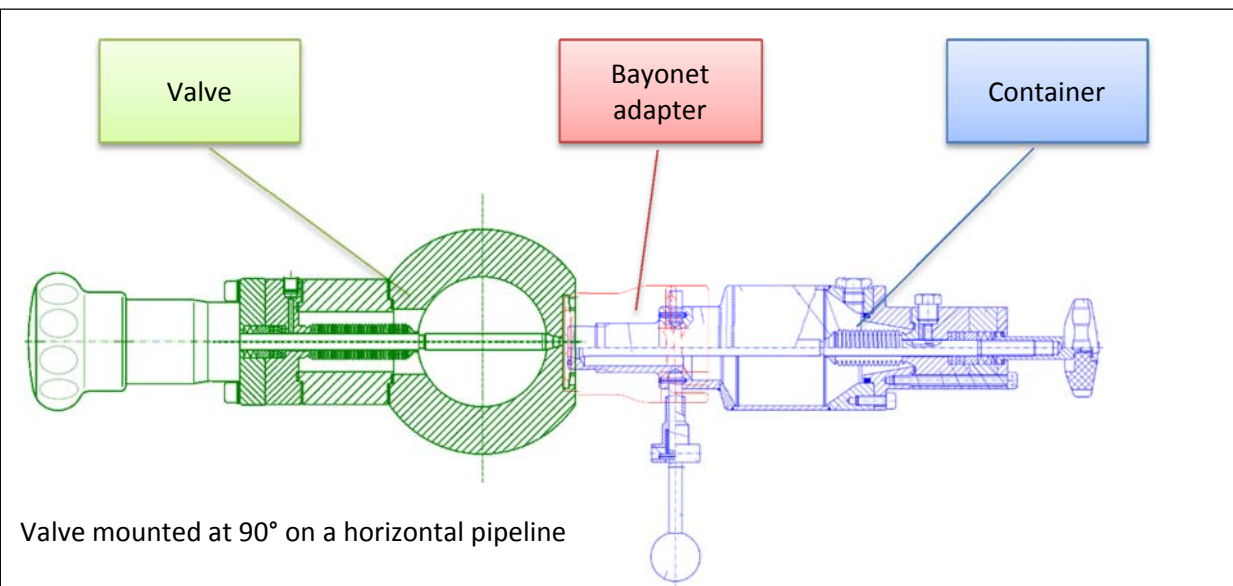
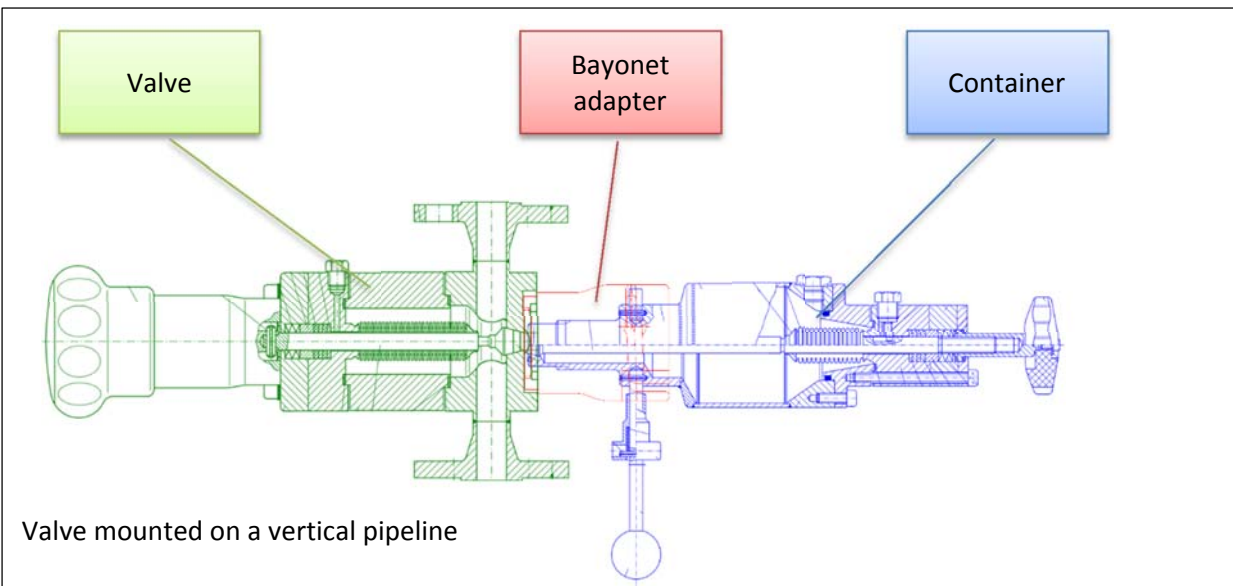


Liquefied Gas (LG) sampling

Challenges: Liquefied gases such as Chlorine, Liquefied Petroleum Gas (LPG) and others are toxic chemical and no exposure is allowed for the operator.

