APPENDICES

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APPENDIX A

Table of Characteristics of pellet from mixed plastic waste and corn stover at various condition.

Table 1 : Table of physical characteristics of pellet from mixed plastic waste and corn stover at 55:45 %w/w with the size of corn stover less than 0.5 mm.

No.	P (MPa)	T (°C)	H (%)	M (%)	ρ (g/cm^3)	Ash (%)	Durability (%)	Stability (day)
1	100	25	5	2.33 ± 0.17	0.5923 ± 0.0089	6.18 ± 0.13	66.23 ± 0.12	365
2	100	25	10	2.83 ± 0.04	0.6218 ± 0.0058	6.1 ± 0.15	75.89 ± 0.14	365
3	100	25	15	4.15 ± 0.17	0.524 ± 0.0069	5.29 ± 0.2	74.8 ± 0.13	242
4	100	25	20	5.48 ± 0.2	0.4915 ± 0.0066	6.24 ± 0.12	69.73 ± 0.12	122
5	100	75	5	1.93 ± 0.08	0.6602 ± 0.0081	6.62 ± 0.11	88.54 ± 0.13	365
6	100	75	10	2.69 ± 0.1	0.6741 ± 0.0096	5.92 ± 0.14	89.96 ± 0.14	365
7	100	75	15	3.81 ± 0.25	0.5515 ± 0.0088	6.03 ± 0.1	82.32 ± 0.15	365
8	100	75	20	5.09 ± 0.15	0.5018 ± 0.0088	6.12 ± 0.14	80.47 ± 0.11	365
9	100	100	5	1.71 ± 0.17	0.6885 ± 0.0104	6.54 ± 0.14	89.82 ± 0.12	365
10	100	100	10	2.15 ± 0.14	0.6004 ± 0.0093	6.46 ± 0.11	85.66 ± 0.15	365
11	100	100	15	3.56 ± 0.07	0.5296 ± 0.0093	6.82 ± 0.17	79.47 ± 0.12	365
12	100	100	20	4.92 ± 0.28	0.5723 ± 0.0088	6.44 ± 0.17	86.02 ± 0.1	365
13	150	25	5	2.21 ± 0.24	0.6061 ± 0.0065	6.18 ± 0.13	66.54 ± 0.1	365
14	150	25	10	2.86 ± 0.22	0.6603 ± 0.0093	6.42 ± 0.12	80.94 ± 0.9	365
15	150	25	15	4.1 ± 0.6	0.5364 ± 0.0106	6.53 ± 0.16	77.22 ± 0.1	365
16	150	25	20	5.32 ± 0.19	0.5102 ± 0.0065	6.29 ± 0.13	68.67 ± 0.12	212
17	150	75	5	1.96 ± 0.12	0.6976 ± 0.0088	6.29 ± 0.14	90.49 ± 0.11	365
18	150	75	10	2.46 ± 0.22	0.7472 ± 0.0099	6.21 ± 0.15	95.73 ± 0.9	365
19	150	75	15	3.92 ± 0.14	0.5768 ± 0.0065	6.18 ± 0.16	94.08 ± 0.12	365
20	150	75	20	5.03 ± 0.15	0.5211 ± 0.0097	6.24 ± 0.12	89.16 ± 0.9	365
21	150	100	5	1.83 ± 0.18	0.7051 ± 0.0064	6.38 ± 0.16	95.67 ± 0.12	365
22	150	100	10	2.31 ± 0.2	0.8357 ± 0.0092	6.45 ± 0.16	96.3 ± 0.11	365
23	150	100	15	3.81 ± 0.16	0.6125 ± 0.0083	6.3 ± 0.15	93.21 ± 0.9	365
24	150	100	20	4.72 ± 0.14	0.5812 ± 0.0094	6.43 ± 0.13	88.02 ± 9.95	365
25	200	25	5	2.24 ± 0.12	0.6974 ± 0.0085	7.02 ± 0.15	78.41 ± 0.9	365
26	200	25	10	2.73 ± 0.19	0.7876 ± 0.0086	6.4 ± 0.14	82.76 ± 0.1	365
27	200	25	15	4.15 ± 0.15	0.554 ± 0.0093	6.12 ± 0.16	78.01 ± 0.12	365
28	200	25	20	5.21 ± 0.24	0.5221 ± 0.0094	6.81 ± 0.22	70.35 ± 0.1	212
29	200	75	5	2.13 ± 0.14	0.7355 ± 0.0111	6.83 ± 0.12	93.51 ± 0.14	365
30	200	75	10	2.69 ± 0.19	1.3383 ± 0.6438	6.46 ± 0.13	98.84 ± 0.9	365
31	200	75	15	4.07 ± 0.19	0.7822 ± 0.0065	6.76 ± 0.13	96.4 ± 0.1	365
32	200	75	20	4.89 ± 0.18	0.6213 ± 0.0093	6.32 ± 0.11	90.92 ± 0.1	365
33	200	100	5	2.04 ± 0.18	0.8426 ± 0.0093	6.05 ± 0.14	96.53 ± 0.12	365
34	200	100	10	2.54 ± 0.18	1.0051 ± 0.0086	6.83 ± 0.13	98.94 ± 0.11	365
35	200	100	15	3.83 ± 0.2	0.8598 ± 0.0086	6.26 ± 0.15	95.17 ± 0.9	365
36	200	100	20	4.76 ± 0.19	0.7272 ± 0.0093	6.11 ± 0.94	90.01 ± 0.12	365

