ALEXYS LC 100
Pump

Preventive maintenance procedure

Symbols

The following symbols are used on the equipment:

Consult the manual for further safety instructions

Frame or chassis ground terminal

The following pictograms are used in this manual:

Caution

Caution, risk of electric shock or other electrical hazard (high voltage)

Safety practices

The following safety practices are intended to ensure safe operation of the equipment.

Electrical hazards

- Removal of panels may expose users to dangerous voltages. Disconnect the LC 100 from all power sources before removing protective panels.
- Always replace blown fuses with fuses of the size and rating indicated on the fuse panel and holder. Refer to Appendix B of this manual for more information on fuses.
- Replace or repair faulty insulation on power cords.
- Check that the actual power voltage is the same as the voltage for which the LC 100 is wired. Make sure power cords are connected to correct voltage sources.
- The LC 100 must only be used with appliances and power sources with proper protective grounding.

Take precautions against electrostatic discharge during installation/removal of boards, EPROM's or other electrical components at all time to prevent damage of the circuit boards.

Other precautions

The LC 100 has moving parts, care should be taken to prevent personal injury or damage to parts of the LC 100.

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C H A P T E R 1

Introduction

This Preventive Maintenance procedure describes step-by-step the complete Preventive Maintenance on the LC 100 pump. The procedure gives the instruction on which parts should be checked or replaced. It will give also all information needed to check or replace each part. The Preventive Maintenance Checklist is used for each pump to mark every checked item.

The procedure is written for trained and qualified service engineers, who are experienced with the LC 100 and ALEXYS data system software. For more details on adjustments, assembling and troubleshooting use the service manual (p/n 182.0020) as reference. For instructions on the ALEXYS data system, use the Help file of ALEXYS or the user manual (p/n 185.0010) as a reference.

Before you start, be sure you have read and understood the procedure and the information.

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Tools

The list bellows gives an overview of the tools which are required to perform Preventive Maintenance:

Service tools

Tool for exchange of piston seals 1/16" or 1/8"
Wrench 1/4" – 5/16"
Wrench 13 mm
Wrench 19 mm
Allen key 2 mm
Allen key 2.5 mm
Allen key 4 mm

Adjustable spanner (max. 20 mm)
Phillips screw driver
Syringe 10 mL
Flat precision screw driver
magnifying glass

Solvents / Tubing

Methanol or iso-propanol for cleaning of parts
Degassed & filtered HPLC grade water
1/16" PEEK restriction capillary L= 10 m, ID: 0.125 mm (0.005")
1/8" FEP/PTFE tubing L ~ 1 m, ID: 1.58 mm (1/16")
0.2 µm Whatman IFD aqueous filter
Silicon tubing

Test equipment

Calibrated flow meter *or*
Graduated analytical pipette (5mL +/- 0.030 mL), stop watch (+/- 0.01 s)
AC 100 & ALEXYS data system *or* line-recorder
AC 100 analogue input cable for LC 100 (for analogue pressure monitor)
Digital voltmeter (resolution equal to or better than 0.1 mV)
LC 100 service program software (in case re-calibration is required).

Contents of shipping box

Check the contents of the shipping box, before you start the Preventive Maintenance, to make sure you will have all necessary parts available:

The Shipping box contains the following parts:

- 182.0026 LC 100 Preventive Maintenance procedure.
- 182.0028 LC 100 Preventive Maintenance checklist.
- Preventive Maintenance parts according the following lists:

182.3000 PM spare parts for the LC 100 analytical pump head:

Part no.	Description	Qty
182.0416	Piston seal for 1/8", aqueous	2
182.0422	Piston wash seal 1/8", aqueous	2
182.0364	O-ring washing unit an. or micr.	2
182.0360	Kel-F ring for washing unit, analytical	2

182.3002 PM spare parts for the LC 100 micro pump head:

Part no.	Description	Qty
182.0418	Piston seal /piston wash seal 1/16", aqueous	4
182.0364	O-ring washing unit an. or micr.	2
182.0332	Kel-F ring for washing unit, micro	2

Contact your supplier in case of damage or if not all marked items on the checklist are included.

