

SUNY POLYTECHNIC INSTITUTE

Vacuum Components: Fastener and Seals, Assembly and Test Procedures Laboratory

A NEATEC Workforce Development Training Course

Exercise #2 – Component Assembly

Notes for System Assembly: Assembly of KF-series flanges involves first inspecting tubing flanges for burrs or contamination and checking the elastomeric seal for damage prior to assembly. Next, insert the flange between the tubing sections as shown in Component Photograph 4 and place the clamp in a manner to cradle both tubing section flanges. Place the opposite side of the flange over the top of the mated sections. Rotate the screw lever rotated into the slotted flange. Prior to tightening the wingnut ensure tubing sections are within the clamp, squarely in place and the nut can turn without interference from other tubing. You need only hand-tighten the wingnuts.

WARNING: Do Not Remove Protective Caps except for flange/sealing surface inspection prior to assembly. Do not discard any cap. Always restore caps to any disassembled component. Protect sealing surfaces.

NOTE: Inspected all gasket material prior to installation free of defects, clean and replace as necessary.

TORQUE METHODS: Torque all bolt/nut fasteners using the Torque Turn to Tighten method (TTT), 60 degrees (one flat for hex) 20 degrees each bolt, then to 40 degrees each bolt and a final turn to 60 degrees. Use the appropriate bolt ring pattern. Number each fastener to assure proper sequence. Tighten VCR/VCO/Compression fittings as specified in the Swagelok drawings in your appendix.

Assembly Procedure for Fitting Trainer components to Baseplate:

Task 1: Assemble Baseplate to Basic Chamber: A 4.5-inch CF Full Nipple forms the test chamber when mounted to the baseplate. Components subsequently mounted form a prototype vacuum system complete with pressure measurement.

Task 1.1: Gather components and tools in quantities listed below to begin baseplate to chamber assembly as shown in Graphics 1, 2, and 3.

- 1 – Baseplate
- 1 – 4.5-inch CF Full Nipple
- 2 – Upper Saddle Clamp
- 2 – Lower Saddle Clamp
- 4 – ½-13 hex head bolts
- 4 – ¼-20 hex head partially threaded bolts
- 1 – Hex key set

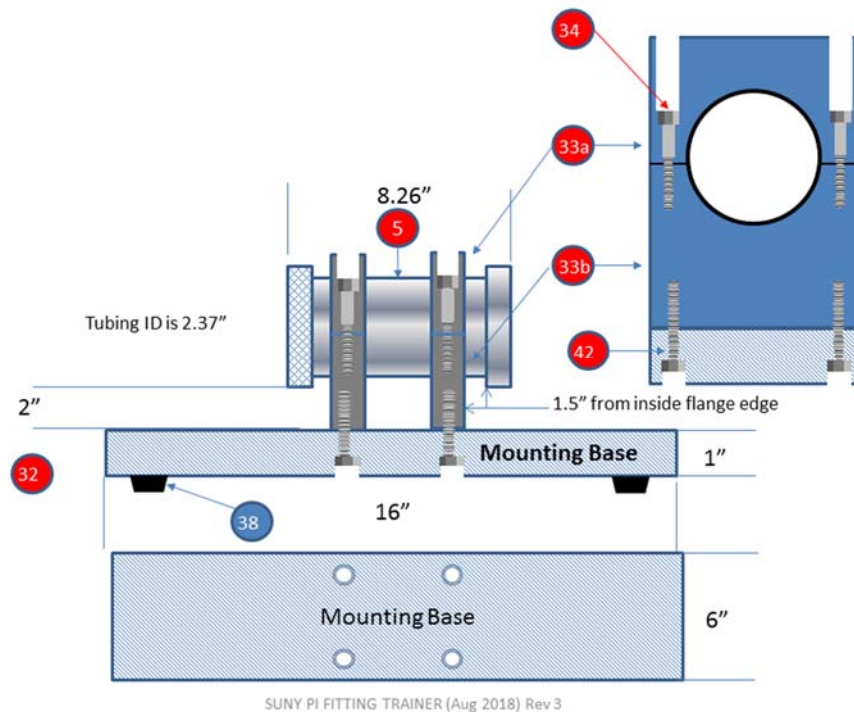
Task 1.2: Assemble Lower Saddle Clamp.

