Insights for Higher-Performing Fluid Systems

WEBINAR

Fundamentals of Safe Liquid Grab Sampling

Thursday, April 13

11 am – 12 pm ET

Matt Dixon
Application Commercialization Manager

Swagelok

Meet the Presenter

Application Commercialization Manager

25 years with Swagelok

Application and product expertise:

- Manual sampling stations
- Mechanical seal support systems
- Automatic changeover assemblies
- General industry
- Modular platform components (MPC)
- Pre-engineered subsystems (PrESS)

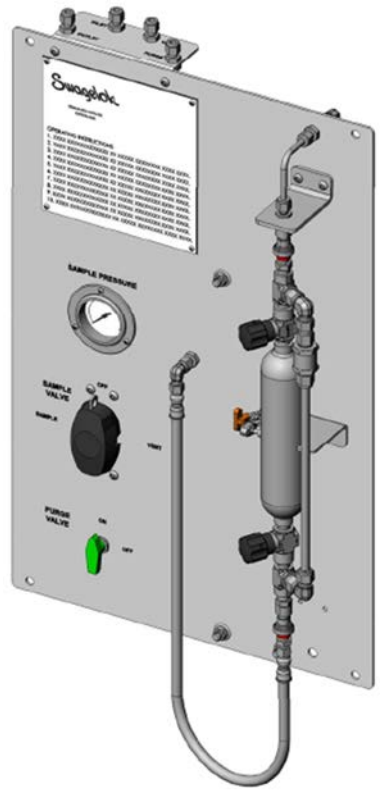
Education

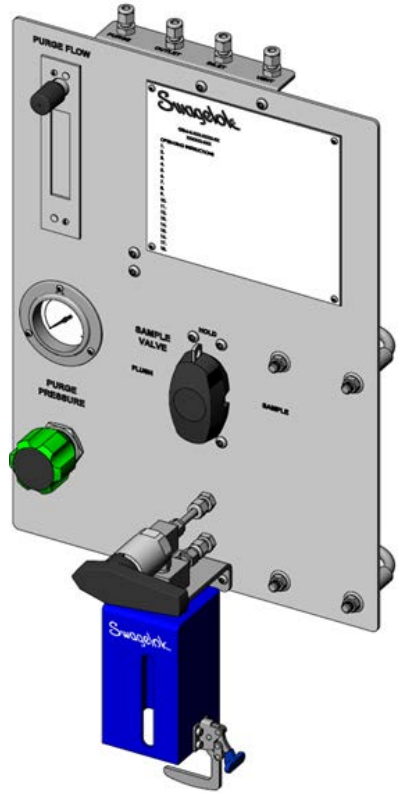
- B.S. in Mechanical Engineering from Ohio Northern University

Matt Dixon
Application Commercialization Manager

What Is Grab Sampling?

- Collection of a sample of fluid in a pipeline, tank, or system
- Sample is transported to laboratory for analysis
- Many different types in two broad categories:
  - Cylinder panels
  - Bottle panels
- Other names:
  - Spot sampler
  - Laboratory sampler
  - Field sampler





Grab Sampling in Processes

Why Grab Sampling?

- Validation of the process conditions
- Validation that end products meet specifications
- Loading platforms, reference sample of sold product
- Evaluation of environmental emissions according to local regulations
- Validation of online analyzers

Basic Rules of Sampling

Representative – The sample must be the same as the process

- Avoid phase changes in the sampling system and transportation
- Use probes to sample from middle of pipe

Timely – Understand when the sample was taken

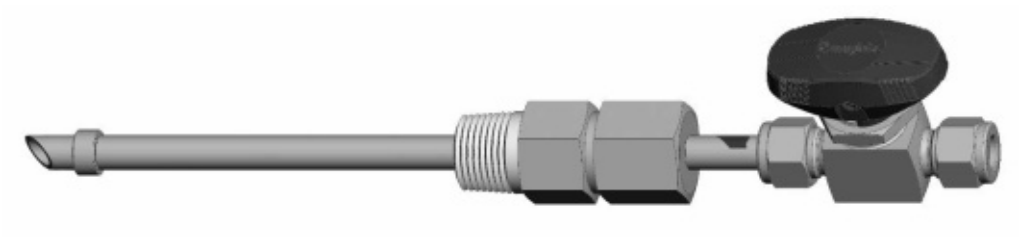
- Minimize transport time from process to sample container
- Not as important as with online analyzers

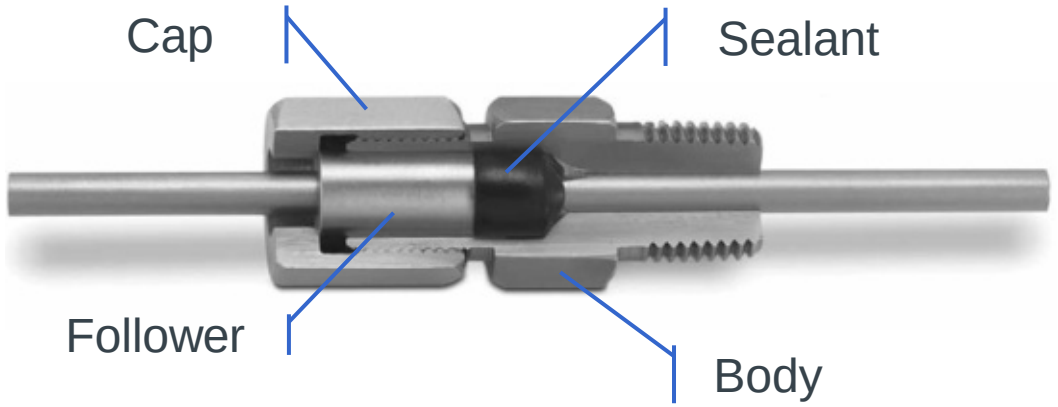
Pure – Do not contaminate the sample

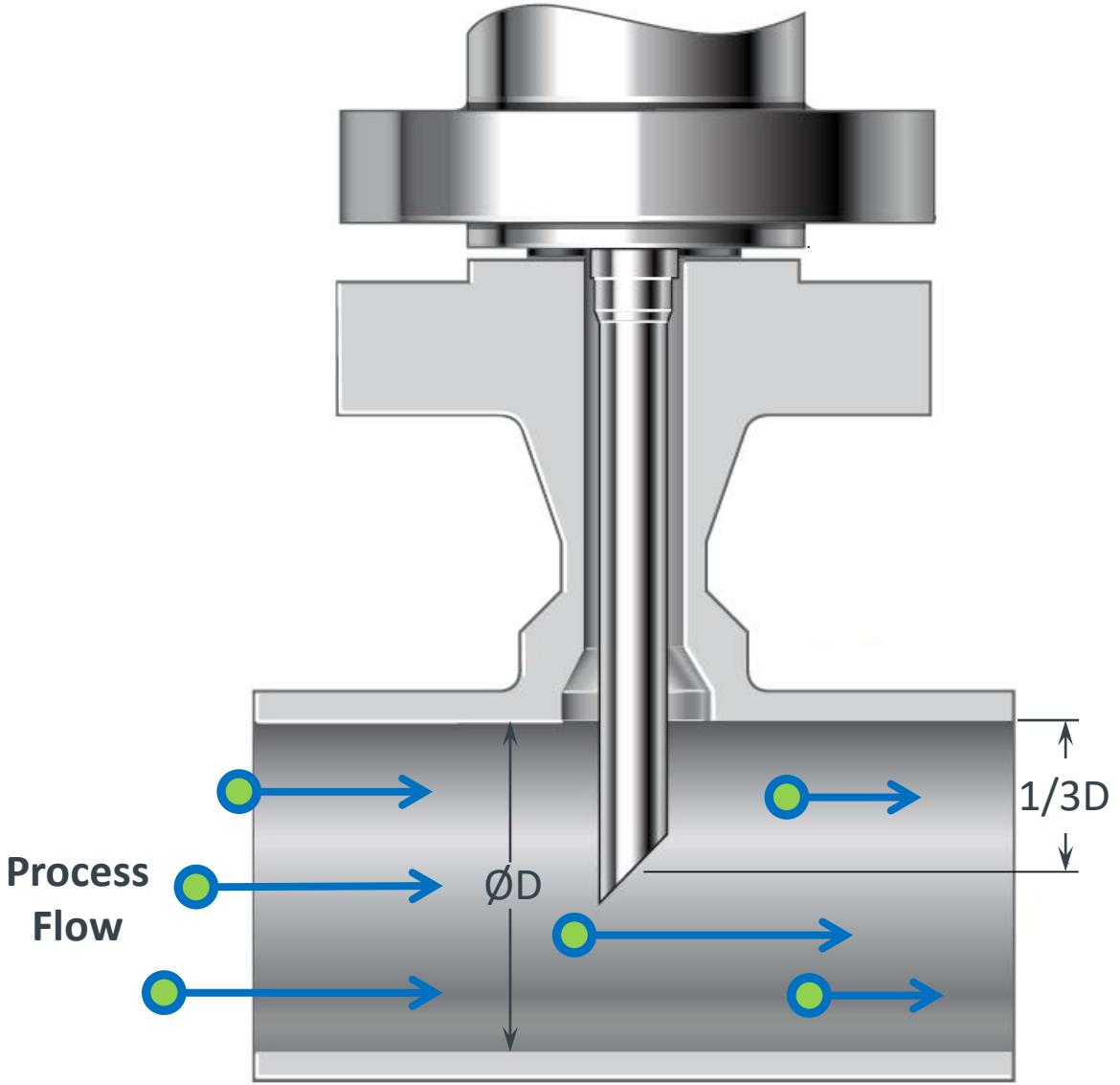
- Allow for adequate purging/flushing
- Use clean sample containers
- Avoid dead legs upstream of sample container

Sample Probes

- Sample from middle third of pipe
- Fixed probes vs retractable
- Minimize internal volume of probe





