Physico-Chemical Properties of Porous Microcarriers in Relation with the Adhesion of an Anaerobic Consortium

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In anaerobic digestion the use of reactors with high cellular density has revealed great advantages, enabling the operation with low hydraulic retention times and high cellular retention times. The attached microorganisms are less affected by unfavourable environmental conditions. The early stages of bacterial adhesion can be described by van der Waals forces of attraction and electrostatic forces of repulsion as formulated in DLVO-theory and by a thermodynamic approach [1]. The energy of the electrostatic interactions is determined by the zeta potencial and the van der Waals forces can be understood in terms of hydrophobic attraction. The thermodynamic approach postulates that adhesion is favoured when the interfacial free energy of interaction between bacteria and the adhesion surface is negative. Apart from the above mentioned surface properties, other characteristics are also important in adhesion, such as surface roughness, porosity, and chemical composition. In the present work the biomass colonisation capacity of four porous mineral microcarriers was assessed and related with their physico-chemical properties. The surface tension of bacteria was determined by contact angle measurements considering van Oss approach [2] and the surface tension of mineral supports was obtained by the Thin-Layer Wicking Technique [3]. Table 1 represents the amount of adhered biomass expressed per liter of fixed bed volume.

As far as electrostatic interactions are concerned both pozzolana and clay behaved similarly showing an oscillatory pattern of zeta potential with pH: negative for pH between 6.9 and 7.5 and positive outside this pH range. The interaction energy between the support, the biomass and the medium was in the same range for all the supports. Visual inspection by scanning electron microscopy (SEM) and EDS analysis of the cleaned surfaces showed that sepiolite have the roughest surface and a higher level of magnesium while foam glass was the less rough material. However, the specific methanogenic activity of the adhered biomass showed an inhibition of 50% on sepiolite relative to the non adhered biomass and the less inhibited adhered biomass was observed in pozzolana with only 2.3% of reduction relative to the non adhered biomass. This reduction in activity was more related to diffusion limitations than to the release of toxic components from the supports to the medium, because chemical composition did not reveal the presence of toxic elements, although clay showed a higher level of aluminium.

Table 1 - Attached biomass ± 95% confidence interval

Support material	Attached volatile solids ($gVS/L_{fixed\ bed}$)
Clay	7.2±0.2
Foam Glass,	9.4±0.7
Pozzolana	6.7±0.2
Sepiolite	15.0±0.9

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