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中文题名	泥沙颗粒生长生物膜后基本物理性质的实验研究
英文题名	Experimental Study on the Basic Physical Properties of Sediment Particles after Biofilm Vegetating
中文关键词	泥沙颗粒;生物膜;几何特征;容重;流变
英文关键词	sediment particles;biofilm;geometrical features;bulk density;rheological properties
中文文摘	在河流、湖泊等湿地环境的所有固体表面都有以生物膜形式存在的微生物，由于近年来许多河流和湖泊水体的营养程度过剩，泥沙颗粒表面吸附的大量营养物质为微生物在其表面的吸附成膜提供了有利的条件。一方面，微生物生长及生物膜的形成会改变水体环境中营养物质的迁移转化规律，影响水质模型参数；另一方面，泥沙颗粒表面生长生物膜后，其几何特征及力学特性等亦会随之发生变化。虽然在水、土壤和生物环境中，生物膜的重要性已经逐渐得到认识，但是以往的研究多侧重于其在环境方面的作用，对水体环境中泥沙颗粒基本物理性质的影响研究尚少，而这正是泥沙运动力学所关注的重要方面。 论文的研究重点为泥沙颗粒生物膜生长后基本物理性质发生的变化。研究工作建立在泥沙表面生物膜生长培养实验的基础之上，并通过高精度的观测仪器取得所需数据，进而对泥沙颗粒生长生物膜后其单颗粒的几何特征、群体特性的容重及流变等物理性质的变化进行分析和研究。 对于单颗粒泥沙生物膜生长后几何特征的改变主要从投影轮廓和表面微形貌两方面开展研究，在大量环境扫描电子显微镜图片统计的基础上，采用傅立叶和小波分析方法构建了单颗粒泥沙生物膜生长后的投影轮廓模型，采用一阶和二阶算子分析了长膜泥沙的表面微形貌，进而构建了生物膜生长后的“数学泥沙”。研究表明：泥沙颗粒生长生物膜后其粗糙程度减小。 对于生物膜影响泥沙群体特性的容重研究，分别针对生物絮凝泥沙的干容重和湿容重进行分析。在激光扫描共聚焦显微镜观察生物絮凝泥沙生长过程的基础上，利用图像处理的方法对其结构特性进行分析，采用 Logistic 生长曲线方程描述生物膜随时间生长变化的规律，给出生物絮凝泥沙干容重的计算公式，并根据泥沙长膜后粒径的变化对其湿容重进行修正，为泥沙输移计算打下基础。 论文采用 MCR300 高级扩展流变仪研究原状沙和长膜沙流变性质的差异，探讨细颗粒泥沙流变性质受生物膜影响的规律，研究表明：细颗粒泥沙受生物膜生长的影响，流变性质发生变化，呈现出具有触变性塑性体的特点，这与高含沙水流的流变特性有差异，并建立了长膜泥沙的流变方程及各流变参量随时间的变化式。
外文文摘	Microorganism exists in the form of biofilm on all solid surface in the wetland environment such as rivers, lakes, and so on. In recent years, because of the nutrient surpluses of many rivers and lakes, the adsorption of large quantities of nutrient materials on sediment particles’ surface provides more favorable conditions for the bacterial sorption and biofilm growth. On the one hand, bacterial growth and biofilm formation would change the transfer laws of nutrient materials in aquatic environment and influence paremeters of water quality model. On the other hand, the geometrical features and mechanical properties of sediment particles would also change because of the biofilm growth. Although the importance of biofilm in water, soil and biotic environment has gradually been recognized, the previous research usually focuses on its environmental effect, and little is about the influence on the basic physical properties of sediment particles in aquatic environment, which is the important aspect of sediment transport mechanics. This dissertation would focus on the basic physical properties’ changes of sediment particles after biofilm vegetating. The research work is based on the culture experiment of biofilm vegetating on sediment particles’ surface. The required data are obtained through high-precision apparatus, and then the changes of biofilm sediment properties are studied and analyzed, including particles’ geometrical features, bulk properties of density, physical properties of rheology, and so on. The geometrical features’ changes of sediment particles after biofilm vegetating are studied from two aspects of projection profile and micro-morphology. Based on the statistics of abundant ESEM pictures, the methods of Fourier analysis and Wavelet analysis are used to build the project profile model of sediment particles after biofilm vegetating, the first-order operator and second-order operator

	are applied to analyze the surface micro-morphology of biofilm sediment, and further the “mathematical sediment” is built. The research shows that sediment particles become smoother after biofilm vegetating. The research on bulk properties of density is directed respectively through the dry bulk density and wet bulk density of bioflocculation sediment. Based on the observation of growth process of bioflocculation sediment using the confocal laser scanning microscopy, some image processing methods are used to analyze the structural properties, and the Logistic growth curve equation is applied to describe the growth and variation of biofilm over time. A dry bulk density formula of bioflocculation sediment is proposed and the wet bulk density is modified according to the change of grain size, laying a foundation for the calculation of sediment transport. MCR300 advanced extension rheometer is used to study the difference of rheological properties between original sediment and biofilm sediment, and the influence on rheological properties of fine-grained sediment from biofilm is investigated. The research shows that the rheological properties of fine-grained sediment change greatly due to biofilm growth, assuming the properties of plastic fluid with thixotropy, which is different from that of hyper-concentration flow. Also the rheological equation of biofilm sediment and expressions of rheological parameters over time are proposed.
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