CANNON® Service Bulletin

Technical Note 1607291

CAV 4.2 Advanced Setup, Tuning and Troubleshooting Guide

Issue:	Instrument setup	**Date:**	7/29/2016
Instrument(s):	CAV 4.2	**Associated documents:**	CAV 4.2 Operator's Manual, Rev 2.0

This technical note provides advanced instructions for setting up, tuning and troubleshooting the CANNON® CAV® 4.2 dual-bath kinematic viscometer. It is a supplement to the CAV 4.2 Operator's Manual. Some content, as applicable, may be included in future revisions of the operator's manual. It is constantly being revised, so please visit the CANNON® website for the latest version.

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Overview

"Tuning" refers to adjusting the settings of the CAV® 4.2 to provide desired results. "Troubleshooting" is required when the CAV 4.2 is not working properly within the given method setting. These terms are not mutually exclusive. The instrument must be running properly before it can be tuned, but some issues may be uncovered when tuning an instrument.

Before attempting to tune a CAV® 4.2, you must be familiar with the basic operation of the instrument. This technical note is written for experienced technicians. It provides general guidelines and suggestions, not step-by-step procedures.

Typical setup issues

Inspection and setup

The CAV® 4.2 must be on a level workbench.

Verify that the stirrer pulley and motor pulley are inline. The belt is meant to float up and down on the gear teeth between the side walls of the pulley. If the pulleys are not inline, the belt will wear quickly by being drawn against one sidewall of the pulley.

Solvent and waste line plumbing

Do not tee solvent inlet lines. Each solvent line must run independently from the top of the instrument to the solvent bottle. If a single solvent line is split and run to both inlets, the vacuum pumps may draw against each other when both baths run at the same time.

Do not combine vacuum outlet lines. A vacuum outlet line is pressurized during various steps when a bath is running. If these lines are combined, one bath may pressurize the other when both baths run at the same time.

Thermoelectric cooler and temperature calibration

Caution: Do not mount a thermoelectric cooler onto a high temperature bath. A high temperature bath is designed to run at temperatures above 100 °C, which can damage the cooler even when it is not turned on.

Temperature calibration depends on the state of the thermoelectric cooler. If the bath is calibrated at a particular temperature with the thermoelectric cooler turned on, it will need to be recalibrated if the bath is run at that particular temperature with the cooler turned off.

Vacuum and air pressure settings

The vacuum and air pressure settings should be adjusted when the instrument is initially set up, then they should not be changed. Several test parameters, such as sample overdraw times, bulb select time, and air dry times, depend on these settings.

Vacuum

The default vacuum setting is between 3 and 4 inches of Hg. The goal is to set the vacuum low enough to draw the sample of highest viscosity up the A-pipe without drawing it too far up the B-pipe. The sample should not be drawn into the B-pipe any further than the bottom of the CANNON logo.

Air Pressure

The default air pressure setting is between 4 and 5 pounds. If the pressure is too low, the tube viscometer tube will not be cleaned and dried effectively. If the pressure is too high, sample and solvent may be blown out of the sample vial.

Bath fluid viscosity and level

The basic instruction (page 13 of the CAV® 4.2 Operator's Manual) recommends using 10 cSt silicone fluid for temperatures under 100 °C and 20 cSt for temperatures above 100 °C. Thicker bath fluids do not mix well at lower temperatures. You should use the thickest silicone bath fluid that still mixes thoroughly to provide uniform temperatures throughout the length of the bath.

Another issue with choosing bath fluid involves thermal expansion. The 10 cSt silicone fluid expands more than the 20 cSt silicone fluid over the same increase in temperature.

- At ambient temperature, the bath fluid must lift the float.
- At the lowest test temperature, the bath fluid must cover at least 1/2 the top bulb of the viscometer.
- At the highest test temperature, the fluid must not overflow the bath.

Waste container level

The waste outlets must be able to freely gravity drain into a waste container. Do not allow the discharge end of waste line to become submerged in the waste container. This will create back pressure and prevent the unit from operating properly.

