The usage of biofuel as well as wood fuel has increased in Sweden and all of Europe during recent decades, and there are several reasons to believe that this increase will continue. An important reason for this increase is that the environmental and climate problems caused by fossil fuels are becoming even more evident. By replacing fossil fuel with biofuel, the problem of emissions from, among others carbon dioxide and sulphur compounds can be alleviated. However, substitution requires in many cases high quality processed biofuel. An early stage in the processing of biofuel is drying. Previous work treats the possibility of drying wood fuel in an efficient and environmentally sustainable manner.

This thesis studies the bed drying technique, conducted both experimentally and through modeling of the drying process. The experimental work is based on continuous temperature measurements in the fuel bed and provides characteristics of the drying zone that develops in the bed during drying. The character of the drying zone is affected by both the qualities of the fuel and the operating parameters, and is decisive regarding the possibility of making the drying more efficient, i.e. optimize the usage of energy and produce a fuel with low and homogeneous moisture content.

A mathematical simulation model has been developed to increase the understanding of bed drying. The model is based on fundamental physical principles and is made up of five differential equations that describe vapor flow, air flow, the fuel’s moisture content, and the bed’s pressure and temperature. The modeling work complements the experimental work and a simulation of the temperature distribution, pressure and the drying zone’s dispersion is in agreement with the experimental result.

The drying of wood can signify an environmental and human health risk, since volatile organic compounds (VOC) are emitted during drying. The thesis studies these emissions with regards to type and quantity. The measurements show that the majority of the emitted compounds from Norway spruce and Scots pine are volatile monoterpenes, but also that other compounds are emitted, especially higher terpenes. Further, major differences between how the compounds are emitted and the quantities of the emitted compounds from heartwood and sapwood are shown. There are also large differences between types of wood, i.e. spruce and pine. It can be stated that both emission rate and total amount of emitted compounds increase with an increase in temperature.

To reduce VOC emissions, the drying temperature should be maintained low. To develop an efficient bed drying process for wood biofuels, additional parameters must be analyzed further and weighed against each other. Based on the experimental method and the simulation model presented here, the drying can be optimized towards a more efficient use of thermal energy and a low and even moisture content in the dried biofuel.

Keywords: biomass, bioenergy, drying, bed drying, drying zone, modeling, VOC, terpenes, wood fuels, wood chips, sawdust, Norway spruce, Scots pine