Detailed Inj/Repl System Troubleshooting

General Points

To date, problems experienced in this system have been primarily from these causes:

The use of heavy salt electrolytes

These tend to precipitate, causing plugs, especially in the replenishment needle assembly or inside the level sense capillary (“blue restriction capillary”). Installing a vial of pure water in tray position# 49 is useful to minimize the formation salt crystals on the replenishment needles. Periodic use of the Clean Tubes function and the Clean Levelsensor diagnostic is recommended.

The use of high concentration surfactants (soaps)

These tend to bubble in the vial being replenished, causing level sensing problems. This can be mitigated by the use of a two-step replenishment for each vial. Periodic use of the Clean Tubes function and the Clean Levelsensor diagnostic is also recommended. Therefore the current firmware revision should be installed.

Misalignment of the replenishment double needle assembly

Causing it to be bent when the replenishment lift assembly is raised. When doing any work in this area, carefully check the alignment of the replenishment needle assembly/replenishment lift pre-puncher.

Reversing the A and B tubes at the replenishment needle assembly

This causes the long needle to attempt the role of level sensor. The ultimate effect of this problem is the instrument makes several unsuccessful attempts to replenish a vial, and terminates the operation with a TIMEOUT DURING REPLENISH message in the logbook.

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Particles from the vial cap or dust inside the vials

This causes a blocked replenishment needle or even a blocked level sense capillary ("blue restriction capillary") in the fill valve which results in a continuous drip at the long needle. This has been fixed by the introduction of the current filter design.

Poor sealing between bottle and bottle caps

This problem has been largely corrected by the implementation of sealing O-rings in the bottle cap assemblies.

Troubleshooting the Inj/Repl System by Symptom

Match your symptom to one of the symptoms below:

System fails to generate pressure and/or vacuum at turn on

AIRPUMP FAILED TO GENERATE PRESSURE/VACUUM messages are set. The troubleshooting procedure is similar for either problem.

The problem is related to pressure or vacuum. For either a pressure or vacuum problem:

- Are bottles present and not cracked? Are bottle caps tight?
- Are the bottles themselves defective? Try adding cap O-rings.
- Is the inlet air filter very dirty? Remove it and try again.
- Is the air pump running? If no, is AC being applied to the pump? Is the rear pump fuse ok?
- Any gross fittings leaks?

Intermittent Air pump Failed to Generate Pressure/vacuum errors

This can happen if the air pump has lost capacity, or if it takes longer than 60 seconds to regenerate pressure or longer than 33 seconds to regenerate vacuum. If vacuum regeneration is less than 1 second this problem will also occur. Check both pressure and vacuum regeneration times with empty bottles. For excessively long pressure or vacuum regeneration times:

- Are bottle caps tight
If the problem is an EL5208 vacuum error which occurs only when there is liquid in the waste bottle:
o Is the volume in the waste bottle more than 400 ml? If yes, empty the waste bottle. If no, install a restrictor in the vacuum sensor tube.

**System pressure and vacuum are ok at turn on, but in the flush mode pressure loss is excessive, or the AIRPUMP FAILED TO GENERATE PRESSURE message is set.**

If pressure is now stable:

o Does the inlet lift push the bottle all the way up?

o Is the inlet lift oscillating? If yes, check CE firmware revision; must be 1.4 or greater.

o Is the inlet pre-puncher sealing correctly?

If pressure is still unstable:

o Loose or leaky fitting?

**Initial pressure and vacuum are ok, and the flush mode works ok, but pressure injections fail. The injection pressure profile is poor or missing, the INJECTION AREA OUT OF LIMITS or INJECTION TIMEOUT condition is set**

Is the inlet lift oscillating under pressure? If yes, check CE firmware revision; must be 1.4 or greater.

