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Predicting flotation efficiency using neural networks

J. Labidi [a,*], M.À. Pèlach [b], X. Turon [b], P. Mutjé [b]

[a] *Department of Chemical and Environmental Engineering, University of the Basque Country, Plaza Europa 1, 20018 San Sebastian, Spain*
[b] *Department of Chemical Engineering, Escola Politecnica Superior, University of Girona, Avda. Lluís de Santaló s/n, 17071 Girona, Spain*

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Abstract

This paper presents a model of flotation stage using a neural network to predict the efficiency and the effect of operational parameters on the efficiency of ink removing. Two methods are used to determine the kinetic parameters of the flotation process using particular experimental conditions: experimental data obtained at a laboratory level, and simulated data by means of a neural network.

Simulated values obtained with a neural network correspond closely to the experimental results. Neural networks are long-range tools for studying processes when some knowledge of the phenomena that occur in the process is acquired in order to develop models based on the experimental results. The neural network model accurately reproduces all the effects of operation variables and can be used in a simulation of a deinking plant to determine the optimal operational conditions.

Keywords: Deinking; Flotation; Neural network; Modeling

1. Introduction

Recycled paper is the main source of cellulosic fibre for the paper making industry. According to data from the European Council for Paper Recovery and Recycling in 2004 the European pulp and paper industry recycled around 46.5 million tonnes of used paper, 1.8 million tonnes more than in 2003. This represents 53.7% of the total amount of paper consumed. Presently, a third of the recovered paper is treated in mills with the deinking system.

Deinking plants are very complex due to:

- the large diversity of polluting agents present in the paper, making the deinking processes difficult;
- the lack of knowledge, at the industrial level, about the physic-chemistry of the different processes involved in the deinking process, such as flotation.

2. Deinking operation

2.1. Description of the deinking process

The deinking operation is essentially a purification process in which the ink, in addition to other polluting agents that can be found in the recovered paper such as clips, staples, rubber, etc., are eliminated. The purpose of this process is to remove all the polluting agents from the recovered paper in order to produce a pulp that is free of impurities. The most important steps in the deinking process are: washing, flotation, purification and screening. The effectiveness of these operations depends on the size of the particles of the polluting agent which needs to be eliminated.

A simplified flow sheet of a deinking process is presented in Fig. 1. Several alternatives are used for deinking recycled paper. These processes are differentiated by the operations used to eliminate ink. In the washing stage, ink is eliminated using washers that consume a lot of water. The flotation method combines washing and flotation. The washers eliminate small ink particles, whereas the flotation cells remove larger ink particles. Normally, between the two operations fine screening is

* Corresponding author. Tel.: +34 9430171 78; fax: +34 9430171 30.
E-mail address: jalel.labidi@ehu.es (J. Labidi).

