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Review

EVALUATION OF MOIST BIOMASS

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Biomass as a fuel for the direct processing of energy is accessible in many forms of variable quality. Therefore, determining the price is problematic. This paper deals with the price determination of biomass depending on its moisture. Fuel moisture influences the amount of heat it is possible to gain from the combustion process, as well as the production costs of the heat. These factors are analyzed for variable fuel moisture. Evaluation of the biomass is carried out according to computed dependencies and the dependence of biomass price on its moisture is proposed.
Key words: biomass, biomass price, moist biomass.

Evaluacija vlažne biomase. Biomasa kao gorivo za izravnu proizvodnju energije je dostupna u mnogim oblicima različite kvalitete. Stoga, određivanje cijene je problematično. Ovaj rad bavi se određivanjem cijene biomase ovisno o njegovoj vlažnosti. Vlažnost goriva utječe na količinu topline koju je moguće dobiti iz procesa izgaranja, kao i na troškove proizvodnje topline. Ovi su parametri analizirani za promjenjive vrijednosti vlažnosti goriva. Provedena je evaluacija biomase prema izračunatim ovisnostima i predložena je ovisnost cijene biomase o njezinoj vlažnosti.
Ključne riječi: biomasa, cijena biomase, vlažnost biomase.

INTRODUCTION

Biomass as a fuel for the production of energy is accessible in many forms with a wide range of quality. Biomass has a minimal ash content, thus its combustion properties are primarily influenced by its water content. High moisture results in a decrease of the lower heating value and deteriorates the possibility of utilizing the biomass energy [1], [2], [3], [4]. Therefore, it is wrong to only evaluate biomass by weight (€/t) or by lower heating value (€/GJ), as is customary, for instance, with coal [5]. It is more objective to determine the price of biomass according to the heat which is actually utilized in the boiler after its combustion, with respect to other factors related to the utilization of moist biomass, for example, larger fuel and flue gas flow, more complicated boiler construction, etc. Hence, the price should not be derived from only the type of biomass, but also from its actual water content [3].

USEFUL HEAT FROM BIOMASS COMBUSTION

The heat potential of fuel is usually specified by its lower heating value, which, together with the heat obtained by its combustion in the boiler, decreases with an increase in water content. The utilization of heat released in the boiler does not generally relate to biomass moisture; it is determined by the possibilities of flue gas cooling by an available medium, for example, by feed water or combustion air. The following considerations are based on the assumption that a new boiler could be designed with the same outlet flue gas temperature regardless of fuel water content. The influence of biomass moisture on boiler efficiency was calculated for an outlet flue gas temperature of 150°C and an air excess coefficient of1.5 – see Figure 1.Boiler efficiency deteriorates with increasing biomass moisture due to a decrease in the lower heating value and an increase in the amount of flue gas flow, which is reflected in increasing stack loss. The ratio of produced heat and lower heating value of the fuel (boiler efficiency - see Fig. 1) also decreases. It is evident that the biomass price should not be derived from the lower heating value, because utilization of heat from biomass combustion depends on the changes in water content.

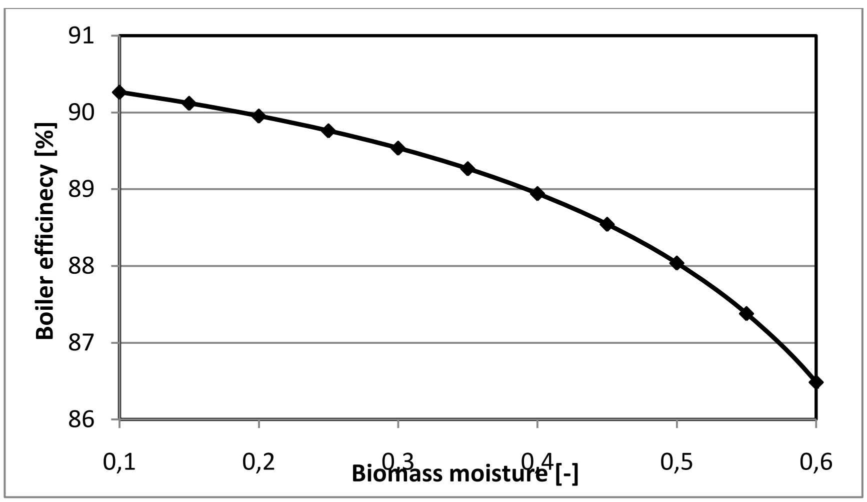

Figure 1. Boiler efficiency decreases with increasing biomass moisture content
Slika 1. Smanjenje stupnja djelovanja kotla s povećanjem udjela vlage biomase

Evaluation of heat costs is based on the calculation of biomass consumption for the generation of 1 GJ. The result is shown in Figure 2 where the amount of raw biomass needed for 1 GJ of heat in fuel and the amount of biomass needed for 1 GJ of produced heat increases with increasing fuel moisture.