Recommended spare parts

The following list gives an overview of the parts, recommended to have available when performing a preventive maintenance on a LC 100. Refer to the user & service manual (p/n 182.0010 & 182.0020) for instructions on replacement if necessary.

Part no.	Description
182.0366	LC 100 inlet capillary
182.0368	LC 100 s-link capillary
182.0372	LC 100 outlet capillary
182.0374	LC 100 purge valve inlet capillary
182.0356	LC 100 check valve screw
182.0312	Piston spring analytical (sec.)
182.0318	Piston spring micro & analytical (prim.)
	Analytical pump head:
182.0346	Zirconium piston 1/8"
182.0348	Sapphire support ring for piston 1/8"
182.0352	Check valve cartridge 1/8" (inlet)
182.0354	Check valve cartridge 1/8" (outlet)
	Micro pump head:
182.0320	Zirconium piston 1/16"
182.0322	Sapphire support ring for piston 1/16"
182.0326	Check valve cartridge 1/16" (inlet)
182.0328	Check valve cartridge 1/16" (outlet)

Preliminary Observations

Before PM is started, talk to the end users about any unusual observations they have made, or anything that has changed since the last PM or service visits. Perform general visual inspection of exterior of the pump (Check for damage, leakage, corrosion, salt crusts etc.)

C H A P T E R 2

PM procedure LC 100 pump

The sections on the next pages describe the complete PM procedure of the LC 100 pump step-by-step.

The following parts should be replaced:

- Piston seals
- Piston wash seals
- Parts of piston back flush assembly: Kel-F rings & silicone O-rings

The following parts should be inspected, cleaned and in case of damage or malfunction be replaced:

- Inlet and outlet check valve
- Pistons & springs
- Sapphire support rings
- Flushing tubes

The following test procedures should be executed to check if the pump operates within specifications:

- Flow rate deviation measurement
- Residual pressure pulsation measurement

It may be necessary to re-adjust the pump in case the performance specifications are not met.

Before starting the PM procedure make sure you have all correct parts available. All steps of the PM procedure should be recorded in the LC 100 Preventive Maintenance checklist (182.0028). The customer has to sign off the results of the PM procedure for approval.

Replacement of piston seals

For replacement of the piston seals on the high pressure side, proceed as follows:

1. Remove the FEP inlet tubing connected to the LC 100 inlet capillary (Figure 1, 1).
2. Remove the pump head from the pump by removing the outlet tubing (Figure 1, 3) and the four bolts at the front of the pump head. In the case of an analytical pump head put marks on the piston guide tubes to discriminate which one is right, and left!

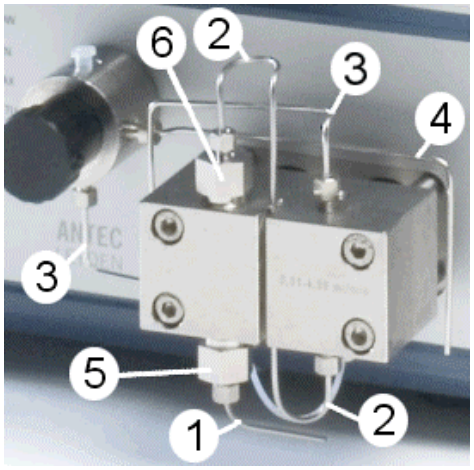


Figure 1. Front view of LC 100 pump head.

3. Remove the piston guide tubes from the head.

Note that both piston guide tubes of the analytical pump head are different, place marks and do not interchange them!

4. Take the O-ring, piston flushing tube, and sapphire ring out of the pump head. If the sapphire ring does not come out, use a pipette tip to pick it up.

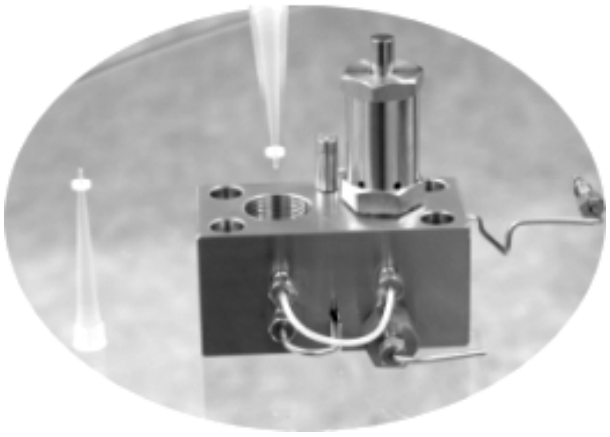


Fig. 2. Taking out the sapphire ring carefully, using a pipette tip.

