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Nachwachsende Rohstoffe und Bioenergie

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Improving thermal conversion properties of rice straw by briquetting

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Abstract

Rice is the staple food for more than half of the human population. As an agricultural residue, more than 600 million tons rice straw are produced yearly in Asia. In many countries of the world this straw is field burned after harvest. Not only is this practice polluting the environment but it is also a waste of potential revenues and energy. Alone for Southeast Asia, there is a potential quantity of 198 million tons of rice straw available. On a conservative attempt the average lower heating value is 14 MJ/kg. The amount of energy available from this rice straw is equivalent to 2772 PJ or 13.5% of the total primary energy supply in Southeast Asia. If the straw would be used for energy production, there would be some benefits. One is the reduction of greenhouse gas emissions and air pollution caused by field burning and anaerobic mineralization. Another is the reduction of traditional biomass use and therefore a decrease of deforestation. Additionally, the straw would gain a certain value which can increase the income on farm level. Solid biofuels made of rice straw would also increases the fuel availability on farm level which could have a significant impact on active food drying and though on the reduction of postharvest losses. The low density of rice straw makes it very unsuitable for transportation and storage. Furthermore, the low heating value per unit volume is making it technically unfeasible for direct use due to combustion and handling problems. A densification through briquetting can solve these problems. The combination of bale opener, straw chopper, and a hydraulic piston briquetting press produced high quality briquettes (14.57 $MJ \cdot kg^{-1}$). Biomass materials, especially straw, often show a strong heterogeneity in their physical properties and chemical composition. Therefore a characterization of these properties as well as the determination of variance and a minimum number of required samples is important, these analyses have been performed according to DIN EN 14778. In the present experiment, during the dry season 2012 straw directly after harvest was collected and artificially dried to a final moisture content of approximately 8 % and processed to round bales. For the briquetting experiments, the particle size of the straw was varied between 7 and 15 mm and the briquetting pressure was varied between 4, 6 and 8 MPa. The produced briquettes were cylindrically shaped, 66 mm in diameter and around 50 mm in length. This form enables them to be used as feedstock in automatic systems. Initial measurements of the consumption to output ratio show that the briquetting process only consumes 1.4% of the energy, the briquettes provide. With variation in pressure, solid densities of 0.74 to 0.97 $g \cdot cm^{-3}$ and bulk densities of 377 to 477 $kg \cdot m^{-3}$ could be achieved. The briquettes durability was found to be between 87.3 % and 95.3 %. Beside the above-mentioned measures, also the static- and dynamic angle of repose as well as static friction on different materials were measured. Briquetting was found to be a promising option as pre-treatment for rice straw.