

SYNERGISM AND ANTAGONISM OF ARSENIC,  
CHROMIUM AND FLUORIDE ON  
NITRIFICATION PROCESS

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ABSTRACT

Based on the experimental data obtained for nitrification in a fixed film packed bed reactor, a rate expression of the following form has been developed under the shock load of trivalent arsenic, hexavalent chromium and fluoride, in pair:

$$\alpha_i = V_{\max} \left\{ 1 - \sum_{j=0}^k \beta_j (I_2) \left[ \frac{I_1}{K_{I_1} + I_1} \right]^j \right\}$$

where  $I_1$  is the concentration of the stronger inhibitor and  $I_2$ , that of the weaker one in the pair. In the expression,  $k$  is equal to 4 for the chromium arsenic and arsenic-fluoride combinations while for the chromium-fluoride combination it is equal to 3.  $\beta_j$  is the

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regression coefficient of the polynomial curve fit. Amongst chromium, arsenic and fluoride, which non-competitively inhibit nitrification, chromium is most inhibitory while fluoride, the least. Under the simultaneous presence of any two of these, the mode of inhibition has been characterised in terms of synergism and antagonism. Interaction factor  $\Psi$ , has been introduced to quantitatively take these phenomena into account.  $\Psi$  has been correlated to the experimental data by the following expression:

$$\Psi = \frac{1}{\sum_{n=1}^2 \frac{I_n}{K_{I_n} + I_n}} \left[ 1 - \sum_{j=0}^k \beta_j (I_2)^j \left( \frac{I_1}{K_{I_1} + I_1} \right)^j \right]$$

The physical significance of  $\Psi$  is that the interaction between  $I_1$  and  $I_2$  is synergistic for  $\Psi$  greater than unity and antagonistic for  $\Psi$  less than unity. It is additive when  $\Psi$  is equal to unity. The analysis of the data shows that synergistic inhibition occurs upto 26.0 and 29.0  $\text{mg l}^{-1}$  of chromium for corresponding arsenic concentrations of 75.0 and 150.0  $\text{mg l}^{-1}$ , respectively. The same phenomenon takes place upto 26.0, 23.6, 16.0 and 14.4  $\text{mg l}^{-1}$  of chromium corresponding to fluoride concentrations of 150.0, 300.0, 600.0 and 800.0  $\text{mg l}^{-1}$ , respectively. Arsenic suppresses nitrification synergistically upto 200.0, 180.0, 145.0 and 125.0  $\text{mg l}^{-1}$  for fluoride concentrations of 300.0, 150.0, 600.0 and 800.0  $\text{mg l}^{-1}$ , respectively. Beyond the above concentrations of chromium and arsenic, the effect is found to be antagonistic.

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