DYNAMICS OF BIOFILM FORMATION

M.J. Vieira, L. Melo and M.M. Pinheiro
University of Minho, Braga, Portugal

ABSTRACT

Biofilms found in industrial systems are composed by living organisms such as bacteria, fungi and algae, and by non-living material such as inorganic particles and extracellular substances produced by the microorganisms. Biofilms are unwanted in heat exchangers, tubes, valves, etc., (the so-called biofouling). Oppositelly, their biological activity finds a very useful application in water and wastewater treatment.

The growth of microbial films on surfaces in contact with a circulating fluid involves different steps : the formation of a "conditioning film" made of organic molecules existing in the fluid ; the attachment of microorganisms to the surface, either by direct contact or with the assistance of biopolymers excreted by the cells ; the growth and reproduction of the microorganisms, together with the production of a biopolymer network, at the expenses of the nutrients available in the fluid ; the sloughing off (erosion, removal) of parts of the biofilm by the action of the flowing fluid.

The rate at which these processes occur is, in many cases, unknown and unpredictable, although the initial formation of the conditioning film is usually very rapid (a matter of minutes). To obtain data on biofilm formation rates (which, in turn, bring information on their biological activity), tests were run using Pseudomonas fluorescens as an areobic biofilm producer. In some of the tests, kaolin particles were also present to study the effect of inorganic material in biofilm behaviour. The living and inert substances were suspended in an aqueous solution of glucose flowing at choosen velocities. Biofilm formation was monitored through heat transfer measurements (the thermal resistance of the biofilm layer was evaluated).

As expected, higher fluid velocities resulted in lower thermal resistances of the biofilm, the effect being less pronounced when the biofilm contained inorganic particles. It seems that biofilm growth benefited from the presence of those particles. This may be due to several reasons : the biofilm may become more porous, improving the diffusion of nutrients and metabolic products ; the kaolin particles may adsorb and transport nutrients to the biofilm, increasing their availability in the inner zones of the biolayer.

Some runs were also made where nutrients were removed from the aqueous suspension after a stable biofilm had been formed. The amount of biofilm decreased substantially a few days after removing the nutrients : 2-3 days for a bacteria-particle biofilm, and around 1 day for a biofilm without inorganic particles. These results appear to confirm that, at least for the present system, the presence of inert particles increases biofilm activity.

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