**Pressure and vacuum are ok, but replenishment, or the individual fill and empty operations, fail. The REPLENISHMENT TIMEOUT condition is set**

**NOTE** Watch out for heavy salt electrolytes, which tend to precipitate and cause plugs.

1 Most commonly, failures of the replenishment operations are caused by defects in the level sensing circuit. Check the level sensing circuit:

2 Are the A and B tubes reversed, either at the replenishment needle assembly

3 If the level sense circuit is ok, check the long needle for a plug, or check the path between the electrolyte bottle and the long needle for plugs. Excessive restriction might reduce the fill flow rate to the point where the 2-minute replenishment timeout elapses before the expected vial level is reached.
If the electrolyte is very viscous, the fill flow rate might be reduced to the point where the 2-minute replenishment timeout elapses before the expected vial level is reached.

**CLEAN TUBES problems**
The function works, but the liquid exchange is slow, or the selected vial emptying/filling operations fail.

1. Are pressure and vacuum ok? If not, troubleshoot pressure/vacuum problems as described above.

2. If your problem is the liquid exchange is too slow:
   - Electrolyte filter dirty?
   - Liquid too viscous?

3. If your problem is failure of the emptying/filling operations, troubleshoot for replenishment problems as described above.

A continuous drip of liquid can be seen coming from the long replenishment needle. The drip stops when the electrolyte bottle (pressure) is removed

To date, this symptom has been caused only by a defective fill valve. The valve was damaged either by particles or by precipitation of heavy salt electrolyte.

**Bent replenishment needle assembly caused liquid to be sprayed all over the replenishment lift assembly during the attempt to replenish**

If careful alignment is not observed, the replenishment needle assembly is easily bent as the replenishment lift assembly is raised. In this case, the double needle assembly no longer goes correctly through the pre-puncher into the vial. If an attempt to replenish is made in this state, the following happens:

- The vial is raised up, looking for the current liquid level. Since an empty vial is legal, the fact that the short needle never touches liquid does not stop the process.

- The filling step begins. Liquid is sprayed from the long needle in whatever direction it happens to be!

- The level sensing circuit is waiting to eventually feel the level of liquid as it expects the level in the vial to rise. After 2 minutes without sensing a level, the filling stops. 2 minutes of liquid has been sprayed into the instrument!
Vials are overfilled during replenishment

This can happen if circumstances are such that the level sensing is not working. In this case, a vial could potentially be filled for 2 minutes; the timeout period if a level is not sensed during filling. In this case, troubleshoot a general replenishment problem as described above. Also, a dripping long needle (see F above) may contribute to this problem.

Flush function seems normal, but capillary has chronic current problems

It’s possible that the inlet pre-puncher air inlet fitting is plugged in such a way that the pressure system is pressure-tight, but pressure is not actually reaching the vial. This happens most frequently when heavy concentration salt electrolytes or surfactants are used. Since the vial is not being pressurized, the pre-conditioning table is not actually being carried out. The conductivity of the capillary is therefore unreliable when High Voltage is applied.

Air pump fails to run when instrument is turned on

check the main line voltage setting or the air pump fuse. Try a new air pump.

Simple troubleshooting of the External Pressure System

General: The external source pressure applied to the instrument MUST be at least 3 bar greater than the external pressure setpoint. A source pressure/setpoint differential of less than 3 bar causes external pressure regulation to be unreliable. Also, try to make sure that the full recommended 15 bar of external source pressure is available in every case. Then, the system can always deliver and correctly regulate the maximum external pressure setpoint of 12 bar. This eliminates the possibility that the user accidentally creates a source pressure/setpoint differential which is too small. Cases where the external source pressure and the external pressure setpoint are too close together can have symptoms which are intermittent and hard to troubleshoot. In such cases, be on the lookout for valves which "don’t sound right!".

15 bar = 217.5psi

It seems that house air and nitrogen regulators are often limited to only 100 psi (about 7 bar). In this case, the external pressure setpoint may not be greater than 4 bar.

