

PID Controlled Hemofiltration for Poison Control

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According to the U.S. Renal Data System Annual Report, there are currently over 660,000 Americans being treated for kidney failure and 468,000 of those patients are on dialysis. The kidney has several functions, including filtering blood and the excretion of wastes and toxins from the body. When a patient has renal failure they often undergo dialysis, a process in which the patient is attached to a machine which performs the filtering functions of the kidney, mechanically. Although dialysis is typically used for patients undergoing chronic renal failure, and often doesn't handle sufficient enough blood volumes to treat acute renal failure. The Maryland Poison Control center handles about 44,000 calls a year regarding people who have been poisoned with substances such as household chemicals, snake venom, alcohol or opioids.

Hemofiltration will be used to treat patients suffering from acute renal failure rather than traditional dialysis. High hemofiltration clearance levels can be achieved by taking advantage of Extracorporeal Membrane Oxygenation (ECMO). ECMO technology is capable of oxygenating the body's blood volume at a rate of 5L/min. By applying this technology to hemofiltration, thousands of lives could be saved.

Proportional Integral Derivative (PID) control was implemented using an Arduino microcontroller in order to set the flow rate for fluid replacement equivalent to the flow rate of effluent being filtered out from the system once the saline solution from the main centrifugal pump was filtered. The user could set the flow rate at which the effluent was being filtered out and the system would correct the flow rate to that value.

Results of the testing conducted showed that the relationship between Lpm and read voltage was approximately 0.1V for every 0.2 Lpm of flow. This relationship was needed to convert the desired setpoint to a voltage that could be compared to the voltage being read by the flow sensor. Based off of the information received by the sensor, the controller can adjust the flow rate as necessary. The PID controller was tested at two different flow rates against a PI controller to determine which overshoot less at the two flow rates. It was found that the PI controller was favorable in both cases of flow rates. The PI controller resulted in less overshooting and a faster response in the case of the 0.5 Lpm trial. The controller was observed to cause more overshooting at higher flow rates. This device will improve outcomes for patients with acute renal failure cases that could not be treated using current methods.