ViscPro II setup

The two most common issues with ViscPro II:

- Establishing communication: ViscPro II must running on the remote computer before instructing the CAV® 4.2 to communicate with it. Toggling the Local/Remote Mode button causes the instrument to send out a ping. If it is able to connect with ViscPro II, the icon turns green.
- ViscPro II crashes when attempting to connect to CAV® 4.2: This is typically caused by a mismatch between the version of ViscPro II on the remote computer, and the GUI software on the CAV® 4.2. It is always best practice to load the latest ViscPro II software, CAV 4.2 GUI software and CAV 4.2 firmware.

Tuning

Sensor training

Sensor training uses the bulb 2 **Advanced Setting** parameters from the default method assigned to the tube being trained. However, it uses the bulb 2 wash parameters from the **Default Wash** settings.

Sample heaters

The CAV® 4.2 has two independent heaters (separate from the thermal bath) that affect the running sample. Do not associate these heaters with the thermal soak, which is provided by the thermal bath. They have different purposes.

- Sample cup heater (bucket): this heater assists in maintaining the sample temperature during a run and in improving the efficiency of the wash cycle (page 50 of the CAV® 4.2 Operator's Manual). The trick with this heater is to not increase the temperature of the sample between effluxes to a point where the thermal sensors do not detect the sample when it is drawn into the tube. Thermal sensors detect the sample by measuring an increase in electrical resistance caused by a decrease in temperature when the sample is drawn up the tube across the thermistor. If the temperature of the sample is higher than the temperature of the bath, the sample will not be detected during a draw.
- Sample preheater (extendable crescent): this heater is used to melt samples that are solid or too viscous to pull up the viscometer tube at room temperature, such as waxes, residues, #6.
    - Minimum preheat starts the preheat cycle as soon as the previous sample begins running and runs for at least the set preheat time. Minimum preheat behaves like serialized preheat for the first sample in a run.
    - Serialized preheat starts the preheat cycle after the previous sample finishes and runs for exactly the set preheat time.

	Type	Time	Temp.	Details
1	Minimum (behaves like serial in first sample run)	300 sec	100 °C	Starts at ambient and begins to warm to 100 °C while the 300 seconds is counting down. Heater stays at 100 °C anticipating the next sample.
2	Serial	300 sec	100 °C	Heats for exactly 300 seconds starting as soon as sample 1 run completes.
3	Minimum	300 sec	80 °C	Heats as soon as sample 2 run starts and continues heating for as long as sample 2 runs. If sample 2 runs in fewer than 300 seconds, sample 3 will continue to receive preheat for at least 300 seconds before running. As soon as the sample 3 run starts, the heater begins to cool down, since sample 4 does not use preheat.
4	No preheat*	300 sec	100 °C	No preheat and since it is turned off, it cools down and does not anticipate the next sample.
5	Minimum	300 sec	100 °C	Begins to warm to 100 °C while the 300 seconds is counting down. Heater stays at 100 °C anticipating the next sample.
6	Serial*	0	100 °C	No preheat, but the heater drop at 80 °C anticipating the next

	Type	Time	Temp.	Details
				sample.
7	Serial	300 sec	80 °C	Heats for exactly 300 seconds starting as soon as sample 6 finishes. Heater shuts down when sample is running.

*Take note of the difference in behavior between samples 4 and 6. Neither receive preheat, but by setting the preheater to serial with a 0 time for sample 6, the preheater stays on

The most time efficient use of preheating during a full carousel run is to set the heater to the temperature of the bath and apply it using the **Minimum Preheat Time** setting. This prevents the sample from heating to above the bath temperature, and it preheats while the previous sample is running.

The highest degree of preheating control is achieved by using the **Serialized Preheat** option. The sample will only preheat for the exact amount of time specified.