3. Remove old seal using special tool as shown in Fig. 3. Place the shaft in the pump head; screw the tool in old seal and with the thread of the tool pull out gently the old seal.

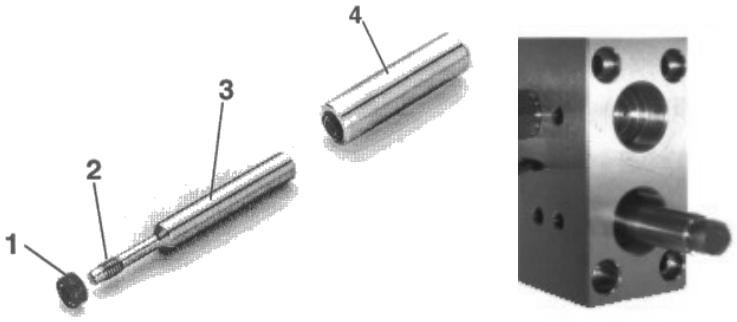


Fig. 3. Tool for taking out old seal. Piston seal (1), thread (2), shaft (3) and setting sleeve (4).

4. After removal of seals clean the pump head thoroughly with water and check carefully that no particles are left.
5. Press the new seal firmly but manually into the tool, the seal spring being in outside position (must be visible, see figure 4). Then put the tool into the pump head and press the seal into its seat inside the pump head using the other end of the piston pull-out tool.

Fig. 4. New seal in replacement tool.

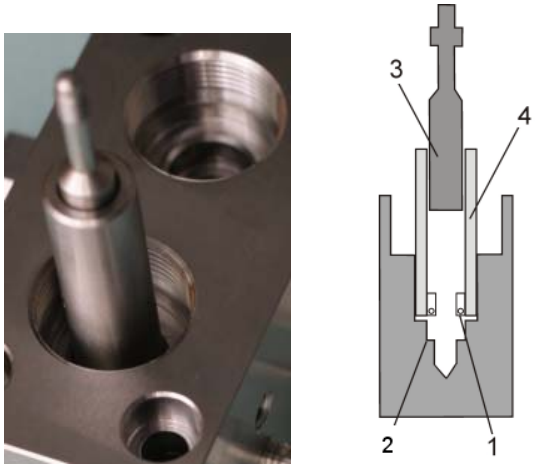


Fig. 5. New seal (1) pushed in place (2) using seal tool (3, 4).

Inspection of check valves

To inspect and clean the inlet and outlet check valve, proceed as follows:

1. Remove the check valve cartridges from the pump head (Figure 6). **Do not open the check valve cartridges!**
2. Inspect the outside valve cartridges visually. In case of signs of damage (plastic side), replace the valve cartridges with new ones.
3. Put valves in a beaker with methanol or iso-propanol, and clean them ultrasonically for about 5 min.
4. After cleaning, take out check valve cartridges and shake the valve in up and down ward direction. Listen for ticking of the sapphire ball in the check valves. This indicates that the check valves are freely moving, if not, repeat step 3.
5. If in case of repeated cleaning the sapphire balls are still not freely moving, replace the valve with a new one.

Note that the check valve assemblies are different, do not interchange them! Interchanging the valves will destroy the seals since an extreme pressure is then built-up inside the working cylinder.

6. Reinstall the valves. Make sure that the plastic side of the cartridges are in contact with the pump head and that the cartridge is centered in the middle. Use gently force to fix the check valve screws.

