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Micro-Bioreactors in Space: Case Study of a Yeast (Saccharomyces cerevisiae) Bioreactor With a Non-Invasive Monitoring Method

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Abstract:
Bioreactors in space have applications from basic science to microbial factories. Monitoring bioreactors in microgravity has challenges with respect to fluidics, aeration, sensor size, sample volume and disturbance of medium and cultures. We present a case study of the development of small bioreactors and a non-invasive method to monitor dissolved oxygen, pH, and biomass of yeast cultures. Two different bioreactor configurations were tested for system volumes of 60ml and 10.5ml. For both configurations, the PreSens SFR vario, an optical sensor array, collected data autonomously. Oxygen and pH in the cultures were monitored using chemically doped spots, 7mmin diameter, that were fixed to the bottom of sampling chambers. Spots emitted a fluorescent signal for DO and pH when reacted with oxygen molecules and hydrogen ions, respectively. Biomass was sensed using light reflectance at centered at 605 nm. The, optical array had three light detectors, one for each variable, that returned signals that were pre- and post-calibrated. For heterotrophic cultures requiring oxygen and respiring carbon dioxide, a hollow fiber filter, in-line with the optical array, oxygenated cells and remove carbon dioxide. This provided oxygen levels that were sufficient to maintain aerobic respiration for steady state conditions. Time series of yeast metabolism in the two bioreactors are compared and discussed. The bioreactor configurations can be easily be modified for autotrophic cultures such that carbon dioxide is enhanced and oxygen removed, which would be required for photosynthetic algal cultures.

Keywords: yeast bioreactor, SFR vario optical array, case study, system development, lunar missions, optical measurements