EXPERIENCES WITH SAMPLERS ON COLD LIQUIDS

Author:
Ole-John Melkevik, Statoil ASA

ABSTRACT

This abstract will tell Kårstø Gas Processing Plant experiences with samplers on cold products starting from 1984 up to 2013. It will start with the first grab samplers where one did not have any back pressured cylinder. The sample of Propane did vaporize as soon as it entered the sample line. The result was no level in the sample can.

The next generation came with Argon back pressured cylinder. The start problem was that the grab was too small. The sample did vaporize with the original grab of 1ml. The grab was replaced with a 4ml cup. Now the sampler started to function. But still it needs a lot of maintenance to keep the cylinder functioning. Due to low temperatures one sees that the O-rings sealing rolls of the piston and start leaking.

The third generation was based on fast loop and a pump located in a cabinet. It was now easy to do maintenance and replace parts since everything was located in a cabinet. A drawback was that there was a need for a recirculation pump. Many of the components were of the same construction as in the previous versions. This again are leakages in the components due to dry product i.e. the can and the pump.

The fourth generation of sampler for cold products are based on standard parts and put together in a cabinet. The pump is based on a Haskell pump which fills up the pump chamber by means of the process pressure and empties with air pressure. This means that we fill up the cup for every sample grab. And all the parts are robust and easy to get when they fail. These samplers operate as expected on cold products from -40ºC to +2ºC. It operates on pressures from 5 to 50barg.

THE HISTORY OF SAMPLERS FOR COLD PRODUCTS AT KÅRSTØ.

1. GENERATION

When the plant at Kårstø was started up in 1985 there were installed liquid samplers on all liquids metering stations. They were all located at the jetty. The samplers were set up for LPG and Naphtha. The LPG included Propane and Butanes which had a temperature band from -40 to 0°C. During the commissioning and startup we struggled to get liquids into the sampler cans. This was managed when we vented the tubing and the sampler was immediately started. If it was a large batch it could take some time between the samples. If it was a bit too long waiting time the liquid vaporized and the sampler stopped working. Then it was to struggle with draining and venting to get it running again. Since this was cold, -40, the valves froze and the valves were not able to close again. So the personnel were hidden in a gas cloud. Gas alarms and blue light was the result. During these hazardous operations we also managed to fill our boots with liquids. This then ended up in a Propane dance on the Jetty. The words spoken will not be quoted here.

The result of this sampler installation ended up with demolition.

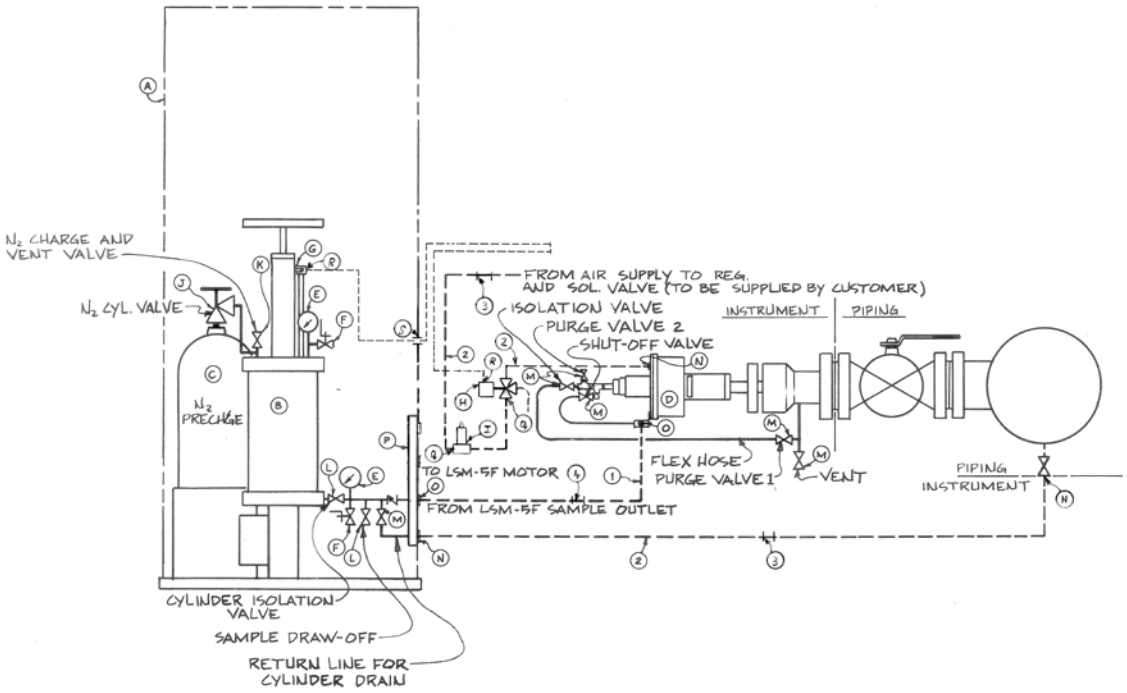

Figure1. An overview of 1st generation sampler at Kårstø

2. GENERATION

In 1998 there were a new project going on at Kårstø. There should be installed new metering stations with samplers. This time it came with backpressure on the can and also a pressurized system on the sample side. This was set up with pressure relief valve with a set point around 26barg between the sample pump and the can. The cup was 1ml and we struggled to get any sample into the can.