- Assemble the two lower saddle clamps Item # 33b to Item # 32 (Fitting Trainer Base) using four Item # 42 (½-13 hex head bolts socket head bolts). Snug bolts finger tight then torque all bolts. Use bench clamp Item #51 to secure the base to the worktable.

Task 1.2.1: Assemble CF Nipple and Upper Saddle Clamp.

- Place Item # 5 (4.5-inch CF Full Nipple) in the lower saddles with the rotating flange on the left as in Graphic 1 and clamp in place as in Graphic 4. Assemble two upper saddle clamps Item # 33a to two lower saddle clamps Item # 33b using four partially threaded socket head bolts Item # 34. Snug bolts finger tight then torque all bolts. The nipple position may need adjusted in subsequent steps to allow flange fastener installation.

Graphic 4 – Fitting Trainer Support Frame with CF Full Nipple



Task 2: Assemble Rotating Flange components: The rotating flange side in this step connects via CF elbow and CF to KF adapter to the Pirani gage from the Basic Vacuum Trainer.

Task 2.1: Gather components and tools in quantities listed below to begin component assembly to chamber assembly as shown in Graphics 1 and 2

- 1 – mini-CF elbow
- 1 – mini-CF to KF16
- 1 – Zero length adapter, 4.5-inch CF to Mini CF
- 6 – #8-32 socket head screw SS (1/2 inch)
- 6 – #8-32 socket head screws (9/16 inch)
- 3 – #8-32 plate nuts
- 8 sets – 5/16-24 x 2-1/4 bolts, w/flat washers and nuts
- 16 – Belleville washers
- 1 – 4.5-inch CF copper gasket
- 2 – mini-CF copper gaskets

- 1 – Hex key set
- 1 – 9/64 inch shortened hex key
- 2 – Combination wrench 1/2 inch
- 1 – Blunt-Point All-Metal Scissors

Task 2.2: Using graphics 1 and 2 assemble each component to the Rotating Flange, starting with the mini-CF elbow and mini-CF to KF16 Adapter.

- Assemble six Item # 41 (#8-32 socket head screw SS (9/16 inch)). Use Item # 53 to cut open a Conflat gasket package (if necessary) and center one mini-CF gasket Item # 17 between Item # 19 mini-CF elbow and Item # 39 (mini-CF to KF16 adapter). Insert screws in the through holes and capture with the plate nuts (curved bracket with two tapped holes). Snug then torque.

Task 2.2.1: Using Graphics 1 and 2 assemble the mini-CF to Zero-Length-Adapter to the Rotating Flange.

- Assemble eight Item # 31 (5/16-24 x 2-1/4 bolts w/flat washers and nuts). Use Item # 53 to cut open a Conflat gasket package (if necessary) and center one 4.5-inch CF gasket Item # 18 between Item # 5 rotating flange and Item # 20 (zero-length-adapter 4.5 inch CF side). Install one flat washer per bolt then insert bolts in the flange through holes. Install two Item # 35 Belleville washers each bolt with the bell (larger diameter against the flange). Install nuts and snug fasteners but **do not** torque. Ensure the copper gasket remains centered.

Task 2.2.1: Using Graphics 1 and 2 assemble the mini-CF elbow to the Zero-Length-Adapter.

- Use Item # 53 to cut open a Conflat gasket package (if necessary) and center one mini-CF gasket Item # 17 between Item # 19 mini-CF elbow and Item #20 mini-CF to 4.5-inch CF zero-length-adapter. Assemble six Item # 30 socket head screws then insert into the tapped holes. Snug then torque. Rotate the assembly so the KF16 flange remains vertical. Ensure the copper gasket remains centered. Using one wrench, hold Item # 31 nuts in place. Torque Item # 31 bolts with the second wrench to Item #5.

Task 3: Assemble Fixed Flange Adapter: The fixed flange side connects a variety of vacuum fittings and provides the leak detection port.

Task 3.2.1: Gather components in quantities listed below to begin component assembly to chamber assembly as shown in Graphics 1 and 2

- 8 sets – 5/16-24 x 2-1/4 bolts w/ 16 flat washers and 8 nuts
- 1 – 4.5-inch CF copper gasket
- 2 – Combination wrench 1/2 inch
- 1 – Blunt-Point All-Metal Scissors

Task 3.2.2: Using Graphics 1 and 2 assemble the 4.5-inch CF flange to KF40 Adapter to the fixed flange.

