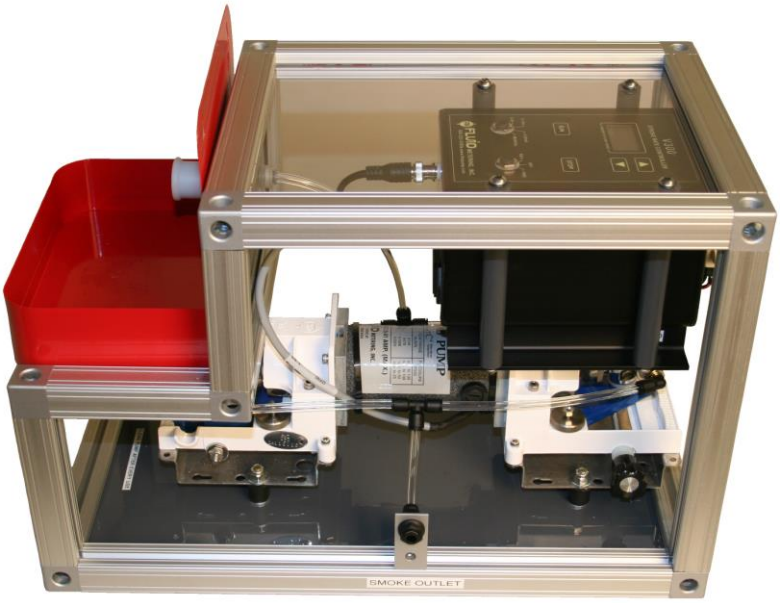
Cigarette Smoking Machine
CSM-SCSM



User's Manual

CH TECHNOLOGIES (USA), Inc.

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CONTENTS

1. Introduction

This User's Manual describes the CH Technologies Cigarette Smoking Machine CSM-SCSM. Instrument configuration, operation, maintenance, and safety procedures are described.

2. CSM-SCSM Description

The CH Technologies Cigarette Smoking Machine CSM-SCSM is a cigarette smoke generator designed for small scale applications. The CSM-SCSM is a single cigarette smoking machine and features state-of-the-art manual cigarette smoking technology for analytical and inhalation exposure studies.

CSM-SCSM is a portable, light weight system that allows for simple operation and maneuverability. It consists of a Fluid Metering Inc pump and its stroke control unit, an industry-standard cigarette holder with labyrinth seals, a Laptop computer which runs the CSM-SCSM control software and a National Instruments data processor that interfaces the smoking machine with the computer. The CSM-SCSM pump uses a dual head, valveless rotary piston technology to deliver an exact, repeatable puff volume according to a programmable puff profile. All smoking machine components are mounted inside a custom built, open T-slot aluminum frame. A general view of the CSM-SCSM smoking machine and its components is given in Figures 1 and 2.

Cigarettes are loaded and removed manually, and lighted with an appropriate gas igniter. This system, with minor changes, can be made compatible with any length and diameter of cigarette. Smoking materials such as cigars, natural wrapper materials, pharmaceuticals and narcotics are also possible. The material is held in place with a standard Filtrona-type holder and seals. The seals are washable and field replaceable if necessary.

The machine can simulate various protocols, flow rates, regimens, cigarette sizes, and tests, including FTC and ISO specific requirements. Custom smoking regimen can be user-programmed as needed. CSM-SCSM is controlled by proprietary software called Smoking Cessation. The software, which runs under Windows XP/Vista/7 environments, offers flexible and easy to use tools to apply existing smoking regimen as wells as future protocols that meets specific study requirements. Smoking profiles are executed directly with the click of a button.

CSM-SCSM can be optionally equipped with a side-stream collection and main stream and side stream mixing/dilution system. The side stream collection system consists of a glass bell shaped hood fitted around the cigarette, a variable-speed blower that control flow rate of side stream smoke removal and a flexible tube for the smoke transfer. The main stream and side stream smoke are turbulently mixed and diluted with clean, dry air in a 4-neck glass vessel (Figure 3). By varying main stream smoking protocol and flow rates of side stream and dilution air, the system can generate a wide range of cigarette mixtures with various main stream to side stream ratios and overall smoke concentrations.

The CSM-SCSM is a turn key system that is designed to be fully compatible with CH Technologies nose-only or whole-body inhalation exposure system (Figure 4). However, using appropriate connectors, the machine can be used with any type small scale commercial or custom built inhalation exposure system.

