A New Method for Reducing Biofouling in Paper Pulp Production Processes

M.O. Pereira[1], M.J. Vieira[1], V.M. Beleza[2] and L.F. Melo[1]
[1]Centro de Engenharia Biológica – IBQF, Universidade do Minho, 4700 Braga, Portugal
[2]Instituto Superior de Engenharia do Porto, R. S. Tomé, 4200 Porto

Key words: pulp and paper industry, biofouling, biocides, Pseudomonas fluorescens

Biofilm growth on paper and pulp mills decreases the operational efficiency of the process, since it contributes to the release of microbes into the process water, affecting product quality (holes, specks and spots in the paper), paper machine breaks, corrosion, bad odours and health problems.
The use of strong biocides in this industry has been decreasing since they are highly toxic. They were replaced by less toxic, but less effective compounds. As a result, biological growth is still a common problem in the paper industry. Only a few studies were published on biofilms in the paper machine environment, in spite of paper and pulp production being one of the largest industries in the world.
This work presents a novel approach based on the retention of bacterial cells on the cellulose fibres in order to reduce biofilm formation. The retention agent, in this case, was a non-oxidizing biocide (mixture of two carbamate solutions). Tests were performed to determine the combined effects of carbamate and pH on: i) cell (*Pseudomonas fluorescens*) adhesion to stainless steel coupons; ii) zeta potential of the cells; iii) retention of the cells by the pulp fibres (measured by total protein).
Addition of the carbamate biocide changes the pH of the paper pulp suspension and can also shift the bacterial surface charges from negative to neutral or positive values, depending on the pH value and the biocide concentration (Table 1). Therefore, cell adhesion to the fibres is promoted, since the latter are negatively charged : in fact, a cell retention of 45% to 75% was obtained within less than 5 minutes of contact between the carbamate and the pulp suspension (Figure 1). This effect increased with the biocide concentration (from 100 to 300 mg/L). In papermaking, the time span between the biocide application point and the head box of the papermachine is very important. The results suggest that the best time interval would be 30 minutes, which is compatible with the residence time in the process.

Table 1. Zeta potential of *Pseudomonas fluorescens* (the standard deviation in brackets) without biocide and treated with different concentrations of biocide at several pH.

System	pH	Zeta Potential (mV)
	5.5	-27.400 (±7156)
P. fluorescens	6.7	-20.988 (±6.906)
	8.3	-26.235 (±7.906)
P. fluorescens	5.9	0
+	6.8	0
100 mg/L of biocide	8.3	-25.633 (±5.948)
P. fluorescens	5.5	18.681 (±3.103)
+	6.7	0
200 mg/L of biocide	8.3	-29.547 (±5.076)
+		
P. fluorescens	5.9	17.905 (±2.953)
+	6.7	12.241 (±6.093)
300 mg/L of biocide	8.3	-28.463 (±6.423)

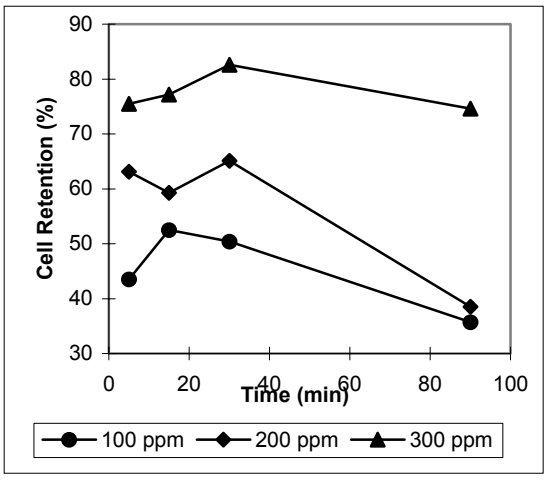

Figure 1. Cell Retention(%) as function of time, obtained in the assays with pulp suspensions in presence of several concentrations of biocide