Remark : The stability can not represent the result in term of average ± STD. Because the experimental of pellet stability is tested for only one trial.

Table 2 : Table of chemical characteristics of pellet from mixed plastic waste and corn stover at 55:45 %w/w with the size of corn stover less than 0.5 mm.

No.	P (MPa)	T (°C)	H (%)	HV (MJ/kg)	S (%)	Cl (%)	C (%)	H (%)	N (%)	O (%)
1	100	25	5	26.65 ± 0.86	0.1194 ± 0.0014	0.12 ± 0.03	64.56 ± 7.3	13.82 ± 0.23	0.2 ± 0.04	21.38 ± 7.11
2	100	25	10	27.53 ± 0.53	0.1205 ± 0.0011	0.19 ± 0.03	67.9 ± 0.11	13.13 ± 0.39	0.22 ± 0.06	18.68 ± 0.49
3	100	25	15	28.22 ± 0.2	0.1303 ± 0.0008	0.08 ± 0.03	66.25 ± 0.11	13.43 ± 0.04	0.25 ± 0.13	20.12 ± 0.04
4	100	25	20	27.15 ± 0.13	0.1212 ± 0.0011	0.12 ± 0.04	66.22 ± 0.25	13.41 ± 0.37	0.19 ± 0.05	20.15 ± 0.13
5	100	75	5	26.65 ± 0.86	0.1194 ± 0.0014	0.12 ± 0.03	64.56 ± 7.3	13.82 ± 0.23	0.2 ± 0.04	21.38 ± 7.11
6	100	75	10	27.53 ± 0.53	0.1205 ± 0.0011	0.19 ± 0.03	67.9 ± 0.11	13.13 ± 0.39	0.22 ± 0.06	18.68 ± 0.49
7	100	75	15	28.22 ± 0.2	0.1303 ± 0.0008	0.08 ± 0.03	66.25 ± 0.11	13.43 ± 0.04	0.25 ± 0.13	20.12 ± 0.04
8	100	75	20	27.15 ± 0.13	0.1212 ± 0.0011	0.12 ± 0.04	66.22 ± 0.25	13.41 ± 0.37	0.19 ± 0.05	20.15 ± 0.13
9	100	100	5	26.65 ± 0.86	0.1194 ± 0.0014	0.12 ± 0.03	64.56 ± 7.3	13.82 ± 0.23	0.2 ± 0.04	21.38 ± 7.11
10	100	100	10	27.53 ± 0.53	0.1205 ± 0.0011	0.19 ± 0.03	67.9 ± 0.11	13.13 ± 0.39	0.22 ± 0.06	18.68 ± 0.49
11	100	100	15	28.22 ± 0.2	0.1303 ± 0.0008	0.08 ± 0.03	66.25 ± 0.11	13.43 ± 0.04	0.25 ± 0.13	20.12 ± 0.04
12	100	100	20	27.15 ± 0.13	0.1212 ± 0.0011	0.12 ± 0.04	66.22 ± 0.25	13.41 ± 0.37	0.19 ± 0.05	20.15 ± 0.13
13	150	25	5	26.65 ± 0.86	0.1194 ± 0.0014	0.12 ± 0.03	64.56 ± 7.3	13.82 ± 0.23	0.2 ± 0.04	21.38 ± 7.11
14	150	25	10	27.53 ± 0.53	0.1205 ± 0.0011	0.19 ± 0.03	67.9 ± 0.11	13.13 ± 0.39	0.22 ± 0.06	18.68 ± 0.49
15	150	25	15	28.22 ± 0.2	0.1303 ± 0.0008	0.08 ± 0.03	66.25 ± 0.11	13.43 ± 0.04	0.25 ± 0.13	20.12 ± 0.04
16	150	25	20	27.15 ± 0.13	0.1212 ± 0.0011	0.12 ± 0.04	66.22 ± 0.25	13.41 ± 0.37	0.19 ± 0.05	20.15 ± 0.13
17	150	75	5	26.65 ± 0.86	0.1194 ± 0.0014	0.12 ± 0.03	64.56 ± 7.3	13.82 ± 0.23	0.2 ± 0.04	21.38 ± 7.11
18	150	75	10	27.53 ± 0.53	0.1205 ± 0.0011	0.19 ± 0.03	67.9 ± 0.11	13.13 ± 0.39	0.22 ± 0.06	18.68 ± 0.49
19	150	75	15	28.22 ± 0.2	0.1303 ± 0.0008	0.08 ± 0.03	66.25 ± 0.11	13.43 ± 0.04	0.25 ± 0.13	20.12 ± 0.04
20	150	75	20	27.15 ± 0.13	0.1212 ± 0.0011	0.12 ± 0.04	66.22 ± 0.25	13.41 ± 0.37	0.19 ± 0.05	20.15 ± 0.13
21	150	100	5	26.65 ± 0.86	0.1194 ± 0.0014	0.12 ± 0.03	64.56 ± 7.3	13.82 ± 0.23	0.2 ± 0.04	21.38 ± 7.11
22	150	100	10	27.53 ± 0.53	0.1205 ± 0.0011	0.19 ± 0.03	67.9 ± 0.11	13.13 ± 0.39	0.22 ± 0.06	18.68 ± 0.49
23	150	100	15	28.22 ± 0.2	0.1303 ± 0.0008	0.08 ± 0.03	66.25 ± 0.11	13.43 ± 0.04	0.25 ± 0.13	20.12 ± 0.04
24	150	100	20	27.15 ± 0.13	0.1212 ± 0.0011	0.12 ± 0.04	66.22 ± 0.25	13.41 ± 0.37	0.19 ± 0.05	20.15 ± 0.13
25	200	25	5	26.65 ± 0.86	0.1194 ± 0.0014	0.12 ± 0.03	64.56 ± 7.3	13.82 ± 0.23	0.2 ± 0.04	21.38 ± 7.11
26	200	25	10	27.53 ± 0.53	0.1205 ± 0.0011	0.19 ± 0.03	67.9 ± 0.11	13.13 ± 0.39	0.22 ± 0.06	18.68 ± 0.49
27	200	25	15	28.22 ± 0.2	0.1303 ± 0.0008	0.08 ± 0.03	66.25 ± 0.11	13.43 ± 0.04	0.25 ± 0.13	20.12 ± 0.04
28	200	25	20	27.15 ± 0.13	0.1212 ± 0.0011	0.12 ± 0.04	66.22 ± 0.25	13.41 ± 0.37	0.19 ± 0.05	20.15 ± 0.13
29	200	75	5	26.65 ± 0.86	0.1194 ± 0.0014	0.12 ± 0.03	64.56 ± 7.3	13.82 ± 0.23	0.2 ± 0.04	21.38 ± 7.11
30	200	75	10	27.53 ± 0.53	0.1205 ± 0.0011	0.19 ± 0.03	67.9 ± 0.11	13.13 ± 0.39	0.22 ± 0.06	18.68 ± 0.49
31	200	75	15	28.22 ± 0.2	0.1303 ± 0.0008	0.08 ± 0.03	66.25 ± 0.11	13.43 ± 0.04	0.25 ± 0.13	20.12 ± 0.04
32	200	75	20	27.15 ± 0.13	0.1212 ± 0.0011	0.12 ± 0.04	66.22 ± 0.25	13.41 ± 0.37	0.19 ± 0.05	20.15 ± 0.13
33	200	100	5	26.65 ± 0.86	0.1194 ± 0.0014	0.12 ± 0.03	64.56 ± 7.3	13.82 ± 0.23	0.2 ± 0.04	21.38 ± 7.11
34	200	100	10	27.53 ± 0.53	0.1205 ± 0.0011	0.19 ± 0.03	67.9 ± 0.11	13.13 ± 0.39	0.22 ± 0.06	18.68 ± 0.49
35	200	100	15	28.22 ± 0.2	0.1303 ± 0.0008	0.08 ± 0.03	66.25 ± 0.11	13.43 ± 0.04	0.25 ± 0.13	20.12 ± 0.04
36	200	100	20	27.15 ± 0.13	0.1212 ± 0.0011	0.12 ± 0.04	66.22 ± 0.25	13.41 ± 0.37	0.19 ± 0.05	20.15 ± 0.13

