EFFECT OF VARYING SALINITY ON THE RBC SYSTEM PERFORMANCE

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ABSTRACT

The non stationary state caused by varying salinity on the Rotating Biological Contactor (RBC) was analyzed. An RBC plan consisting of 4 stages was operated continuosly during 58 days at a hydraulic loading of 0.078 $m^3/m^2.d$ and at an organic loading of 11.66 g $COD/m^2.d$, under different cycles of salt + fresh wastewater, using synthetic wastewater based on glucose, and salt water prepared with NaCl. While working under 6h + 6h and 6h + 18h (salt + fresh wastewater cycles), a 90% COD removal was achieved. The performance showed by the first stage is lower under varying salinity contitions than with fresh wastewater. The process shows lower COD remotion as the time with salt wastewater increases. The organic load applied has bigger impact on varying salinity than with fresh wastewater.

KEYWORDS

biofilm; RBC; salinity; salt wastewater; varying salinity; high salinity.

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 non stationary effect caused by varying salinity on the RBC system has not been previously studied, although 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 fed to the trickling filters was 230 pmm. They conclude that constant saline settled sewage containing up to 20,000 ppm of NaCl could be satisfactory treated on percolating filters filters.

The use of the RBC system for the treatment of constant 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 18,810 ppm of NaCl, 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 concentration of 33,000 pmm of NaCl, at hydraulic loading rates of 0.04 and 0.08 $m^3/m^2.d$, organic load opplied of 9.64 g $COD/m^2.d$ and 19.28 g $COD/m^2.d$, achieving mean COD removals of 61% and 64% respectively.

The object of the present study is to evaluate the non stationary state that varying salinity could cause on the RBC system performance.

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 (Fig. 1.).

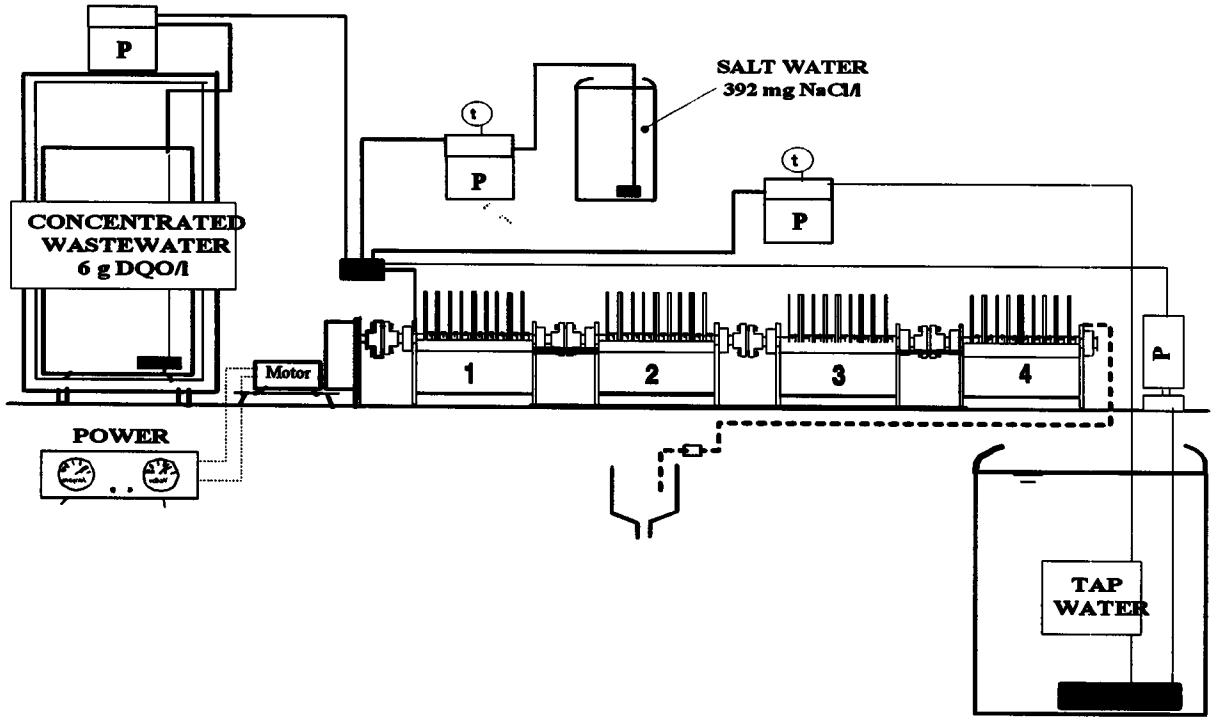

Fig. 1. Pilot Plant Unit

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 below 1,500 ppm. Notice that the high salt concentration of 15,000 ppm of NaCl is lower than the 20,000 ppm recomended for satisfactory treatment (Mills & Wheatland, 1962).