Figure 1. General View of the CSM-SCSM System

Figure 2. CSM-SCSM's Main Components

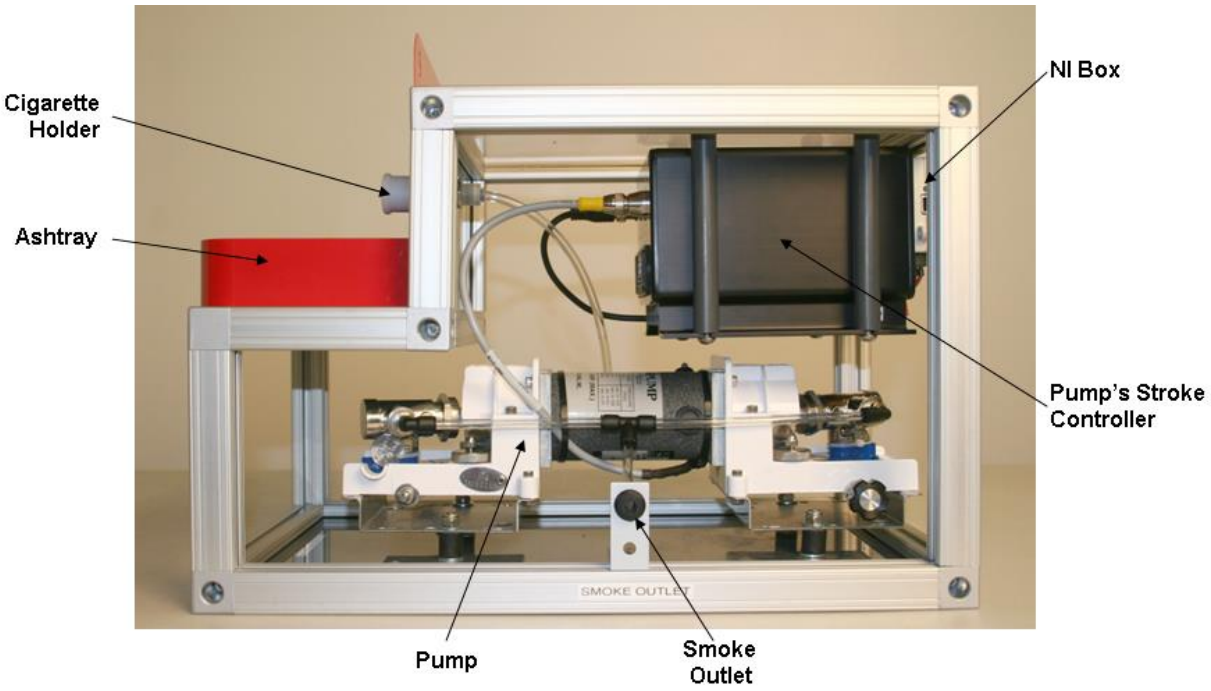


Figure 3. CSM-SCSM Equipped with Side Stream Collection/Mixing Module

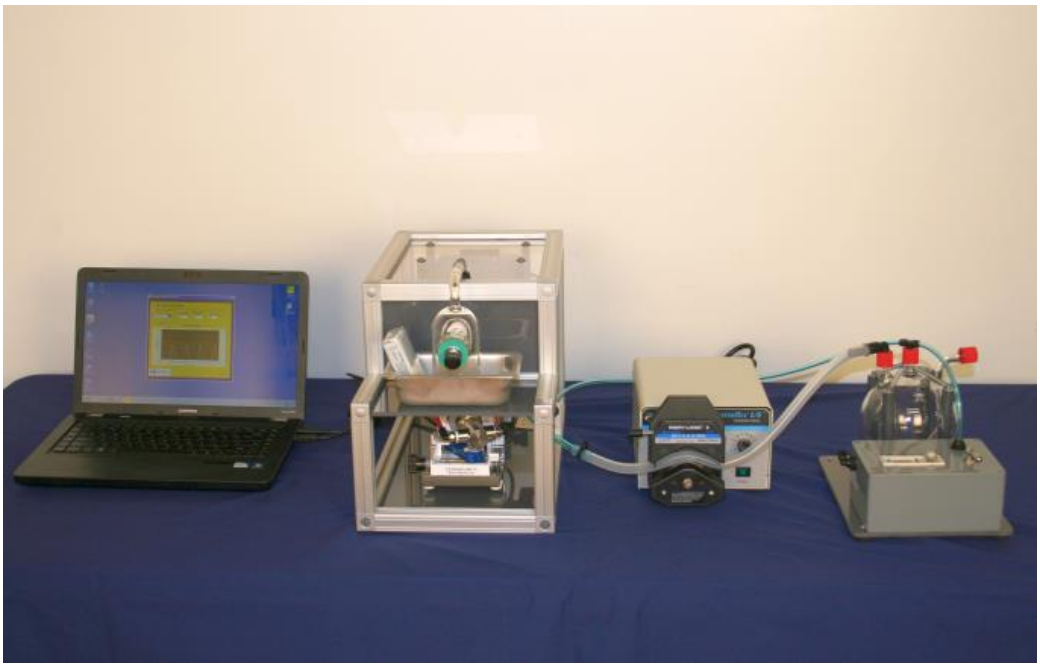
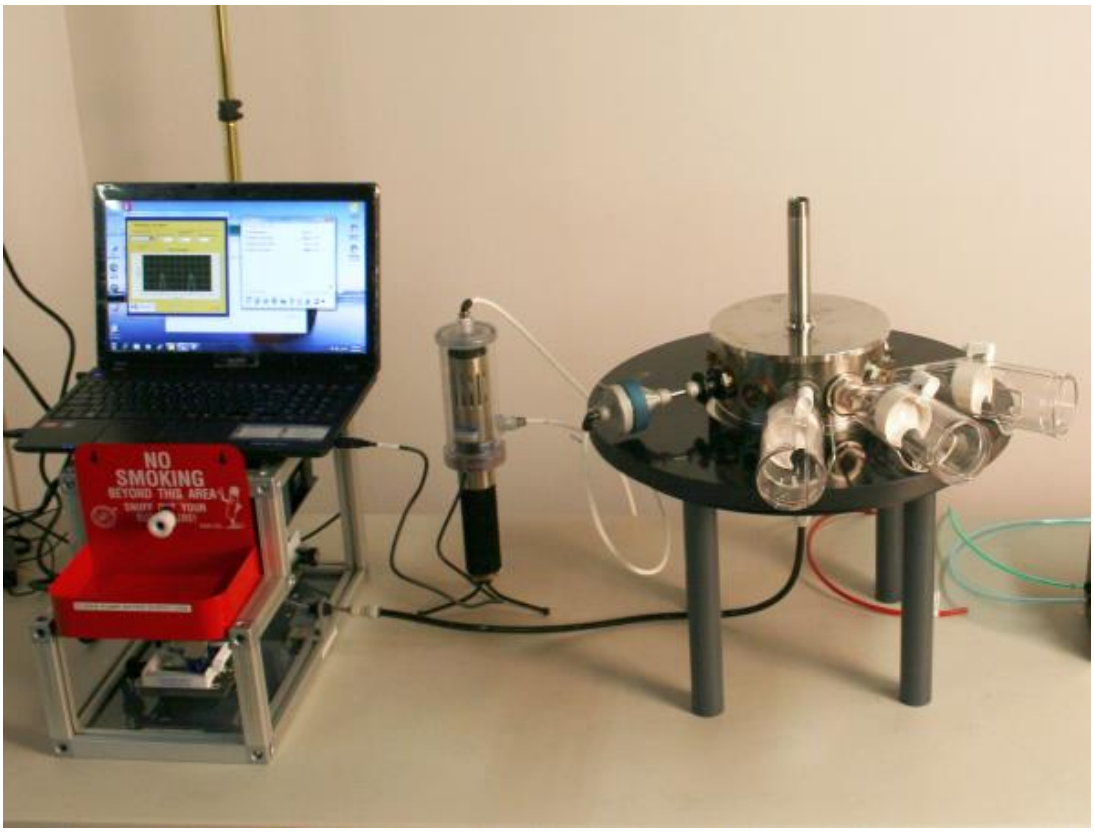


Figure 4. Example of CSM-SCSM Connected to a CH Technologies Nose-Only Inhalation Tower



3. CSM-SCSM Specifications

Physical:

Dimensions:	Pump Unit (in):	6 x 9 x 18 (H x W x D)
	Servo Controller (in):	4 x 6 x 9 (H x W x D)
	Puff Controller (in):	5.1 x 9.3 x 10.2 (H x W x D)
Weight:	Pump Unit (lbs):	16 approximate
	Servo Controller (lbs):	5 approximate
	Puff Controller (lbs):	3.5

Operating Temperature: Electronic Components 0-40 º C, Ambient

Electrical:

100-240 VAC, 47-63 Hz, 500 W (max peak) 3-prong IEC inputs

Note: Transformers and adaptors for operation on many unique foreign voltages are available special order.