Maybe we should increase the size of the cup. It was possible to increase the size to 4ml without changing any other part. New cups were purchased and installed. Now we managed to get enough sample into the can. We reduced the number of samples to 2500. We saw that there is a bit different in operating on oil and operating on LPG/NGL. Crude oil is lubricating O-rings etc. LPG/NGL doesn't do any lubricating. This caused in twisted O-rings and leakages etc. Also the sample pump was covered in a Glacier, since the pipeline is always cold due to loading or recirculation. Had also some problems with the material in the cups and O-rings since they could not withstand fully chilled Propane they swelled up.

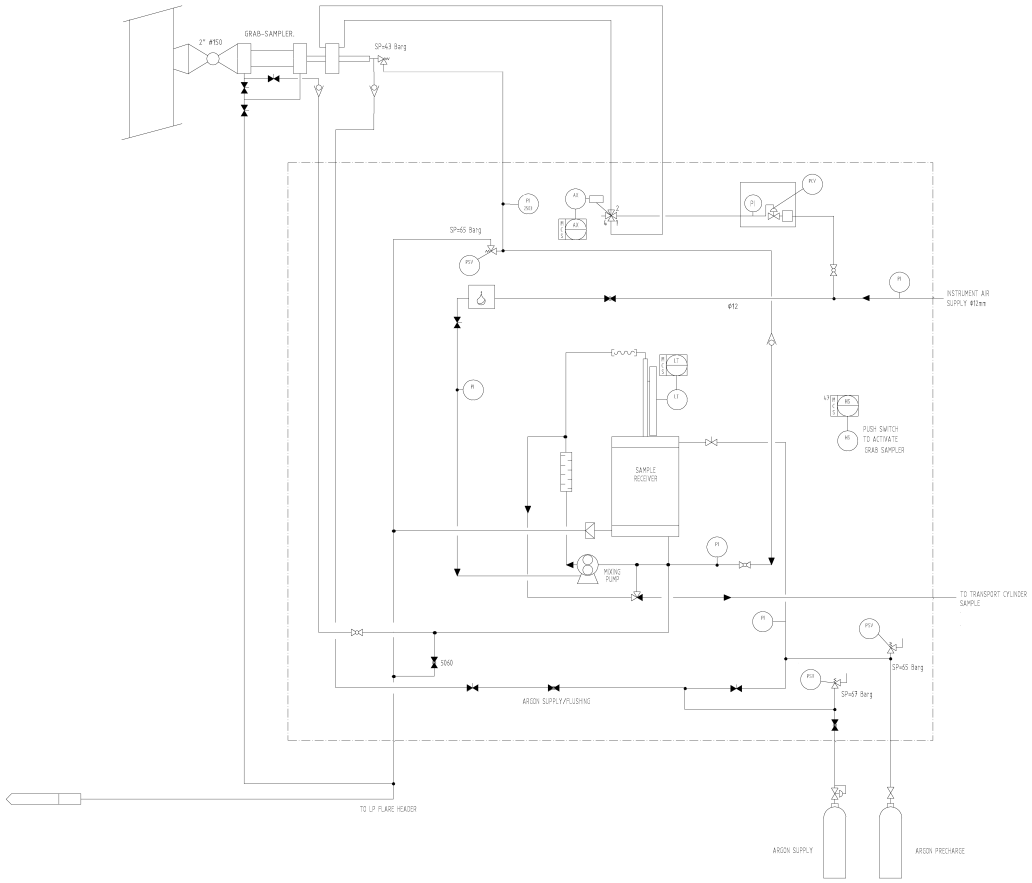

Figure2. An overview of 2nd generation sampler at Kårstø.

3. GENERATION

In 2004 the people at the lab also wanted to have samplers on the old metering stations same type as the solution in 1998. But instead of inline sample pumps there were installed small sample pumps in a bypass loop. The loops should be operated by means of pitot probes with circulation without any circulations pumps. The size of the cups was as previous 4ml. It was also highlighted that the material in the cup must withstand both temperature and LPG.

We struggled with operation of the sample pumps. It was not able to get any flow in the loop although it was calculated that it should be able. Therefore there was a need for a pump circulation pump in the loop. The startup was then delayed with 6 months. In the meantime air operated circulation pumps were installed and tested out. Still we didn't manage to get flow in the loop. The sampler pumps were opened and then we saw that the material had swelled out. The reason for that was that the material was not according to the spec. The O-rings and cups were replaced and then everything functioned very well. But also here we're struggling with twisted O-rings due to lack of lubrication. A reduced diameter of the can would have helped a lot.