Table 3 Table of physical characteristics of pellet from mixed plastic waste and corn stover at 55:45 %w/w with the size of corn stover between 0.5-1 mm.

No.	P (MPa)	T (°C)	H (%)	M (%)	ρ (g/cm^3)	Ash (%)	Durability (%)	Stability (day)
1	100	25	5	2.44 ± 0.13	0.6124 ± 0.0086	6.18 ± 0.12	68.43 ± 0.9	365
2	100	25	10	3.5 ± 0.25	0.6339 ± 0.0104	6.52 ± 0.15	76.99 ± 0.9	365
3	100	25	15	4.18 ± 0.96	0.5421 ± 0.0093	6.03 ± 0.12	72.87 ± 0.9	242
4	100	25	20	7.03 ± 0.17	0.5011 ± 0.0066	6.42 ± 0.15	70.07 ± 0.25	122
5	100	75	5	2.37 ± 0.24	0.672 ± 0.0086	6.62 ± 0.15	87.36 ± 0.13	365
6	100	75	10	3.26 ± 0.22	0.7292 ± 0.0099	6.46 ± 0.11	95.83 ± 0.1	365
7	100	75	15	3.87 ± 0.28	0.6305 ± 0.0088	5.95 ± 0.13	88.48 ± 0.12	365
8	100	75	20	6.58 ± 0.15	0.6261 ± 0.0093	6.05 ± 0.12	80.19 ± 0.9	365
9	100	100	5	2.27 ± 0.21	0.8259 ± 0.0086	6.38 ± 0.15	95.47 ± 0.1	365
10	100	100	10	2.92 ± 0.2	1.0112 ± 0.0093	6.4 ± 0.13	98.72 ± 0.9	365
11	100	100	15	3.67 ± 0.14	0.8493 ± 0.0099	6.1 ± 0.15	97.94 ± 0.1	365
12	100	100	20	6.33 ± 1.03	0.618 ± 0.0088	6.3 ± 0.14	93.25 ± 0.98	365
13	150	25	5	2.42 ± 0.39	0.8746 ± 0.0088	6.76 ± 0.19	78.98 ± 0.12	365
14	150	25	10	3.37 ± 0.15	0.9526 ± 0.0093	6.1 ± 0.1	81.62 ± 0.12	365
15	150	25	15	4.19 ± 0.23	0.6453 ± 0.0094	6.34 ± 0.15	78.86 ± 0.66	365
16	150	25	20	6.3 ± 0.19	0.5779 ± 0.0065	6 ± 0.13	72.58 ± 0.12	212
17	150	75	5	2.36 ± 0.14	0.8779 ± 0.0106	5.46 ± 0.14	90.7 ± 0.9	365
18	150	75	10	3.23 ± 0.22	1.0231 ± 0.0082	6.24 ± 0.14	98.57 ± 0.13	365
19	150	75	15	3.81 ± 0.31	0.8012 ± 0.0086	6.12 ± 0.13	93.83 ± 0.1	365
20	150	75	20	6.05 ± 0.18	0.7734 ± 0.0082	6.38 ± 0.15	90.7 ± 0.12	365
21	150	100	5	2.21 ± 0.24	0.9444 ± 0.0093	6.77 ± 0.1	95.48 ± 0.12	365
22	150	100	10	3.07 ± 0.21	1.0319 ± 0.0094	6.29 ± 0.12	98.62 ± 0.1	365
23	150	100	15	3.77 ± 0.22	0.8669 ± 0.0088	6.42 ± 0.13	96.85 ± 0.13	365
24	150	100	20	5.97 ± 0.23	0.6191 ± 0.6129	6.57 ± 0.16	93.21 ± 0.1	365
25	200	25	5	2.34 ± 0.21	0.8746 ± 0.0093	6.23 ± 0.15	81.66 ± 0.12	365
26	200	25	10	3.32 ± 0.18	0.9758 ± 0.0099	6.42 ± 0.11	83.17 ± 0.9	365
27	200	25	15	4.46 ± 0.2	0.6658 ± 0.0092	6.27 ± 0.13	79.17 ± 0.12	365
28	200	25	20	6.78 ± 0.22	0.5937 ± 0.0086	6.14 ± 0.15	73.06 ± 0.11	212
29	200	75	5	1.98 ± 0.2	0.9031 ± 0.0082	6.08 ± 0.16	95.03 ± 0.12	365
30	200	75	10	2.36 ± 0.17	1.0524 ± 0.0065	6.45 ± 0.14	98.86 ± 0.11	365
31	200	75	15	2.94 ± 0.17	0.8289 ± 0.0094	6.67 ± 0.11	97.97 ± 0.9	365
32	200	75	20	3.41 ± 0.19	0.7857 ± 0.0106	6.31 ± 0.13	95.63 ± 0.11	365
33	200	100	5	1.54 ± 0.16	0.9526 ± 0.0092	6.38 ± 0.01	97.23 ± 0.12	365
34	200	100	10	1.48 ± 0.18	1.0724 ± 0.0086	6.78 ± 0.04	99.06 ± 0.9	365
35	200	100	15	2.02 ± 0.17	0.8785 ± 0.0094	6.14 ± 0.04	97.33 ± 0.12	365
36	200	100	20	3.06 ± 0.14	0.8024 ± 0.0086	6.63 ± 0.04	85.02 ± 0.11	365

