# PROCESS SIMULATION FOR WATER CONSUMPTION MINIMIZATION IN PULP MILL

K. DIONÍSIO DE OLIVEIRA, M. CARDOSO and R. NICOLATO

*Department of Chemical Engineering/ School of Engineering, Federal University of Minas Gerais (UFMG), 30160-030 Belo Horizonte, Brazil. E-mail: katiadionisio@yahoo.com.br*

***Abstract*— Reducing the use of fresh water can lead to energy savings when this is properly planned and executed. Chemical process simulation has proven to be an effective tool for performing a global analysis of water systems to identify routes for maximizing the process efficiency concerning to water recovery. System closure has been introduces in pulp mills resulting in simultaneous buildup of non-process elements (NPEs). This buildup generates operational problems in the bleach plant, the biggest consuming stage of water. This paper describes how to use computer simulation tools to carry out a global analysis of a bleach mill plant in Brazil, using WinGEMS and CADSIM simulators, and the NICA-Donnan Model to predict NPE ($Mn^{2+}$, $Fe^{3+}$, $Mg^{2+}$, $Ca^{2+}$) distribution. Results obtained from simulation in this paper show which changes in the Kraft pulp process in order to implement water savings should be associated to new advanced technologies. The simulated value results for the NICA–Donnan model have been satisfactorily compared with the measurement value. The model made a good description of NPE behavior, and might assist the pulp mill in operating problems caused by the buildup of those elements.**

***Keywords*— simulation process; fresh water; pulp mill; NPEs.**

## I. INTRODUCTION

Pulp and paper mills, one of the most important sectors in Brazil, require a high volume of water to produce the pulp. The bleach stage is one of the biggest water consumers in Kraft processes. Therefore, the minimization of fresh water consumption in the bleach process is an important goal for this sector to achieve.

There are several ways to minimize water consumption in the pulp mill. One of them is system closure in pulp mills, made by inner optimization with water and energy recovery, which is specific for each pulp mill and its operating conditions. And another alternative is the computer simulation, which is more economical and represents a useful tool to evaluate possible alternative processes (Dogan and Guruz, 2004).

The first effort at closing the water circuit of a mill process took place at the Great Lakes Forest Products Bleach Pulp Mill in Thunder Bay, Ontario in the mid-1970s. Later, Norrstrom carried out a conceptual study of the closed cycle mill for the production of bleached chemical pulp (Parthasarathy and Krishnagoplan, 2001). So, the system closure in the pulp mill starts with quantification of water consumption in the stage of processing, with attention focused on the stages with highest consumption, followed by introduction of alternative processes and continuous monitoring of each stage's performance (de Andrade and d'Angelo, 2006; Oliveira 2006).

Nowadays, there are several modeling and simulation software available. The most commercial simulators used in pulp and paper mills are listed in Table 1. This software comprises of: (1) modular units, representing the operations that occur in the pulp mills; (2) executive program, responsible for administration of the modular units; and (3) databases of physicochemical and thermodynamic properties of all components involved in the pulp process. In this paper, WinGEMS and CADSIM have been chosen to predict and simulate the specific changes in the overall process.

However, the water minimization through the recovery results in a simultaneous buildup of Non-Process Elements (NPEs). The NPEs are inert elements that are not within the Kraft recovery process. Their sources include wood chips; make-up lime; mill water and chemical reagents. When NPEs have accumulated in process streams, it has led to different operating problems in the bleach plant (Dogan and Guruz, 2004). Recent experiences have shown that NPEs can be modeled by computer simulations (WinGEMS and CADSIM) if fundamental models are carefully included in the simulation (Oliveira, 2006; Gu *et al.*, 2004).

This paper describes how to use computer simulation tools (Oliveira, 2006; Gu *et al.*, 2004) to carry out a

Table 1-Pulp and Paper simulators (Connaghan and Wunderlich, 1999)

| Simulation pakages | Institution |
|---|---|
| FlowCalc -Flowsheet Calculus | Simulation Software |
| WinGEMS 5.3 - General Energy and Material Balance System | Department of Chemical Engineering University of Idaho; Pacifc Simulation http://www.pacsim.com |
| MAPPS – Modular Analysis of Pulp and Paper Systems | Institute of Paper Science and Technology |
| MASSBAL – Mass and Energy Balance | SACDA Inc. (Systems Analysis Control and Design Activity) e Open Models Inc. http://www.openmodels.com |
| ASPEN PLUS - Advanced System for Process Engineering | Aspen Technology, Inc. http://www.aspentech.com |
| CADSIM PLUS, PAPDYN | Aurel System Inc. http://www.aurelsystem.com |