Pelletizing properties of different grassy and woody biomass

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Introduction

In recent years, the utilization of single-pellet press for testing the pelletizing properties of new types of biomass has attracted more attention. The effects of die temperature, pressure, moisture content, biomass species and additives can be quickly screened by this method. In the present work, single-pellet method was used to suggest optimal operation conditions for further pelletizing tests in a bench-scale pellet mill. The goal of this work is to compare and characterize the pellet quality from different biomass species, and suggest the suitable process conditions for large-scale production.

Materials

Biomass samples were supplied by partners in the LogistEC project. All received biomass were ground by a hammer mill with a Ø-4mm sieve, biomass particles in the size range of 0.25-1mm were used for single-pellet tests.

- Triticale (harvested in 2013 from Spain)
- Miscanthus (harvested in 2013 from France)
- Fescue (harvested in 2013 from France)
- Alfalfa (harvested in 2013 from France)
- Sorghum (harvested in 2013 from France)
- Fresh miscanthus (collected 10 days before the tests, from UK)
- Willow (*Salix viminalis*) (harvested in 2013 from UK)

Methods

In the single-pellet press, biomass was loaded in sequential steps and with 0.25g per layer. The compressing pressure was 200MPa.

The bench-scale pelletizer was equipped with a vertical ring-type matrix, and the biomass was forced outward through the cylindrical holes by the action of an eccentrically mounted roller. The ring matrix had 40 holes, and each hole had a diameter of 7.8mm and a length of 33.5mml.

Figure 1. Picture of single-pellet press with a cylindrical die 8mm in diameter (left) and bench-scale California pellet mill at DTU (right) [1]

Results

Species	Moisture content	Static friction *Px* (N)	Pellet density (kg/m³)	Optimal moisture content for pelletizing
Triticale	10%	1016 (53)	1126 (11)	10%
	15%	745 (20)	969 (17)	
	20%	637 (-)	760 (-)	
Miscanthus	10%	1610 (81)	1145 (8)	10%
	15%	1565 (32)	1046 (17)	
	20%	946 (15)	918 (16)	
Fescue	9%	309 (25)	1178 (5)	9%
	15%	186 (10)	1126 (12)	
	20%	137 (-)	-	
Alfalfa	10%	593 (15)	1233 (26)	10%
	5%	500 (10)	1230 (40)	
	3%	500 (-)	1237 (-)	
Sorghum	10%	287 (12)	1213 (18)	10%
	15%	260 (5)	1215 (37)	
	20%	206 (5)	1173 (-)	
Fresh miscanthus	50%	167 (-)	Didn't form dense pellet	×
Willow	5%	353 (10)	1153 (1)	10%
	10%	436 (44)	1190 (2)	
	12%	343 (20)	1168 (5)	

Table 1. Single-pellet press results at die temperature of 90˚C, and pelletizing pressure at 200MPa (100MPa for fescue). Each pellet weighs about 1g. Numbers in the bracket are the standard deviations.

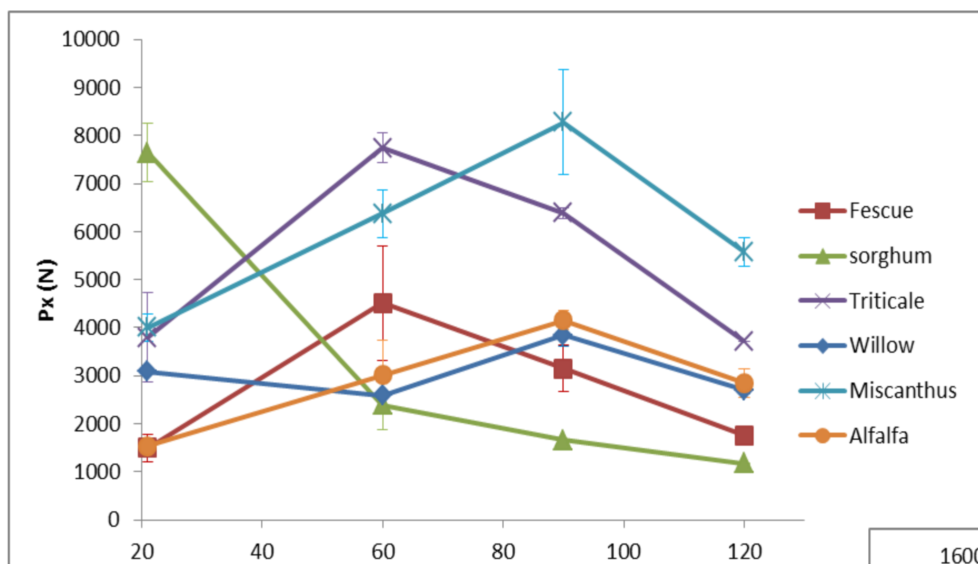

Fig.2

Figure 2 (middle). Static friction of pressing out a long pellet (ca. 3g, Ø-8mm).

Figure 3 (down right). Pellet density measured one week after pelletizing in the bench-scale pelletizer.

Figure 4 (down left). Picture of triticale pellets (left) and fescue pellets (right) from the bench-scale pelletizer

Fig.4

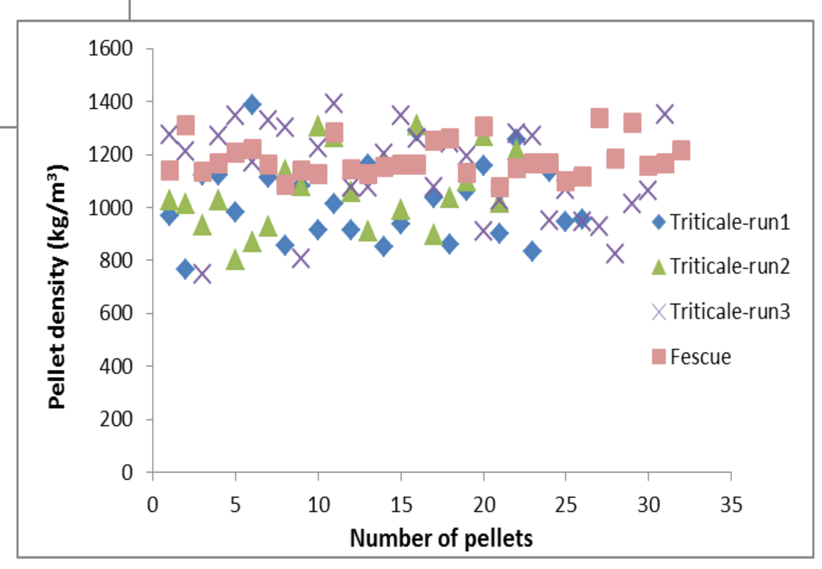

Fig.3

Conclusion

The optimal moisture content for pelletizing was tested on a single-pellet press by building a pellet stepwise, and found to be ca. 10% for all tested biomass. A sudden slope change of static friction was found when die temperature increased to certain levels. This is related to the softening point of biomass polymers. Later, triticale and fescue at optimal moisture content were tested in the bench-scale pelletizer, and steady production was found at a higher die temperature, which is in the region that friction decreased with die temperature. The densities of pellets produced from bench-scale pelletizer and single-pellet press were very close.

Reference

[1] Holm JK, Henriksen UB, Hustad JE, Sørensen LH. Toward an understanding of controlling parameters in softwood and hardwood pellets production. Energy Fuels

Acknowledgement

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