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Effect of varying salinity on the RBC system performance

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Introduction

Varying salinity could be produced by the entry or infiltration of seawater into the sewage system during high tide cycles. It could also be caused by industrial discharges with high concentrations of salts on domestic sewage.

The effect of varying salinity on the RBC system has not been previously studied, but some interesting work dealing with high saline sewage has been conducted on trickling filters and RBCs.

Lawton & Eggert (1957), have studied the effect of salt on trickling filter slimes. They observed that the greater the salt concentration the greater the effect on the slime and the longer the time required for the slime to become acclimatized to it. They affirm that filter growth accustomed to high salt content wastes show a shock effect when weakly saline wastes are applied, but they usually recover and become acclimatized to the new substrate in a shorter period, than those filter growths developed from low salt content wastes when they suffer a high salt content load.

Mills & Wheatland (1962) studied the effect of saline sewage on the performance of percolating filters. The average 5-day BOD of the settled sewage was 230 pmm. They conclude that settled sewage containing as much as 6,600 ppm of common salt could be treated on biological filters. Settled sewage containing as much as 20,000 ppm of common salt for 8 hours per day, five days per week, could also be satisfactorily treated.

The use of the RBC system for the treatment of saline sewage was first studied by *Mikucki & Poon (1976), Poon & Mikucki, (1978) and Poon et al., (1979)*. They affirm that high saline domestic wastewater containing as much as 11,400 ppm of Cl^-, could be successfully treated. Without recirculation of effluents, they suggested an operation range for organic load of 18.4 to 28.6 g $BOD_5/m^2.d$. With recirculation up to 100%, they suggest an organic loading range between 24.4 and 41 g $BOD_5/m^2.d$. For both situations, the recommended range of hydraulic loading goes from 0.016 to 0.2 $m^3/m^2.d$.

Kinner & Bishop (1982) also affirm that the RBC pilot plant evaluated in their study was able to treat domestic wastewater with a salinity that can vary from 0-35,000 pmm, at hydraulic loading rates of 0.04 and 0.08 $m^3/m^2.d$, achieving mean COD removals of 61% and 64% respectively.

The object of the present study is to evaluate the performance of the RBC system under varying salinity conditions.

Methodology

An RBC pilot plant consisting of 4 stages was operated continuously during 58 days at a hydraulic loading of 0.078 $m^3/m^2.d$ and at an organic loading of 11.66 g $COD/m^2.d$, using synthetic wastewater based on glucose, and salt water prepared with NaCl. The residence time was 90 min. Each stage unit consisted of 9 discs of a 2 mm thick plexiglass media with a diameter of 18 cm each. The discs rotated at 13 RPM.

To simulate a varying salinity situation, different cycles of salt + fresh wastewater were studied, establishing the salt water NaCl concentration of 15.000 ppm and fresh water of 1.500 ppm.

Supposing an adverse effect produced by the entry of seawater into a domestic sewage system, in order to acclimatize our reactor to varying salinity, we chose to simulate a 6h + 6h cycle, the first shift corresponding to the saline operation. Thus, we will have a biofilm capable of developing in this environment. A mixture of fresh wastewater and estuary sludge served as the seed to the system. To study the effect of high saline industrial discharges on domestic sewage, by evaluating the RBC performance of different discharge times during a 24 hour period, we tested cycles of 6h + 18h, 8h + 16h and 10h + 14h.

After working with the 24 hour period, the idea was to insert 40 hours of fresh wastewater into the 8h + 16h cycle. This way, we analyzed the reactor's performance during the weekend discharge shutdown. After the results obtained during this experimentation, we reduced the 40 hours to 30.

Results and discussion

The COD removed in the 6 + 6 and 6 + 18 cycle (10.49 g $COD/m^2.d$) is the same (Figure 1). This suggests that the system will achieve the same performance for any fresh wastewater shift between 6 and 18 hours, keeping the salt wastewater shift at a constant time. This confirms that for varying salinity, biofilm processes also show quicker recovery when non saline wastes are applied (*Lawton & Eggert 1957).*

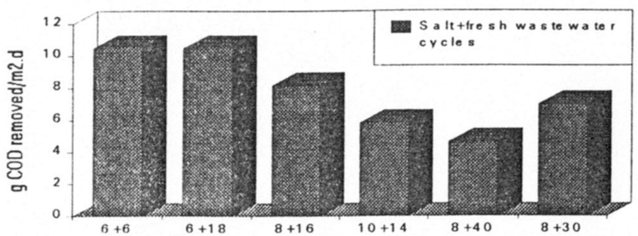

Figure 1. COD removal during cycles.

Accepting this affirmation, that any fresh wastewater shifts between 6 and 18 hours will not affect the RBC performance, we can see that as the time of the salt wastewater shift is increased in the 24 hour cycle, when the range of the wastewater shift is kept between 6 and 18 hours, the COD removed is lower. This happens because biofilms show bigger impact when the time of the salt wastewater shift increases, thus, needing more time to recover from this situation (*Lawton & Eggert, 1957).*

Bezanilla (1993), operating an RBC system of 2 stages, identical to ours, with fresh wastewater based on glucose, at the same hydraulic loading and similar organic loading, achieved COD removals of 78% in the first stage and 91% global. The global RBC system organic load removed when operating with the 6 + 6 cycle (Figure 2) is practically the same as with fresh wastewater (data from *Bezanilla 1993)*, but when comparing the organic load removed in the first stage and the two first stages of varying salinity with fresh wastewater, the performance shown in the 6 + 6 cycle is lower, wich clearly indicates that the last 2 stages of the RBC are necessary to achieve a good global performance under varying salinity conditions. This also indicates that under varying salinity as in highly saline wastes, operation at high organic loading will reduce the system's performance (*Poon et al., 1979).*

During the experimentation, the highest biofilm thickness achieved with fresh wastewater in the first stage was 4 mm, and after operating with salt wastewater over three hours, it will decrease to 3.85 mm. We understand that this is caused by the physical contraction of the bacteria due to the change in osmotic pressure.

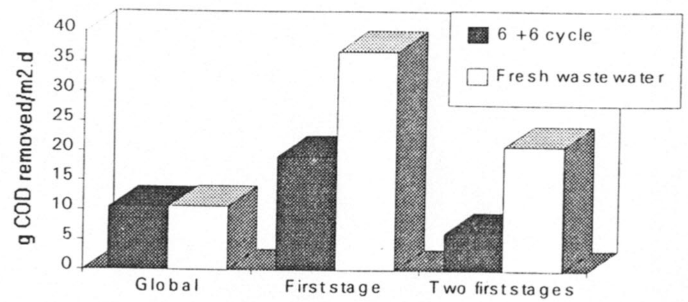

Figure 2. Perfomance comparison between varying salinity and fresh wastewater.

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