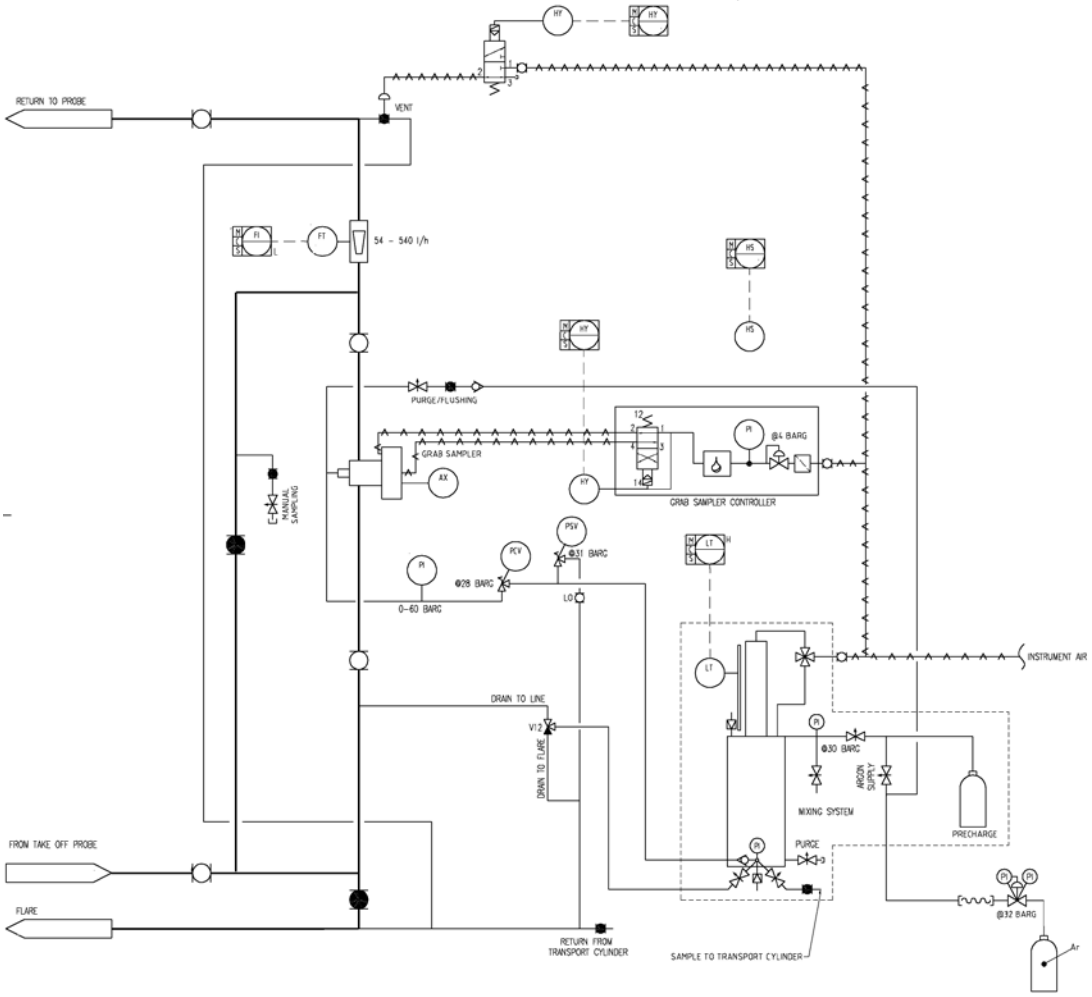

Figure 3 An overview of 3rd generation sampler at Kårstø.

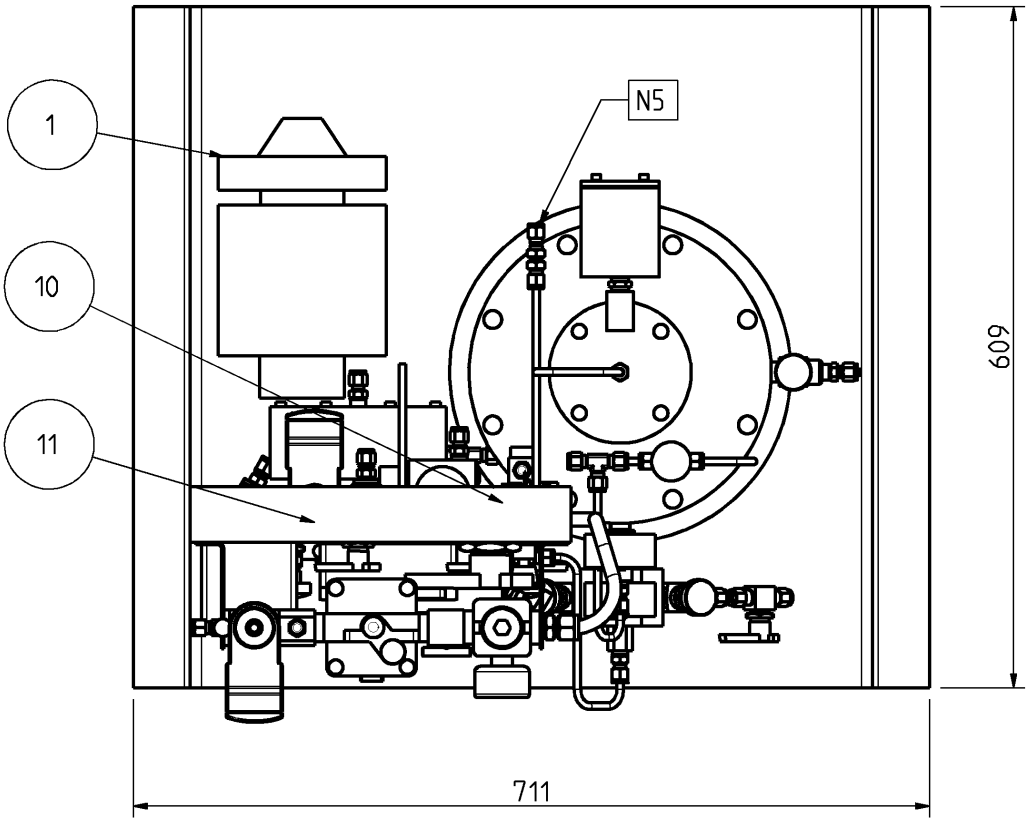

Figure4. shows the dimensions of the sampler pump. As one can see it is easy to maintain this pump compared to the inlinesampler pump.