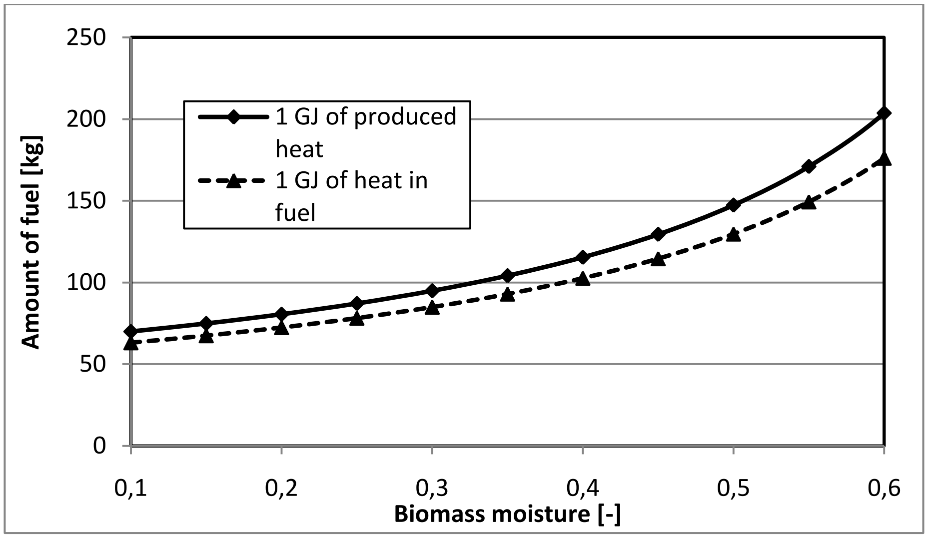

Figure 2. Impact of moisture on the needed amount of fuel
Slika 2. Utjecaj vlage na potrebne količine goriva

COSTS OF HEAT PRODUCED FROM BIOMASS WITH DIFFERENT MOISTURE CONTENT

Considerations concerning the determination of biomass price is based on maintaining the same production costs of heat from biomass regardless of it sentry moisture. In other words, deteriorated conditions of the utilization of moist biomass should be reflected in a decrease of the price of its calorific value. The production costs of the heat are determined by:

- fixed costs -water content in the biomass substantially affects boiler design, size of heating surfaces and dimensioning of auxiliary equipment
- variable costs - a change in biomass water content affects
    - fuel cost -the desired parameter
    - power consumption for auxiliary equipment drives

Price determination of biomass is carried out for the case of a specific boiler, in which biomass with variable moisture content is combusted. In this case the investment costs are constant. The growth of biomass moisture deteriorates flue gas cooling in the boiler. The dependence of the flue gas temperature on biomass moisture is determined for the specific boiler by thermal computation. An increase in outlet flue gas temperature leads to a decrease in boiler efficiency (Fig. 3). Boiler efficiency decreases steeply in comparison with the efficiency of a boiler designed for a specific fuel and constant outlet temperature (see Fig. 1).