Proposal: To improve the current sample method by simplifying the process, reducing potential leak points and improving the general quality of the equipment, we propose using one of our valve with a sample cylinder and associated accessories such as bayonet connection and safety plug.

To provide volume for product expansion, the valve must be installed on a vertical pipeline or at 90° on a horizontal pipeline as illustrated below:

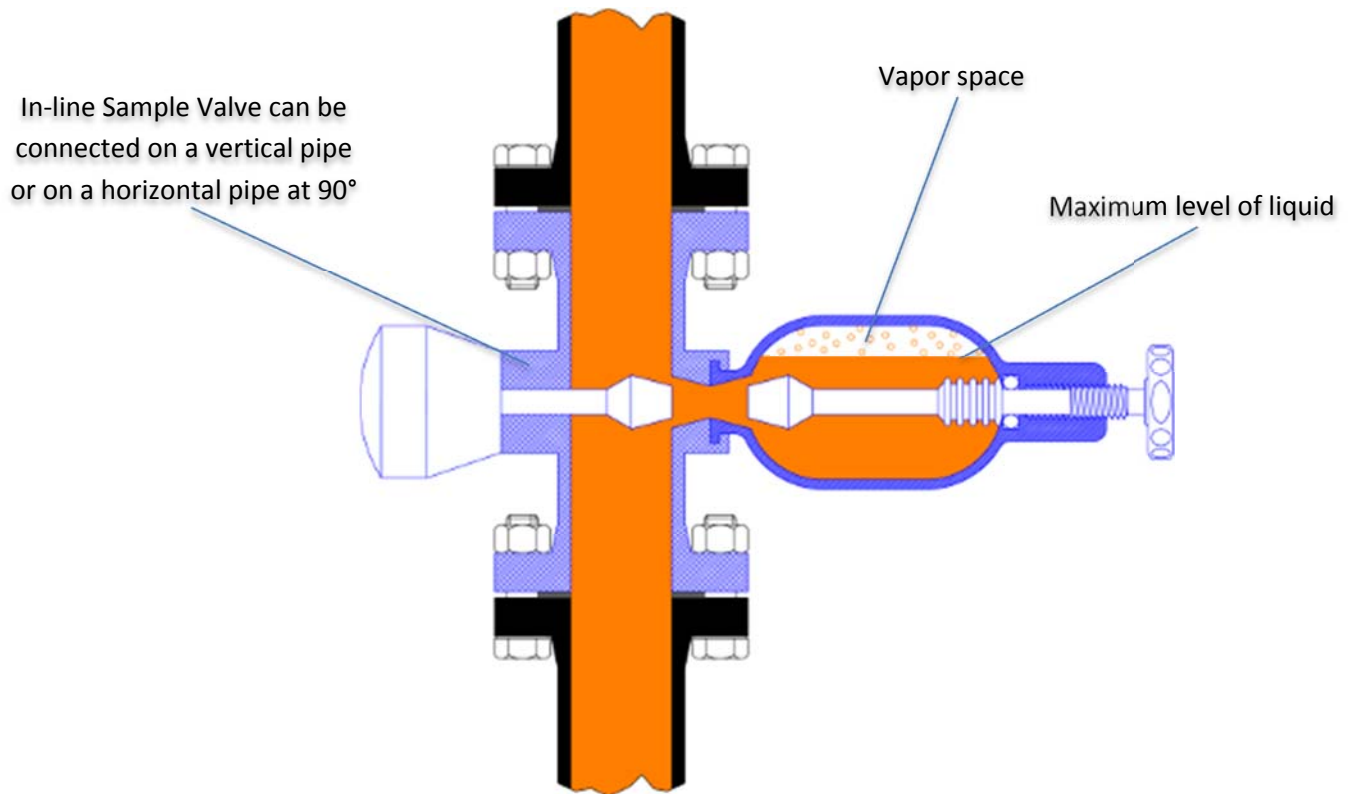


Liquefied Gas (LG) sampling

The following illustration shows how BIAR COLUMBIA-LY sample container provide a sufficient vapor space to prevent overpressure from volumetric expansion.

An increase in temperature causes the internal cylinder pressure to rise by the combination of volumetric expansion of the liquid (compressing the vapor space) and an increase in the vapor pressure of the contents.