ITEM	QTY.	NAME. TYPE. DIMENSION
1	1	FASTLOOP PUMP
2	1	FLOWMETER 1/2" NPT
3	1	GRAB SAMPLER 1/2" NPT
4	1	MIXING SYSTEM
5	1	PI 100 0-25 BARG 1/2" NPT
6	2	RELIEF VALVE 1/4"NPTM - 1/4"NPTF
7	1	PUSH BUTTON
8	1	GRAB SAMPLER CONTROLLER
9	1	LEVEL SENSOR L=440 KSR KUEBLER
10	1	PNEUMATIC BALL VALVE 6mm
11	1	SOLENOID VALVE

Figure5. Definition of items on the pump on figure 4.

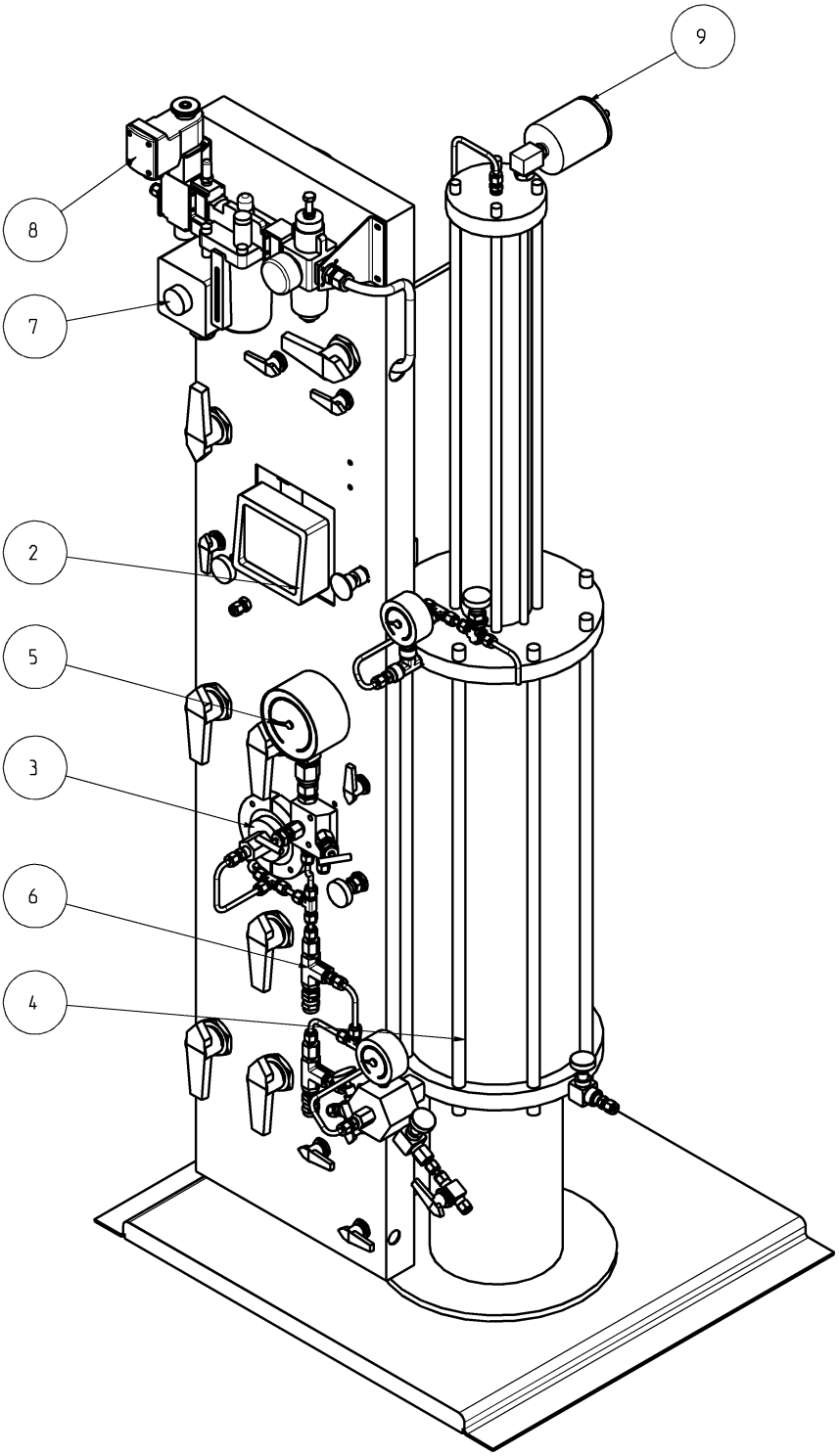

Figure6. Shows how the different parts of the sampler are located on one back plate.