- Assemble eight Item # 31 - 5/16-24 hex head bolts and eight flat washers. Use Item # 53 to cut open a Conflat gasket package (if necessary) and center one 4.5-inch CF gasket Item # 18 between Item # 5 fixed flange and Item # 21 (4.5-inch CF flange to KF40 adapter). Insert the bolts in the through holes. Install a second flat washer and capture with the nuts. Snug fasteners hand tight. Next, using one wrench hold Item # 31 - 5/16-24 nuts in place and with the second wrench torque Item # 31 bolts to Item #5. Ensure the copper gasket remains centered.

Task 4: Final Assembly vacuum components to Fixed Flange Adapter: The final steps connect a variety of quick disconnect components.

Task 4.1: Gather single fastener components in quantities listed below to begin assembly to chamber as shown in Graphics 1 and 2

- 3 – KF40 clamps
- 2 – KF40 SS Centering ring w/O-ring - Fluorocarbon (brown)
- 1 – KF40 SS Centering ring
- 1 – KF40 O-ring - Silicone (red)
- 1 – KF40 to KF16 adapter (from Basic Vacuum Trainer)
- 1 – KF16 clamp
- 1 – KF16 SS Centering ring
- 1 – KF16 /O-ring - Silicone (red)
- 1 – KF40 tee
- 1 – KF40 to 1/4 VCO male adapter
- 1 – VCO O-ring Face Seal Fitting, Union, 1/4-inch VCO Fitting
- 1 – Swagelok Tube Fitting Connector, 1/4-inch WVCR x 1/4-inch Tube Fitting
- 1 – 1/4-inch Ni VCR Gasket
- 1 – 1/4-inch SS VCR plug
- 1 – Hex key set
- 1 – Combination wrench, (9/16-3/4) inch
- 1 – Combination wrench 5/8 inch
- 1 – 1/4-inch SS tube
- 1 – Compression Nut and Ferrule Set (1 Nut/1 Front Ferrule/1 Back Ferrule) for 1/4-inch tubing
- 1 – KJLC 275i Pirani gage from the Basic Vacuum trainer

The following items are pre-assembled and identified as Female VCO face seal to 1/4 inch Female tube fitting adaptor FTFA-1

- 1 – VCO O-ring Face Seal Fitting, Tube Adapter, 1/4 inch VCO Fitting x 1/4 inch Tube OD*
- 1 – 316 Stainless Steel Female Nut for 1/4 inch VCO O-ring Face Seal Fitting (0.66H, 11/16 flat to flat)*
- 1 – Compression Nut and Ferrule Set (1 Nut/1 Front Ferrule/1 Back Ferrule) for 1/4 inch tubing*

Task 4.2: Connect KF components to chamber.

- Assemble Item # 6 (KF40 tee to Item # 21 (KF40 to 4.5-inch CF adapter) using Item # 7 (SS Centering ring with Item #8 O-ring - Silicone (red)) and Item # 9 (KF40 clamp). Orient the tee with the center port up.

- Be sure the seal is centered and the pieces squarely connected and aligned before placing the clamp over the assembly.

Note: Loosen the clamp screws sufficiently so the screw fits over the clamp and hand tighten the clamp.

- Attach Item # 11 (KF40 to 1/4 VCO male adapter) to the center KF flange using Item # 7 (SS Centering ring w/O-ring - Fluorocarbon (brown)) and Item # 9 (KF40 clamp).

- Attach Item # 56 (KF40 to KF16 adapter) to Item # 6 (KF40 tee) using Item # 7 (SS Centering ring w/O-ring - Fluorocarbon (brown)) and Item # 9 (KF40 clamp).

Task 4.3: Connect VCO components to KF Adapter.

- Assemble Item # 37 (VCO O-ring Face Seal Fitting, Union, ¼-inch VCO Fitting) to the 316 SS female nut on item # 11 and snug finger tight. Mark body and nut then tighten 45 degrees.

