Improved control of the cooking process reduces energy consumption in Kraft pulping

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1 Introduction

In this study, the cooking process of the chemical pulping plant is considered. The control of the impregnation vessel and digester has great influence to the energy and raw material savings. A good control of the cooking has significant effects also to the following processes as washing and bleaching. In this research, the effect of the impregnation vessel and digester is analysed and diagnosed.

2 Objectives of the research

The cooking process is modelled using modified Gustafson's (Gustafson et al, 1983) Kappa number model. The model is used in the Downflow Lo-SolidsTM type cooking application; see e.g. Rantanen, 2006, Ahvenlampi et al, 2009a. and Ahvenlampi et al, 2009b.

There are not many on-line quality measurements in the cooking process. Normally the only on-line quality measurement (Kappa number) is located in the blow line of the digester. In this research, the cooking process has been modelled and analysed.

The objective of the research is to study the control of the cooking process and to find out the main effects of the manipulations in the main cooking controls (temperature and alkali controls) to quality, energy and raw material consumption.

3 Results

The studied process is a continuous Downflow Lo-SolidsTM type cooking process (Figure 1). The process has an impregnation vessel and a digester. The chips are impregnated in the impregnation vessel (I1–I2) and in the first zone (D1) of the digester. Between upper extraction and cooking circulation there is a counter-current washing zone (D2). In this zone, black liquor is displaced with cooking circulation liquor which temperature and alkali concentration are high. The lignin is mainly removed in the comparatively long co-current cooking zone (D3). At the bottom of the digester there is a short washing zone. Softwood chips mainly consist of pine chips and hardwood chips consist mainly of birch chips.

In Ahvenlampi et al, (2009b), the effect of the impregnation vessel to the control of the cooking process is evaluated and the effect to the quality and yield has been shown. Example of the effect of the impregnation is shown in Figure 2. The temperature change in the impregnation vessel has affected Kappa number (time period 0–200) in the upper plot in Figure 2 and it has affected also the blow line Kappa number. The residence time from the impregnation vessel to the blow line is about 200 minutes.

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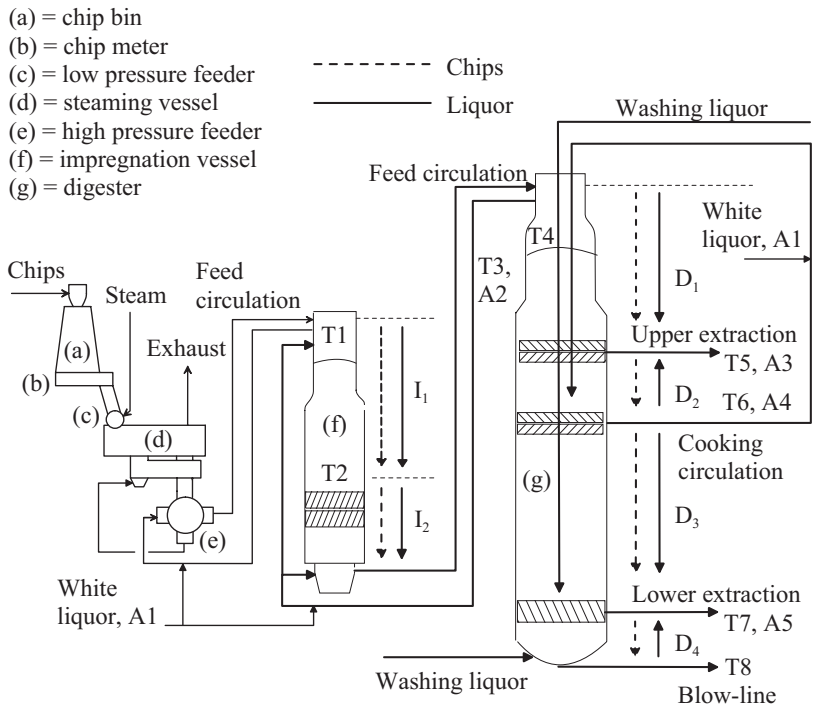

Figure 1 Continuous cooking process

The variation in the cooking process cumulates also to the following sub processes (washing, oxygen delignification, bleaching and recovery boiler).

4 Relevance of the research

If the quality control variations can be eliminated in the cooking process, the energy and raw material saving are significant. Also control of the following sub processes is more energy efficient.