Construction:

Pump:	Dual-head valveless piston type, DC servo driven, ceramic pistons, stainless steel cylinders
Pump Base:	Brushed aluminum, stainless steel hardware, Neoprene vibration isolation feet
Fittings:	Stainless steel and Nickel-plated brass
Tubing:	Teflon and/or Polyurethane (field replaceable)
Labyrinth Seals:	Proprietary polymer
Seal Holder:	Proprietary plastic
Holder Base:	Anodized aluminum
Sidestream Hood:	Pyrex glass (optional)

Computer Requirements:

Laptop or Desktop, 500Mhz, 256M, Windows XP/Vista/7, USB2.0 Port

Cigarette Compatibility:

Cigarette Diameter:	All	(slim, special, extra)
Cigarette Length:	All	(60mm, 100mm, 140mm, etc.)
Filter Type:	All	(unfiltered, standard filters)

Notes: Adaptors for special materials (THC, cocaine, meth-amphetamines, glass tubes, etc.) available special order.

Standard Cigarette Holder does not block ventilation holes. Special order “blocking” holders are available

Available Cigarette Smoking Regimens:

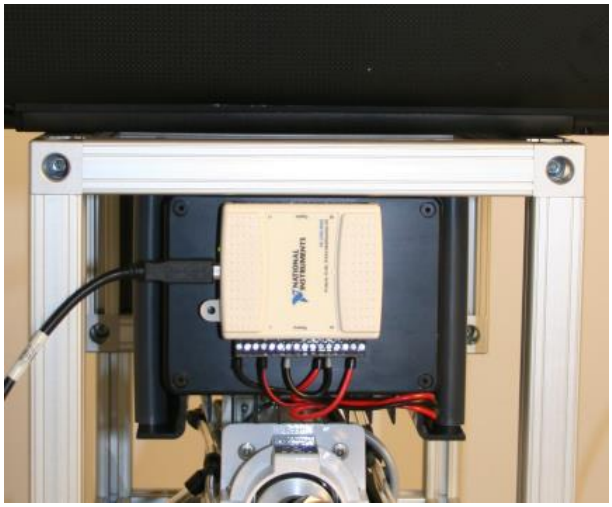
FTC/ISO 3308	Puff Length (ms)	2000	(2 second puff)
	Idle Burn (s)	58	(1 puff per minute)
	Voltage Setting (V) [Corresponds to a Puff Volume of 35 ml]	2.7	
	Puff Profile Shape	Sinusoidal	
CIR	Puff Length (ms)	2000	(2 second puff)
	Idle Burn (s)	28	(2 puffs per minute)
	Voltage Setting [Corresponds to a Puff Volume of 55 ml]	4.2	
	Puff Profile Shape	Sinusoidal	
Custom Profile	Puff Length (ms)	Variable (0.5 second increments)	
	Idle Burn (s)	Variable (0.5 second increments)	
	Puff Volume (ml)	0-66	(0.8 ml increments)
	Puff Profile Shape	Sinusoidal	

4. Preparation of CSM-SCSM for Operation

Place CSM-SCSM on a flat, horizontal work surface inside a chemical hood or other ventilated enclosure. Depending on the available work surface, place the laptop on top of the smoking machine or on the working space to the left of it. Carry out the following steps to prepare the machine for operation:

1. Connect the smoking machine to an appropriate power outlet.
2. With the provided USB cable, connect the NI box located on the rear with a USB port on the laptop.

Figure 5. Connecting the Smoking Machine to the Computer

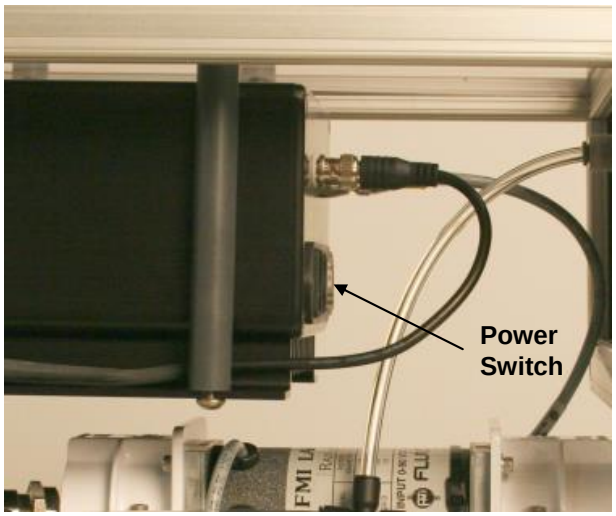


3. Connect the provided main stream smoke outlet tubing to the port labeled "**SMOKE OUTLET**" located on machine's right side.

