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Real role of an ultrafiltration hollow-fibre membrane module in a submerged membrane bioreactor

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Abstract

This paper presents the real role of UF membrane modules with a 0.03 μm pore size used in a submerged membrane bioreactor on effluent quality parameters. For this purpose, the values of effluent and mixed liquor for some parameters were determined at different operational periods. It was shown that the biochemical reactions in the bioreactor have a greater role than the separation of the membrane module on the removal of organic and nutrient pollutants. Inert COD was not removed by the system. Orthophosphate, ammonium and nitrate ions were respectively removed on the levels of 30%, less than 10% and 28% on average. It was considered that the removal ratios of these parameters were affected only by the concentrated activated sludge process and occurring under a place to place anoxic condition.

Keywords: Submerged membrane bioreactor; Ultrafiltration; Module capacity and removal

1. Introduction

Biological processes are primarily designed for the removal of dissolved and suspended organic matter from wastewater. The conditions are provided to encourage the growth of microorganisms which use the organic compounds. The microorganisms that grow on the substrate are subsequently separated from the water, which has had the BOD removed, leaving a relatively clean effluent, by deriving energy and cellular material from the oxidation of this organic matter. Biological wastewater treatment is also capable of removing other wastewater components, including suspended solids, nitrogen, phosphorus, heavy metal and xenobiotics [1].

The suspended solids in biological mixed liquor should be successfully separated from water in order to obtain a good quality effluent.

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For this purpose, gravity settlement is usually used for separation of biomass from the final effluent. The physical properties of the sludge and the configuration and operation of the sedimentation process have a major impact. Membranes for biomass separation would avoid many problems caused from bad sludge quality. A membrane bioreactor (MBR) is the combination of a suspended growth reactor and membrane filtration device into a single unit process. The membrane module can be configured externally or suspended in the bioreactor. Submerged systems have been recently preferred relatively to external systems because of low operating costs. Both systems provide high-quality effluent.

Problems such as non-settling, foam and bulking sludge cannot affect the performance of sMBR. The sMBR allows the use of long sludge ages with the benefits of reduced sludge production, which is about 50% when compared to a conventional activated sludge process (CASP), and a simplification of the sludge treatment line. The volumetric loading rates were two to four times those of CASP. This demonstrated that the volume of the bioreactor by sMBR could be greatly reduced in comparison with that by CASP if the same wastewater is treated. Therefore, a large amount of space and investment could be saved.

Although there are many studies on wastewater treatment by using MBR [2–8], they have not studied the real removal capacity of the membrane module used in MBR. This paper presents the real role of an ultrafiltration hollow-fibre (UF–HF) membrane module on the treatment of whey by a submerged membrane bioreactor.

2. Materials and methods

2.1. Equipment

The experimental system consists of a bioreactor in which a UF–HF membrane was immersed, as seen in Fig. 1. The influent was taken from the feed tank to the bioreactor by a peristaltic pump. The bioreactor, filled with activated sludge, had a working volume of 27 L. The inoculation was made with 4 L of concentrated activated sludge from a domestic wastewater

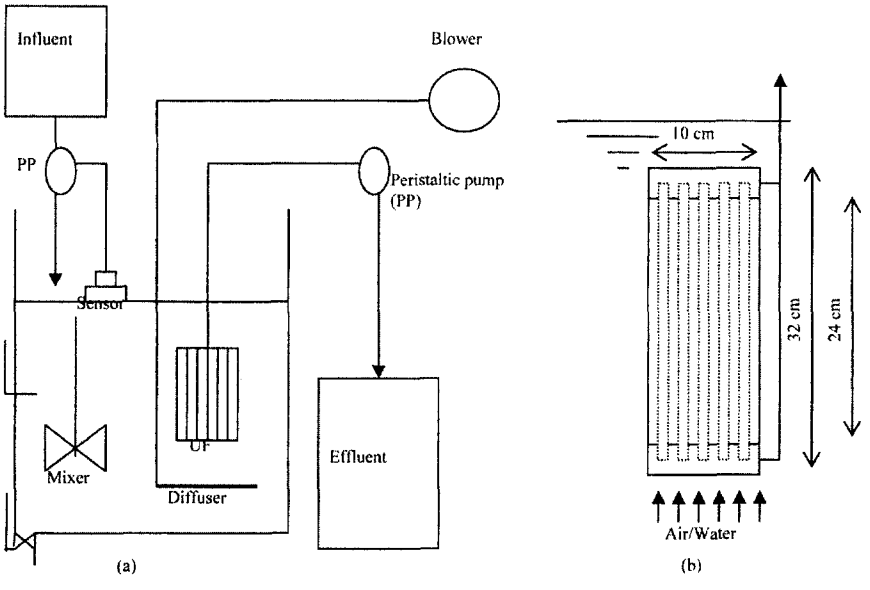

Fig. 1. Set-up of submerged membrane bioreactor.