocouple Connector to the back of the Hotplate.

Support/Contact Us

Please contact us with any of your needs: general and technical questions, pricing/quotes, selection assistance, etc. You will always get a live person at Pine – no calling tree. We are here to serve you.

Call +1 (919) 782-8320 Monday – Friday from 9 AM to 5 PM EST

Email the sales team at pinewire@pineinst.com