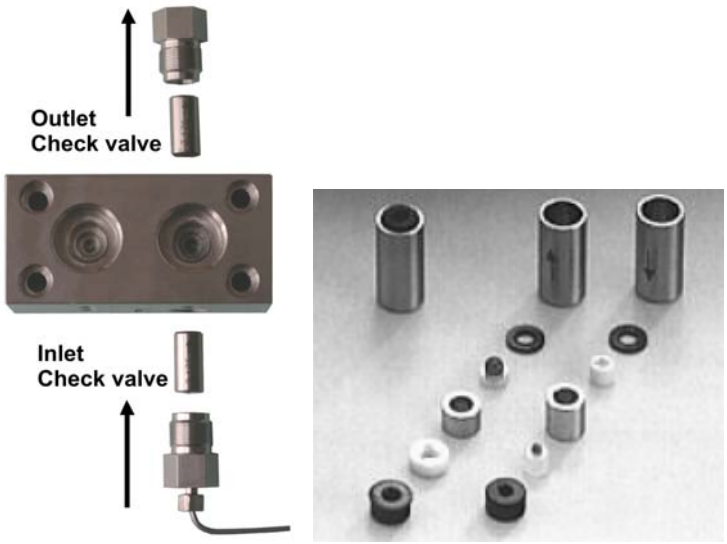


Fig. 6. Exploded view of pump head and check valves. Note the arrows on the check valves should point the direction as indicated.

Inspection of pistons and piston springs

To inspect and clean the pistons and piston springs follow the procedure below:

1. Open both piston guide tubes to release pistons and piston springs (Figure 7).

Caution the piston guide tube is under spring pressure ! Hold the cartridge and cartridge screw firmly when opening the guide tube

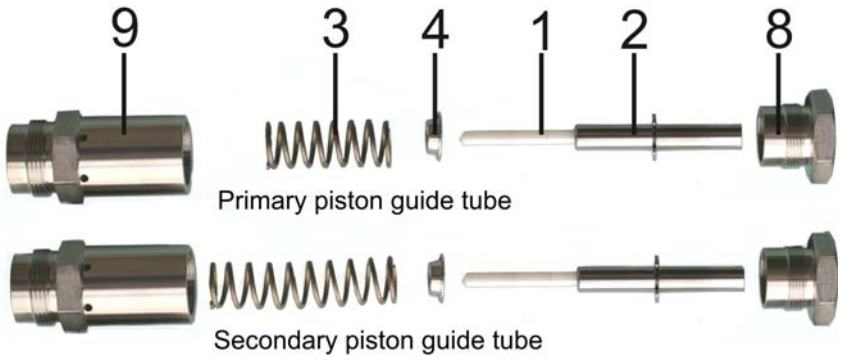


Fig. 7. Exploded view of piston guide tubes: 1. piston, 2. piston shaft, 3. spring, 4. ring, 8. piston cartridge screw, 9. piston cartridge.

Note that both piston guide tubes of the analytical pump head are different, do not interchange them. For the micro pump head the piston guide tubes for the primary and secondary cylinder are identical.

1. Check the piston springs for damage or corrosion. In case of damage or corrosion replace the springs with new ones.
2. Clean the pistons with methanol or iso-propanol.
3. Inspect the piston surface with a magnifying glass for scratches or other damage. In case of a damaged surface replace the piston with a new one.
4. When servicing a micro pump head reassembly the piston guide tubes again. In case of a analytical pump head do not reassemble the part yet, but follow the instruction in the next section.

Replacement of piston wash seals

To replace the piston wash seals execute the following procedure:

Analytical pump head

1. Remove the white Kel-F ring covering the piston wash seal located inside the cavity in the piston cartridge (figure 8, 3).