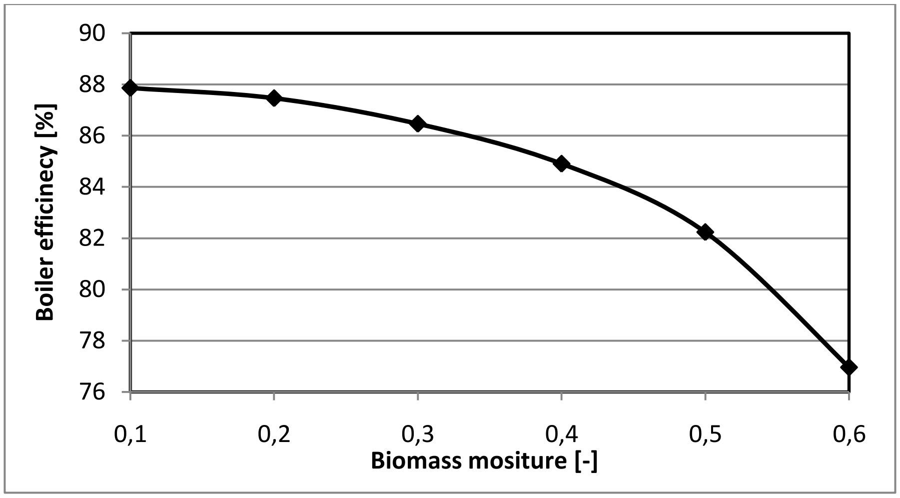

Figure 3. The impact of moisture content changes on boiler efficiency
Slika 3. Utjecaj udjela vlage na stupanj djelovanja kotla

Higher fuel moisture and lower boiler efficiency result in an increase in the power consumption of auxiliary equipment drives. This effect is the most significant for air and flue gas fans. The dependence of the total volume of air and flue gas on biomass moisture for 1 GJ of produced heat is shown in Figure 4.The dependence of the drive power consumption should follow a similar course. The dependence of biomass consum-ption for 1 GJ of produced heat on its moisture is shown in the same figure (Fig. 4).

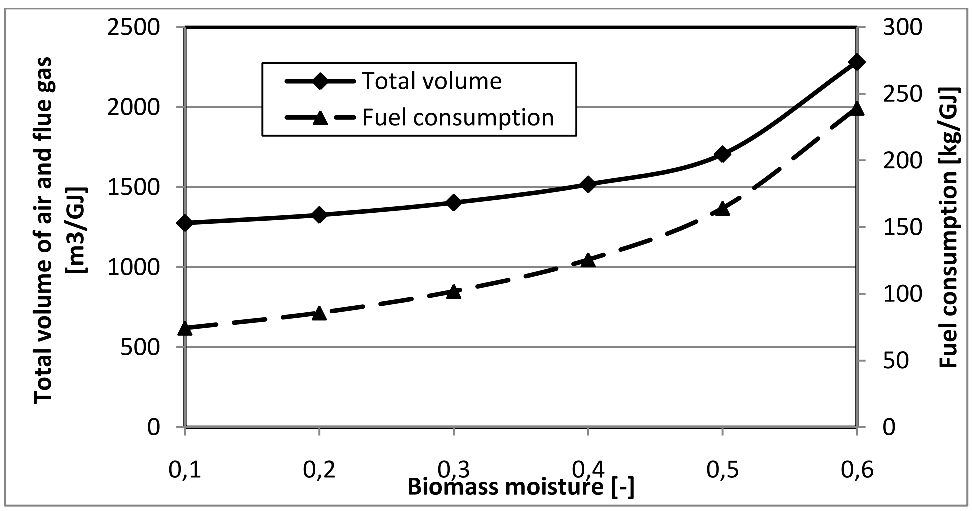

Figure 4. Influences of moisture on the total volume of air and flue gas and fuel consumption
Slika 4. Ukupni volumen zraka i dimnih plinova i potrošnja goriva

Assuming that the total costs to produce 1GJ of heat are identical regardless of the fuel moisture, the fuel cost can be calculated by subtracting the electricity cost for the auxiliary equipment from the total costs. The power consumption costs of air and flue gas fans are calculated for fans with a working pressure of 1,5 kPa, a fan efficiency of 0,7 and an electricity price of 0,15 €/kWh. The resulting electricity cost is adjusted by a coefficient of 1,5 which accounts for fuel transport, solid residues outlet, etc. Factual values are calculated for a reference price of 6 € / GJ of heat in fuel which conforms to biomass with 40% moisture [6]. The value of the partial operational costs to produce 1 GJ of heat depending on biomass moisture is obtained by adding the electricity cost (Fig. 5).The fuel cost for the relevant moisture remains after subtracting the electricity costs for the relevant fuel moisture (Fig 5). The dependence of the price of1GJ of heat in biomass on its moisture is based on these values (Fig. 6).

