ASCEND: Aqueous Spectrometric Copper-Electrolytic Nutrient Detector

Bhaskar, Aditi (School: Wilsonville High School)

Runoff of surplus nutrients causes algae blooms which endanger marine wildlife. This study aspired to design and construct an accessible device which provides accurate quantitative, in-situ, cost-effective feedback on trace nutrient content to reduce excess applied fertilizer costs and eutrophication. Research's resulting device determined molarities of organic compounds (NO3)-, (NH4)+, (PO4)3-, and (SO4)2- by chemically manipulating samples independently of major user interaction. A modular vacuum physical geometry containing electrolytic and spectrometric chambers was designed. Turbid flow (Reynolds > 34,000) was maintained within chambers. 4mm-diameter inter-chamber-pathways & viscosity prevented unsolicited inter-chamber leakage. A PCB was iteratively designed, containing: display board, 5 LED/receiver ports (one per compound of interest, plus baseline), accelerometer, valve, pump (60cc/s), and interactive elements (switches & buttons). C++ code controlled the device via microcontroller using a state machine structure and "smart pauses" for button input features. Pauses moderated potentially dangerous device attributes such as conducting copper electrodes. The modular physical device can disassemble to thirteen sub-parts. Calibrations on organic compounds (NO3)-, (NH4)+, (PO4)3-, and (SO4)2- resulted in R^2 values >0.95. Mixed samples of (NO3)-, (PO4)3-, and (SO4)2- demonstrated predicted molarities to >96% accuracy using neural networks. Natural samples from local natural sources (ponds, creeks, rivers, and soil) successfully tested for (NO3)- and (NH4)+, then correlated to powder-indicator test results. Using this device with copper-electrolytic and spectrometric methods shows promising results to reduce eutrophication with accessible, low-cost materials.

Awards Won: