

Comparison of pumps, syringes and flow stability

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INTRODUCTION

Flow stability is a key parameter which influences the precision of measurement in microfluidic systems (including microdialysis) with electrochemical sensors. The short term flow instabilities analysis can be found (in principle) in technical specifications of pumps. The long term stability is studied here.

The flow stability measurement was done in 10 hours experiments. Details of flow measurement principle can be found in poster named 'Efficiency Wall-Jet Cell FC2' by I. Ventrubová.

EXPERIMENT AND METHOD

Tested pumps:

- BVT linear pump (LP) - The pump is not certified. It was measured as a reference.
- Technic I (AMV) - Producer is located in same region as BVT. Effective collaboration enables change of pump properties. Certified for clinical use.
- Argus 606 S (SN 10007005) - It was evaluated as the best linear pump, based on references. Certified for clinical use.
- Argus A707 - Reference infusion pump. Certified for clinical use.

Tested syringes:

- B Braun Omnifix 50/60 ml
- Terumo 50/60 ml
- Codan 50/60 ml
- B Braun 20ml
- Glass syringe Chirana 50 ml



Fig. 1. Different syringes

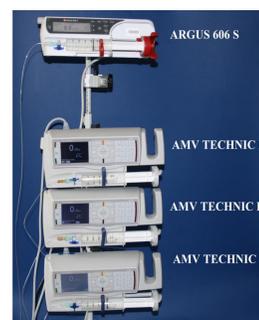


Fig. 2. Pumps

Tests:

- a) Precision and stability of flow at 10 μ L/min flow rate in 10 hours.
- b) Flow rate time profile for different syringes.
- c) Dependence of flow rate if the pump is placed in different highs (0m, 2m) – influence of additional hydrostatic pressure.
- d) Comparison pumps Technic I and Argus A707.

Methods:

1. Collecting of distilled water and weighting [a, c]
2. Solution $[\text{Fe}(\text{CN})_6]^{3-}/[\text{Fe}(\text{CN})_6]^{4-}$ redox couple in concentration 10mM. [b, c, d]
3. All measurement was done at flow 10 μ L/min.
4. Infusion prolongation tubing (FN Brno, PN 3215, ID 0,9mm) [a] or tubing ID 0,3mm in tests [a, c, d] both 2m long was used for measurement.
5. Experimental setup is in fig.2.

RESULTS AND DISCUSSION

Fig. 3 shows a typical result of 10 hour stability test. BVT pump was used with glass syringe and it was not calibrated for this syringe. There is differences among Technic I pumps flow at the same experimental conditions.

Fig. 4 shows a typical result of flow stability test of different syringes. The short term stability of flow is significantly influenced by syringe.

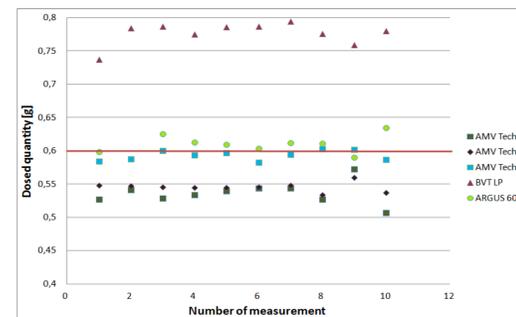


Fig. 3. Stability of doses quantity

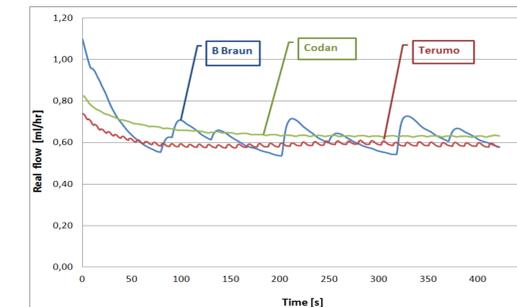


Fig. 4. Comparison of different syringes (flow rate on pump AMV Technic I 0,6 ml/hr)

Fig. 5 shows typical change of flow if the additional hydrostatic pressure (20kPa) is applied. Fig. 6 shows the comparison of infusion pump Argus A707 and linear pump AMV Technic I.

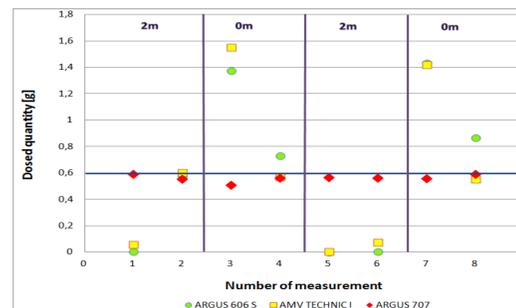


Fig. 5. Stability of doses quantity when the location of the pump is changed

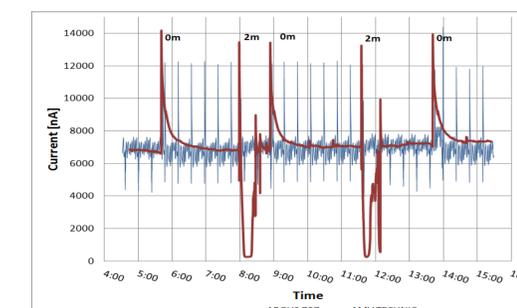


Fig. 6. Comparison of long-term stability of pumps ARGUS 707 and AMV TECHNIC I

CONCLUSION

- Additional hydrostatic pressure significantly changes the long term flow stability. The change of pressure for 20kPa (2m) destabilise the flow for 90 min if 50/60 ml syringes are used. The increase of hydrostatic pressure (movement from 0 to 2m) stops the flow for 20 minutes. The instability is caused by elasticity of syringes and pump moving arm.
- The best set up is Argus 606S and Codan 50/60 ml syringe.
- Difference between Argus 606S and Technic I is minimum.
- Short term flow stability is mostly influenced by syringes. CODAN syringe is the best.
- The syringe CODAN exhibits leakage of liquid in long term tests.
- The pump Argus A 707 is nearly independent on the hydrostatic pressure. The peristaltic mechanism generates hydrodynamic noise, which is regular and can be removed.
- Long term flow rate stability is significantly influenced by user skills and proper handling of pump and syringe.
- There is quite high difference between Technic I pumps flow rates. Only one Argus pump was tested.
- Air bubbles can generate the changes in the hydrodynamic resistance. It can generate long term flow instability (time constant 10 – 20 min).

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