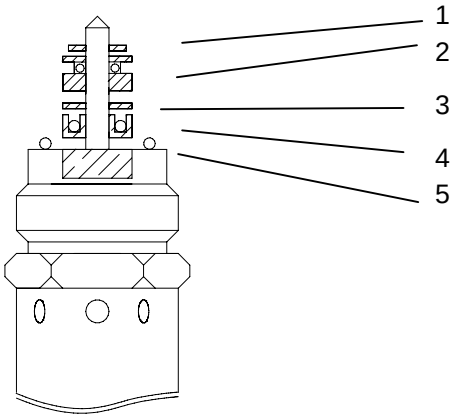


Fig. 8. Piston wash assembly, analytical pump head

1. Sapphire support ring 1/8"
2. Flushing tube 1/8"
3. Kel-F ring 1/8"
4. Piston wash seal 1/8"
5. O-ring

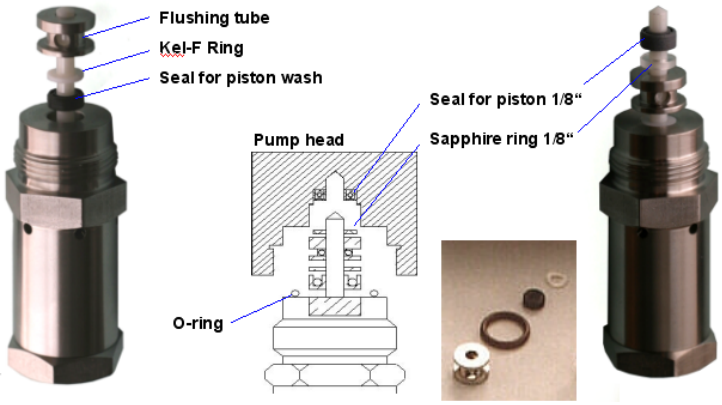


Fig. 8. Piston cartridge and piston wash assembly, analytical.

2. Remove the piston wash seals (Figure 8, 4) from its seat in the piston cartridge using the seal replacement tool.
3. After removal of seals clean the seats in the piston cartridge thoroughly with water and check carefully that no particles are left.
4. Install new piston wash seals manually. The seal springs should face towards the pump head. So the seals should be visible from the outside of the piston cartridge.
5. Re-assembly the piston guide tubes (see figure 7).

Micro pump head

1. For the micro pump head the piston wash seals (figure 10, 3) are integrated in the flushing tube ((figure 10, 2) Remove the piston wash seals from its seat in the flushing tube using the seal replacement tool.
2. After removal of seals clean the seats in the flushing tube thoroughly with water and check carefully that no particles are left.
3. Install new piston wash seals manually. The seal springs should face towards the pump head. So the springs should not be visible from the outside of the flushing tube.

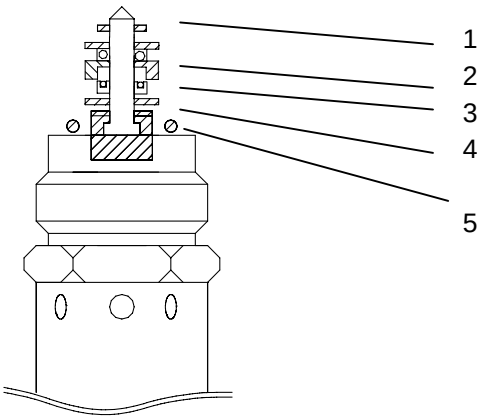


Fig. 10. Piston wash assembly, micro pump head

1. Sapphire support ring 1/16"
2. Flushing tube 1/16"
3. Piston wash seal wash 1/16"
4. Kel-F ring 1/16"
5. O-ring

Inspection of sapphire support rings

1. Clean the sapphire support rings with methanol (figure 8, 1 or figure 10, 1 in case of a micro pump head).
2. Inspect the sapphire support rings for damage using a magnifying glass.
3. In case of visible damage replace the support ring.

Replacement of Kel-F rings & O-rings

Before reassembly of the pump head:

1. Replace both Kel-F rings (figure 8, 3 or figure 10, 4 in case of a micro pump head).
2. Replace both O-rings (figure 8, 5 or figure1 0, 5 in case of a micro pump head).

Reassemble pump head and reinstall pump head on the LC 100 pump body.

During assembly of the pump head keep piston in upward position, to avoid parts falling of the piston.

Fig. 10. During assembly keep piston in upward position.

C H A P T E R 3

Performance check LC 100

After replacement of all parts in the preventive maintenance procedure the performance of the LC 100 should be checked by means of a flow rate deviation and residual pressure pulsation measurement. See for detailed information the LC 100 service manual (182.0020).