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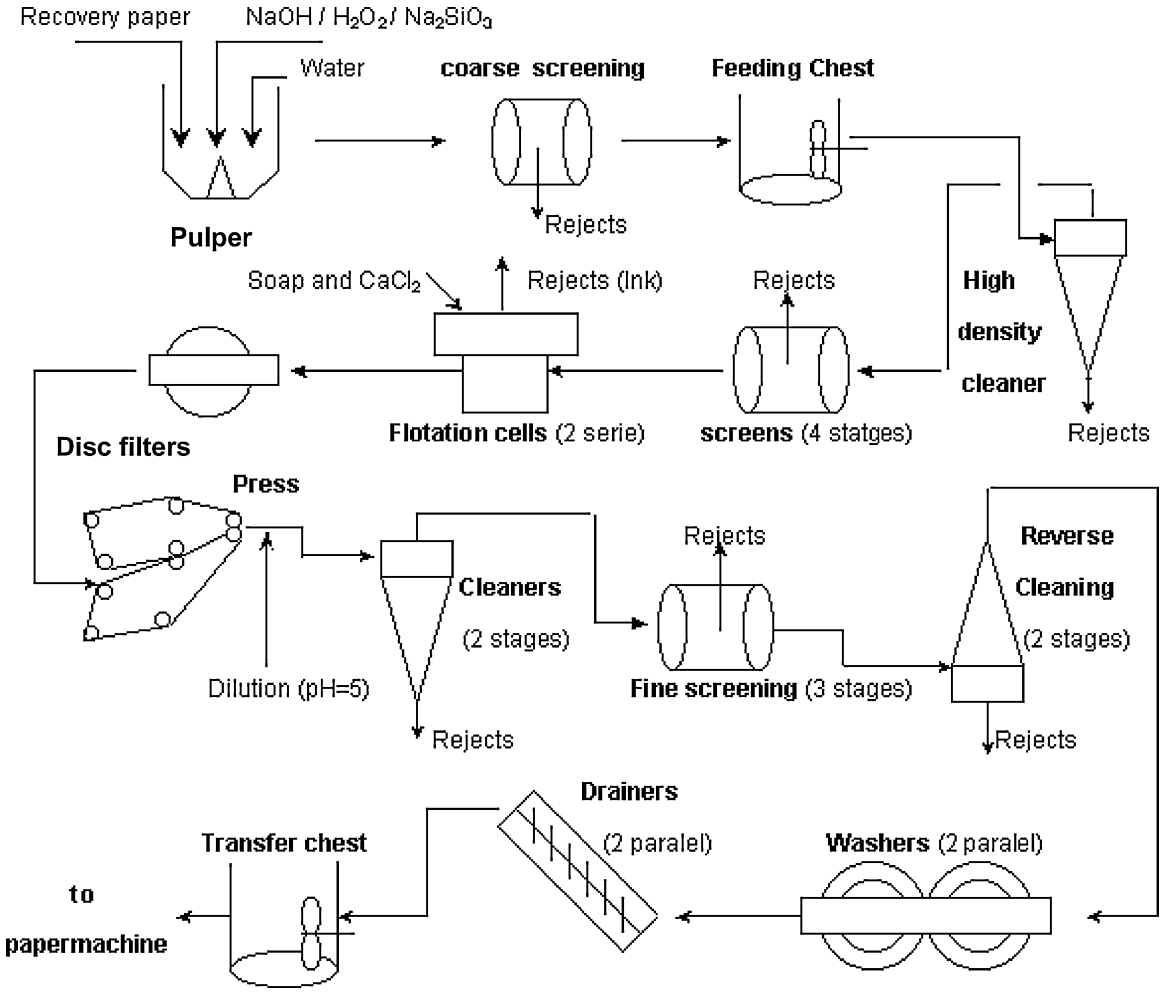

Fig. 1. Simplified flow sheet of the deinking process.

used to eliminate small particles and reverse cleaners are used to eliminate particles with a density lower than 1 (fibre suspension density), as for example sticky and plastic particles.

The deinking process includes an alkaline loop, starting from the pulper and finishing with the flotation cells, propitious to the ink-fibre separation. The second section of the process is an acid loop, which allows the colloidal matter and the soluble matter to be precipitated and therefore it can be eliminated later.

2.2. Flotation

Flotation technology was applied for the first time in the mining industry in the 50 s. Flotation was used to separate mineral particles from rocks. This technology was later adapted to the pulp and paper industry.

Flotation is a physical–chemical separation process carried out in flotation cells, it is represented in Fig. 2. An airflow is injected into the bottom of the cell forming small bubbles which are mixed with the pulp suspension and a surfactant that is added to facilitate foam formation.

The separation principle consists of influencing the surface of ink particles based on their hydrophobic or hydrophilic nature. If the ink is not hydrophobic it is converted by the adsorption of the surfactants added to the suspension. The hydrophobic and converted particles join to the air bubbles and are dragged in aggregate form with an inferior specific density towards the surface of the suspension where they form a foam layer.

The process of eliminating ink using flotation is complex, since it involves a mixture of components: ink, water, particles, fibres and loads. The flotation process works like a separation

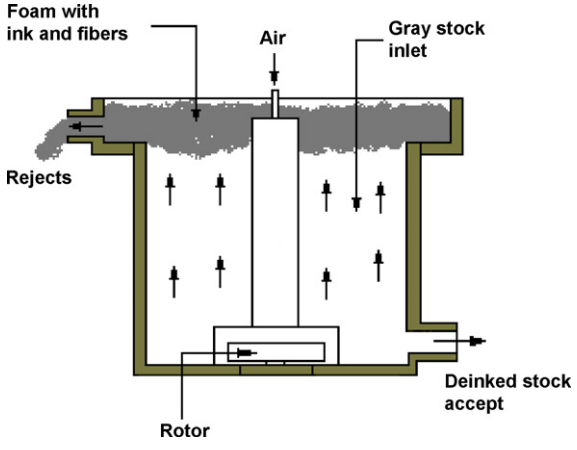

Fig. 2. Experimental flotation cell.