4. GENERATION

The 4th generation came when it was time to replace the old metering stations for LPG. With references to the ASTM Designation D 1265-97: Standard practice for sampling liquefied petroleum gases there is accept for manual samples of cold products. This will be very complicated when there is a possibility to have 5 batches simultaneously. Therefore it was essential for us to make it a bit simpler. Together with our contractor we agreed upon an automatic manual sampler. It is possible to choose between 2 to 20 samples for a batch. The default setting is 10 samples. These are evenly spread over the batch. This will also give an indication to the lab people that the system is functioning.

The system is set up with fast loop over flow control valves downstream the station. The sample is taken out with a pitot probe. Since there can be up to 10 bar differential pressure we need a flow control in the fast loop. This is done with a coriolis meter and a control valve. The speed is set to approx. 1 m/s.

The standard pump then fills itself up with the process pressure which triggers the air to reset the pump. The pump continues to run as long as there is air on. And every sample is the same volume (if we could have controlled the number of strokes it would have been perfect)

The sample receiver also contains a level transmitter and a local level indicator. At the HMI we can monitor the level, flow, density, number of samples to be collected, number of samples collected. All this information is also available on the process explorer so that it can be monitored from the office or at the lab.

The sampler can is also a standard receiver containing 4 liter. Normally the can will be filled with 3 liter.

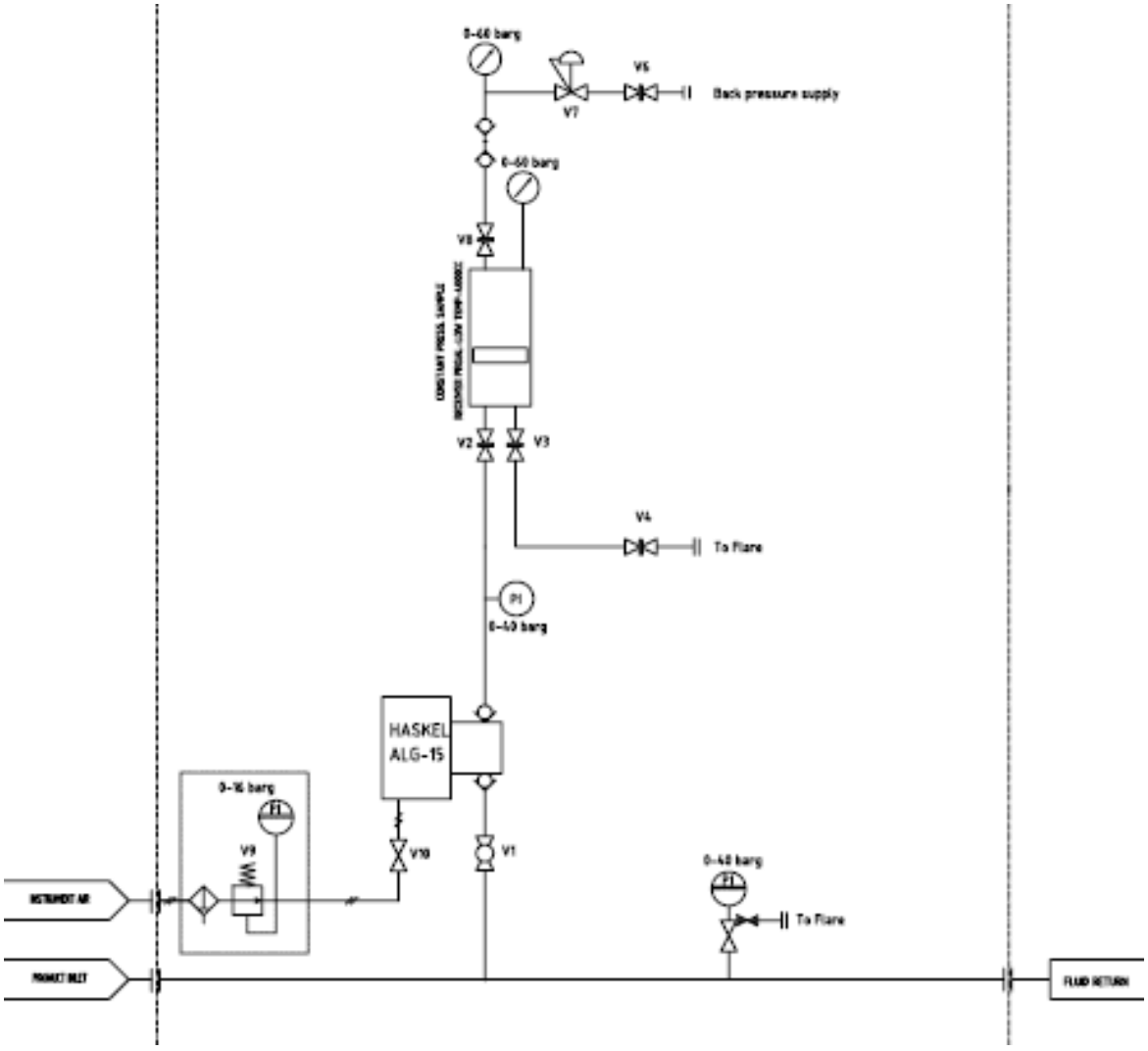

Figure7. Illustration shows the principle of the sampler. With fast loop to the cabinet for the pump and back-pressured sample can.