Metal sleeves are available for preheating. They hold a glass vial and conduct the heat from the crescent heater around the sample more uniformly than applying the crescent heater directly to the glass vial. Because the metal sleeves are larger than the glass vials, they require a unique carousel, bucket heater, and preheater. Metal sleeves are good for use with paraffin samples. Liquids conduct heat sufficiently to not need a metal sleeve; paraffin does not conduct heat as well and is better treated by applying a uniform heat all the way around the sample. If you need metal sleeves, you will probably also need both internal and external waste line heaters.

Optimize thermal soak and bulb overdraw

If the thermal soak is too short, the first efflux will be longer than subsequent effluxes. The simple check to see if your thermal soak is long enough is to increase the soak time and see if it makes a difference.

Thermal soaking requires that the sample drawn into the viscometer tube be completely covered by the bath fluid. Ideally, the top bulb should be covered at least halfway by the bath fluid, and the Bulb 2 Overdraw Time should be set to draw the thickest sample halfway into bulb 3. Be careful to ensure that the thinnest samples do not draw above the top of the tube.

Wash parameters

The wash settings are where time can be saved, but this may come with degraded performance. Solvent left within the system from a wash can contaminate the next sample. The drying time increases as the bath temperature decreases for a given solvent, i.e. heptane does not dry as quickly at 40 °C as it does at 100 °C.

Only wash the B-pipe if a highly viscous sample is drawn into it. If you must wash the B-pipe, use at least 3 or 4 solvent fluses Otherwise, do not flush any solvent through the B-pipe. Instead, check **Wash B-Pipe** to enable the B-pipe air dry, set all **B-Pipe Solvent Washes** to zero, and set the **B-Pipe Dry Time** to 150 seconds.