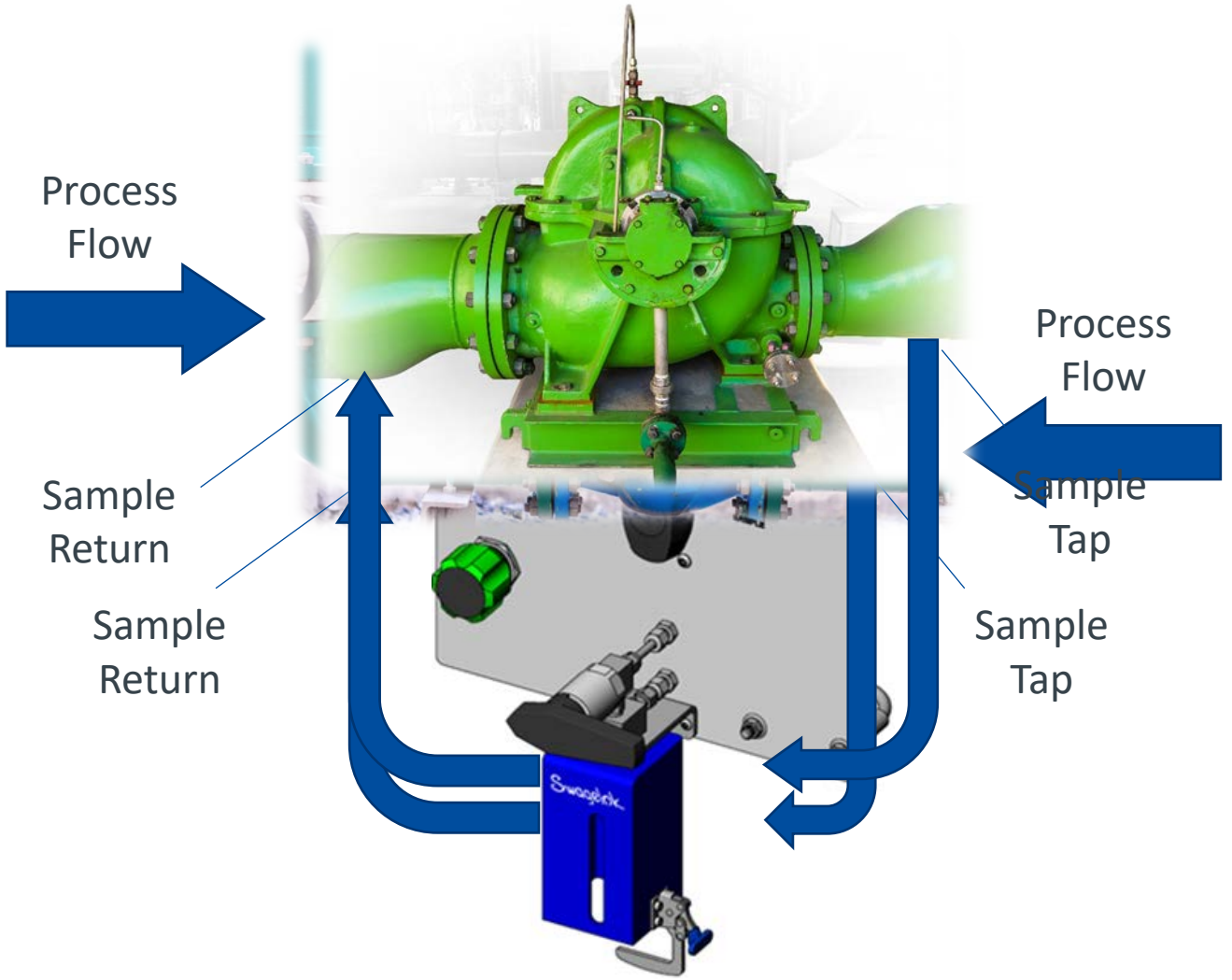


Sample Tap Location

If returning to process, need differential pressure to drive sample flow

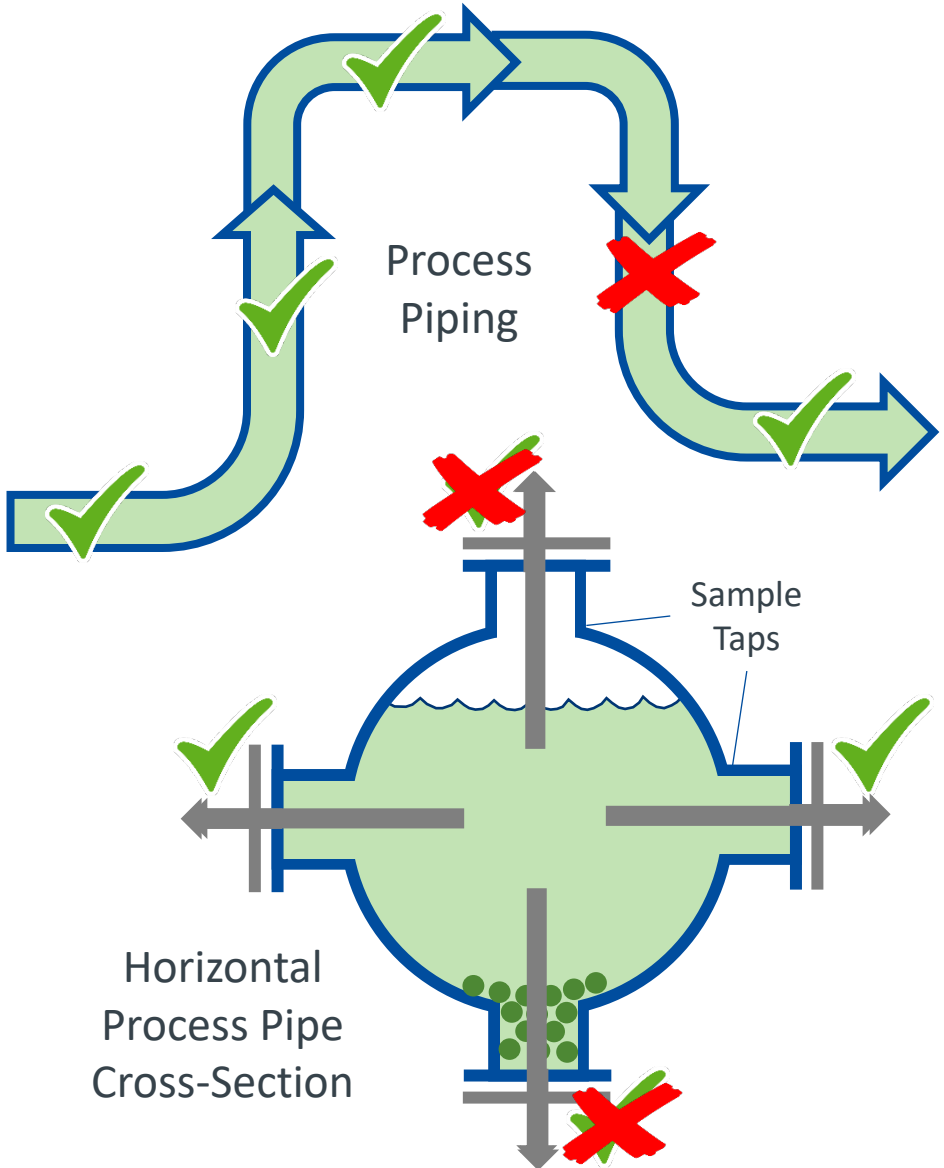
- Across control valve – differential pressure can vary → variable sample flowrate
- Pump discharge to pump suction – stable differential pressure

If *not* returning to process, locate panel as close to tap as possible



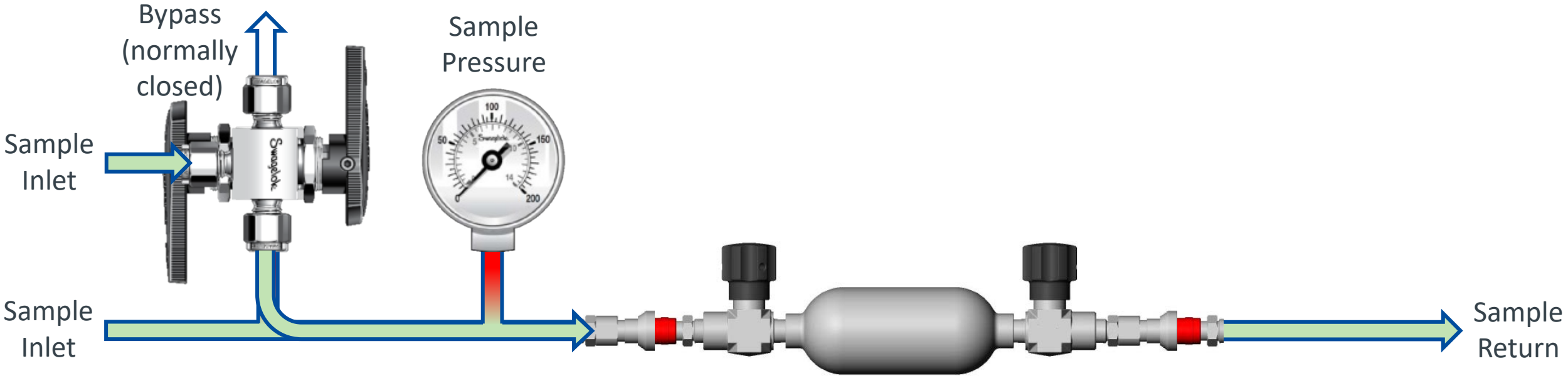
Sample Tap Location

- Sample from horizontal or upward-flowing vertical pipes
- Avoid downward-flowing vertical pipes – may have “waterfall”
- *With* probe – sample tap in any orientation
  - Note: If on bottom, particulate may accumulate in nozzle
- *Without* probe – sample tap on side of pipe
  - Particulate will enter sampling system with bottom taps
  - Vapor may enter sampling system with top taps



Deadlegs

- Branch of a sampling system without flow
- Contaminate passing sample fluid with old molecules – diffuse in & out
  - Slow initial response then *continuous contamination!*
- **If possible:** eliminate deadlegs
- **If deadleg is necessary:** move downstream of sample container



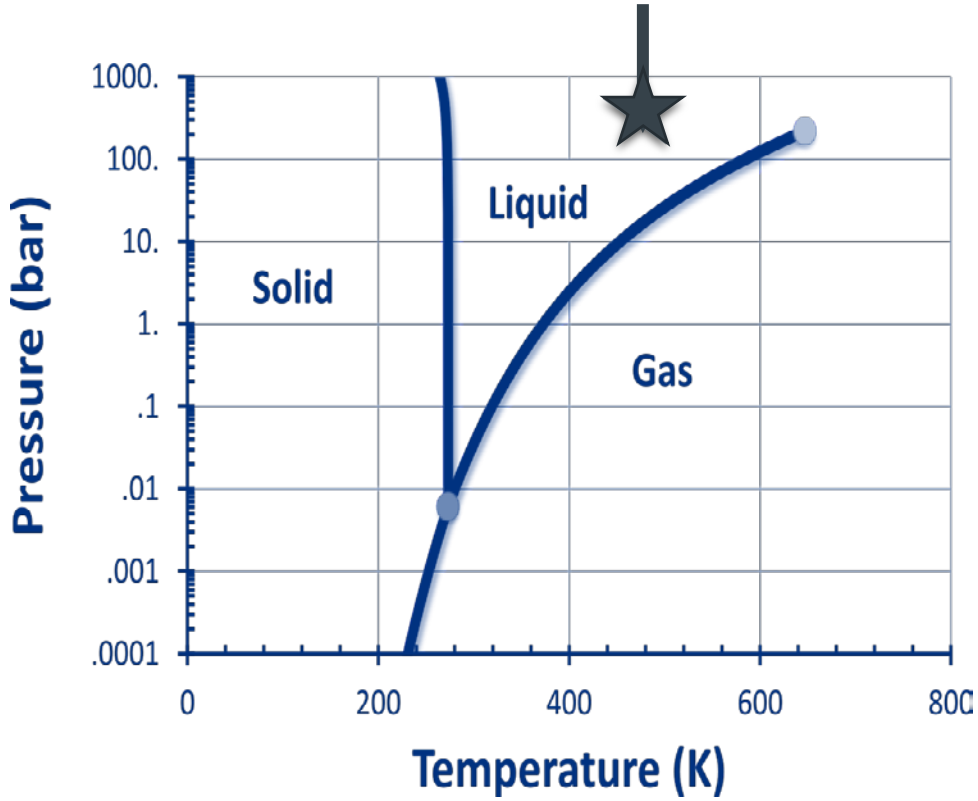
Sample Container Selection

How to select the type of system and sample container?

- Toxicity – Sample cylinders are better for toxic samples
- Cost – Bottles are less expensive
- Sample pressure – Bottles are not pressure-containing
- Sample volatility
  - Bottles can be used for *nonvolatile* liquids.
    - Maximum vapor pressure of 14.7 psia (1.01 bar) at ambient conditions
  - Use a sample cylinder for gases and volatile liquids

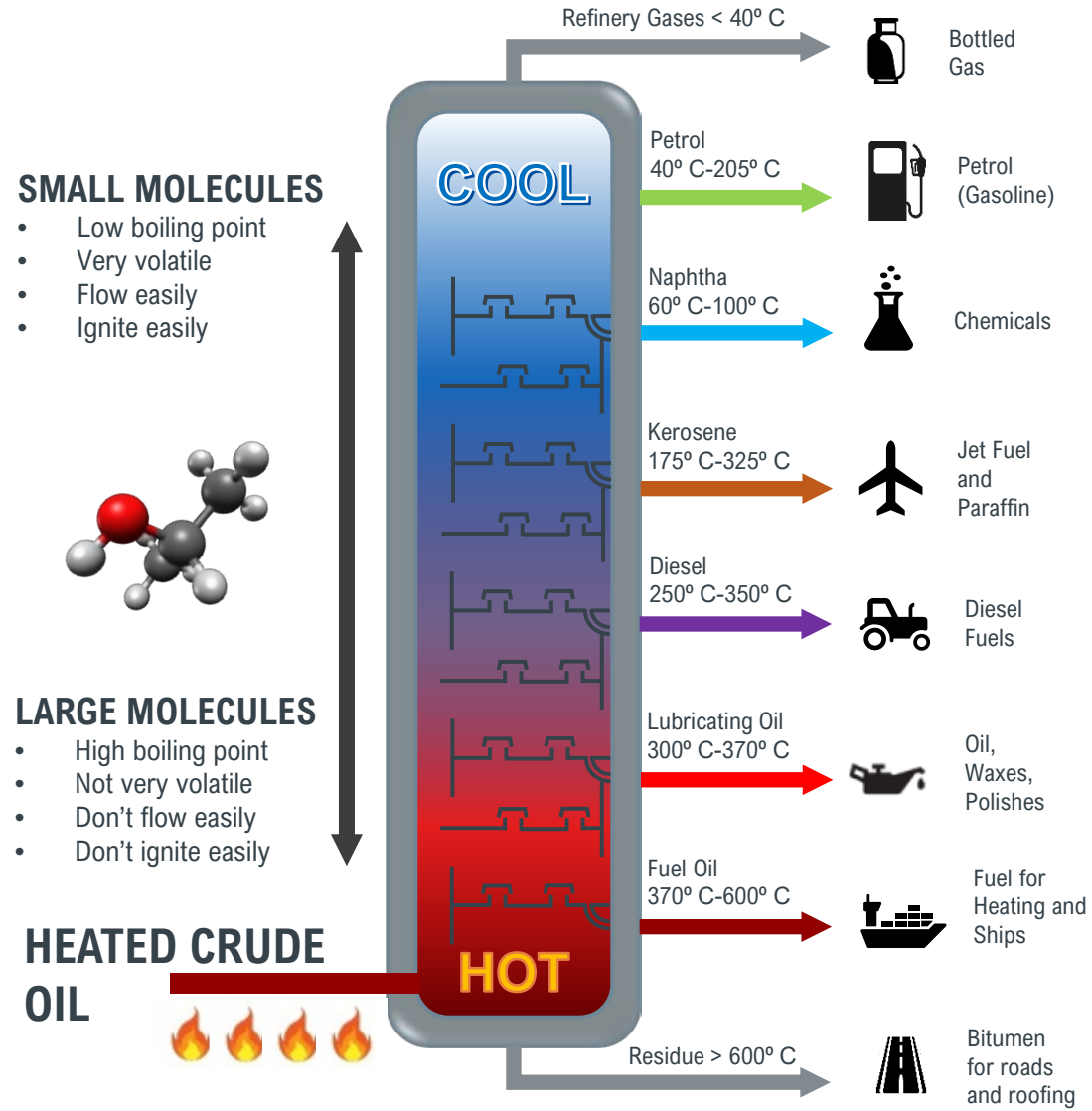
Behavior of Samples

- Pressure / Temperature changes can affect the sample:
  - ***Temperature ↑ or Pressure ↓***
    Lighter components will boil (vaporize) out of liquid sample before the heavier ones
  - ***Temperature ↓ or Pressure ↑***
    Heavier components will condense out of gas samples before the lighter ones



- Avoid phase change – it will change the composition of the sample
- Maintain the sample at process conditions if possible