- Assemble the FTFA-1 to Item # 37 (VCO O-ring Face Seal Fitting, Union, ¼-inch VCO Fitting) and snug finger tight. Mark body and nut then tighten 45 degrees.

- Install Item # 2 (¼-inch Ni VCR Gasket) into the female VCR on Item # 14 (Swagelok Tube Fitting Connector, ¼-inch WVCR x ¼-inch Tube Fitting). Install Item #1 (¼-inch SS VCR plug) finger tight then wrench turn ⅛ rotation.

Task 4.3.a: Assemble a compression fitting.

- Team Member 1, assemble compression nut and ferrules from Item # 16 in the following order; nut, back ferrule, front ferrule onto Item # 52 ¼-inch SS tube. Insert this end into Item # 14 (¼-inch WVCR x ¼-inch Tube Fitting) snug then mark the nut at the 6 o'clock position. While holding the fitting body steady, tighten the nut one and one-quarter turns to the 9 o'clock position. Team Member 2, disassemble this joint and repeat this step for the opposite tube end. Team member 1, disassemble and present this new assembly, known as a dog bone, to the instructor for certification. This component is not required further.

Task 4.4: Connect pressure gage to KF gage port.

- Assemble Item #4 (KF16 SS Centering ring) with Item #13 KF 16 O-ring - Silicone (**red**)), the KJLC 275i Pirani gage from the Basic Vacuum trainer and Item # 3 KF16 clamp onto Item # 39 (mini CF to KF16 Adapter Flange). Install Power supply and LabQuest2 Notify your instructor your system is ready for test.

Task 5: Assembly of Ball Valve to leak detector port and initial leak test:

- Assemble the hose with the KF16 ball valve and vent assembly to the leak detector test port Item # 56 (KF40 to KF16 adapter) using Item # 4 (KF16 SS Centering ring w/O-ring - Fluorocarbon (**brown**)) and Item # 3 (KF16 clamp). Place the valve handle in the 'off' position.

- Plug the KJLC 275i power cord & voltage readout wiring into the electrical outlet on the lab table and connect it to the KJLC 275i gage. (After the KJCL 275i display comes on the initial pressure reading should be in the 750-800 Torr range.)

- Wait for your instructor to turn on the vacuum system (after all teams have completed their assembly).

Fitting Trainer Pumpdown Test Procedure:

- Using the table below to record your data, prepare as a team to record the readings from the KJLC 275i vacuum gauge at 30 second intervals upon opening the ball valve (do not open yet).

- The instructor will inform all groups to open their ball valves. Begin timing. Every 30 seconds record the pressure from the KJLC 275i gauge in the table below until 5 minutes (300 seconds) has elapsed.

Note: The pressure reading should drop quickly.

Time (Seconds)	Pressure (Torr)
30	
60	
90	
120	
150	
180	
210	
240	
270	
300	

Task 5.1: Repeat Pumpdown (if necessary):

- Follow the procedure below **if the measured manifold pressure does not drop to less than 100mTorr after 5 minutes**

- Close the ball valve to isolate the system from the pump.

- Vent the system by opening the vent valve until pressure returns to atmospheric pressure (760T)

- Re-check your connections and re-test the system by closing the vent valve and opening the ball valve. If you still cannot reach 100mTorr after 5 minutes pumping time, consult with your instructor.

Task 5.2: Rate of Rise: After a successful pumpdown, the next step is a quick check of system integrity.

- Record the system pressure.

- Close the ball valve to isolate the system from the pump.

- Record the system pressure after 10 minutes.

- Use the following equation to determine the leak rate.

$$SCCM = 79.2 \times ((273 / (273 + T)) \times V \times (P2 - P1) / t)$$

T = Temperature Kelvin (C + 273.15)

V = Volume of system in cubic centimeters

P2 = Final pressure

P1 = Start Pressure

t = seconds

79.2 Conversion factor to sccm

Leak Rates

10^{-1} std. cc/sec ~ 1 cc/10 sec

10^{-3} std. cc/sec ~ 3 cc/hour

10^{-5} std. cc/sec ~ 1 cc/day

10^{-6} std. cc/sec ~ 1 cc/2 weeks

10^{-7} std. cc/sec ~ 3cc/year

10^{-9} std. cc/sec ~ 1 cc/30 years

Varian Vacuum Products (now part of AMAT)

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