When used horizontally, BIAR sample containers COLUMBIA-LY create a vapor space that is necessary for volumetric expansion of the liquid.



Use

Outage is the vapor space in the cylinder expressed as a percentage of the total volume of the cylinder.

$$\% \text{ outage} = (\text{vapor space} / \text{total volume}) \times 100$$

Liquefied Gas (LG) sampling

Purely from the sample process point of view, the simplest and recommended way is to install the valve directly on the process line. However, if this is not possible, another recommended way is to install the valve on a **fast loop** between the high-pressure and low-pressure sides of the pump in a re-circulation line. Assuming the valve is installed directly on the process line or on a **fast loop** with constant product flow-through, the steps to grab a sample will be the following:

1. Remove the safety plug from the bayonet connection (secondary containment)
2. Remove the safety cap from the sample cylinder
3. Connect the sample cylinder
4. Open the sample cylinder
5. Open the sample valve
6. Wait a defined amount of time to make sure the desired sample amount is collected
7. Close the sample cylinder
8. Close the sample valve
9. Disconnect the sample cylinder
10. Put the safety cap back on the sample cylinder
11. Put the safety plug back on the sample valve

This method represents less steps than traditional sample methods and each steps are intuitive. Furthermore, only the desired amount of product is extracted from the process line, thus eliminating the need to recycle unwanted residue.

