Abstract

A disposable hybrid cartridge for low-flow hemofiltration integrates: (i) a 0.6 m² hemofilter; (ii) a four-layer sorbent stack—urease/activated-carbon, titanium-phosphate cation exchanger, hydrous-titanium-oxide anion exchanger, and bicarbonate buffer—providing on-chip dialysate regeneration; (iii) a micro-pump array that meters dialysate through the column; (iv) an EEPROM that stores lot-ID, capacity byte and expiry bit to lock each cartridge to a controller; and (v) inline urea-optical, NH_3-ISE, conductivity and pH sensors. A conflict-graph scheduler in the controller arbitrates multiple closed loops and, upon sensor deviation or EEPROM tamper, diverts flow to a sterile-bag fallback loop. A twin-column variant with ceramic valves enables duty-cycled regeneration while tracking independent capacity bytes. The integrated chemistry, per-cartridge lifecycle logic and watchdog-enforced safety deliver compact, home-use dialysis with traceable single-use control, features not disclosed in prior REDY or wearable kidney art.