

VALIDATION AND APPLICATION OF A MULTIPARAMETER MODEL FOR THE DENSIFICATION OF BIOCHAR

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Densification is generally addressed to improve both the mechanical properties and the energy density of biomass feedstock. For such reason, it can also be used for biochar. However, the investigation of larger scales production by smaller academic equipment is not straightforward. It is therefore relevant to have access to models to facilitate a reliable comparison between the two different scales. In 2011, Holm et al. provided and validated a multiparameter model for analyzing industrial wood pelleting by a lab-scale single pellet press¹. In 2017, the model was further verified for torrefied wood pelleting by Puig-Arnavat et al.². The intention of the authors of the present study was to prove the suitability of this model for pyrolyzed wood. It may help to understand how the densification process can be optimized at larger scales, especially regarding the forces that act through the pelleting channel, which are often cause of damages. Theoretically the model links the pelleting pressure P_x , that the pellets undergo when ejected out of the channel, to the compression ratio $c = x/2r$ (where x is the length of the channel and r is its radius)¹. This is described by the equation:

$$P_x(c) = \frac{U}{J} (e^{4Jc} - 1) \quad \text{Eq. 1}$$

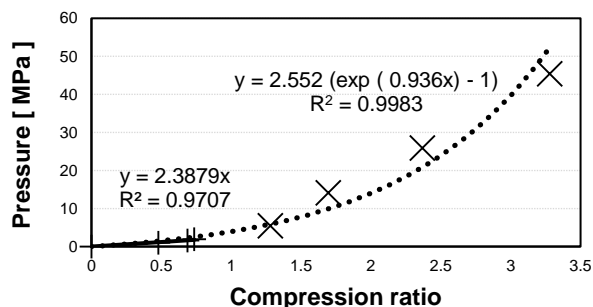


Figure 1 Comparison between experimental data and model equations at 20°C

Where U and J are constant parameters related to the Poisson's coefficient, the friction coefficient and the constant prestressing term¹. The two constants can be easily computed by a limited amount of experiments. For $c \ll 1$, Eq. 1 can be simplified as:

$$P_x(c) = 4Uc \quad \text{Eq. 2}$$

By measuring the pressure for a sufficient number of samples at different compression ratios (in this case with $c < 0.75$), U can hence be obtained by linear regression. Then, it is enough to measure the pelleting pressure for other pellets with $c > 1$, to compute by non-linear interpolation the value of J and define all the

parameters of Eq. 1. In the present work, the model was validated by commercial charcoal. The moisture content was corrected to 10% of the total weight by addition of water. Pelletization underwent at 20°C and for each compression ratio value, a triplet was produced, and pressure computed as average. The result is shown in Figure 1. Afterwards the pressure curve was computed at three different other pelleting temperatures and the behavior of the constants U and J was observed. Finally, the model was further used to understand how pelletization is affected by the pyrolysis temperature and the water content. First, biochar from Norway Spruce produced at 400°C, 600°C and 800°C was pelletized. Then, Norway spruce pyrolyzed at 600 °C was pelletized with an adjusted moisture content of 10%, 20% and 30%. This sensitive study led to get an insight of the main parameters which strictly affect the pelletization of biochar. Higher pyrolysis temperatures and higher moisture contents make pelletization easier since the pressure the channel experience decreases at fixed compression ratio. As result, the forces acting through the pelleting channel become more acceptable at larger scales.

References

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