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PII: S2213-3437(17)30100-8
DOI: http://dx.doi.org/doi:10.1016/j.jece.2017.03.007
Reference: JECE 1513

To appear in:

Received date: 13-12-2016
Revised date: 18-2-2017
Accepted date: 7-3-2017

Please cite this article as: D.E.Tsatsis, D.K.Papachristos, K.A.Valta, A.G.Vlyssides, D.G.Economides, Enzymatic deinking for recycling of office waste paper, Journal of Environmental Chemical Engineering http://dx.doi.org/10.1016/j.jece.2017.03.007

Enzymatic deinking for recycling of office waste paper

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Abstract

Office waste paper constitutes an excellent low cost and high quality fibre source for the papermaking industry. Limitations in the application of conventional deinking to such paper are related to negative environmental impacts chemicals can cause, hence enzymatic deinking is receiving growing attention. This study is focused on the investigation of the effect of cellulases application on the deinking of office waste paper. The methodology involved: preparation of samples, impregnation, repulping, enzymatic treatment, flotation, papermaking, and finally evaluation of optical properties. Five preparations, working under acidic and neutral conditions, were tested (Cellusoft CR, Cellusoft AP, Novozymes 342, Cellusoft L, Accelerase 1500). The added amount of each enzyme preparation corresponded to 150 FPU/100 g paper. It was observed that the deinking experiments using enzymes achieved generally better results in comparison with those in which the enzymes were previously deactivated. Despite the positive effect of activated enzymes as compared to deactivated, the application of enzymes appeared disadvantageous compared with the conventional deinking in terms of specks surface of the deinked paper sheets. Apart from the type of enzyme preparation itself, another critical factor affecting the effectiveness of the enzymatic treatment was the addition of nitric acid used to achieve acidic conditions for the optimum enzyme function. To this end, further study have to be performed on enzyme preparations functioning under alkaline conditions as well as on other paper types while the effect of enzyme amount to the deinking and the subsequent impacts on mechanical strength of produced papers may be also investigated.

Keywords: office waste paper; recycling; enzymes; deinking; flotation; xerography

1. Introduction

According to the Annual Statistics of the Confederation of European Paper Industries (CEPI) the paper recycling rate in Europe was increased from 40.8 % in 1991 to 71.5 % in 2015 [1]. The recovered paper grades which have the highest degree of utilisation are case materials (93.9 %) and newsprint (92.8 %) [1].The lowest utilisation degree (12.8 %) has been recorded for the office waste paper (defined as 'other graphic papers' according to CEPI), despite the fact that this paper grade constitutes 31.1 % of the total paper production in CEPI countries (17 EU members and Norway) while it is also an excellent low cost and high quality fibre source for the papermaking industry. The major limitation in using mixed office waste paper as a raw material for the production of high quality recycled paper is that it contains a high percentage, spanning from 50 % to 80 %, of non-impact printed papers ('laser' and 'xerographic') that are difficult to deink [2, 3]. Difficulty in the deinking process depends on the type and age of the ink and of the paper sheet as well as the printing conditions and the printing process itself. In more detail, xerographic and laser printing processes are indirect printing methods through which the toner particles are firstly transferred to an intermediate carrier and then to the substrate. These processes do not use ink but toner particles instead. Toner particles are solid powders with particle diameter of approximately 20 μm, density of 1 to 1.5 g/cm^3 [4], while their composition primarily consists of coloured pigments such as carbon black, and a thermoplastic resin (60 to 90 %), such as styrene-acrylate copolymers, styrene-butadiene copolymers and polyester or epoxy resins [4, 5,6,7]. Resins in the toner melt and adhere with carbon black on the paper during the printing process [8].