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Use of Low-quality Biogenic Fuels in a Decentralized Biomass Boiler for Thermal Energy Generation

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Abstract

The KIT generate heat with three hot water tube boilers and a combined heat and power unit. Their operation is based on natural gas. Alternatively, light fuel oil can be used in the hot water tube boilers. For the future the KIT has to achieve climate protection goals and for that to consider about alternative heat generation. This could be the operation of a biomass boiler, which is operated with wood chips or wood pellets. The Institute of Technical Chemistry (ITC) and Facility Management (FM) of KIT in cooperation with medium-sized enterprises now plans to integrate a decentralized biomass boiler into the existing heat supply network of KIT Campus North. The goal for the decentralized biomass boiler is to operate with low-quality biogenic fuel. Within the framework of preliminary studies, the biogenic fuels shall be characterized according to their combustion properties. To enhance sustainability, reduce the consumption of resources and increase economic efficiency, the studies are to focus on the use of waste materials. In addition, the waste flows at KIT and the suited waste shall be identified. The considered materials are lop, sieve residues or other previous identified waste.
When planning such a project, legal and licensing-relevant aspects and their consequenses have to be considered. Then, the requirements to be met by the selected fuels will be listed and experimental tests at the “KLEAA” test facility of ITC will be reported. This test facility is a fixed bed reactor used for the characterization of burnout of solid fuels. Studies are aimed at identifying and assessing alternative fuels for future use in biomass boilers. Furthermore side effects such as corrosion, slagging, and emissions shall be taken into account. Depending on the achieved intermediate data the insert of additives to reduce the side effects will be tested. The project findings will be verified in an experimental facility later on.
In the proposed paper first results of the preliminary investigations shall be presented.

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Keywords: low-quality biogenic fuels; waste; biomass boiler

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1. Introduction

Usage of renewable energy sources to replace fossil fuels, such as crude oil, natural gas and lignite, is an important issue of our society, science, and politics.

Renewable energy sources are of great potential not only in e-mobility, but especially in the field of heat and electricity generation. Technologies for using solar heat, photovoltaics, or wind power are well advanced. In addition to volatile generation capacities, flexibly controllable capacities, such as heat and power generation by biogas plants and biomass power plants, are required to secure energy supply in Germany. In the sector of energy utilization by biomass combustion, analysis focuses on the fuels that might be used in an economic way. Besides combustion of specially produced wood chips and wood pellets, co-incineration of low-quality biogenic fuels is gaining importance. One potential source of low-quality biogenic fuel is biogenic waste.

To reach future climate protection goals, Karlsruhe Institute of Technology (KIT) evaluates various alternative heat generation concepts. One option is the operation of a biomass boiler with low-quality biogenic fuel. To enhance sustainability, reduce the consumption of resources, and increase economic efficiency, use of waste materials is considered. The requirements to be met by selected fuels will be listed and experimental tests at the "KLEAA" test facility of KIT's Institute for Technical Chemistry (ITC) will be reported below.

2. Description of Biogenic Fuels

In this chapter, the considered biogenic fuels are described.

2.1. Biogenic Fuels Tested

The series of experiments focused on the combustion of low-quality biogenic fuels, especially from waste management. First, the waste streams of KIT Campus North were analyzed in order to determine potential fuels. When selecting the fuels, legal boundary conditions for plant operation were not taken into account. Classes of waste available for tests in the KLEAA test facility and their applicabilities are listed in the following table:

Tab. 1: Classes of waste at the KIT [1]

No.	Classes of waste	Description	Amount
1	Root wood	Root wood results from construction and excavation work and is separated from the soil by sieves. As the amount of soil is extremely high, the amount of root wood can be neglected.	10.2 Mg/a
2	Sewage waste	Mixture of street sweepings and green waste that mainly originates from cleaning sewers. Due to its high amount of stones, it is not suitable for the experiments either.	13.0 Mg/a
3	Sludge	Sludge that comes from the biological wastewater treatment plant. Due to its high humidity (30% dry matter), it is not suitable for the tests.	110.5 Mg/a
4	Green waste	Material produced by landscaping work on the whole KIT campus. Although it contains certain impurities, the material can be used for experiments.	193.2 Mg/a

In addition, wastes from disposal plants were considered. Residues from paper production as well as sieve overflow from a composting plant were selected. The high humidity content and the limited availability of the paper production residues, however, caused them to be excluded. The sieve overflow was made available by