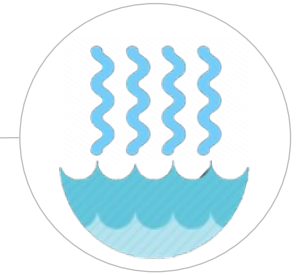
Sample Container Selection



PHASES

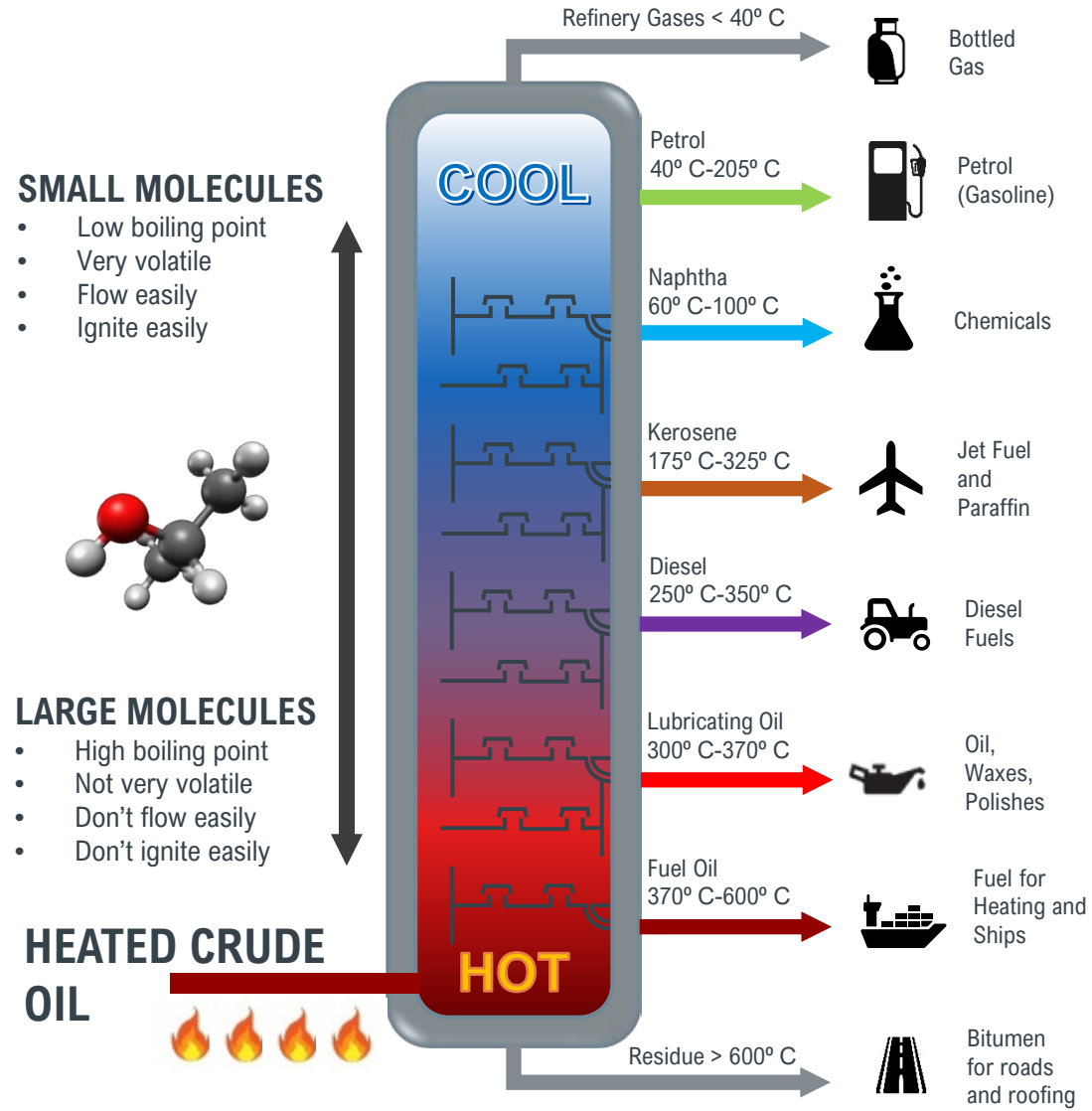
GAS

VOLATILE LIQUID



LIQUID

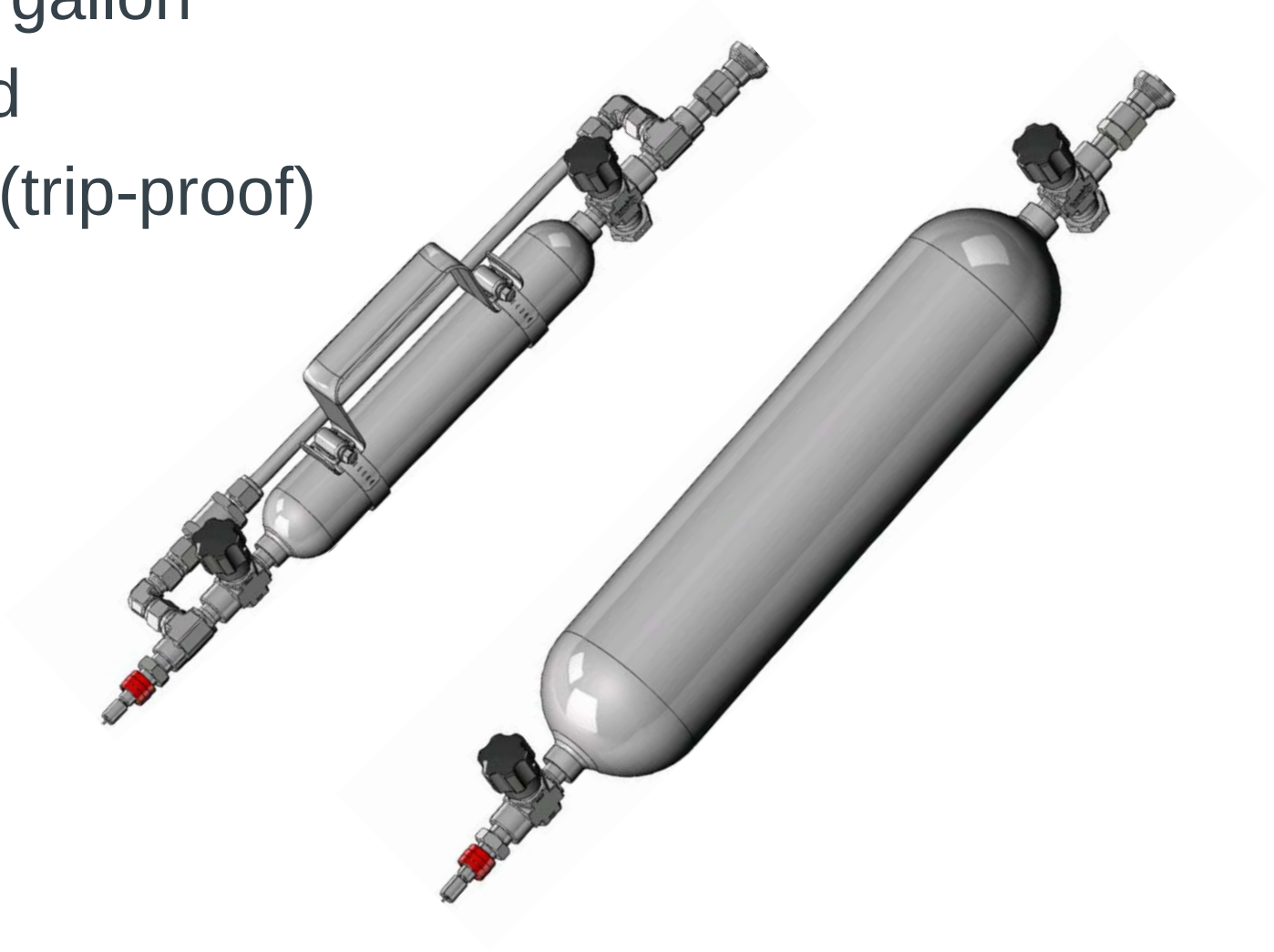
Sample Container Selection



Name of Alkane	How many carbons ?	Chem Formula	Boiling Point in °C	State at (20°C)	Melting Point in °C
Methane	1	CH_4	-162	gas	-183
Ethane	2	C_2H_6	-89	gas	-172
Propane	3	C_3H_8	-42	gas	-188
***n*-Butane**	4	C_4H_{10}	0	gas	-138
***n*-Pentane**	5	C_5H_{12}	36	liquid	-130
***n*-Hexane**	6	C_6H_{14}	69	liquid	-95
***n*-Heptane**	7	C_7H_{16}	98	liquid	-91
***n*-Octane**	8	C_8H_{18}	126	liquid	-57
***n*-Nonane**	9	C_9H_{20}	151	liquid	-54
***n*-Decane**	10	$C_{10}H_{22}$	174	liquid	-30

Sample Cylinder Assemblies

- Range in size from 10mL to 1 gallon
- Single-ended or double-ended
- Needle valves most common (trip-proof)
- Quick-connect fittings
- Bypass lines for purging
- Various accessories/options:
  - Carrying handles
  - Coatings
  - Overpressure protection



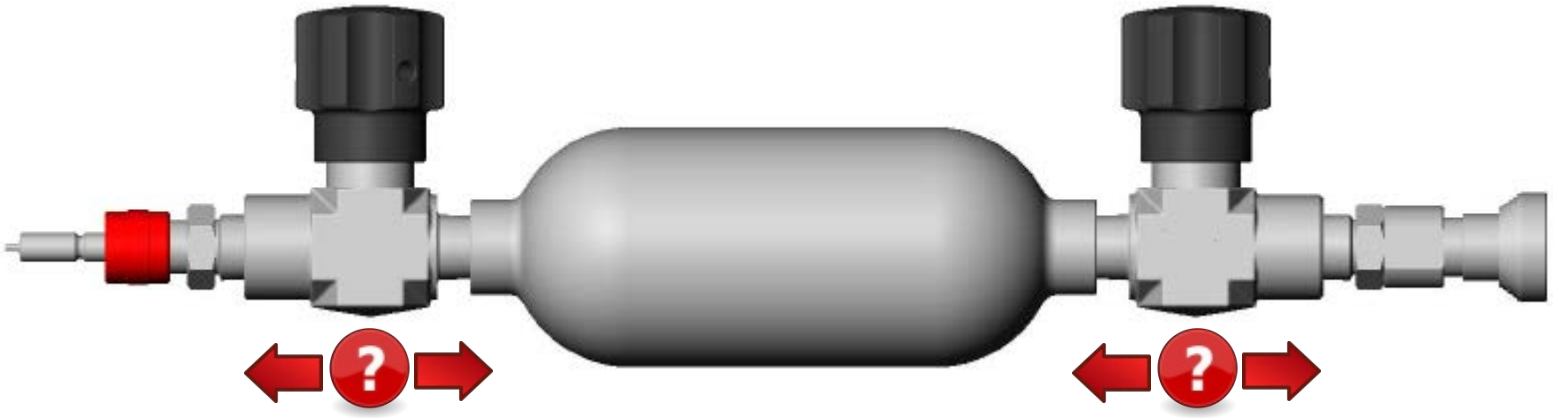
Sample Cylinders – Valve Orientation

In what flow direction should the two needle valves be installed on the cylinder?

A. Both flow arrows pointing toward the cylinder

√ B. Both flow arrows pointing away from the cylinder

C. In the direction of fill – Inlet valve pointing toward the cylinder and the outlet valve pointing away from the cylinder



Sample Cylinders – Overpressurization

- Thermal expansion of liquid can damage cylinders that are 100% liquid filled (liquid is not compressible)
- Three primary over-pressure options:
  - Rupture Disc
  - Relief Valve
  - Outage Tube

Sample Cylinders – Overpressurization Protection

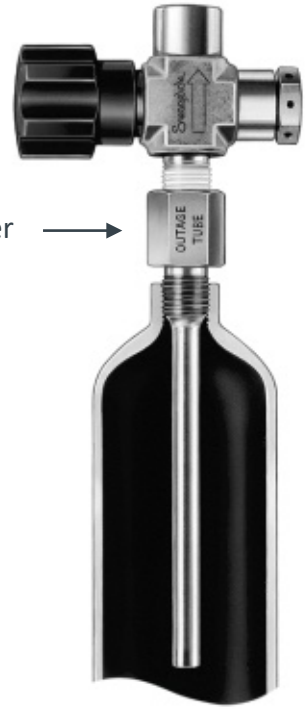
Rupture Disc or Relief Valve

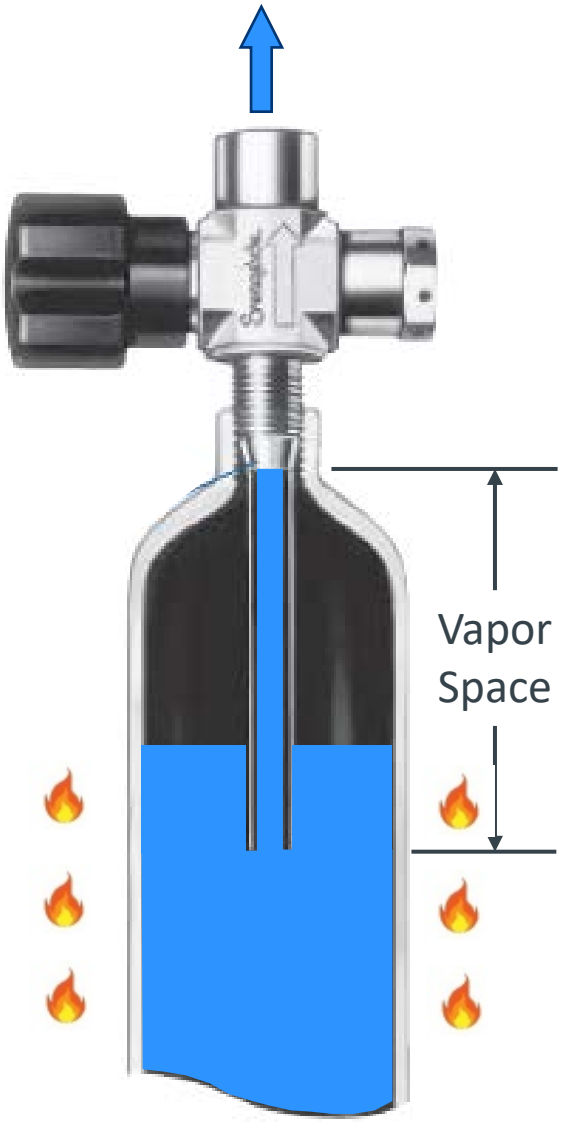
- Relieve pressure/sample to atmosphere
- Available in a tee or integral to cylinder valves
- Should not be used for toxic fluids

