Turbisc Pump with an Integrated Flowsensor for Closed-loop Operation

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To target applications such as precise liquid dispensing, driving liquids in compact fluidic systems or dispensing of adhesives, the Turbisc pump has been developed at CSEM [1]. Since the pump offers pulsation-free flow and very fast liquid acceleration, a closed-loop operation using a flow-rate feedback is facilitated, which in turn enables precise metering and with it accurate dispensing of liquid volumes regardless of flow-resistance and backpressure.

The Turbisc pump [1] has proven to be a valuable tool in dispensing and other applications where a quantification of the volume flow is essential. Hence an advanced version of the Turbisc pump was developed including an integrated flow-sensor. Within a width of only 8 mm the Turbisc pump, the flow-sensor, as well as the control electronics for closed-loop operation are combined (Figure 1).

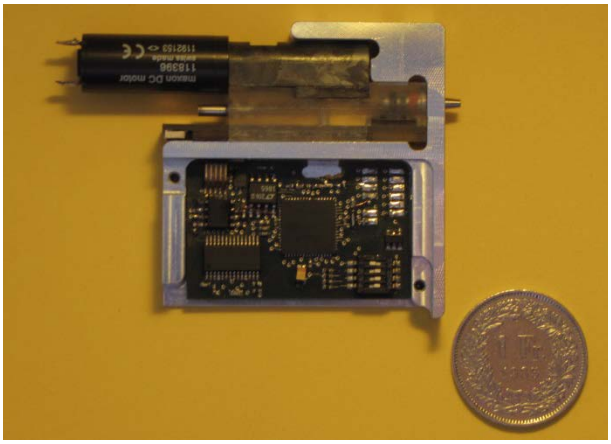

Figure 1: Turbisc pump with an integrated flow sensor and closed-loop control electronics utilizing CAN interface for communication.

The flow-sensor is implemented as a differential pressure sensor. Thus, the flow can be determined from the liquid-viscosity, the dimensions of a flow restriction and the pressure difference across this flow restriction.

If, for instance, a constant flow through the pump is desired, the pump controller manages the motor speed to warrant the desired flow-rate. Figure 2 shows a measurement of the two pressure signals during a constant flowrate run of the Turbisc pump.

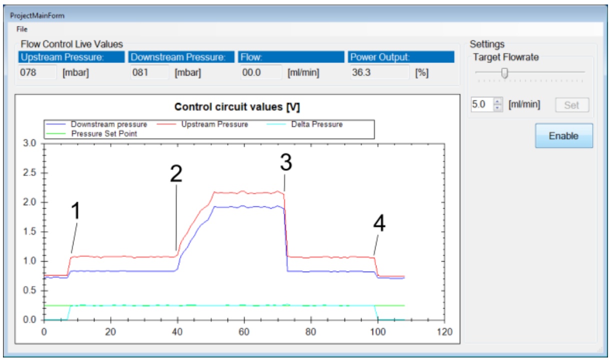

Figure 2: Constant flowrate run of the closed-loop Turbisc pump. Red and blue represent the upstream and downstream pressure of the flow restriction, the set point for pressure difference is displayed in green and the measured pressure difference in magenta.

At the beginning of the run the pump is disabled and set point and measured pressure difference are unequal. At point 1 the motor is activated and the controller sets the motor speed until the pressure difference needed for the given flow-rate is reached. If backpressure (flow resistance) is increased (by turning the dial in Figure 3), both up- and downstream pressure signals rise (point 2) and the controller increases the motor speed, keeping the pressure difference constant. At point 3 the backpressure is reduced to its original value, thus the motor speed and the absolute pressure values are reduced to their former values. At point 4, the closed-loop control is disabled and delta pressure is reduced to zero (no flow) as the pump is stopped.

Clogging can be detected by observing the flow-rate. By integration of the flow-rate over time, the absolute dispensed volume can be calculated.

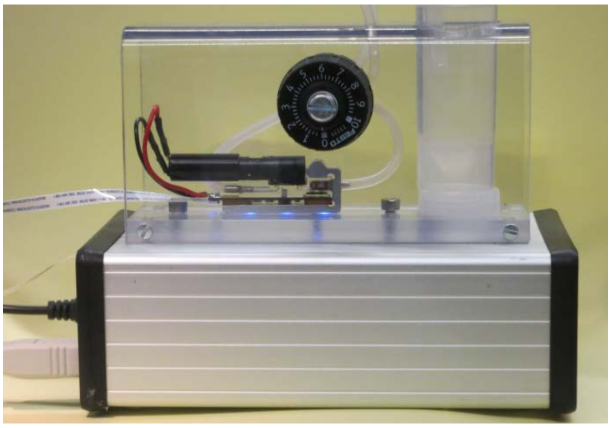

Figure 3: Demonstrator of the Turbisc pump with an integrated flow-sensor. An arbitrary flow resistance can be set with the dial.

The closed-loop operation of the Turbisc pump widens its field of applications by combining the strengths of the pump design, such as its small size, bi-directional and pulsation-free pumping and fast acceleration with a controlled flowrate. This enables exact volume dispensing, including dispensing of small volumes (droplets), which, for instance, is difficult with comparatively heavy syringe pumps. Potential fields of application are laboratory equipment, biomedical devices or generally any application requiring compact fluid actuation solutions.

This work is supported by the Swiss Federation and the MCCS Micro Center Central Switzerland. CSEM thanks them for their support.

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[1] N. Schmid, T. Burch, A. Lisibach, E. Casartelli, H. F. Knapp, CSEM Scientific and Technical Report (2009), 107