The change in the pulping yield affects to the amount of dissolved wood material entering the recovery boiler and therefore to energy balance of the plant. The quality change in cooking process affects the fibre line's energy consumption e.g. in oxygen delignification and raw material consumption e.g. bleaching chemicals.

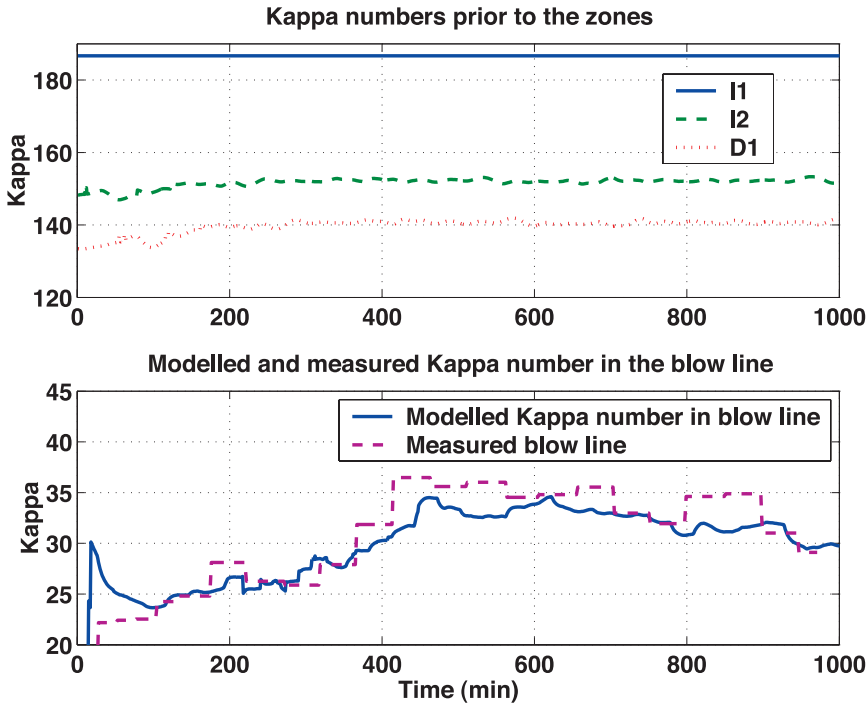

Figure 2 Kappa numbers in impregnation vessel (upper plot) and blow line of the digester

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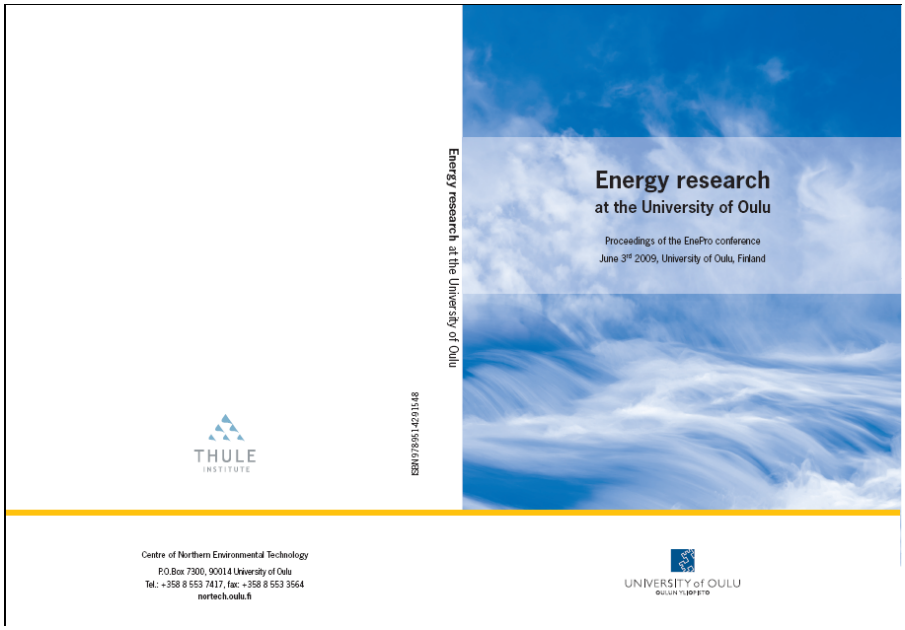

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