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 (Fig. 2.). 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).

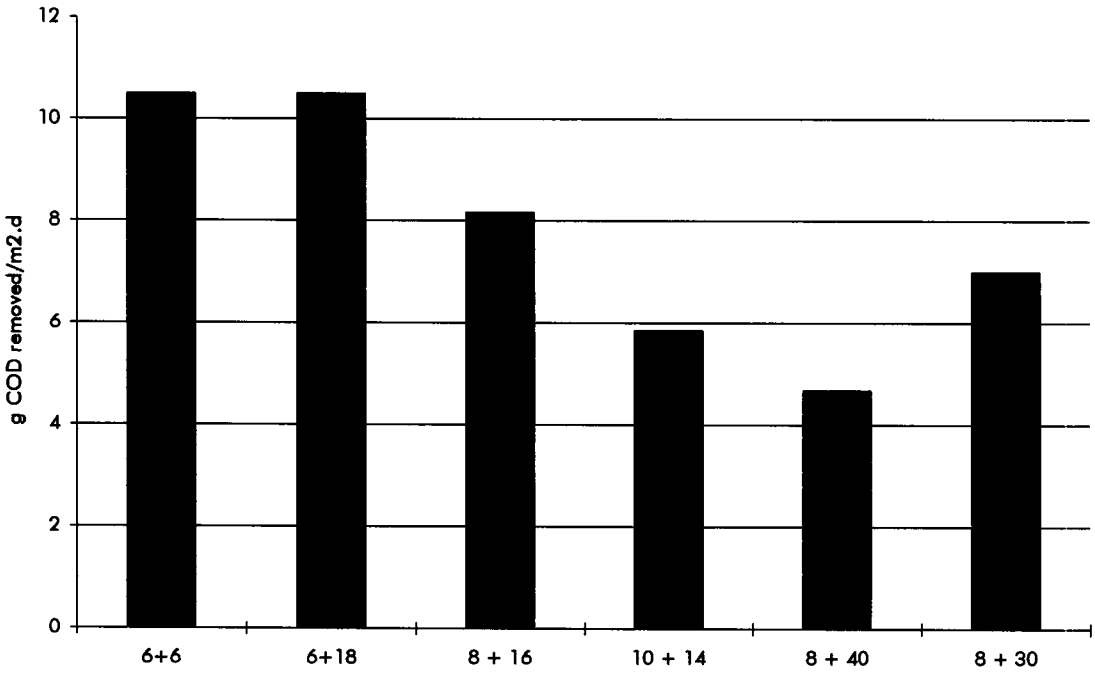

Fig. 2. C O D removal during cycles

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 (Fig. 3.) is practically the same as with fresh wastewater (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).