A. Sights and Sounds of a Correctly Operating External Pressure System

When the application of external pressure begins, the lift(s) move up to the sealing position. Then, the external pressure generation starts. The "clicking" of valve(s) which is now heard depends on whether the external pressure setpoint for this run is higher or lower than the last external pressure setpoint. In other words, is the external pressure already present in the external pressure valves manifold cavity higher or lower than the current external pressure setpoint?
When going from no or low external pressure to higher external pressure, only a few clicks (1-3) should be heard as the system develops external pressure to reach the setpoint. If the external pressure setpoint exceeds the available external source pressure, the result is not excessive valve clicking. In this case, the system will pressurize up to the maximum available external source pressure, and then remain in a not ready: high pressure condition. In the current instrument firmware, this not ready: high pressure condition will then be permanent. However, it can be cleared by just switching HPCE modes, or using the forceready function of the service diagnostics disk. Ordinarily, the value displayed in the external pressure icon represents the external pressure setpoint (correctly achieved and regulated). In this unique case, the value displayed in the icon can be taken to represent the available external source pressure.

When going from higher to lower external pressure, several clicks are heard; much more pronounced than the clicking described above. This is because the system reduces pressure by activating/deactivating the hipot valve. In a correctly operating system, this is the only case where so much valve clicking should be heard.

The system cannot reduce the external pressure from 12 bar all the way down to 2 bar in only one try. Typically, external pressure can be reduced from 12 bar to about 4 bar. The next attempt at 2 bar will then reduce and regulate external pressure to the 2 bar setpoint correctly. In this case, it is suggested to use the manual apply external pressure function to reduce pressure before the run.

When the external pressure setpoint has been achieved, and the run is in progress, clicks may occasionally be heard if the system needs to regenerate external pressure. In a correctly operating, pressure tight system, the frequency of normal external pressure regeneration is entirely dependent on the method, instrument operating mode and other factors. In a correctly working system, the value displayed in the external pressure icon represents the external pressure setpoint.

a. The displayed value does not have to exactly agree with the setpoint. Typically, the displayed value and the setpoint may be different by .1 or .2 bar. Remember, external pressure is a raw pressure, similar to the 940 mbar flushing pressure. The finely tuned regulation of a 50mbar pressure injection is not possible or needed.

b. Typically, if the original displayed value drops by .1 or .2 bar, the system will regenerate external pressure, and the original displayed value will return. Normally, a single such regeneration requires only one or two valve clicks.

B. A Simple Test to Evaluate External Pressure Tightness

Pressure Tightness is a subjective term, just as it is when evaluating the tightness of the low pressure (940 mbar) flushing system. The following is a simple test, with some typical tightness criteria. Recommended criteria are the result of measurements using three instruments of varying ages and cleanliness conditions.
The criteria are conservative.

1 Install the 40cm, 50um (green) test capillary.

2 Make sure that the full 15 bar of external source pressure is available to the instrument.

3 Freshly cap two buffer vials, and install them in the inlet/outlet positions of your choice. The vials should be empty.

4 Put the instrument into its CEC mode.

5 Apply some high external pressure to the inlet vial for a few minutes; until you’re sure that the capillary is empty. If needed, you can observe the capillary outlet during this flush by assigning an empty tray position as the outlet. Using the manual apply external pressure functions (under the external pressure icon), apply 12 bar pressure for 5 minutes to inlet vial, then outlet vial, then both vials. Typical criteria follow. The results of these tests should only be used as one factor in an overall problem diagnosis.

**For inlet/outlet vials:** during these tests, pressure is escaping through the empty capillary. No more than one regulation click every 6 seconds is acceptable.

**For both vials:** during this test, there is no theoretical escape for pressure.

Best case - no regulation clicks during the entire 5 minutes.

Worst case - no more than 1 regulation click per minute.

Remember, if you determine that there are sealing problems in the lift(s), also consider the possibility that the top cover is not applying enough downward force on the cassette. To review recent information about that possibility:

* Need to replace top cover gasket G1600-27104?

* Cassette itself, or electrode isolation base defective?