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# Physicochemical changes of microbe and solid surface properties during biofilm formation

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Cell immobilization is a promising biotechnology process. For example, entrapment of bacteria cells on synthetic polymeric matrices such as biocarriers is widely used for wastewater treatment because they have strong mechanical strength and durability in contrast to natural polymers. This method is based on the formation of biofilm on the surface of the used carriers and combines two different processes; attached and suspended biomass in a hybrid system. Previous studies have shown that immobilized cell systems have the potential to degrade toxic chemicals faster than conventional wastewater treatment systems because high densities of specialized microorganisms are used in immobilized cell systems. The present study elucidates the surface charge and properties of activated sludge and their role in the formation of biofilm. This information can be used for the optimization of the formation of biofilms as well as for the study of the transport of microorganisms in different environments. The two types of biocarriers that were used in this study are polyvinyl alcohol (PVA)-gel beads and Moving Bed Biofilm Reactor (MBBR) carriers. The sludge samples that were investigated were taken from the aeration tank of the wastewater treatment plant of University of Patras (Greece). Measurements of the surface charge of the sludge, the biocarriers and the formed biofilm, were performed using potentiometric mass titrations with different kinds of electrolytes (e.g. NaCl, $NaNO_3$) and at pH ranging from 3 to 11. The determination of pzc and surface charge of activated sludge and biocarriers is significant, because it can provide new valuable informations about the interaction mechanisms and the formation of biofilms. In each case, the point of zero charge (pzc) was identified as the common intersection point of the potentiometric curve of the blank solution of the electrolyte with the corresponding curves of each material. The pzc value for the biofilm was 6.1 to 6.7 and 6.6 to 6.9 for PVA gel and MBBR, respectively. These values differ both from the pzc values found for PVA biocarriers (pzc = 9.4; no pzc value was obtained for MBBR as expected based on its hydrophobic nature and the absence of surface groups with acid-base behavior) and the pzc value of activated sludge (activated sludge mixed liquor: pzc = 8.0 to 8.2, solid activated sludge: pzc = 7.2 to 7.3). These results lead us to the conclusion that the formed biofilms have different acid-base behavior and properties in relation to the activated sludge and the biocarriers. This fact is in accordance to previous studies, where biofilm-associated cells can be differentiated from their suspended counterparts due to the generation of an extracellular polymeric substance (EPS) matrix. One other possible explanation is that the complicated processes of the biofilm formation can alter the distribution of different cells in the sludge compared with the cell distribution in the suspended unsupported sludge.