Figure 6. Connecting Machine's Smoke Outlet

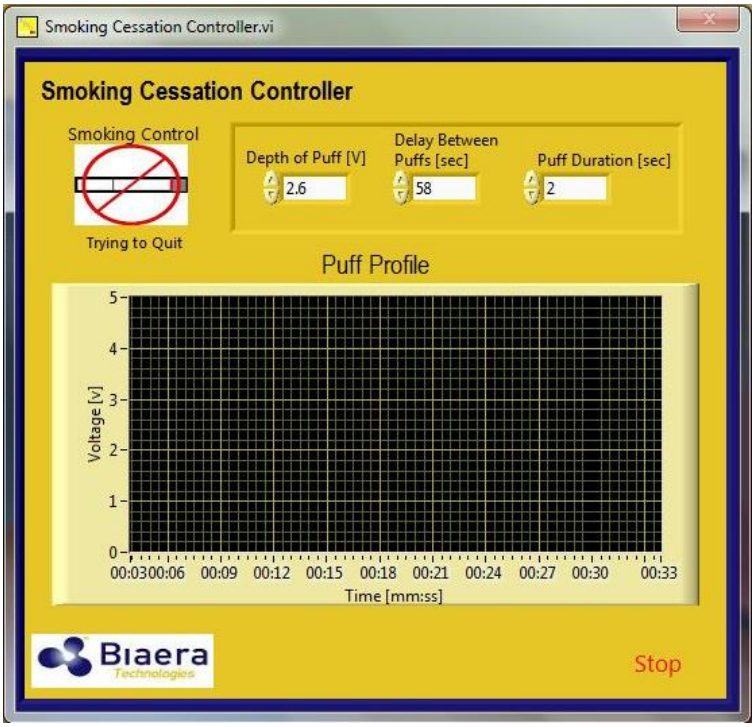
4. Turn **ON** smoking machine power. Check the display of the stroke control unit and make sure that is turned on.

Figure 7. Location of Power Switch



5. On computer's desktop, click on icon  to launch smoking machine control software "**Smoking Cessation"**. The graphical interface shown in Figure 8 will open. The default control parameters are those of FTC smoking protocol

Figure 8. Control Software Graphical Interface



5. Operating CSM-SCSM

Make sure that, before starting to operate CSM-SCSM, you have gone through all the preparatory steps outlined in Section 4. After you have done that, carry out the following procedure to operate the machine:

1. Adjust the software parameter to match the pre-defined standard or user-defined smoking protocol. The default control parameters on the graphical interface are those of the FTC smoking protocol.

Figure 9. Parameters of Standard Smoking Protocols

FTC

CIR

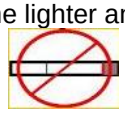
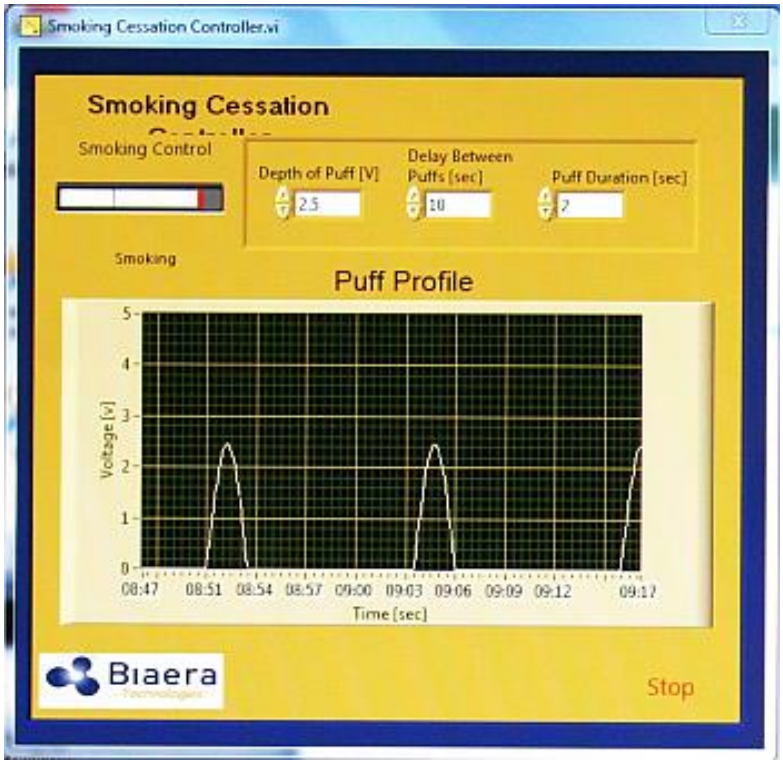
2. For other user-defined protocols, adjust the **Depth of Puff** voltage to between 0-5 V, to achieve a puff volume between 0 and 66 ml (see next section regarding puff volume calibration) for a 2 second puff. To increase the amount of cigarette smoke generated, increase the number of puffs per minute by decreasing the **Delay between Puffs** interval.
3. Pour some water into the ashtray until the bottom is covered
4. Using a pair of tweezers, load a test cigarette (or other smoking material) filter first onto the cigarette holder. Make sure that you push the filter in until it can go no further.
5. Fire the lighter and hold the flame close to the cigarette tip. At the same time, click on button  start operating the machine. You will notice the bell shaped puffs starting to appear on the moving time chart, as shown in Figure 10.