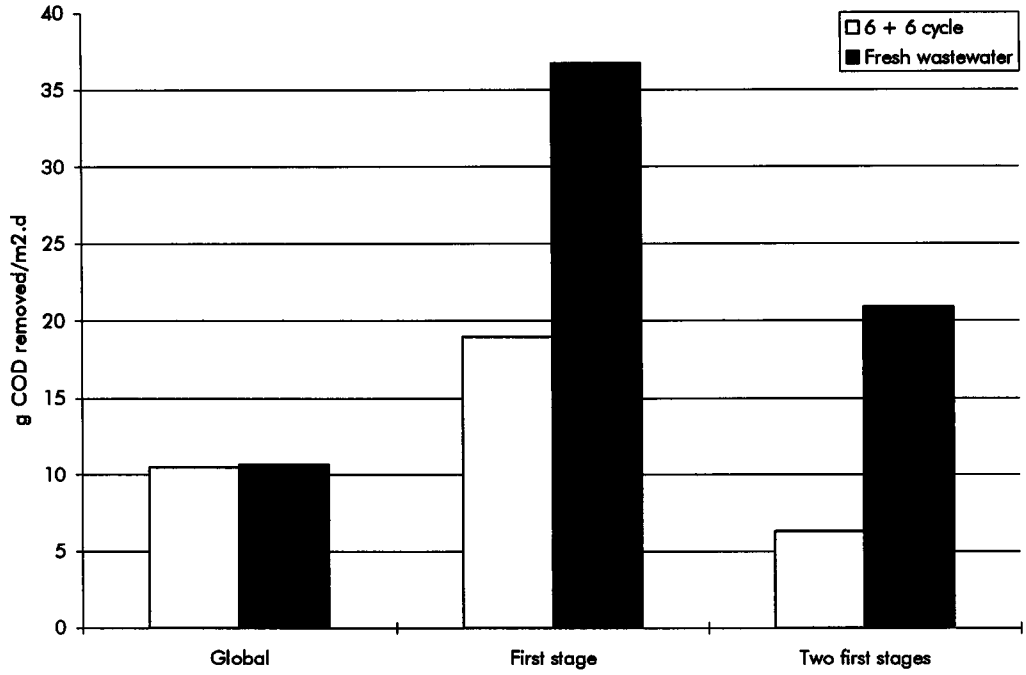

Fig. 3. Performance comparison between varying salinity and fresh wastewater

Mikucki & Poon (1976), Poon & Mikucki (1978), Poon et al. (1979) and Kinner & Bishop (1982) worked with RBC's operating under constant saline sewage. When we compare their results with the ones obtained with varying salinity (Fig. 4.), we observe better performance with varying salinity than with constant saline sewage. The results obtained with varying salinity are probably better because of the use of synthetic wastewater based on glucose, and salt water based on NaCl, instead of real wastewater mixed with seawater.

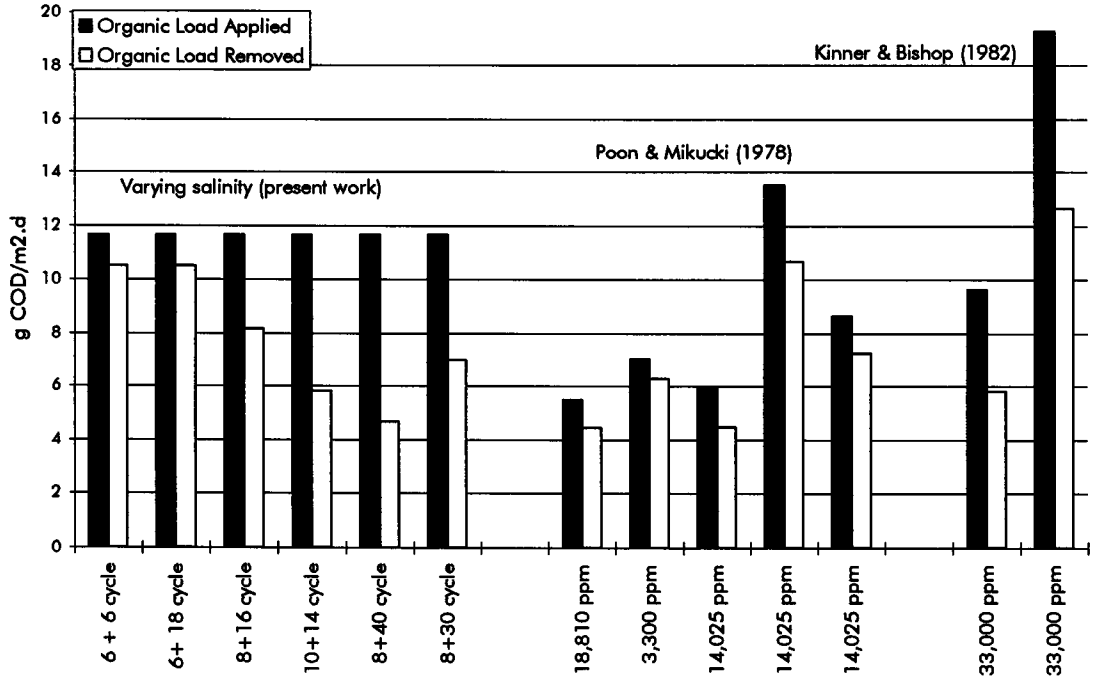

Fig. 4. Performance comparison between varying and constant saline sewage

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.

REFERENCES

Bezanilla, J. A. (1993). Depuración de aguas residuales en un Contactor Biológico Rotativo (RBC) con alternacia en el sentido de flujo. Doctoral Thesis. University of Cantabria. Santander, Spain.

Castillo, P. A. (1994). Depuración de agua residual con salinidad variable empleando un RBC. Master Thesis. University of Cantabria. Spain.

Kinner, N. E. & Bishop, P. L. (1982). Treatment of saline domestic wastewater using RBC's. *Env. Eng., ASCE*, 108, 650-664.

Lawton, G. W. & Eggert, C. V. (1957). Effect of high sodium chloride concentration on trickling filter slimes. *Sewage & Ind. Wastes*, 29, 1228-1236.

Mikucki, W. J. & Poon, C. P. C. (1976). An evaluation of the bio-surf process for the treatment of saline-domestic wastewater. Proceedings of the 8th Annual Offshore Technology Conference, Houston, Tex., 293-298.

Mills, E. V. & Wheatland, A. B. (1962). Effect of saline sewage on the performance of percolating filters. *Water & Waste Trt. Journal.*, 9, 170-172.

Poon, C. P. C.; Chao, Y-L & Mikucki, W. J. (1979). Factors controlling rotating biological contactor performance. *J. WPCF*, 51, 601-611.

Poon, C. P. C. & Mikucki, W. J. (1978). Rotating biological contactors treat Island's saline sewage. *Water Sewage Works*, 62-66.