Ultraviolet-Absorption Spectroscopic Biofilm Monitor

Continuous monitoring could provide early warnings of potentially harmful buildups of bacteria.

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An ultraviolet-absorption spectrometer system has been developed as a prototype instrument to be used in continuous, real-time monitoring to detect the growth of biofilms. Such monitoring is desirable because biofilms are often harmful. For example, biofilms in potable-water and hydropneumatic systems act as both sources of pathogenic bacteria that resist biocides and as a mechanism for deterioration (including corrosion) of pipes.

Biofilms formed from several types of hazardous bacteria can thrive in both plant-growth solutions and low-nutrient media like distilled water. Biofilms can also form in condensate tanks in air-conditioning systems and in industrial heat exchangers. At present, bacteria in potable-water and plant-growth systems aboard the space shuttle (and previously on the Mir space station) are monitored by culture-plate counting, which entails an incubation period of 24 to 48 hours for each sample. At present, there are no commercially available instruments for continuous monitoring of biofilms in terrestrial or spaceborne settings.

The prototype biofilm monitor includes a commercial fiber-optic-coupled ultraviolet/visible (UV/VIS) spectrometer module with charge-coupled-device (CCD) array detection that has dimensions of 6 by 6 by 2 in. (about 15 by 15 by 5 cm) and that communicates with a notebook computer via a Personal Computer Memory Card International Association (PCMCIA) interface card. The instrument includes two 4-ft (1.2-m)-long optical fibers — one for coupling light from a xenon source to a flow-cell/fiber sensor assembly, the other for coupling light from the flow-cell/fiber sensor assembly to the spectrometer module. In the flow-cell/fiber sensor assembly, the ends of the fibers are coupled into the quartz windows of the cell with small collimating lenses. The inner surfaces of the windows are in contact with the flowing water to be monitored.

In tests of the prototype biofilm monitor, biofilms were found to produce characteristic absorption spectral bands at wavelengths from 230 to 400 nm. The absorption bands obtained from biofilms grown from a single strain of Pseudomonas aeruginosa were found to differ from the absorption bands obtained from biofilms grown from a mixed bacterial population from untreated urban river water; thus, it appears possible to use instruments of this type not only to detect biofilms but also to distinguish among species of bacteria in biofilms.

This work was done by Ronald H. Micheels of Polestar Technologies, Inc., for Johnson Space Center. Further information is contained in a TSP (see page 1).

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