Figure 10. Graphical Interface During Operation



6. When the cigarette is almost completely burned, remove the remaining filter with tweezers and through it into the ashtray.
7. While the smoking machine is running, load and light another cigarette. Continue loading and lighting consecutively fresh cigarettes until the end of your smoke exposure session.

CAUTION! Try to unload burnt cigarettes and load and light new ones as fast as possible to minimize large smoke concentration fluctuations in the inhalation chamber

8. At the end of the exposure session, click on button  to stop smoking
9. Click on button  to close the software
10. Remove the ashtray and dispose of the cigarette residues collected during smoking session
11. Proceed with cleaning procedures (refer to Section 7 for details).

6. Puff Volume Calibration

The CSM-SCSM smoking machine simulates volume-defined bell shape puffs by controlling the current applied to the smoke pump (between 0 and 5 VDC). In order to use the machine with a standard or user-defined smoking protocol, the relationship between the pump current and puff volume has to be identified. The CSM-SCSM is delivered in full working order with copies of the factory set calibration. The FMI pump heads are factory set at the maximum angle setting (10) and opposed.

Given that the CSM-SCSM operates with flow pulses, not continuous flow, the most appropriate calibration method is using a manual or electronic bubble meter. Other primary standard or standard-traceable volume measurement devices can also be used as appropriate. This section describes calibration procedures with a simple manual bubble meter. Follow the steps below. Document your data onto the provided electronic version of the puff volume calibration template, supplied by CH Technologies, or create your own.

1. Setup a graduated bubble meter
2. Attach one end of a 3/8" OD tube to the top of meter and insert the other end into the cigarette holder
3. Launch "**Smoking Cessation**" program
4. Change "**Delay Between Puffs**" to 10 or 15 seconds
5. Set "**Puff Duration**" at 2 seconds
6. Change the "**Depth of Puff**" to 1 Volt. Note it on your calibration template.
7. Generate some bubbles and start smoking sequence. Note the change in volume of the bubble meter when the machine puffs. Take at least three measurements and use the average volume for the calibration template.
8. Repeat steps 3 through 6 with "Depth of Puff" set at 2, 3, 4, and 5 Volt, and note the average puff volume for each voltage. This will give you an adequate dataset to generate a calibration curve.

CAUTION! DO NOT change the factory set angle of the smoking pump's heads during calibration or machine operation.

CAUTION! You DO NOT need to smoke a cigarette while you are carrying out puff volume calibration

If instead of the standard smoking protocols (TFC and CIR) you are using user-defined ones that require puff duration different than 2 seconds, you will need a calibration curve for each puff duration value.

It is recommended that the puff volume be calibrated periodically. The frequency of calibration will depend on the intensity of CSM-SCSM use.

7. Cleaning and Maintenance Procedures

The SCSM has tube fittings, tubes, and pump heads that need to be frequently cleaned. A cleaning schedule should be determined and posted for all users to follow. Daily cleanings are a minimum and cleaning prior to storage is critical. When wet smoke residues are allowed to age inside the SCSM they form solids which bond moving parts and render the instrument inoperable.

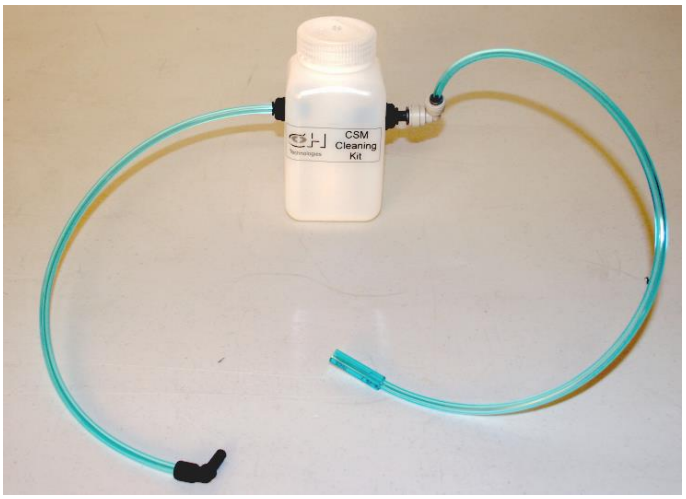
Listed below are two procedures for cleaning the SCSM.

7.1. Fast Cleaning

The simplest way to clean the SCSM is to circulate a cleaning solvent, methanol or ethanol, from the inlet to outlet until the tar deposited on the pump heads and internal surfaces of tubing and fittings is dissolved and removed. The machine is equipped with a Fast Cleaning kit which consists of a closed plastic container and solvent circulation tubes (Figure 11).

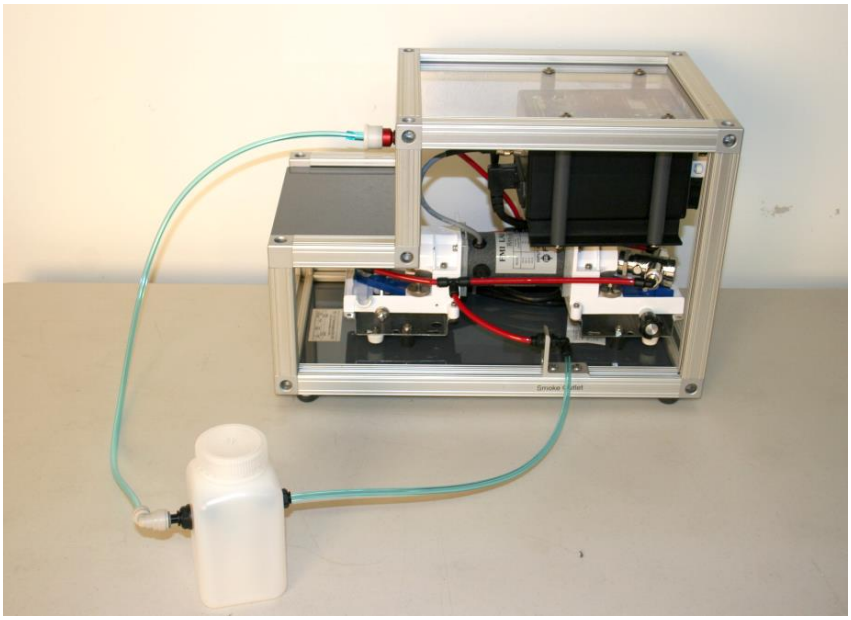
Perform Fast Cleaning at the end of each smoke generation session.

Figure 11. Fast Cleaning Kit



1. Fill the plastic container half way with the cleaning solvent and close it
2. Insert the 3/8" OD end of the tube labeled "**Outlet**" into the cigarette holder and connect the other end of the tube to the "**OUTLET**" port of the plastic container.
3. Connect one end of the tube labeled "**Return**" to the **SMOKE OUTLET** of the smoking machine and the other end to the "**RETURN**" port of the plastic container. This will create a closed circuit for the cleaning fluid to circulate (Figure 12)

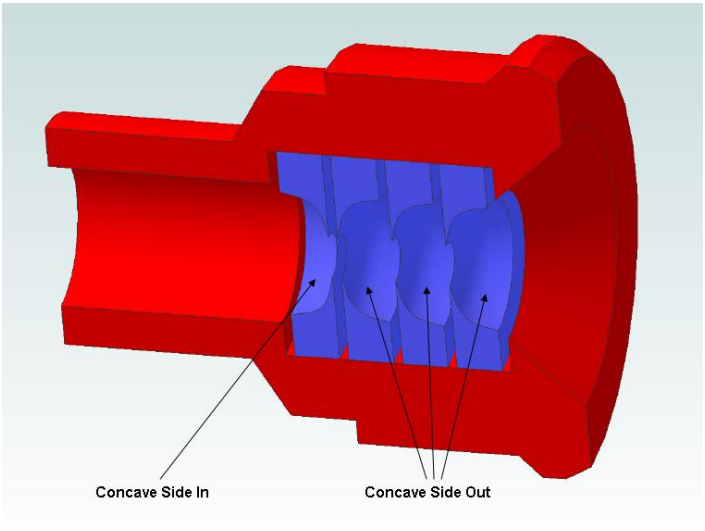
Figure 12. Connecting the Fast Cleaning Kit to the Machine