Remark : The stability can not represent the result in term of average ± STD. Because the experimental of pellet stability is tested for only one trial.

Table 4 Table of chemical characteristics of pellet from mixed plastic waste and corn stover at 55:45 %w/w with the size of corn stover between 0.5-1 mm.

No.	P (MPa)	T (°C)	H (%)	HV (MJ/kg)	S (%)	Cl (%)	C (%)	H (%)	N (%)	O (%)
1	100	25	5	26.65 ± 0.86	0.1194 ± 0.0014	0.12 ± 0.03	64.56 ± 7.3	13.82 ± 0.23	0.2 ± 0.04	21.38 ± 7.11
2	100	25	10	27.53 ± 0.53	0.1205 ± 0.0011	0.19 ± 0.03	67.9 ± 0.11	13.13 ± 0.39	0.22 ± 0.06	18.68 ± 0.49
3	100	25	15	28.22 ± 0.2	0.1303 ± 0.0008	0.08 ± 0.03	66.25 ± 0.11	13.43 ± 0.04	0.25 ± 0.13	20.12 ± 0.04
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7	100	75	15	28.22 ± 0.2	0.1303 ± 0.0008	0.08 ± 0.03	66.25 ± 0.11	13.43 ± 0.04	0.25 ± 0.13	20.12 ± 0.04
8	100	75	20	27.15 ± 0.13	0.1212 ± 0.0011	0.12 ± 0.04	66.22 ± 0.25	13.41 ± 0.37	0.19 ± 0.05	20.15 ± 0.13
9	100	100	5	26.65 ± 0.86	0.1194 ± 0.0014	0.12 ± 0.03	64.56 ± 7.3	13.82 ± 0.23	0.2 ± 0.04	21.38 ± 7.11
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25	200	25	5	26.65 ± 0.86	0.1194 ± 0.0014	0.12 ± 0.03	64.56 ± 7.3	13.82 ± 0.23	0.2 ± 0.04	21.38 ± 7.11
26	200	25	10	27.53 ± 0.53	0.1205 ± 0.0011	0.19 ± 0.03	67.9 ± 0.11	13.13 ± 0.39	0.22 ± 0.06	18.68 ± 0.49
27	200	25	15	28.22 ± 0.2	0.1303 ± 0.0008	0.08 ± 0.03	66.25 ± 0.11	13.43 ± 0.04	0.25 ± 0.13	20.12 ± 0.04
28	200	25	20	27.15 ± 0.13	0.1212 ± 0.0011	0.12 ± 0.04	66.22 ± 0.25	13.41 ± 0.37	0.19 ± 0.05	20.15 ± 0.13
29	200	75	5	26.65 ± 0.86	0.1194 ± 0.0014	0.12 ± 0.03	64.56 ± 7.3	13.82 ± 0.23	0.2 ± 0.04	21.38 ± 7.11
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31	200	75	15	28.22 ± 0.2	0.1303 ± 0.0008	0.08 ± 0.03	66.25 ± 0.11	13.43 ± 0.04	0.25 ± 0.13	20.12 ± 0.04