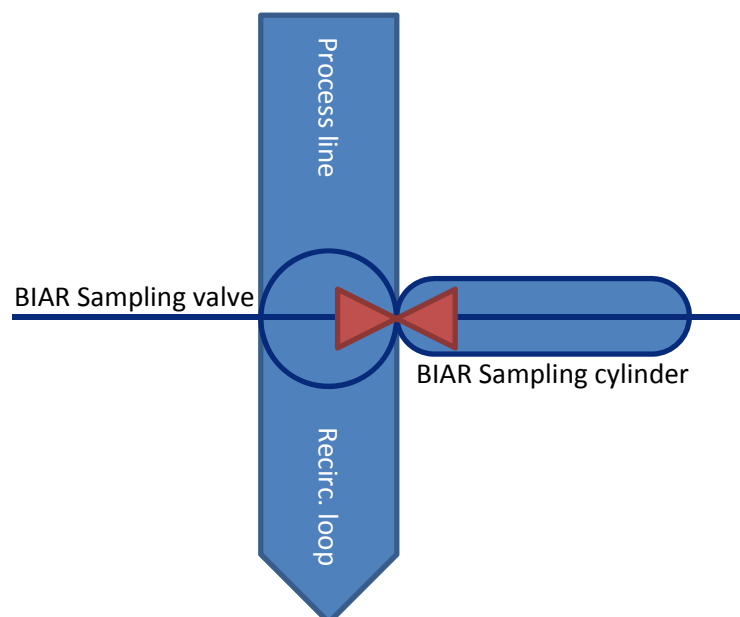


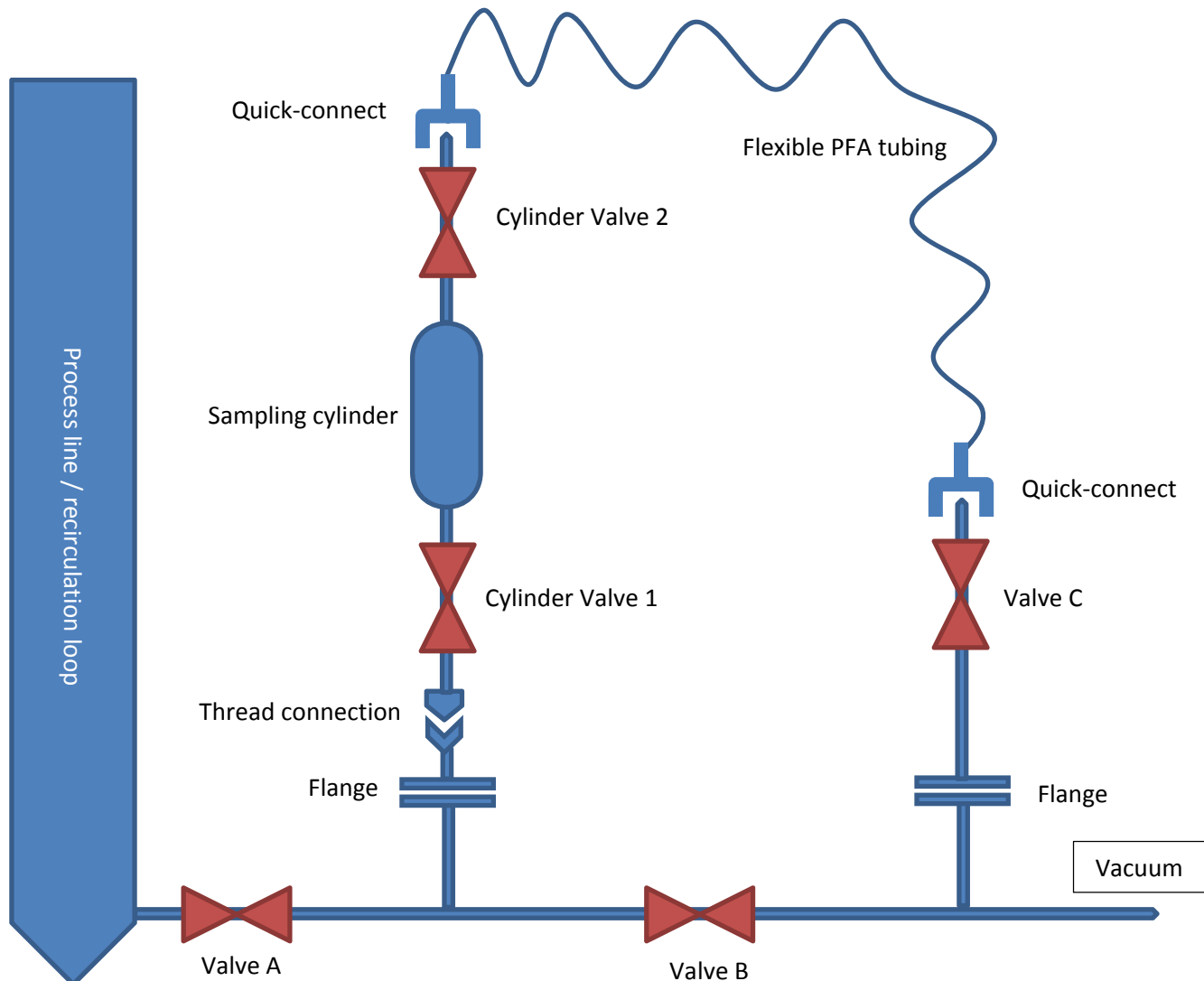
Illustration of the proposed sample method showing the Sample Valve and Sample Cylinder.

Liquefied Gas (LG) sampling

Some risks present in traditional sample methods are:

- Numerous steps require the operator to handle multiple valves in a precise sequence in order to prevent exposure and guarantee a representative sample.
- There are numerous potential leak points
- The nature of some fittings (i.e. Quick-connect flexible tubing) present potential exposure risks
- A robust design is difficultly achieved due to small tubing and numerous equipment involved

Example of Traditional system



Liquefied Gas (LG) sampling

To illustrate the complexity of the current sample method, below is an example of some of the steps the operator may have to follow in order to grab a representative sample in a safe way:

1. Remove the safety cap from the thread connection
2. Remove the safety cap from the sample cylinder
3. Screw the sample cylinder to the thread connection
4. Connect the quick-connect on the sample cylinder
5. Make sure Valve B is closed
6. Open Valve C
7. Open Cylinder Valve 2
8. Open Cylinder Valve 1
9. Open valve A
10. Wait a defined period of time
11. Close Cylinder Valve 2
12. Close Cylinder Valve 1
13. Close Valve A
14. Wait a defined period of time to make sure the flexible PFA tubing has been entirely flushed
15. Close Valve C
16. Open Valve B
17. Wait a defined period of time to make sure the thread connection and tubing between Valve A and Valve B have been entirely flushed
18. Close valve B
19. Disconnect the quick-connect on the sample cylinder
20. Unscrew the sample cylinder from the thread connection
21. Put the safety cap back on the thread connection
22. Put the safety cap back on the sample cylinder

In the above example, one can see that there is not only a lot of steps involved, but it is also important to follow the exact sequence to avoid product exposure, leaks and/or other safety problems.

Additionally, the product that is extracted from the process line and is not collected in the sample cylinder must be recycled in a safe way - this is in itself another challenging aspect linked to sampling.

Other differences of the proposed solution vs. the traditional method:

- Both the Sample Valve and Sample Cylinder can be fitted with bellows-type seals, providing perfect sealing and increased safety versus traditional stuffing box or other sealing technics
- To guarantee a representative sample, the sample cylinder must be prepared prior to sampling - it is not possible to flush it at the sample point.
- To guarantee robust, high quality equipment and disassembling functionality, the design of our sample cylinders are heavier and more bulky than sample cylinders readily available in the industry
- Because it is a proprietary design, BIAR is the only supplier of the proposed sample cylinders