

## **Master in Biomedical Engineering**

**Thesis Title:** Development of a System for the Production of Dialysis Fluid.

### **Background**

Due to the growing market of dialysis machines, manufacturers focus on potential cost reduction. The main unit in the dialysis machine is the unit for the production of dialysis fluid. All the available machines in the market use piston pumps to add the two concentrates: sodium bicarbonate and acid concentrate to the permeate water to prepare the dialysis fluid. Several disadvantages arise with the use of such pumps including the price, maintenance effort, wear and energy consumption. In this work, a novel system for the production of dialysis fluid using the suction pressure generated by one venturi injector was developed.

### **Method and Result**

The reduction in cross section in the venturi injector generates a suction pressure for the two concentrates. The addition of the two concentrates to the permeate water is controlled by the duty cycle of two solenoid valves. The conductivity measured by one conductivity sensor is used as feedback signal. Therefore, the system was split into two single input-single output (SISO) subsystems, where the addition of the first concentrate was controlled at the first stage, followed by the second concentrate. In order to simulate the inlet and outlet conditions in the dialysis machine, a stand-alone setup was constructed. Based on that setup, several modelling methods were compared. The inflectional tangent method for systems with time delay was used for modelling. After that, the root locus method was used to develop a controller and a time-delay control method was used to control the system. The system performance was tested for canister and cartridge inlets of sodium bicarbonate and for canister and central supply of acid concentrate. Moreover, the effect of the balance chamber unit on the system performance was tested. Additionally, a method was developed for the determination of the conductivity generated by sodium bicarbonate from the total oscillatory conductivity.

### **Conclusion**

The one venturi injector system is a cost effective and a low maintenance alternative to the piston pumps system. Using only one controller, the required performance was achieved for different inlet types of the concentrates. As a result, the one venturi injector system was able to provide the required dialysis fluid composition at a reduced cost compared to all the available systems in the market.

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