Sample Cylinders – Overpressurization Protection

Outage Tubes

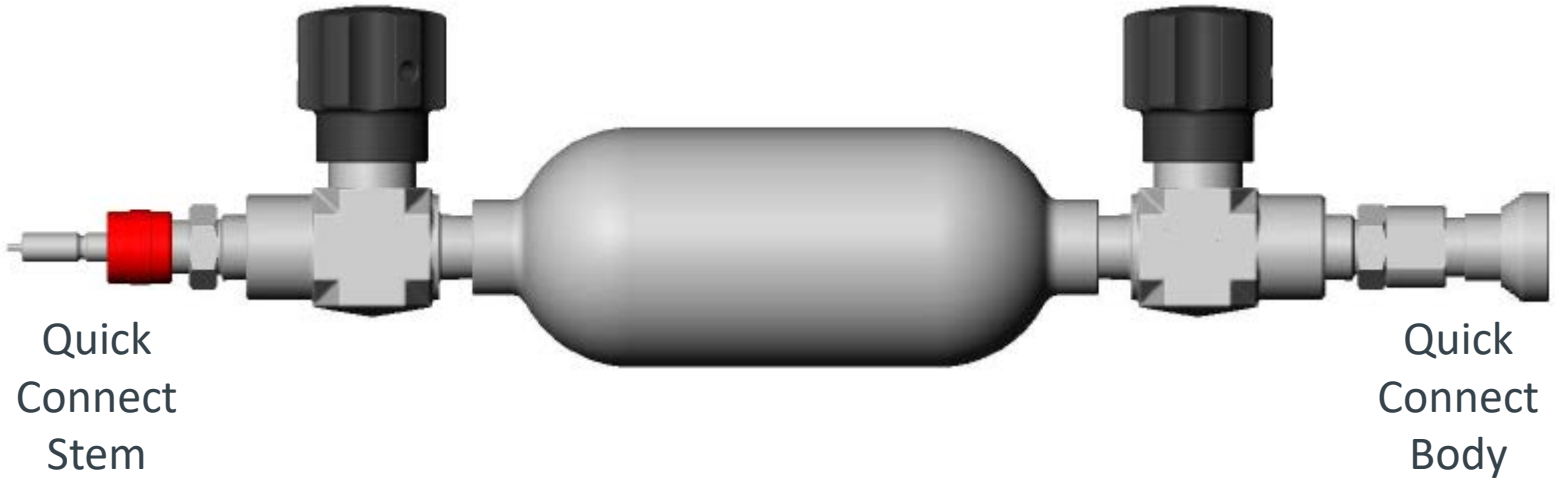
- Vapor space determined by length of tube
  - Specified as percentage of cylinder volume
- Liquid can expand into vapor space

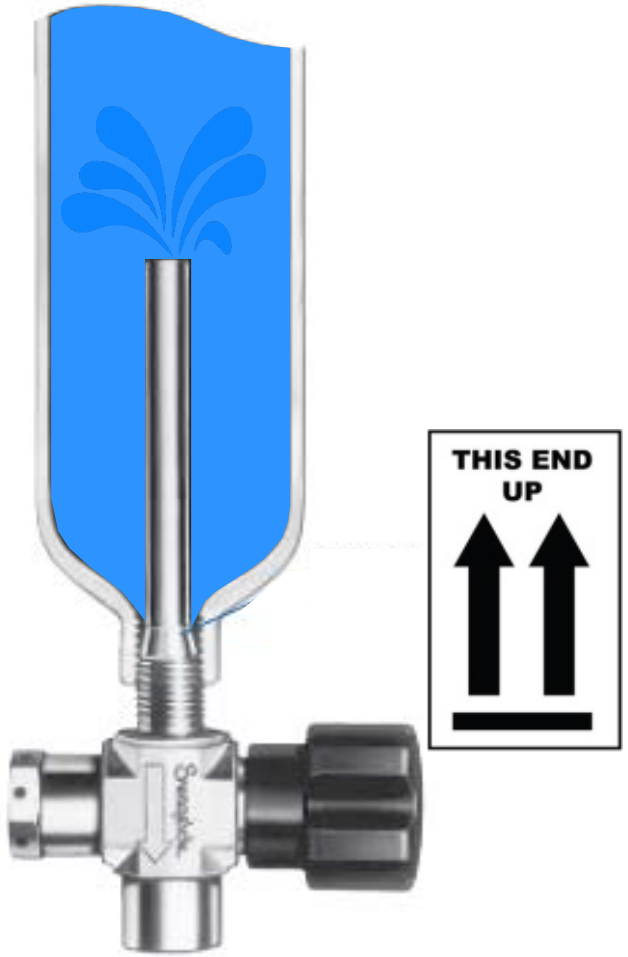




Outage Tubes

- Cylinder must be oriented vertically
- Avoid installing upside-down
  - Add “this end up” arrow on cylinder
  - Install quick-connect stem on one end, body on other





Outage Tubes

- So how much vapor space to we *really* get??
  - Depends on pressure & procedure

  <u>Actual Vapor Space (Worst Case):</u>

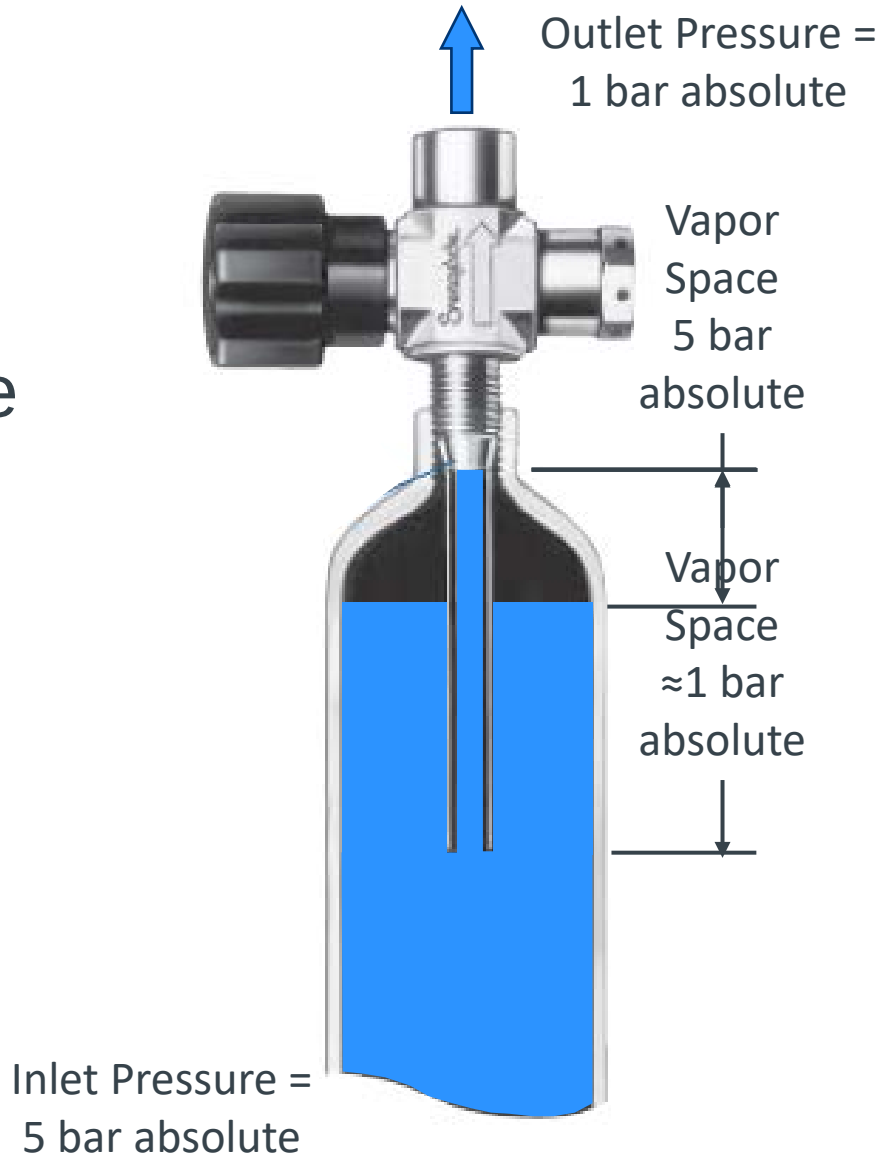
  Cylinder: 1000mL with 20% Outage Tube

  $P_1V_1 = P_2V_2$

  (1 bar) x (200mL) = (5 bar) x V_2

  V_2 = 40mL outage

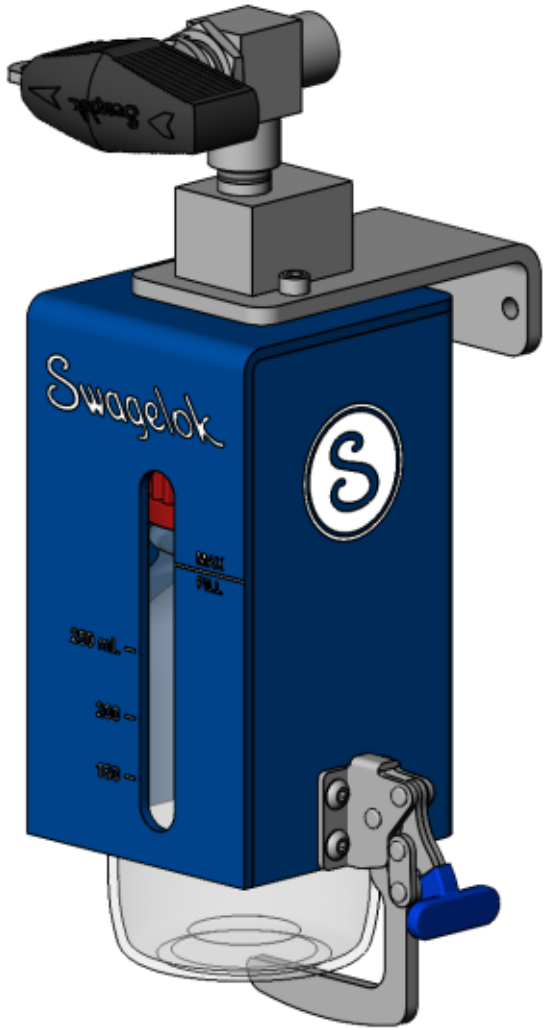
- How to mitigate?
  - Pre-charge cylinder with nitrogen
  - Add back-pressure regulator

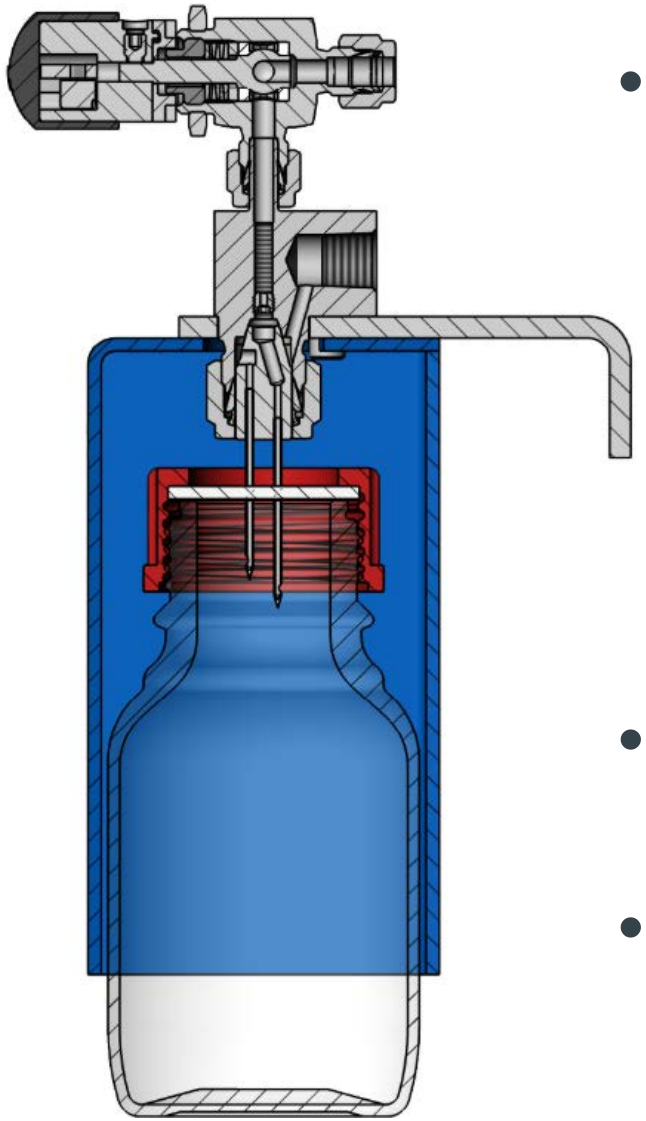


Sample Bottle Types

- Metal “can”
  - Typically used for high-temperature & high-viscosity samples (non-toxic)
- Open-top bottle
  - Glass or plastic
  - Not worries about vapors (non-toxic)
  - Clear vinyl coating for shatter-resistance
- Bottle with cap & septum
  - Contains vapor/spills
  - Requires dual (fill & vent) needles to pierce septum

Sampling with Sample Bottles

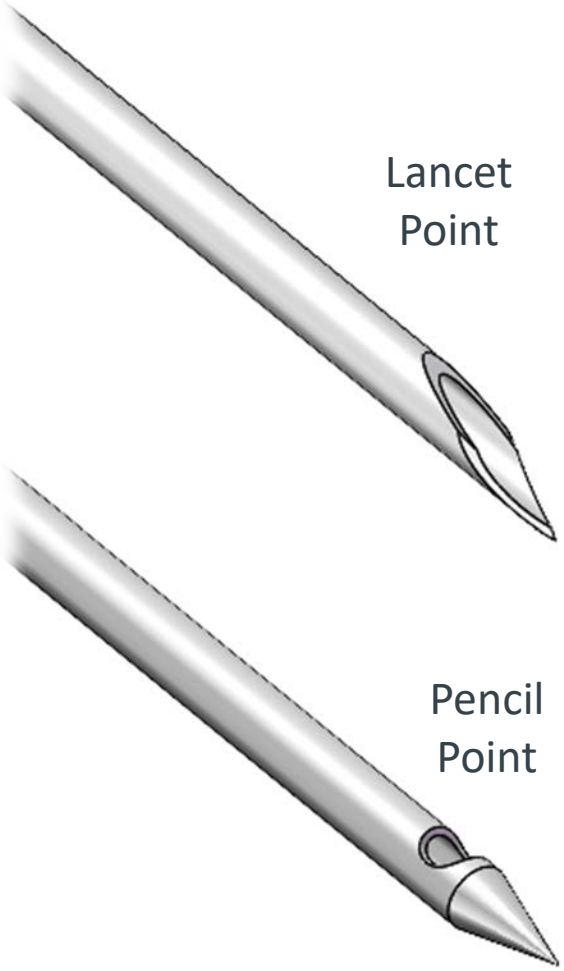




- Best Practice: Use sample valve
  - Controls flow into bottle
  - Various valve configurations
  - Shroud to hold/protect bottle
  - Optional flow orifice
  - Needles/nozzle to dispense sample
- Bottles are not pressure-containing
- Purge for cleanliness