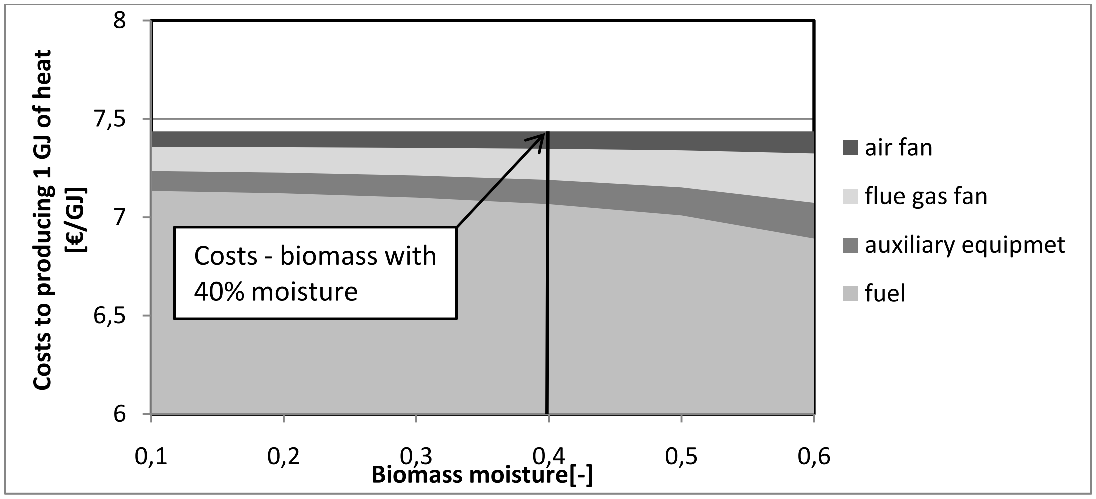

Figure 5. Distribution of costs to produce 1 GJ of heat
Slika 5. Raspodjela troškova za proizvodnju 1 GJ topline

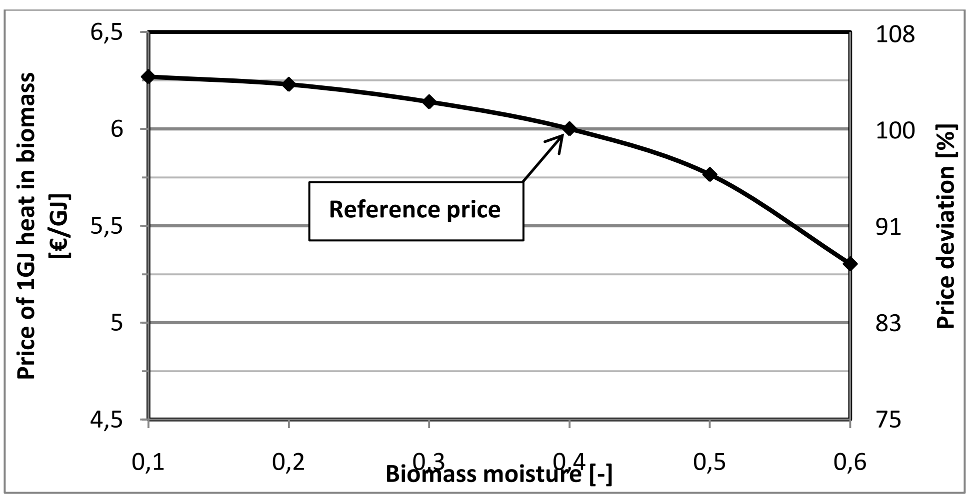

Figure 6. Resulting dependence of biomass price on its moisture content
Slika 6. Rezultantna ovisnost cijene biomase o udjelu vlage

Biomass with a high moisture content deteriorates the possibility of biomass energy utilization. Integrating drying into the energy cycle makes it possible to use these materials. The drying however requires a large amount of energy. Conventional drying methods aren't suitable and cost-effective for moist biomass and more efficient methods are under development. Research works performed by The Department of Energy Engineering at the Czech Technical University in Prague are focused on design and testing of a pilot prototype of a biomass indirect dryer. Several innovative energy cycle schemes with the integration of an indirect dryer have been proposed [4], [7].

CONCLUSION

The price of a unit of produced heat from biomass is affected by its moisture. The fuel has to be priced not only in terms of its lower heating value, but also according to its moisture content. The cost of the produced heat increases with the increase of biomass water content. The price per1 GJ of heat in fuel should take this into account and the price should decrease with the increase in fuel moisture. The dependence of biomass price on its moisture is proposed in accordance to the dependencies of power consumption and fuel consumption on biomass moisture. It is possible to correct the supplied fuel price for a specific moisture according to this dependence.

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