Controlling a micro dosing pump
Pulsed Flow Sensor

Introduction

In this project a KNF FMM-20 dosing pump was used to dispense droplets with a size of 4 to 18 microliters. Its stroke was adjusted by a servo motor to variate the volume. For a control loop the Pulsed Flow Sensor (PFS-V3) was used as a reference.

Used Material

- Pulsed Flow Sensor
- PFS controller
- KNF FMM-20 pump (www.knf-flodos.ch)
- Mettler AT 261 balance
- Servo for stroke adjustment
- Water container
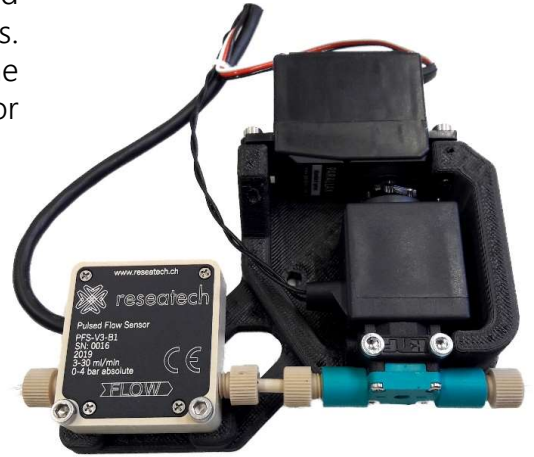- PVDF 1/8" Tubing

Image 1: PFS and FMM 20 Pump stroke adjustment

Experiment setup

The Pulsed Flow Sensor was connected to the aspiration side of the pump. In a vertical setup, single droplets were dispensed at a frequency of 1Hz. The tube between sensor and pump was kept as short as possible to prevent damping.

Stroke and droplet Volume

The stroke of the FMM-20 pump is varied by turning an adjustment screw from 0 to 100°, while in figure 1, 100° is the minimal stroke and 0 the full stroke height of the pumps plunger.

Figure 1: Relation of stroke angle to volume dispensed is almost linear.

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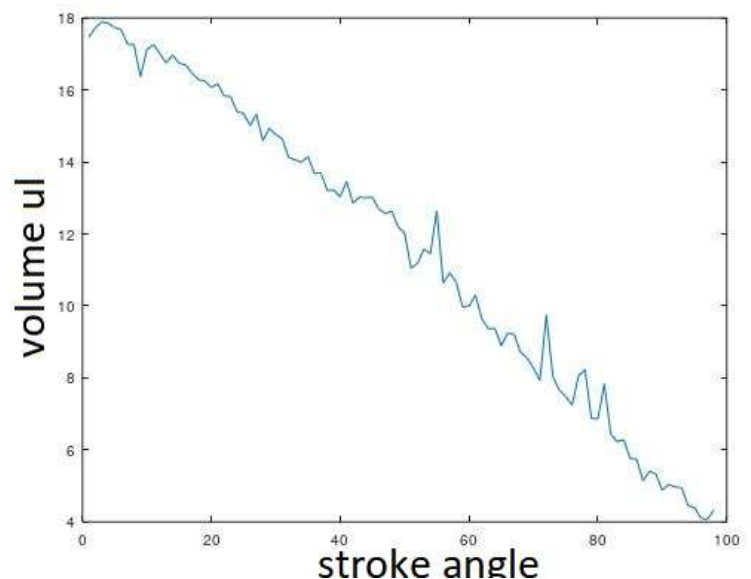
Measurements:

For 35 different plunger strokes, the droplet volumes were recorded by the Pulsed Flow Sensor at a sampling rate of 20 kHz. The data shows:

- Small plunger strokes show an earlier raise in flow than big plunger strokes
- Big plunger strokes show a plateau and an acceleration before closing
- The closing event at 50 ms and the post-pulse oscillation is very reproducible.
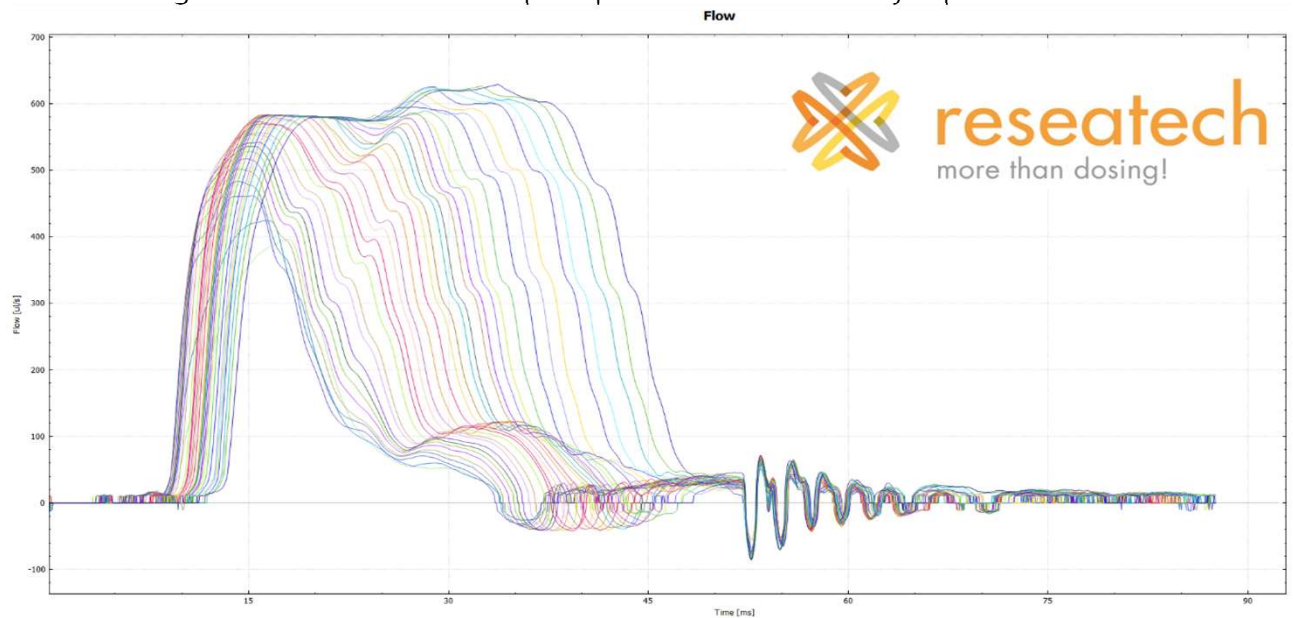

Figure 2: Volume flows produced by continuously increased plunger stroke.

Implementing a control circuit

With a PID control loop the droplet volume was guided to follow a Target volume of 0, 12 and 7 microliters per shot. The flow sensor signal was used as the control variable. As a second reference, a balance measured the droplet volumes.
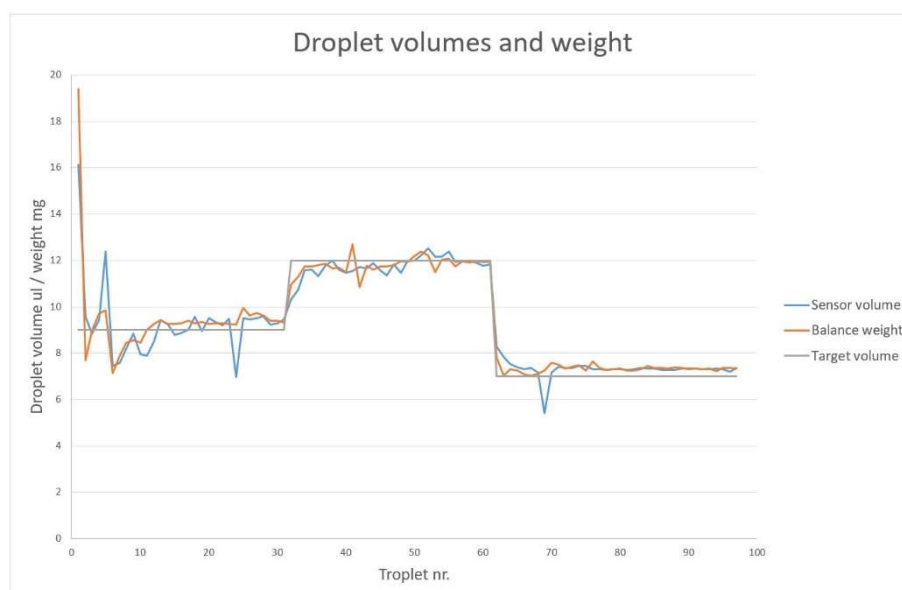

Figure 3: a control loop adjusts the plunger stroke to follow the targeted volumes.