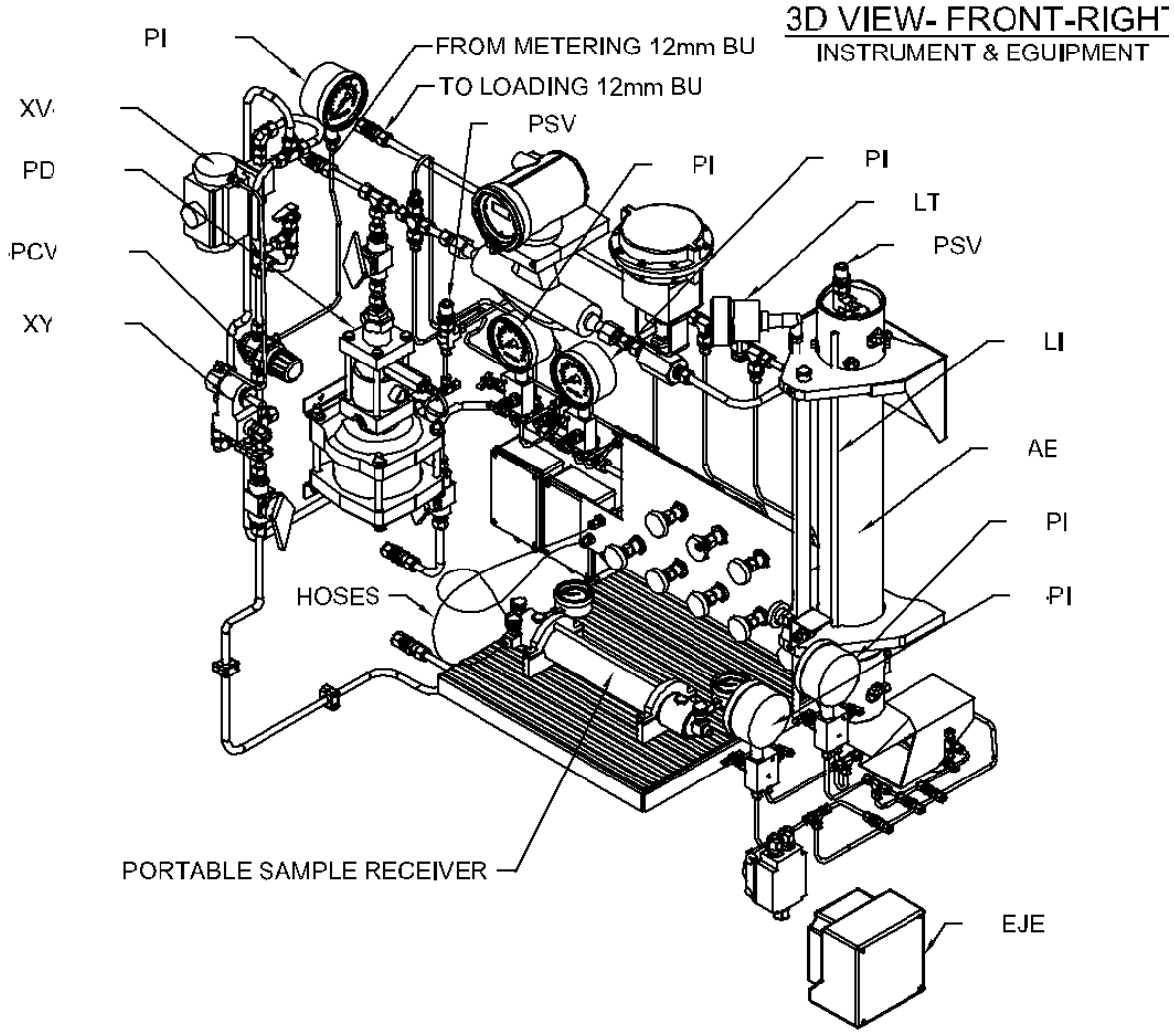

Figure8. General arrangement of the sampler

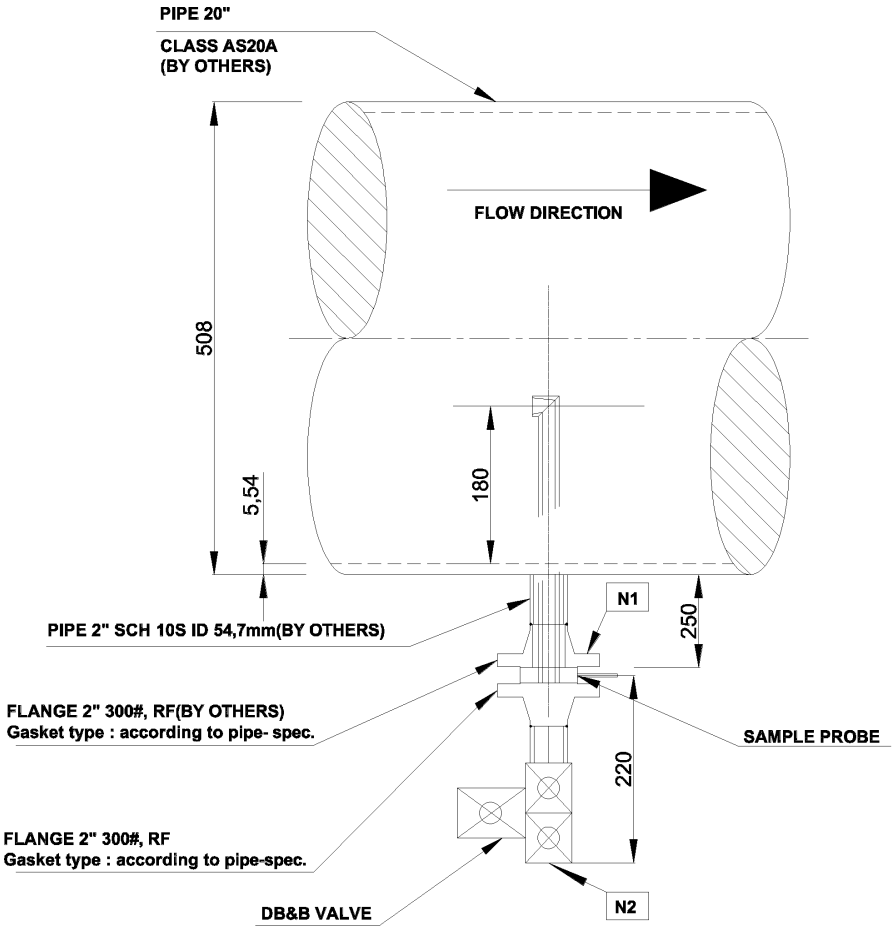

