Oxygen Sensor Development and Evaluation

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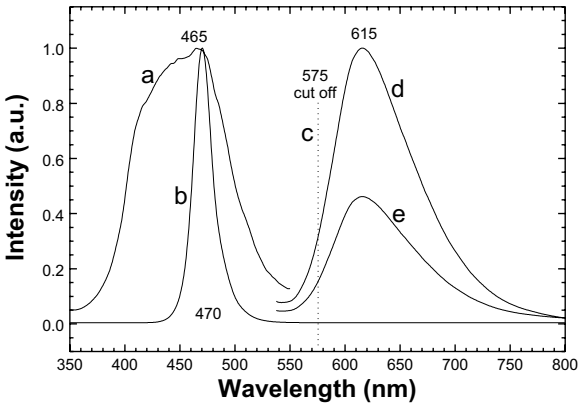
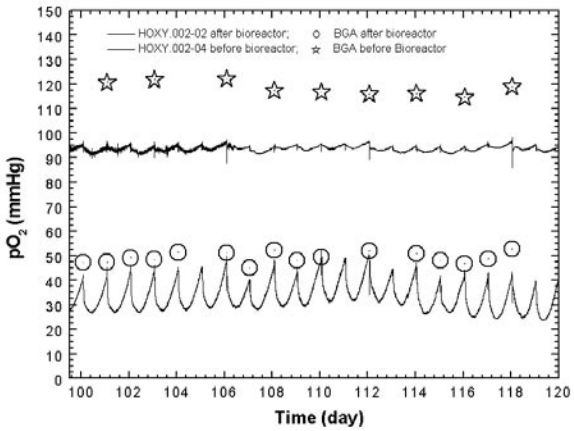
In a bioreactor, it is essential to monitor the concentration of dissolved oxygen (DO) present in the medium to determine the health of the cells. Continuous measurement of the amount of DO in the cell culture medium under sterile conditions in NASA bioreactors requires that the oxygen sensors provide adequate sensitivity and be sterile and nontoxic to the cells. The optical oxygen sensor is based on dynamic fluorescent quenching using a pulsed blue light-emitting diode light source.

The sensor is designed for long-term continuous measurement of DO concentration in the cell culture medium in perfused bioreactors. A ruthenium (II) complex is employed as the fluorescent dye indicator. The sensing element consists of a glass capillary coated inside with a thin layer of the fluorescent dye in silicone matrix and overlaid with a black shielding layer. Irradiation of the sensing element with blue light generates red fluorescence.

The fluorescence intensity is correlated to the concentration of DO present in the culture medium, following the modified nonlinear Stern-Volmer equation. We used the oxygen sensor to continuously monitor the DO present in perfused GTSF-2 medium during a BHK-21 [baby hamster kidney] cell culture in a rotating wall perfused vessel (RWPV) bioreactor for 180 days using a single calibration. We compared the DO concentration determined by the sensor with those measured regularly with the blood gas analyzer (BGA) reference. Sensor output was found to correlate well with the BGA data throughout the experiment, where the DO of the medium ranged between 25 and 50 mmHg. Stand-alone software was also developed to control the sensor and bioreactor as well as to acquire data. The data obtained from one of the cell runs is shown in the figures.

The oxygen sensor assembly.





Results from one cell run.