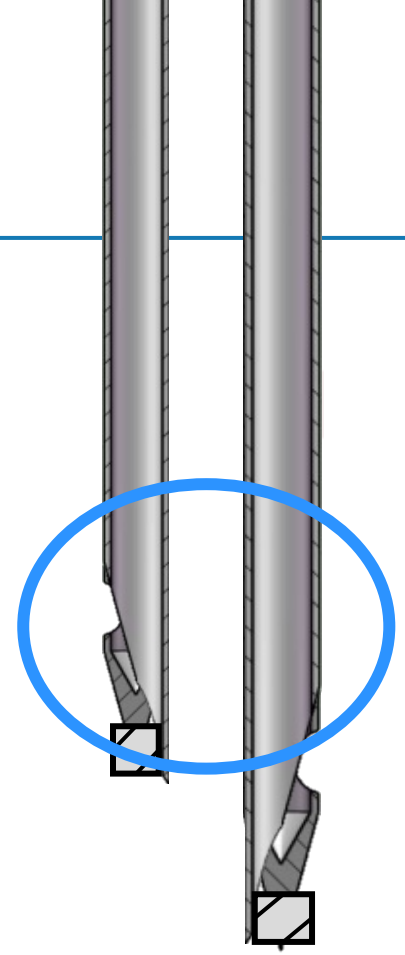
Needle Options

- Tube Stub
  - Used for bottle without septum
- Needle Size
  - Larger → Better flow; more septum damage
  - Smaller → Better septum life; flow restricted
- Lancet point
  - More traditional point style
  - Least expensive
- Pencil point
  - Tip swaged/welded closed and ground to a point
  - Side discharge hole
  - Eliminates “coring” of septum



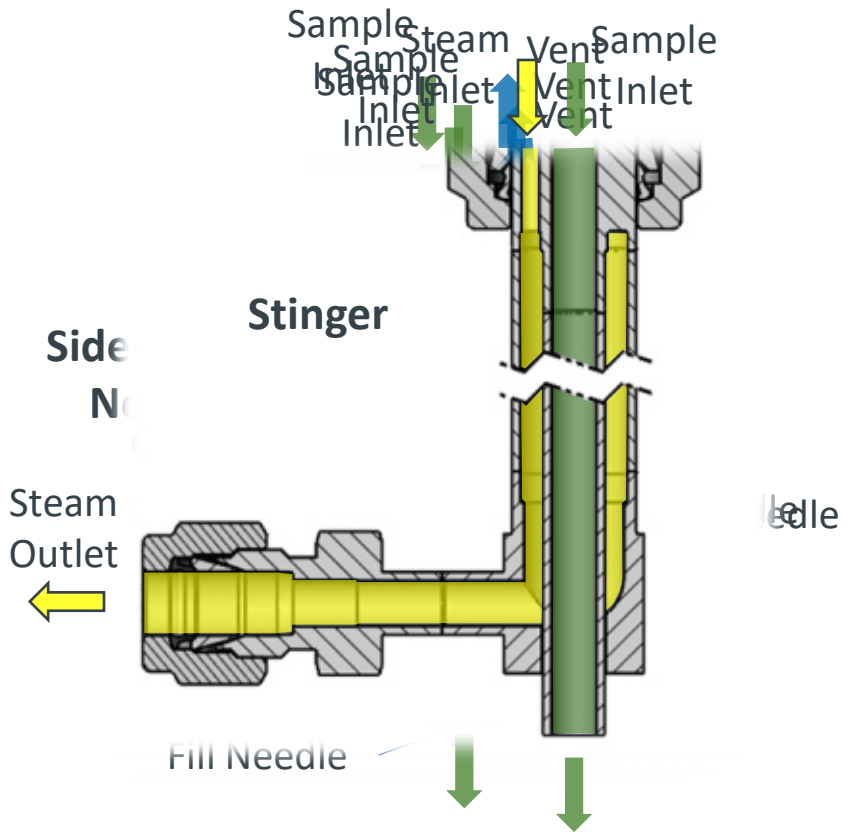
Common Issue – Coring Septa

- Lancet point:
  - Pierces septum
    - Rubber pushed aside
  - Septum reseals
- Lancet point (coring)
  - *Cuts* septum
    - Rubber plug removed – plug needle or pushed into bottle
  - Septum *leaks*
- Pencil point (non-coring)
  - Coring septum impossible
    - Rubber pushed aside
  - Septum reseals



Needle/Nozzle Configurations

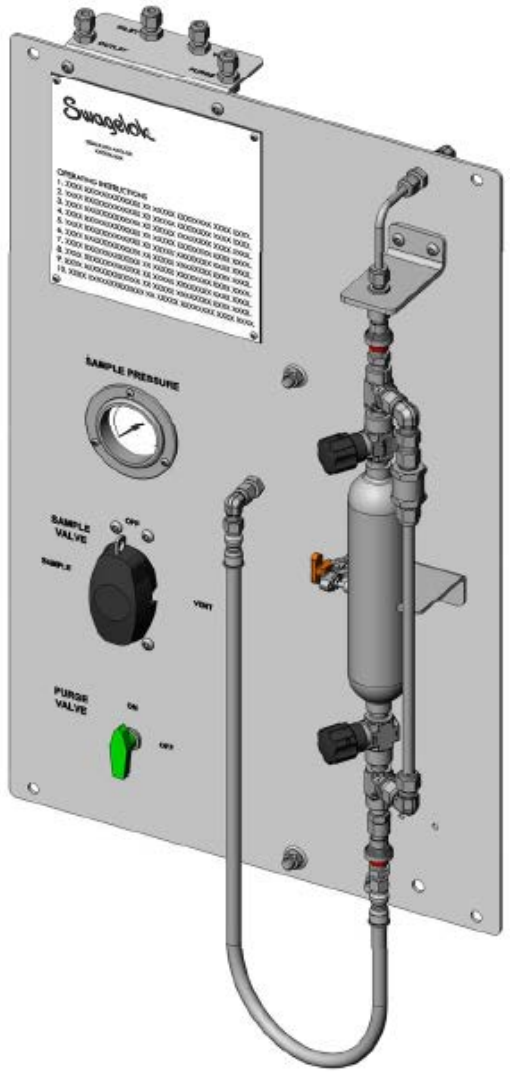
- Side-by-side
  - Most common
- Concentric Needles
  - Bottle can rotate without damaging needles or septum
- Tube stub
  - Used for open-top containers
- Stinger
  - Used for high-temperature/high-viscosity samples
  - Steam used to keep nozzle hot



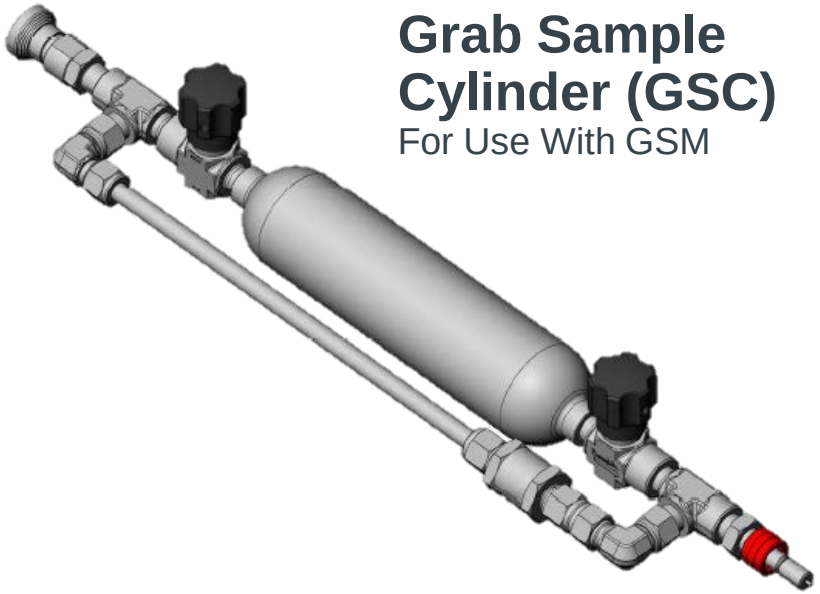
Grab Sampling

Standard Panel Designs

Standard Grab Sample Panels

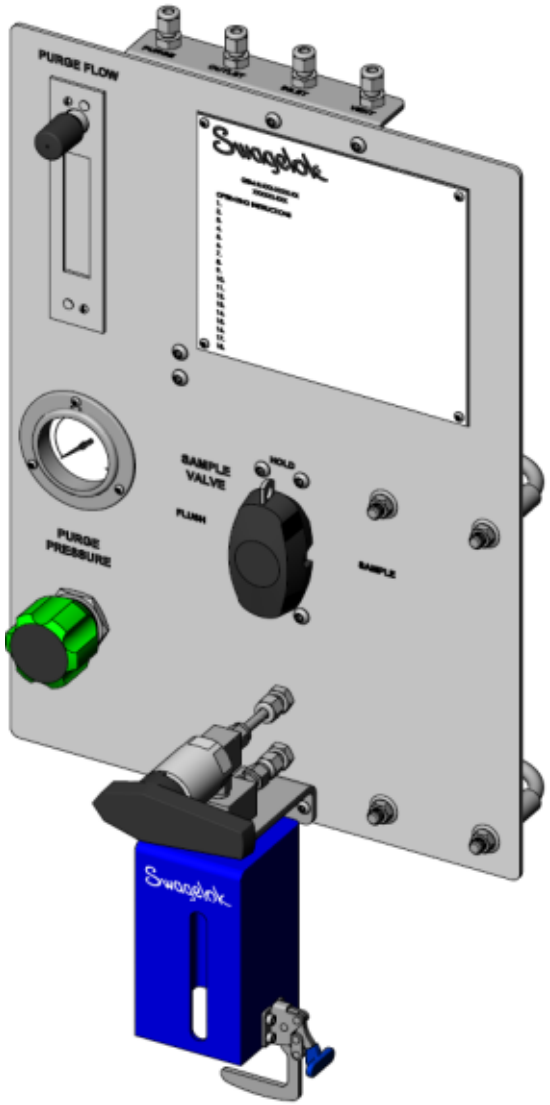


Grab Sample Module (GSM)
Cylinder Style Panels

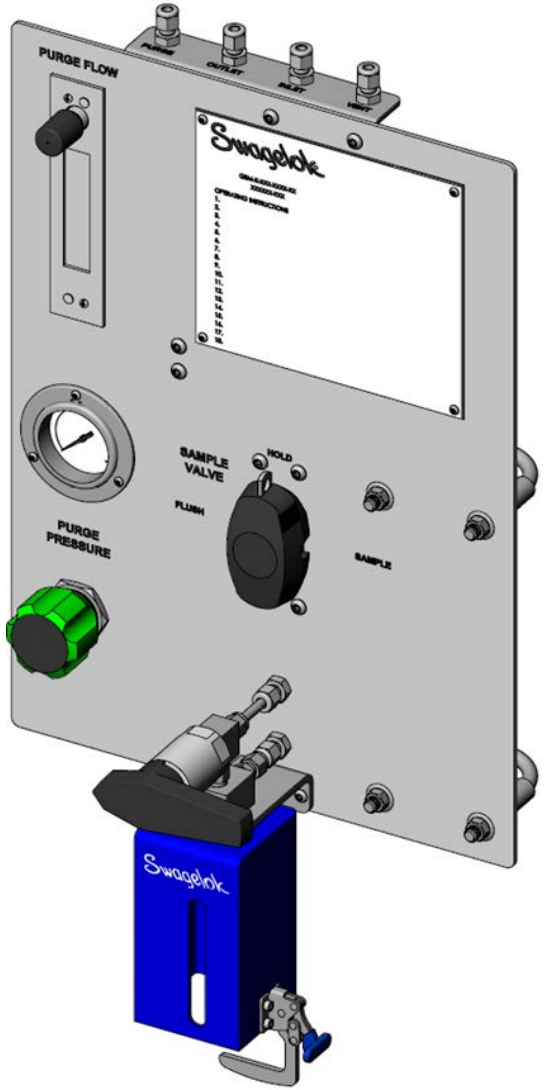


Grab Sample Cylinder (GSC)
For Use With GSM

Grab Sample Liquid (GSL)
Bottle-Style Panels



Grab Sample Panels – Features



- 8 standard GSM (cylinder style) configurations
- 7 standard GSL (bottle style) configurations
- Purge option sample fluid from lines, *including quick connects*
- Unintentionally introducing purge fluid into process line is impossible
- Versatile mounting options
- Engraved placard with instructions, schematic, etc.
- Most panels controlled with single valve handle – geared valves