Figure9. Illustration of the pitot probe for inlet of the fast loop.

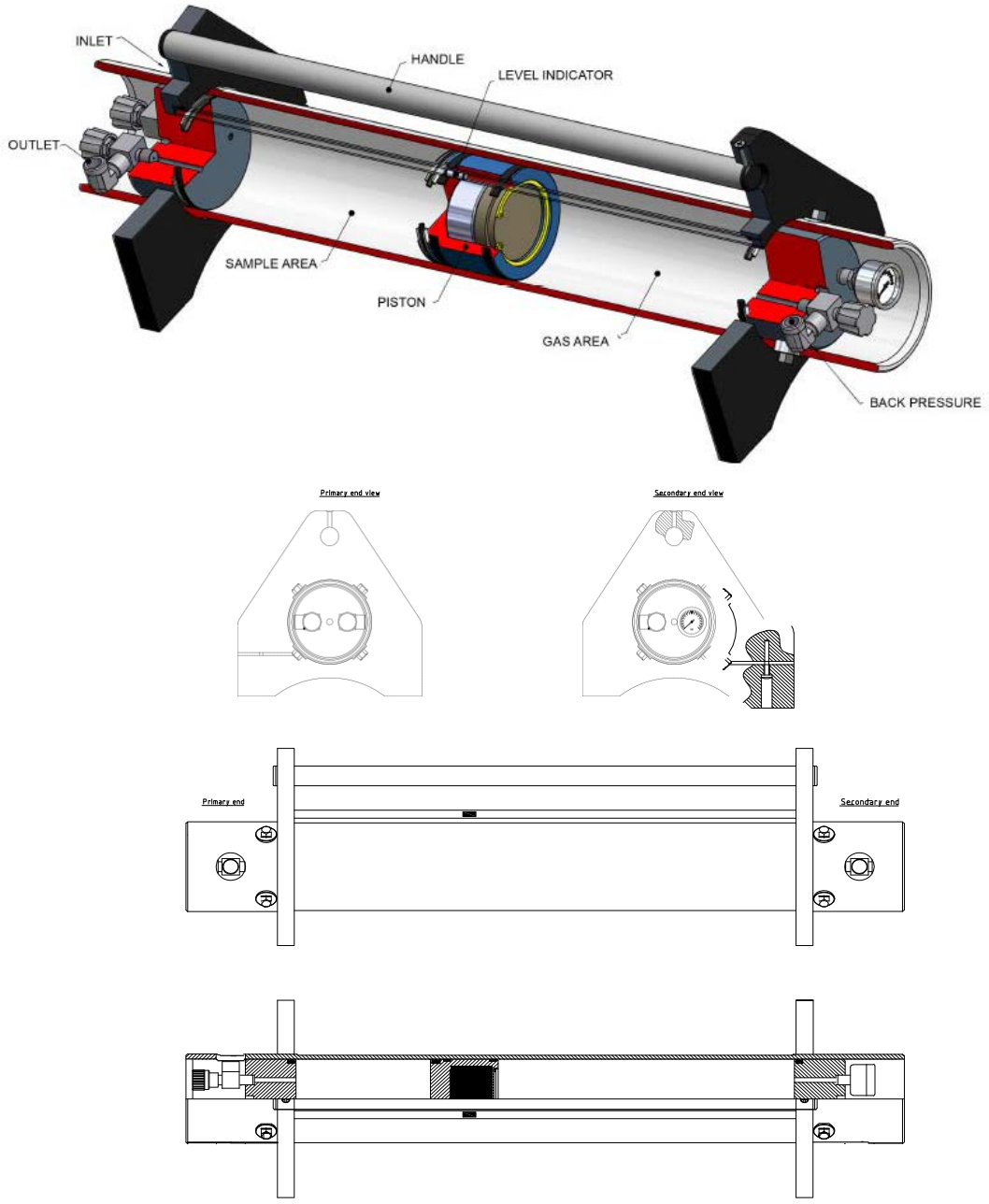

Figure10. How the sampler cylinder is build up.

