



Wood consumption and analysis of the bread baking process in wood-fired bakery ovens

Fabião Armando Manhiça^{a,*}, Carlos Lucas^b, Tobias Richards^c

^a Department of Chemical Engineering and Environmental Science, Forest Products and Chemical Engineering, Chalmers University of Technology, Kemivägen 10, SE-412 96 Gothenburg, Sweden

^b Department of Chemical Engineering, Eduardo Mondlane University, Cp 157 Maputo, Mozambique

^c University of Borås, Allégatan 1, SE-501 90 Borås, Sweden

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ABSTRACT

Combustion of biomass in small-scale furnaces is used widely in different applications. The technology used is often “fixed grate” combustion in small batch furnaces. The efficiency of such a furnace is often low, which results in a high environmental impact. The aim of this work was to analyse the performance of the existing wood-fired bakery ovens that can be used to improve the efficiency. The data collected from 15 semi-direct and 3 indirect bakeries consisted of: the dimensions of the oven, the temperature profiles of the combustion chamber and the baking oven, the baking time and the bread quality. It was found that as much as 60 tons/day of green wood are consumed in the bread baking process in the area investigated. Two types of bakery ovens are used most commonly: indirect and semi-direct. The specific consumption was found to be 0.55 and 0.90 kg of wood per kg of wheat flour baked for the indirect and the semi-direct respectively. The analyses of the bread baked show that the variation of the temperature profile during the baking process influences the quality of the bread produced.

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1. Introduction

Bread is a staple food for many people. The bread making process consists of several different stages, of which baking is the key step: under the influence of heat, raw dough is transformed into a light, porous, readily digestible and tasty product [1]. The control of parameters such as temperature and time during baking is basically an engineering problem that is critical to the successful implementation of commercial composite flour-baking technology [2]. Despite of technological advances and process automation bread making is a traditional food process that still depends on skilled workers. Knowledge about the process time as a function of operating conditions is one of the main interests of design engineers and equipment user. To better understand and therefore to predict, optimise and control baking, it is essential to consider both transport phenomena and quality changes taking place in bread during the process [3]. Industrial baking oven conditions are usually estimated from the tree modes of heat transfer: convection, radiation and conduction. The proportion of each individual mode of heat transfer in baking process depends on oven design,

configuration and operation. Air and oven-wall temperature profiles as well as air velocity can affect the convection/radiation heat transfer and hence the quality of the baked products [4]. Due to the relation between the heat transfer rate, investment cost and lost exergy, all of them must be considered for a realistic optimization [5].

In ovens where the necessary heat is generated from combusting wood, the thermodynamic efficiency of the combustion of wood in fixed grate technology depends upon a large number of factors, such as the design of the furnace, composition of fuel, design of the cooking chamber, cooking practice employed and meteorological conditions. The combustion process is the key to the total efficiency of wood-burning bakery ovens. Fixed grate combustion in small batch furnaces is largely used in developing countries; it is also the technology used most often in Mozambique which is a country with considerable forest resources; the main source of energy for different activities is based on biomass. A recent estimation by GRNB [6] showed that the demand for wood fuel has continually increased over the last two decades. At present, 80% of the energy used comes from biomass which represents an annual average consumption of wood fuel per capita in urban areas estimated at 1.2 m³ and 1.0 m³ in rural areas [6].

In recent years, wood fuels have been used increasingly for industrial applications, mainly in the bread baking process.

* Corresponding author. Tel.: +46 (0) 31 772 2988; fax: +46 (0) 31 772 5095.
E-mail address: fabiao@chalmers.se (F.A. Manhiça).