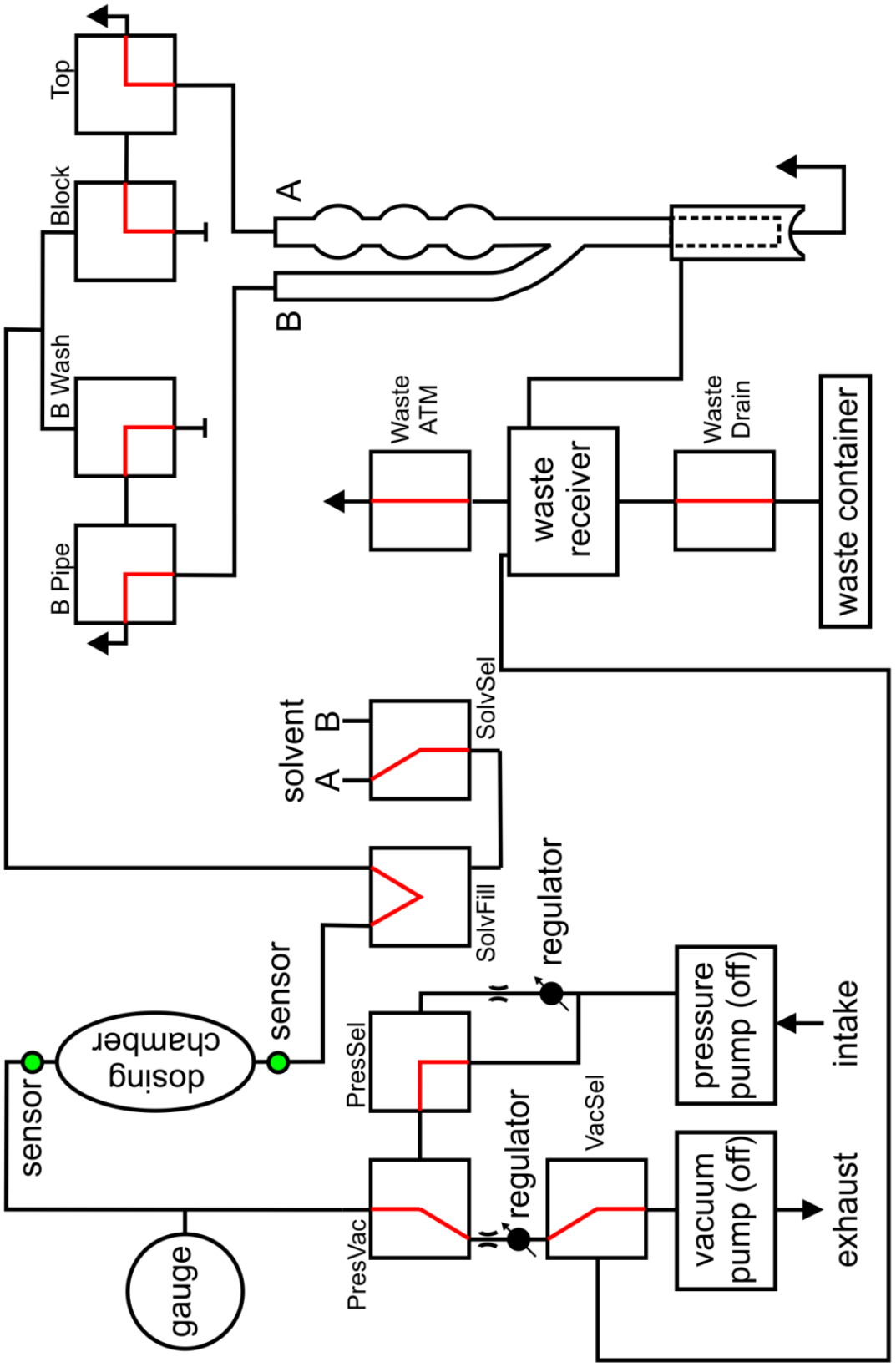
Default settings

Setting	Verify Known KV/Base Oil	Default Wash
TEST		
Wet Tube	No	—
Soak Time Units	Seconds	—
Bulb1 Soak Time	150	—
Bulb2 Soak Time	150	—
Bulb3 Soak Time	0	—
Preheat Type	No Preheat	—
Minimum Preheat Time	0	—
Preheat Temperature Units	Celsius	—
Preheat Temperature	0.00	—
WASH		
Bulb1 Solvent A Washes	**5 (range: 5-9)**	**5 (range: 5-9)**
Bulb1 Solvent B Washes	**0**	**0**
Bulb1 Solvent C Washes	**0**	**0**
Bulb2 Solvent A Washes	**5 (range: 5-9)**	**5 (range: 5-9)**
Bulb2 Solvent B Washes	**0**	**0**
Bulb2 Solvent C Washes	**0**	**0**
Bulb3 Solvent A Washes	**0**	**0**
Bulb3 Solvent B Washes	**0**	**0**
Bulb3 Solvent C Washes	**0**	**0**
Maximum Solvent A Fill Time	**120**	**120**
Maximum Solvent B Fill Time	**120**	**120**
Maximum Solvent C Fill Time	**1**	**1**
Solvent A Injection Time	**8**	**8**
Solvent B Injection Time	**0**	**0**
Solvent C Injection Time	**0**	**0**
Cup Empty Time	**30 (range: 30 – 40)**	**30 (range: 30 – 40)**
Tube Tip Soak Time	**8**	**8**
Solvent Evacuation Time	**10**	**10**
Final Air Dry Time	**150 (range: 60 – 180)**	**150 (range: 60 – 180)**
Wash B-Pipe	**Checked**	**Checked**

Setting	Verify Known KV/Base Oil	Default Wash
B-Pipe Solvent A Washes	**0**	**2**
B-Pipe Solvent B Washes	**0**	**0**
B-Pipe Solvent C Washes	**0**	**0**
B-Pipe Dry Time	**150 (range: 60 – 180)**	**150 (range: 60 – 180)**
Advanced		
Maximum Bulb 1 Fill Time	**150**	—
Minimum Bulb 1 Select Time	**40**	—
Minimum Bulb 2 Fill Time	**0**	—
Maximum Bulb Empty Time	**800**	—
Tube Empty Time	**0**	—
Bulb 1 Overdraw Time	**15**	—
Bulb 2 Overdraw Time	**3**	—
Bulb 3 Overdraw Time	**0**	—
Sample Draw Delay	**5**	—
Bulb 1 Vent Drain Time	**0**	—
Bulb 2 Vent Drain Time	**0**	—
Bulb 3 Vent Drain Time	**0**	—
Drop Criteria		
Maximum Determinations	**3**	—
Required Determinations	**2**	—
Maximum % Difference	**0.350**	—
Maximum Efflux Difference	**0.200**	—
Drop Criteria Mode	**Use Any Determination**	—
Use Percent Difference	**Checked**	—
Use Efflux Difference	**Unchecked**	—
User Either	**Unchecked**	—