Figure11. A picture of the sampler pump. The process pressure fills the chamber of the pump and then the air pressure transfer the trapped volume to the cylinder. In this way the chamber will always be filled. Because the piston has to go all the way to the end before it is pushed back by the air pressure.

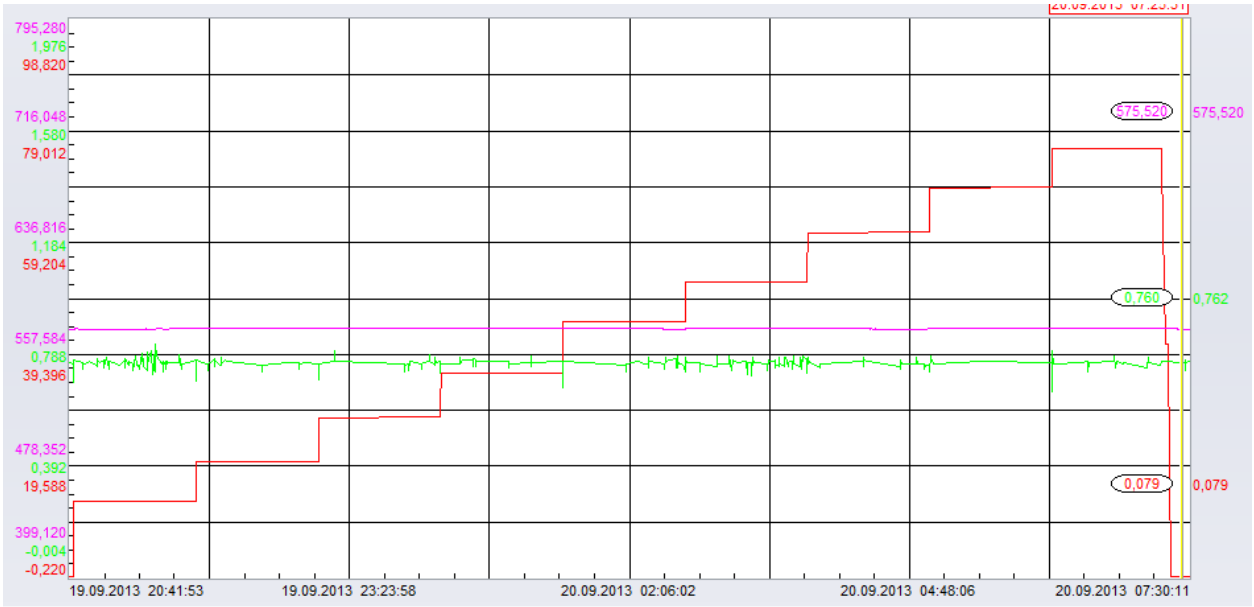

Figure12. An indication of the sampler behaviour during a batch. The stairs show the filling every 10%. The upper curve indicates the velocity of the liquid. The lower curve indicates the density. If water should occur the curve will bounce upward.

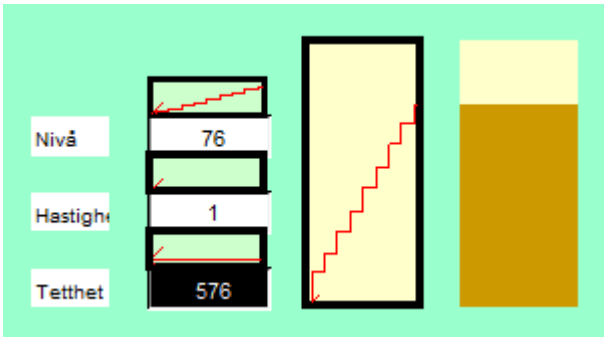

Figure14. Indication on the process explorer with figures in addition to curves.

Conclusion:
For cold products free of water this sampler really does the job every time. All the components are standard as delivered to all customers no special versions. Easy to read variation of the product to the sampler since we have the density available in the flow meter. And by using pressure drop over the control valve we avoid circulation pump. The maintenance will be to overhaul the sample pump. But the cylinders will be replaced with spare from the warehouse. The replaced cylinder will be shipped back to retailer for overhaul.

A roughly estimate shows that this can save up to 3 man-year compared to manual sampling.

The history also shows that this system will be more available than a system with inline sampler. The most obvious reason for this is the lack of lubrication when sampling LPG.

References
[1] Daniel Industries drawing 1984
[2] FMC Drawings 1998
[3] FMC Drawings 2004
[4] Proserv drawings 2010
[5]ASTM Designation D 1265-97: Standard practice for sampling liquefied petroleum gasses