Set-up

Mobile phase	Degassed & filtered HPLC-grade water
Piston wash	HPLC-grade water
Capillary	1/16” PEEK restriction capillary (127 um I.D)
Flow meter	calibrated flowmeter or graduated analytical pipette & stopwatch
P	system pressure between 100 - 200 bar
P signal	Analog pressure output of the pump monitored using an AC 100 and ALEXYS data system software, sampling frequency 10 Hz, or line-recorder
Pmonitor	LC 100 time constant: high (2 sec)
kappa	45 (compressibility)

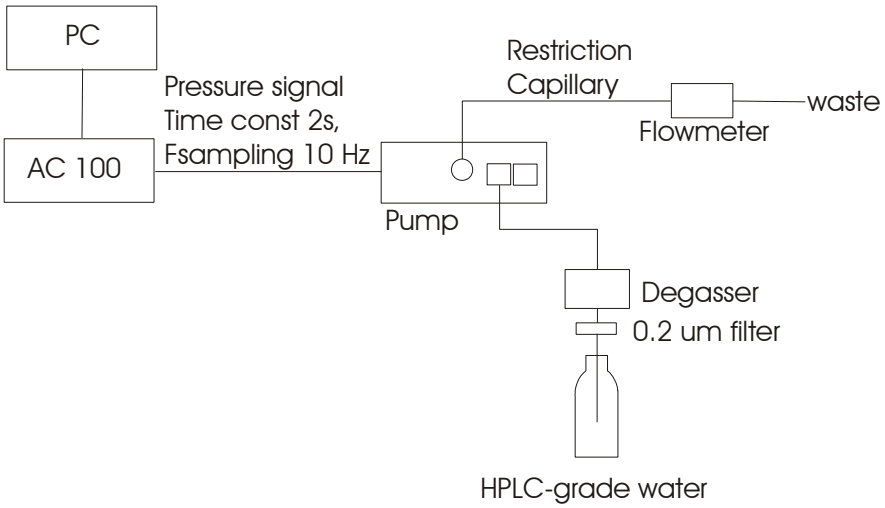


Fig. 11. Test set-up for measuring flow rate deviation & pressure pulsation.

Seal run-in procedure

Before executing the actual test procedures described below let the pump stabilise for at least 30 minutes at a flow rate of 1 mL/min to allow the new seals to run-in. Make sure that you have the piston wash connected and that the low pressure compartment of the LC 100 pump head is filled with wash liquid. The wash liquid is necessary to create sufficient lubrication between piston wash seals and piston. The absence of wash liquid may result in damage of the new piston wash seals. It is advised to monitor the pressure signal during the run-in test. This will give an indication about the stabilisation of the system pressure and if the pump is operating correctly.

Pressure pulsations test

1. Connect AC 100 (controlled by ALEXYS software) or line-recorder to the analogue pressure monitor (1mV/MPa) to monitor the pump pressure .
2. Set the compressibility Kappa to 45.
3. Set TIME CONST. to HIGH (2s).
4. Set the flow rate to 1 mL/min.
5. Press <R/S> to start the pump.
6. Record the pressure signal for 10 minutes via the pressure monitor output at 1 mL/min.
7. After 10 minutes stop the flow and record the pressure signal for 5 more minutes to determine the pressure at 0 mL/min.

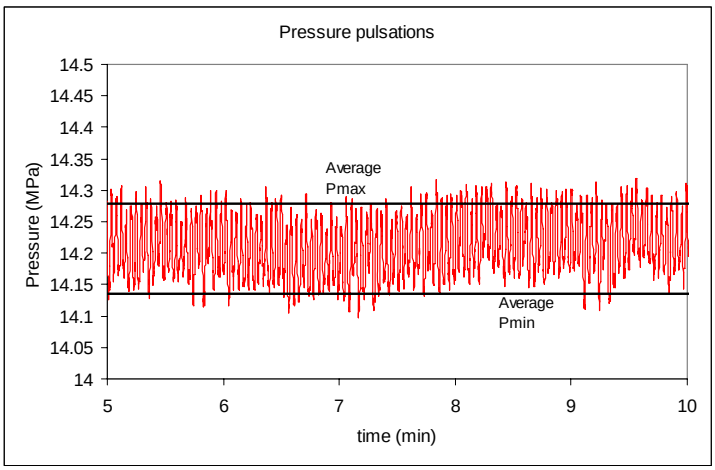


Fig. 12. Pressure signal with lines indicating Pmax and Pmin.

8. When using a line recorder determine the average maximum and minimum pressure values at 1 mL/min, as depicted in figure 12 . Draw straight parallel lines through minimum and maximum. Subsequently, determine c (c = Pmax-Pmin).