4. Start the "**Smoking Cessation**" program to circulate the solvent. The cleaning with be faster if the "**Depth of Puff**" is set between 3 and 5 volts and the "**Delay Between Puffs**" is set to 1.
5. When the solvent has circulated for a predetermined duration, remove the **Outlet** tube from the cigarette holder and keep the machine running to allow the remaining solvent to purge.
6. Once the solvent is purged, stop the pump and remove the **Return** tube from the machine's **SMOKE OUTLET**.
7. Remove the white cap and blue seals from the cigarette holder.
8. Start the pump again and pump room air or filtered air for five to ten minutes. This should evaporate most of the residual solvent. During this step, clean the white cap and blue seals in solvent and air dry. The white cap has an O-ring that may need grease.
9. Reassemble the white cap and blue seals on the cigarette holder. The SCSM is now clean and ready for next use.

CAUTION! The first three seals are oriented **concave side out**, and the fourth is **concave side in** (Figure 13). .

Figure 13. Cross-Section of Cigarette Holder



10. Restore "**Smoking Cessation**" settings and close program.

7.2. Deep Cleaning and Pump Servicing

The most thorough cleaning procedure is to disassemble the CSM-SCSM and clean parts individually and replace parts as needed. This procedure requires an individual that has had some experience servicing such equipment.

1. Unplug CSM-SCSM from power outlet.
2. Remove the top two thumb screws on the front panel.
3. Pull the bottom thumb screws to roll out the pump drawer. This will give the user full access to the serviceable parts.
4. Use a 5mm Allen wrench to remove the red cigarette holder. Make notes and take pictures for reference when reassembling.
5. Remove the lock nuts on both the inlet and outlet fittings.
6. Remove the four thumb screws holding the pump to the drawer and place pump next to housing.
7. Remove all tubing from the push to connect fittings.
8. Prior to disassembling the FMI pump heads, read the FMI manual, online, for the correct reassembly procedure. It is critical that the seals and pistons are reassembled in such a way that no damage occurs to seals.
9. Once all the parts are removed, clean them using a solvent, kimwipes and cotton swabs.
10. It is easier to replace tubing than to clean it. Use old tubing as a template for cutting new tubing to length.

11. With all parts clean and dry, reassemble the machine in reverse order to how it was disassembled.

CAUTION! Whenever the pump is serviced, a new voltage/volume calibration should be performed.

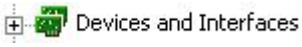
8. Functionality Tests and Troubleshooting

8.1. System Functionality Check

1. Plug in the power cord and turn the power switch **ON**.
2. Check whether the stroke controller's display is turned **ON**.
3. If the machine fails to power up, make sure that the power outlet you are using is working and the power cord is properly connected. If the machine still doesn't turn on, contact CH Technologies for specialized assistance.

8.2. Connectivity Test

1. Using the USB cable provided, connect the NI box with a USB port on the laptop PC.
2. Boot the computer
3. Check the NI board and make sure that the green light indicator is flashing. If not, check the connections between the laptop and the NI box.
4. Double click on the icon 

to launch Measurement & Automation Explorer
5. Expand menu 

. Make sure that the name of the National Instrument device matches the name given to you by the manufacturer, i.e. Dev1.
6. If the current name is different, click on the NI device name to highlight it, click again to activate text editor, and type in the correct device name. If the NI device is communicating with the computer, the icon to the left of the device name should appear colored in green. However, if the icon appears blank, with a small red cross, it means that the device is not communicating.

8.3. Software Functionality Test

1. Launch "**Smoke Cessation**" control software
2. Start machine operation by clicking on button 
3. As the puff profile appears on the time chart, you observe the smoke pump vibrating slightly while pulling the puff. If nothing happens, there is no communication between the computer and the smoking machine. Check USB cable connections and connections

between NI box and the pump's stroke controller and between the latter one and the pump.

4. Repeat the procedure. If the problem persists, contact CH Technologies for specialized assistance.

CAUTION! You DO NOT need to smoke a cigarette while you are carrying out software functionality test

5. Close "**Smoke Cessation**" software by clicking on button