Geared Valve Assemblies

2-Valve Switching Valve

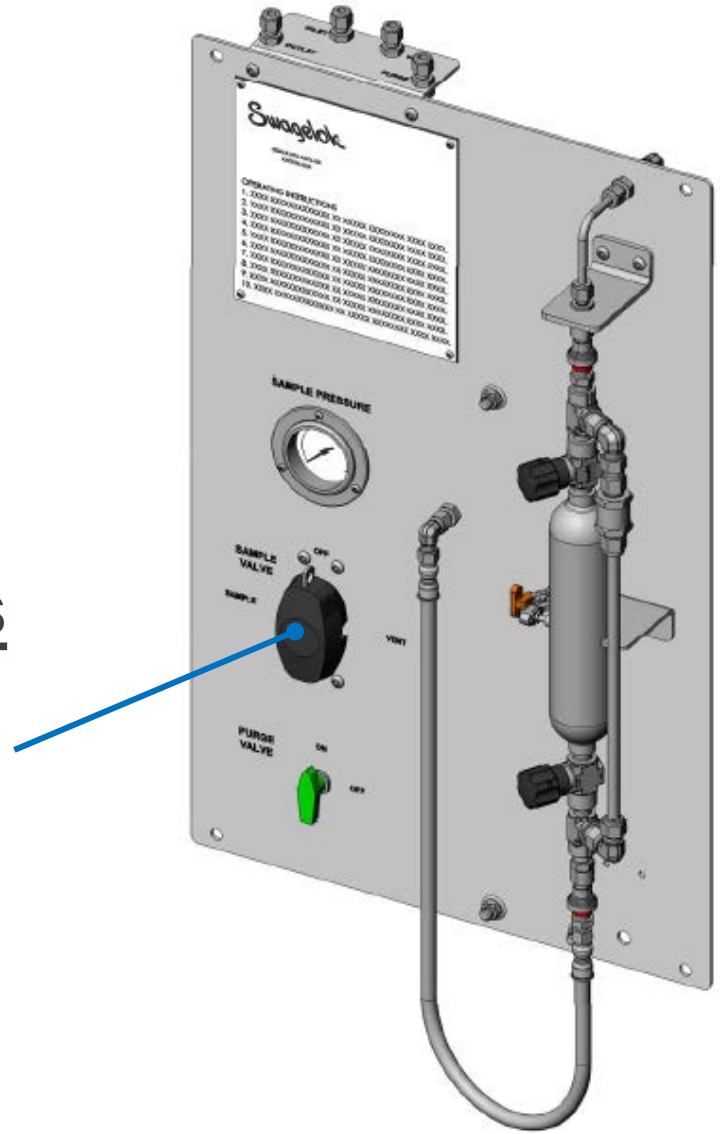
3-Valve Switching Valve

Handle Positions

Sample

Off

Vent

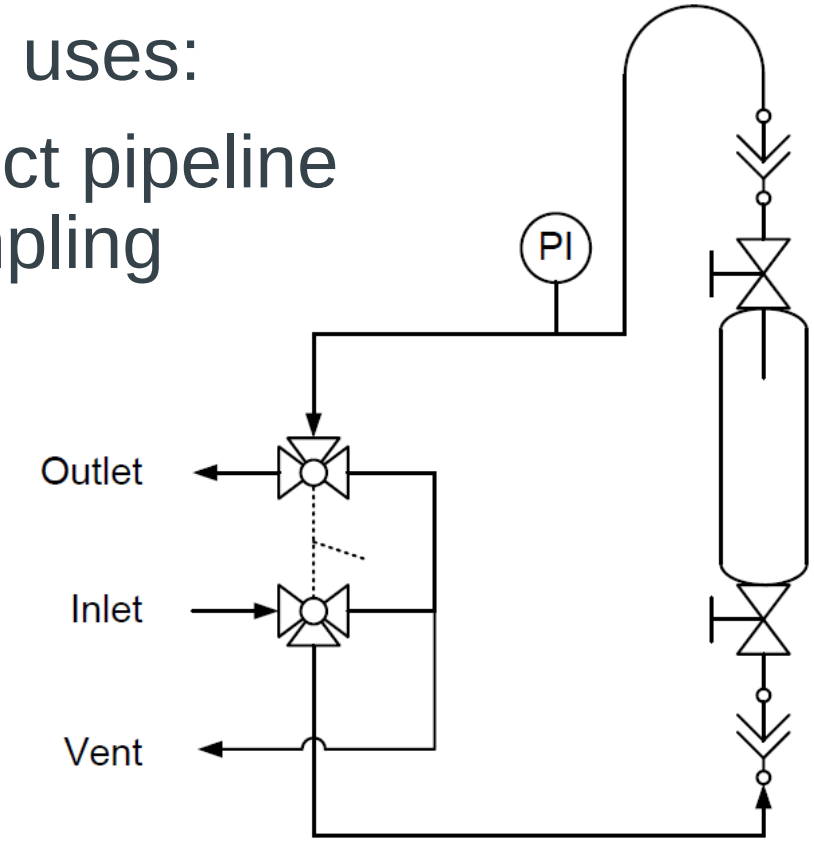


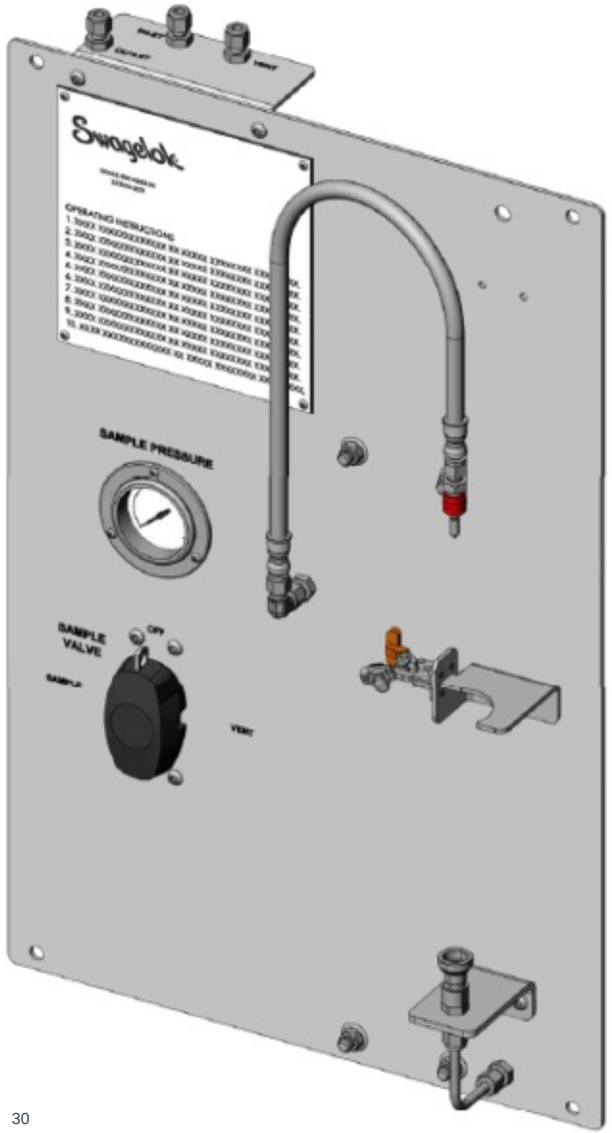
GSM Flow Path 1 - Standard

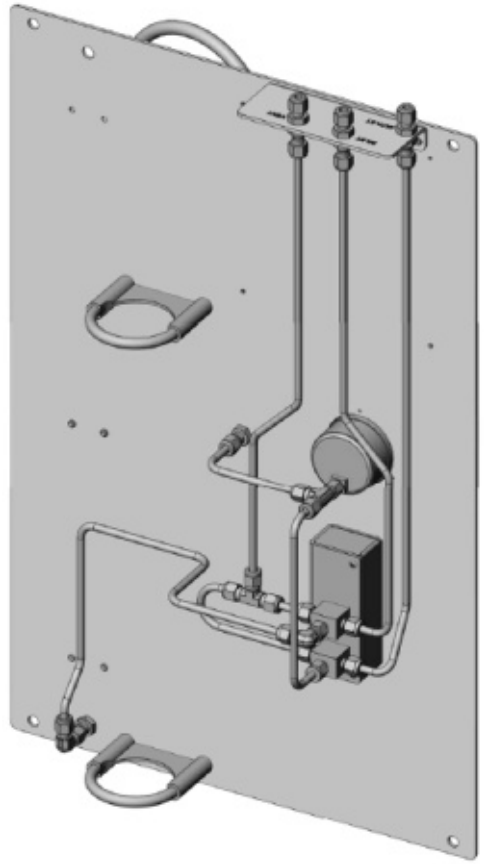
Most simple (and least expensive) model

Typical uses:

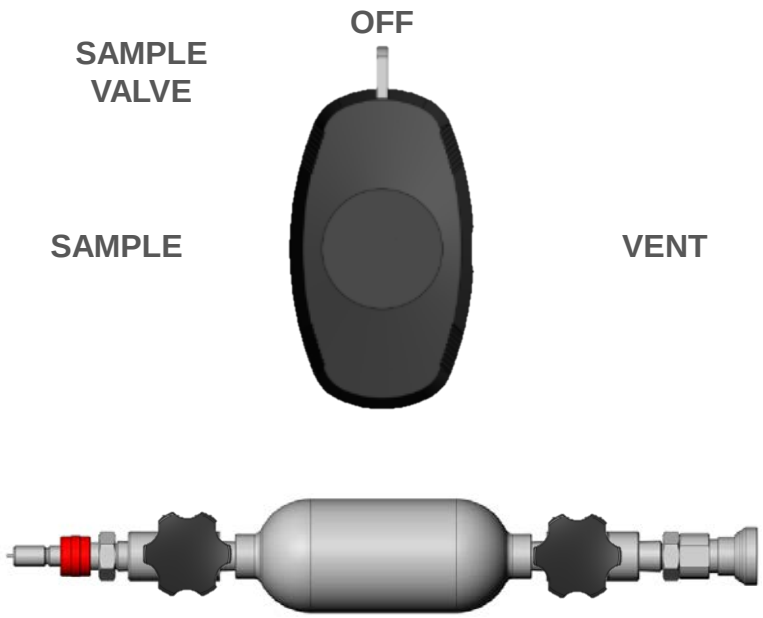
- Direct pipeline sampling

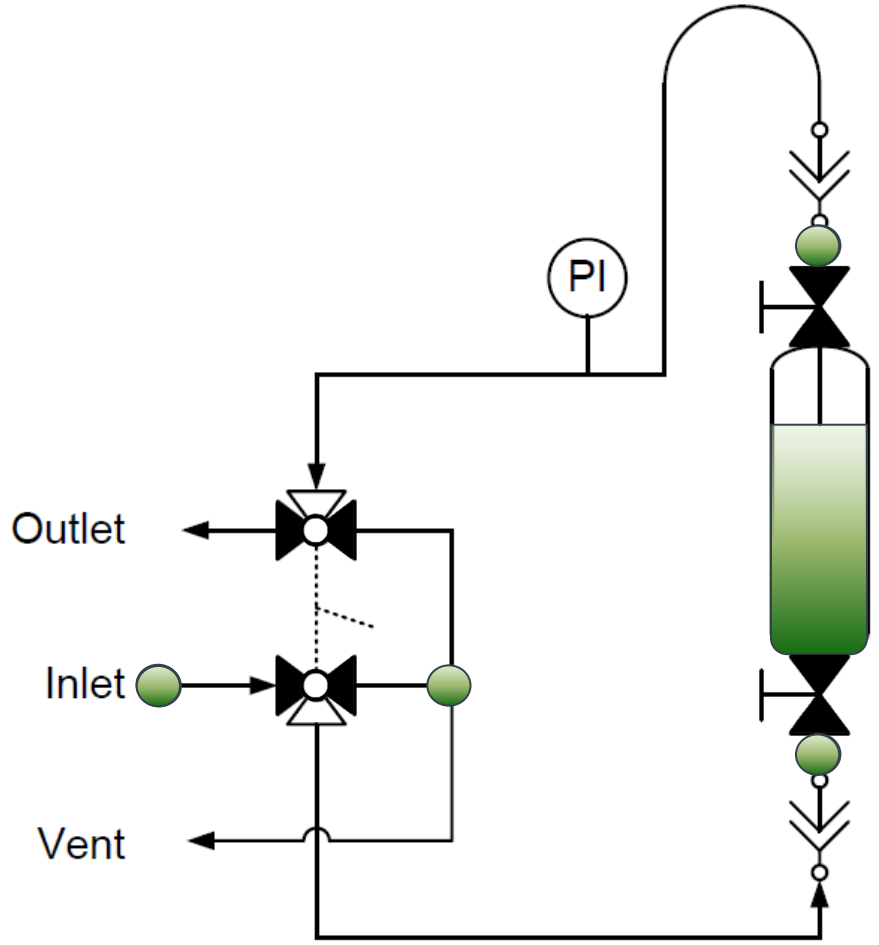




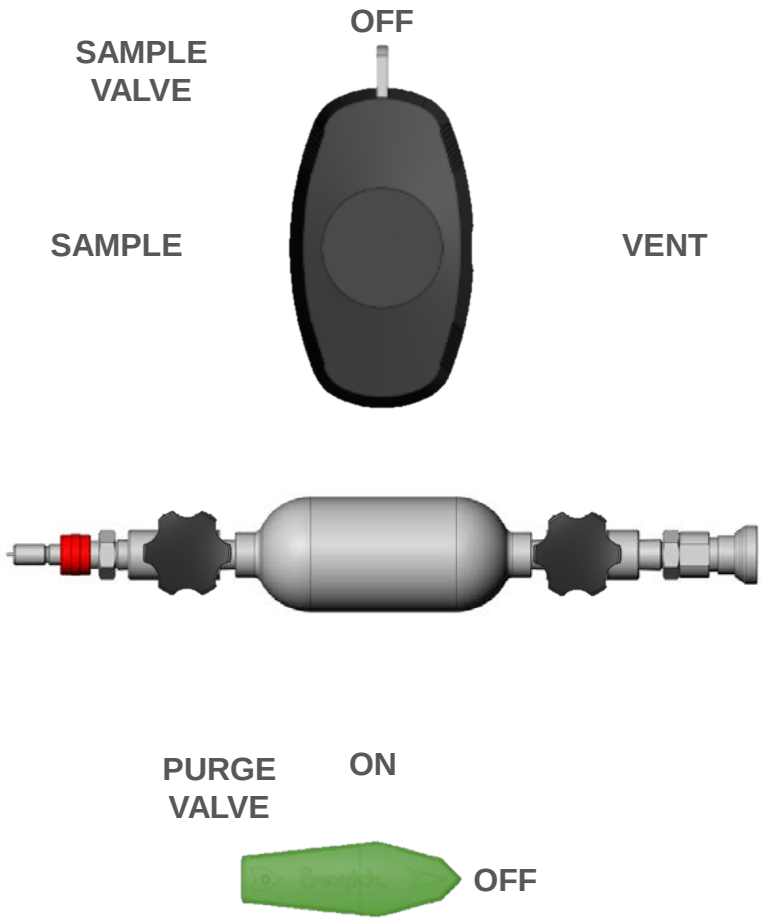


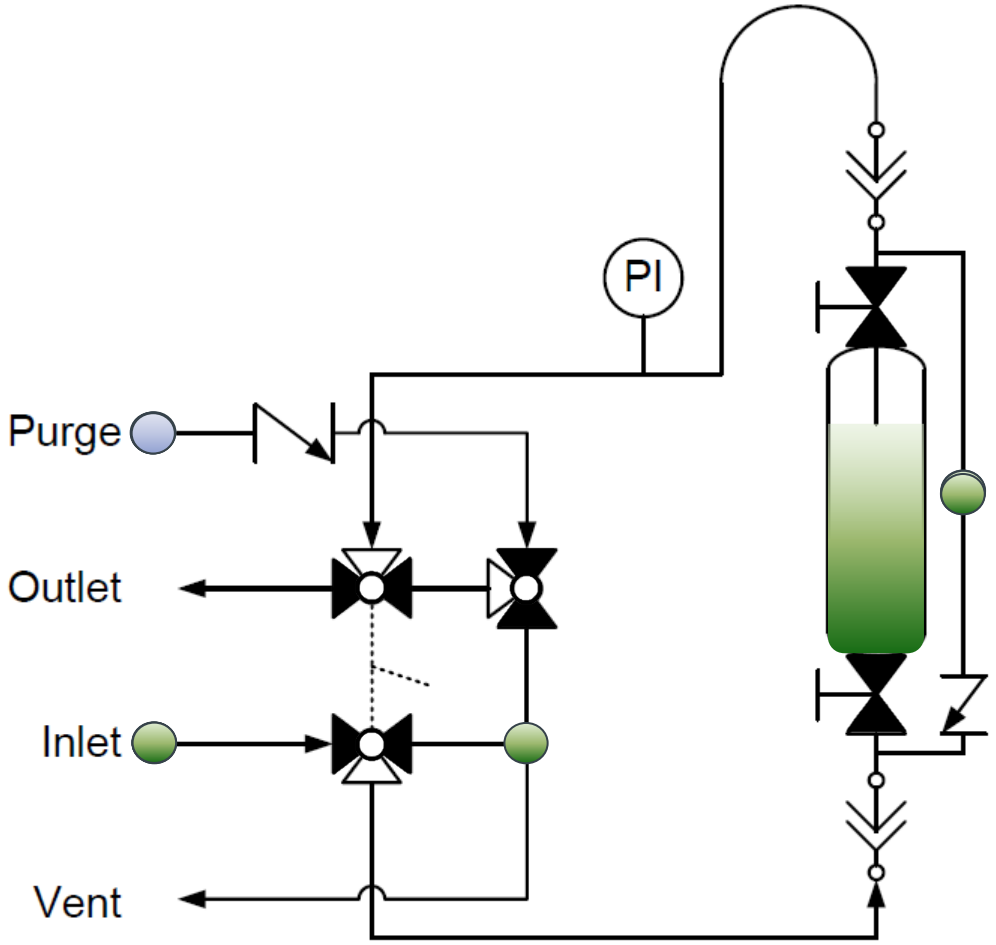
1. Standard (Liquid)