When recording a pressure profile with the AC 100, export the data to excel, and determine the average pressure signal at 0 and 1 mL/min, and the standard deviation σ of the pressure signal at 1 mL/min. Use the standard deviation to calculate c ($c=4\sigma$).

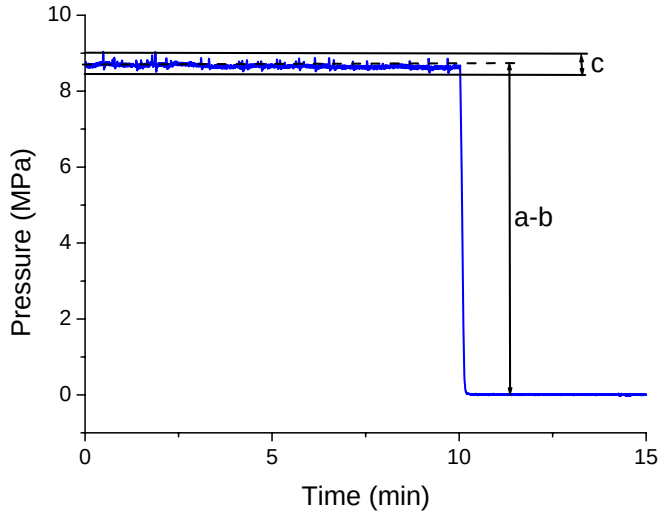


Fig 13. Calculation of pressure pulsations %P.

9. Calculate the residual pressure pulsations in the following way (see figure 13):

$$\%P = \frac{c}{(a-b)} * 100$$

Where:

c = Pmax - Pmin (MPa) *or* 4σ .

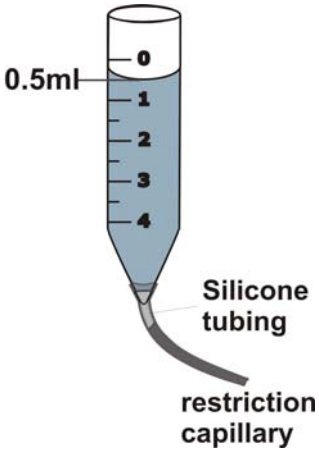
a-b = Actual system pressure (average pressure at 1 mL/min - average pressure at 0 mL/min)

Pressure pulsations %P must be smaller than < 3%.

10. If the instrument fails test, first check for leakage or air in system, if pump head is assembled correctly and all critical parts (check valves, pistons etc.) are in tact . After set-up and pump head are checked and the problem remains consult the test & readjustment section in the service manual.

Flow rate deviation test

1. Set the flow rate to 1 mL/min and check if purge valve is closed.
2. Connect the inlet of the graduated analytical pipette to the outlet of the restriction capillary using a short piece of silicon tubing (see figure 14). Or connect the restriction capillary to a calibrated flow meter.
3. Press <Run/Stop> to start the pump.



Correct volume reading from the pipette is at the lowest point of the meniscus.

Fig. 14. Flow measurement with graduated 5 mL pipette.

4. Measure the flow rate with the pipette using the following procedure: start the stopwatch exactly at the moment that the liquid meniscus in the pipette passes the 4 mL line (for a good reading it is important that the pipette is kept perfectly vertical).
5. Stop the flow rate exactly at the moment that the liquid meniscus in the pipette passes the 0 mL line.
6. Calculate the actual flow rate. Flow rate = 4 mL/ stopwatch time (min). In case of using a calibrated flow meter complete 5 flow meter readings and calculate the average. Subsequently calculate the flow deviation:

   $$\text{Flow deviation \%} = \frac{\text{(actual flowrate - set flow rate)}}{\text{set flow rate}} * 100$$

   The flow deviation should be smaller than +/- 3%.
7. Repeat this experiment at 2 mL/min.

8. Also at a flow rate of 2 mL/min the flow deviation should be smaller than +/- 3%.
9. If the instrument fails test, first check for leakage or air in system, if pump head is assembled correctly and all critical parts (check valves, pistons etc.) are in tact . After set-up and pump head are checked and the problem remains consult the test & readjustment section in the service manual.