Bath temperature	Sample cup heater duty cycle
40 °C	20%
100 °C	75%

Plumbing Diagram (de-energized state)



Troubleshooting

Issue …	Try …
VISCPRO II will not connect to the CAV 4.2	Start VISCPRO II first, then toggle the **Local/Remote Mode** button on the CAV 4.2.
VISCPRO II crashes when attempting to establish the initial connection to the CAV 4.2	Update VISCPRO II. The latest software is available from the **CANNON® Website > Library > Downloads**: http://cannoninstrument.com/en/page/240/downloads
Erratic flow times	Check waste container level Disable waste line heater Toggle valves, listening for the click of the solenoid
"Thin" sample draws into bulb 1	Increase the **Minimum Bulb 1 Select Time**
First efflux time is longer than subsequent efflux time	Increase the thermal soak time Increase the drying time Increase the duty cycles of the bucket heater Increase the overdraw time to draw the sample into the center of the bulb above the upper sensor being used

Replacing/resetting the sample handler

The position of the CAV 4.2 carousel is determined by an optical sensor inside the hub. This differs from the miniAV/PV systems in which the position sensors are part of the carousel. Therefore, it is possible to safely home and reset the sample handlers with the carousel removed, which is the preferred method.

To zero the bucket position on the sample handler:

1. Remove the three sheet metal panels around the sample handler assemblies.
2. Remove the carousel.
3. Slide the tray in.
4. Check the position of the bull gear. Tighten the set screw if necessary. The set screw must mate to the flat side of the spindle. The bull gear must be level with the pinion gear. Apply appropriate grease to both spur gears and to the worm gear.
5. Gently rotate the bull gear until the bucket is fully lowered.
6. Press the reset button on the sample handler assembly.
7. From the CAV 4.2 screen, enter the **Service > Control Motors** screen for the bath being worked on.
8. Home the sample handler.
9. Raise the bucket and check to see that the tube tip passes through the center of the hole in the bucket. Adjust the position of the sample handler assembly if necessary.
10. Lower the bucket. Install the carousel. Home the unit. Raise the bucket. During all of these movements, listen for any impingement. If necessary, TeraTerm may be used to adjust the rotational and horizontal positions of the carousel.

Spare Parts List (P/N 68.0542)

Part Number	Description
81.2102	FEP Tubing, 6mm OD blue (3 ft)
81.2185	FEP Tubing, 1/8" OD blue (10ft)
62.1500.3	Tubing, Nyloseal natural Fre-Lon 1/2" (6 ft)
81.2903	Tube, bearing w/ glued shaft
81.2227	RTD probe assembly
68.0439	Thermal fuse assembly
68.0518	Float assembly
81.2109	Valve, solenoid 3-way Kalrez
68.0212	Manifold valve, solvent select
68.0179	Sample handler with preheat
68.0251	Valve control
68.0253	Solvent sense
68.0289	Bath control
68.0258	Main relay driver
68.0240	Pump, vacuum
68.0531	Pump, pressure
68.0490	Fuse, mini blade 5A (12 fuses)
65.3244	Fuse, 10A (for 115 VAC MAINS) (2 fuses)
51.2029	Fuse, 5A (for 230 VAC MAINS) (2 fuses)
81.0008	Orifice barbed 5/64" ID tubing (2)
68.0309	Fitting, male elbow 45 1/2 T x 3/8 MPT Swagel
68.0052	Manifold valve, bath assembly
68.0075	Pulley (3)
68.0286	Pulley, .08 Pitch (3)
68.0287	Belt, .08 Pitch (6)