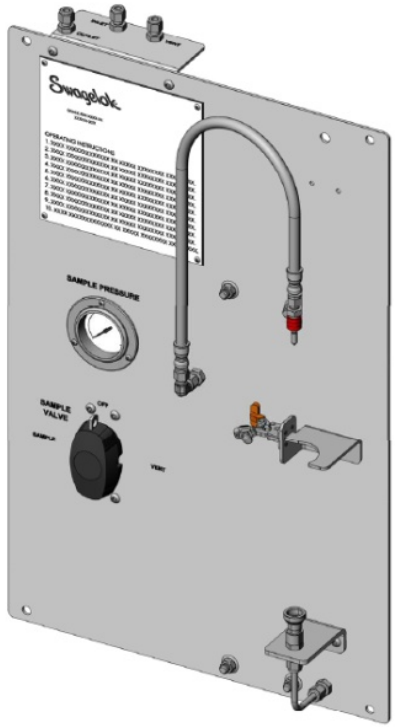
1. Standard (Liquid with Purge Option)

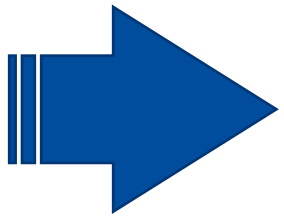


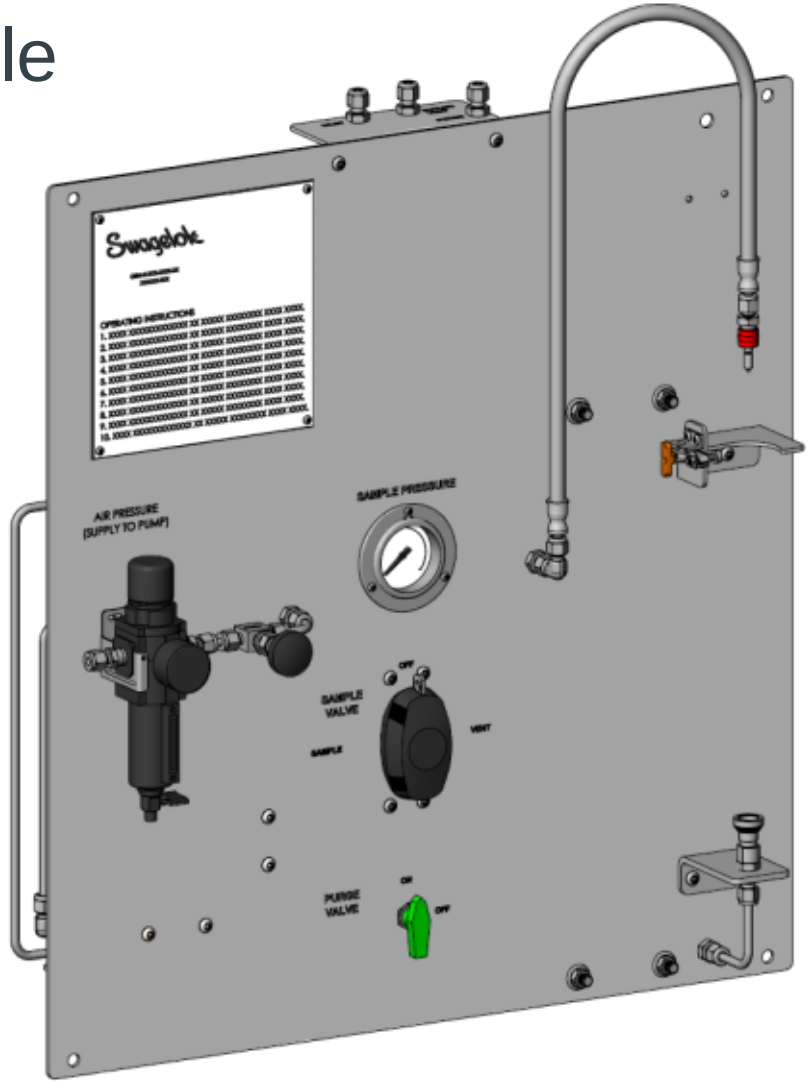


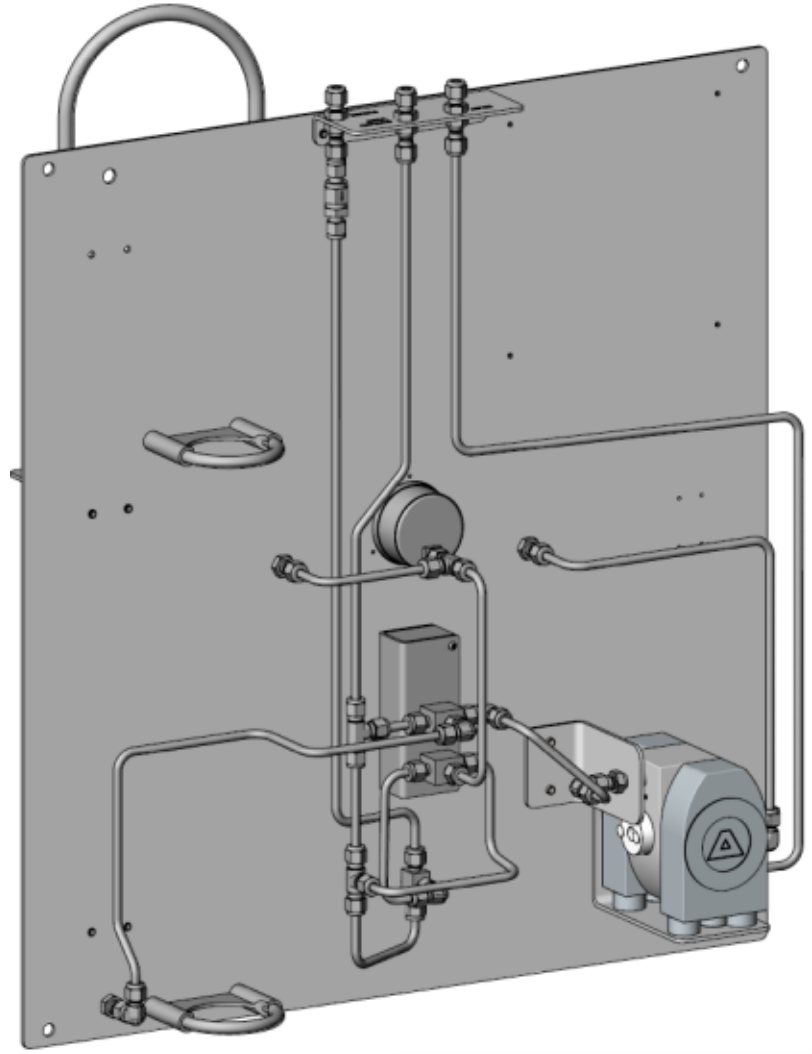
Customization – Pump Added to Inlet

- Low-pressure sample







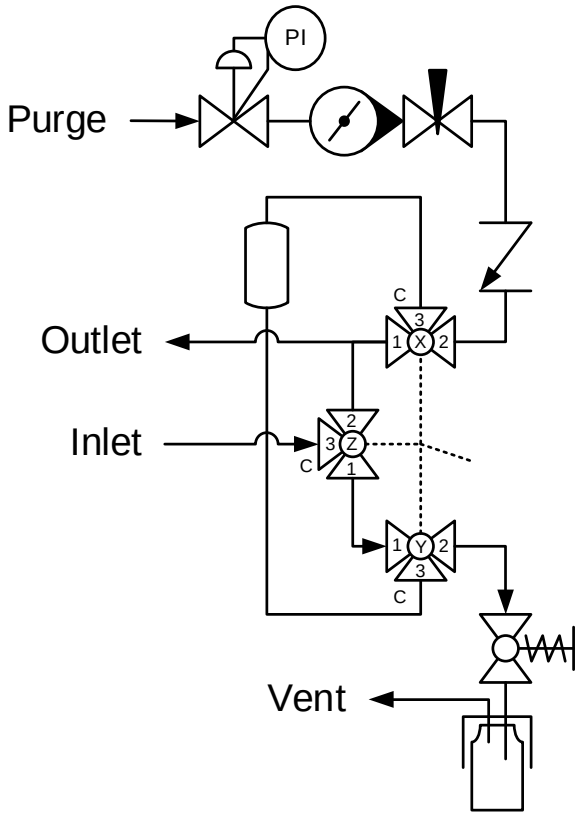


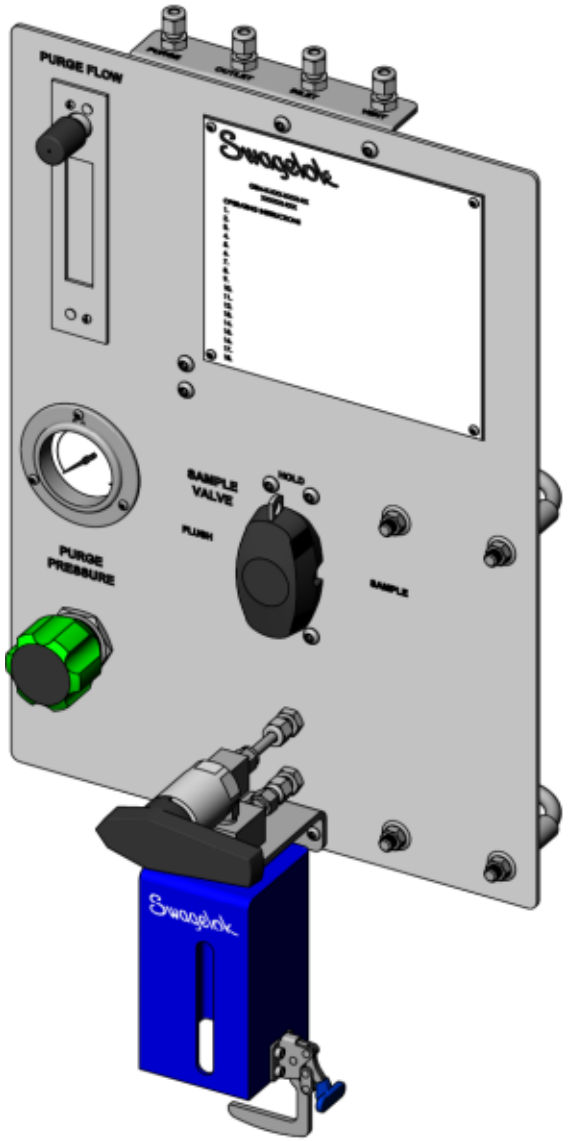
GSL Flow Path 7 – Fixed Volume, Continuous Flow

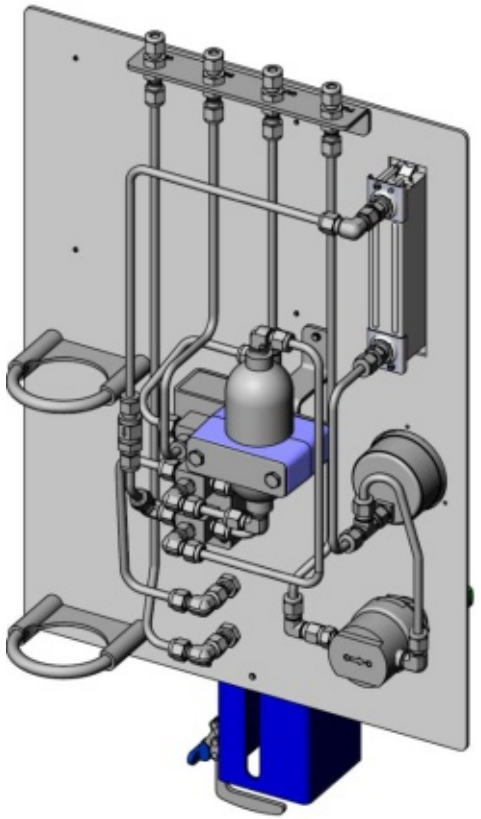
Continuous flow
from inlet to outlet

Typical uses:

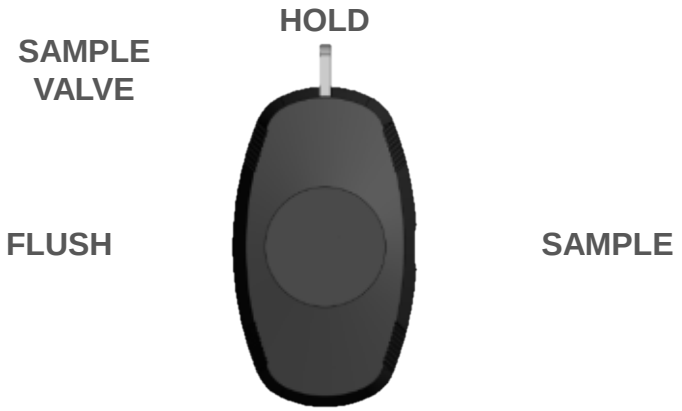
- Fast loop sampling

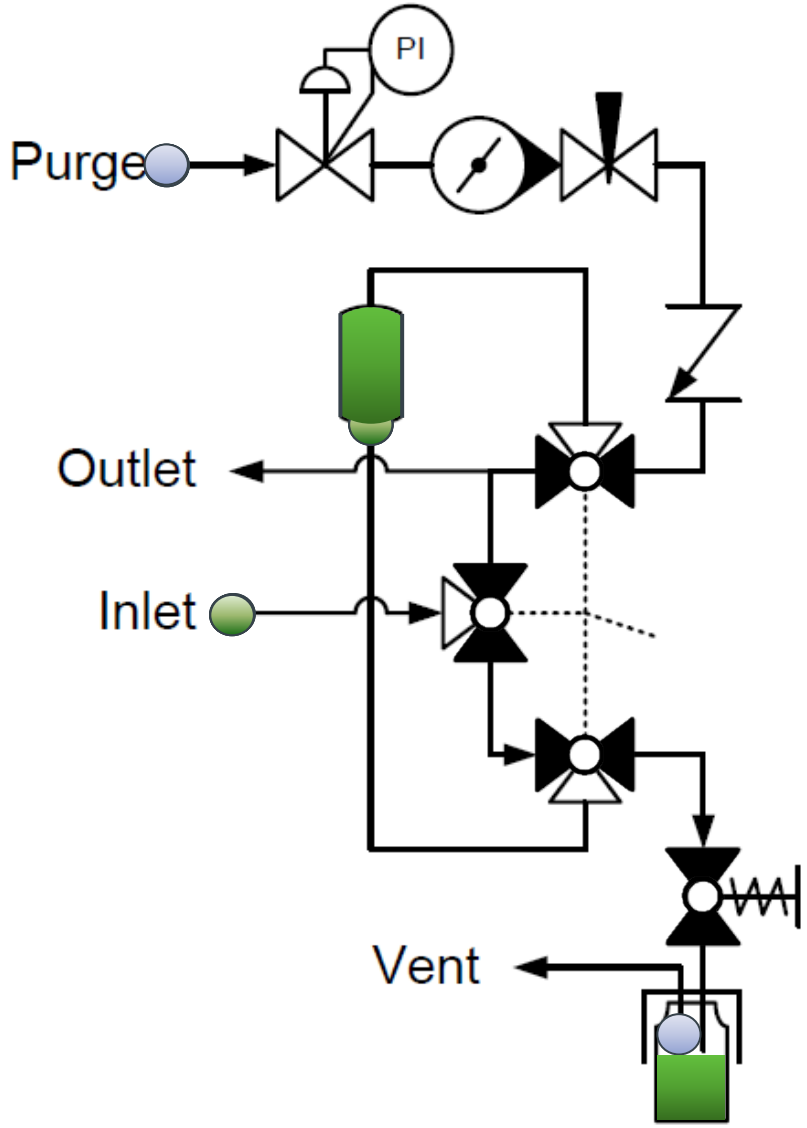






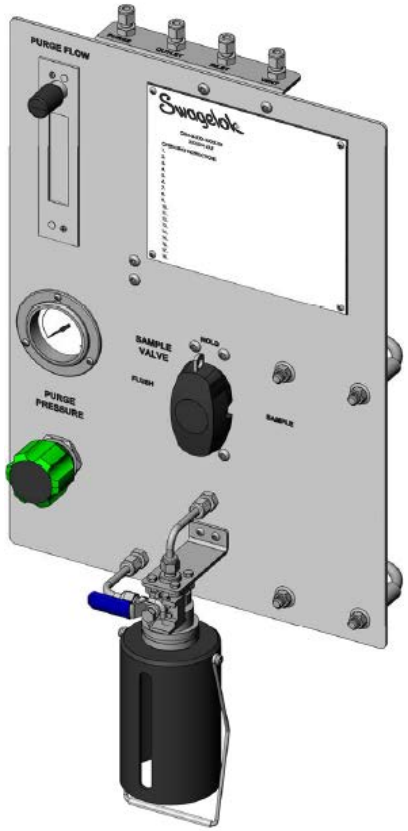
7. Fixed Volume, Cont. Flow

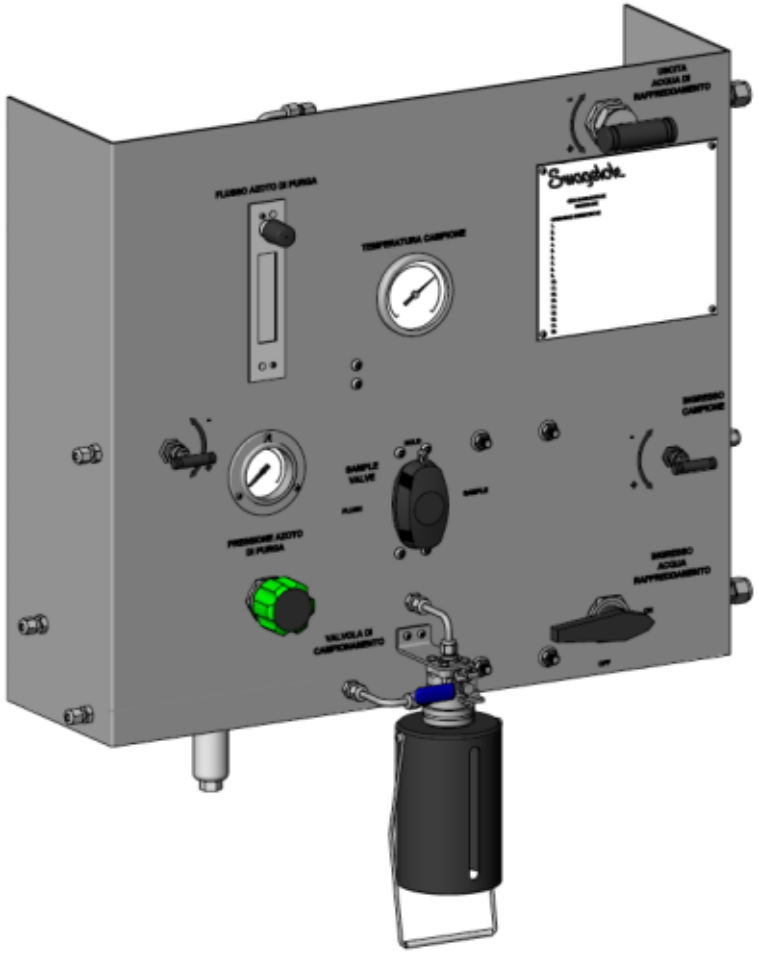


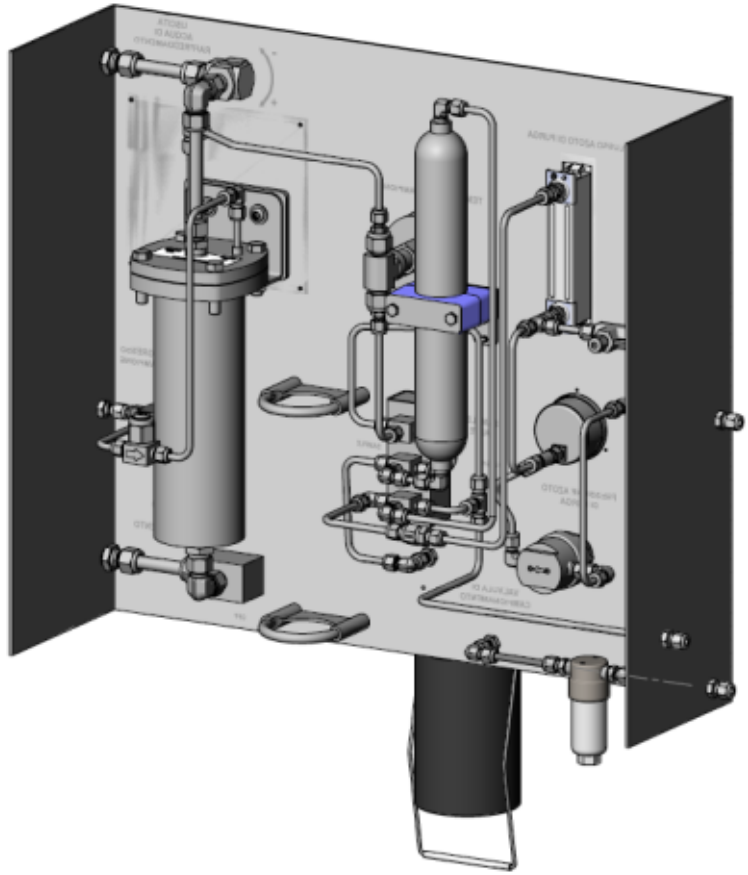


Customization – Inlet Filter, Carbon Vent Filter, Cooler

- Hot sample
- Captured/treated vent

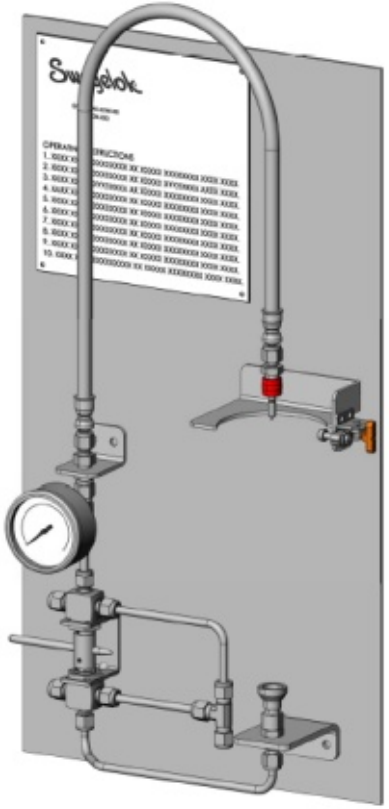


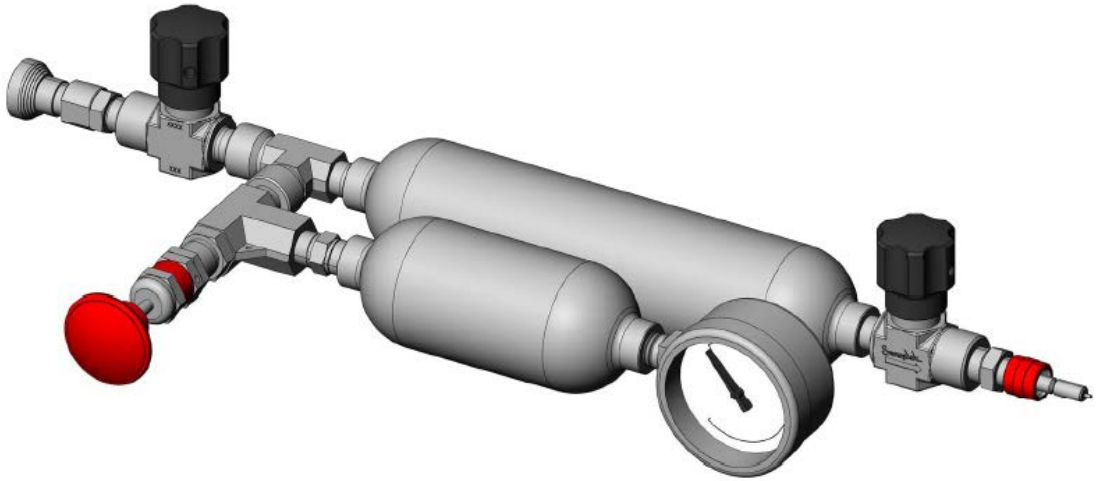


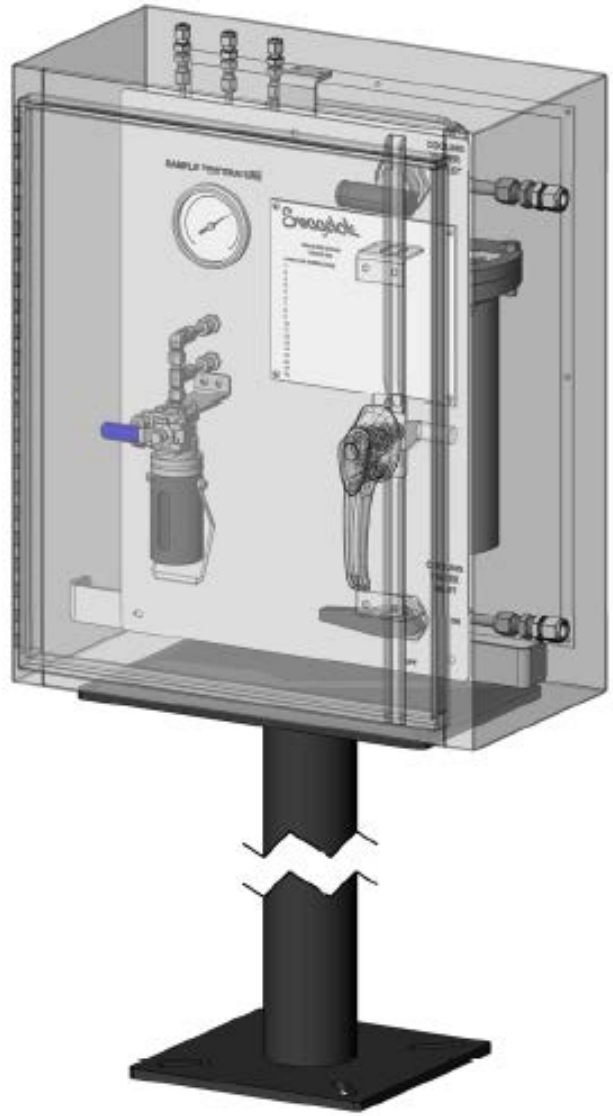


Grab Sample Panels – *A Design Platform*

- Limitless customization options
- Swagelok sales & services centers certified for local engineering and support







Learn More

Expect an email from *PTQ/Digital Refining* with a link to request more information about grab sampling. A representative from your authorized Swagelok sales and service center will reach out to you within 3 business days.

Meanwhile, read more about sampling system design and operation best practices on *Swagelok Reference Point*, our blog for industrial fluid system professionals.

You can also learn more about our grab sampling systems and services here: https://www.swagelok.com/en/services/design-assembly/grab-sampling-systems

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