32	200	75	20	27.15 ± 0.13	0.1212 ± 0.0011	0.12 ± 0.04	66.22 ± 0.25	13.41 ± 0.37	0.19 ± 0.05	20.15 ± 0.13
33	200	100	5	26.65 ± 0.86	0.1194 ± 0.0014	0.12 ± 0.03	64.56 ± 7.3	13.82 ± 0.23	0.2 ± 0.04	21.38 ± 7.11
34	200	100	10	27.53 ± 0.53	0.1205 ± 0.0011	0.19 ± 0.03	67.9 ± 0.11	13.13 ± 0.39	0.22 ± 0.06	18.68 ± 0.49
35	200	100	15	28.22 ± 0.2	0.1303 ± 0.0008	0.08 ± 0.03	66.25 ± 0.11	13.43 ± 0.04	0.25 ± 0.13	20.12 ± 0.04
36	200	100	20	27.15 ± 0.13	0.1212 ± 0.0011	0.12 ± 0.04	66.22 ± 0.25	13.41 ± 0.37	0.19 ± 0.05	20.15 ± 0.13

Table 5 Table of physical characteristics of pellet from mixed plastic waste and corn stover at 55:45 %w/w with the size of corn stover between 1 – 2 mm.

No.	P (MPa)	T (°C)	H (%)	M (%)	ρ (g/cm^3)	Ash (%)	Durability (%)	Stability (day)
1	100	25	5	2.75 ± 0.14	0.5479 ± 0.0093	6.38 ± 0.02	74.25 ± 0.98	365
2	100	25	10	3.12 ± 0.18	0.6061 ± 0.0082	6.18 ± 0.01	78.76 ± 0.12	365
3	100	25	15	4.45 ± 0.14	0.503 ± 0.0093	6.29 ± 0.04	71.7 ± 0.11	242
4	100	25	20	6.53 ± 0.21	0.483 ± 0.0069	5.92 ± 0.04	70 ± 0.9	122
5	100	75	5	1.47 ± 0.12	0.6526 ± 0.0065	6.03 ± 0.03	85.69 ± 0.98	365
6	100	75	10	2.77 ± 0.14	0.6756 ± 0.0106	6.42 ± 0.03	87.04 ± 0.11	365
7	100	75	15	3.11 ± 0.14	0.6005 ± 0.0088	6.62 ± 0.02	82.03 ± 0.12	365
8	100	75	20	4.25 ± 0.2	0.5809 ± 0.0086	6.53 ± 0.01	76.07 ± 0.9	365
9	100	100	5	1.07 ± 0.12	0.7158 ± 0.0082	6.82 ± 0.03	94.37 ± 0.9	365
10	100	100	10	1.62 ± 0.84	0.7545 ± 0.0066	6.46 ± 0.01	97.57 ± 0.11	365
11	100	100	15	2.26 ± 0.16	0.7278 ± 0.0094	6.76 ± 0.01	97.94 ± 0.9	365
12	100	100	20	2.98 ± 0.13	0.6001 ± 0.0065	6.27 ± 0.02	91.26 ± 0.98	365
13	150	25	5	2.07 ± 0.12	0.6354 ± 0.0082	6.08 ± 0.02	73.49 ± 0.11	365
14	150	25	10	3.09 ± 0.12	0.6513 ± 0.0065	6.38 ± 0.01	75.81 ± 0.12	365
15	150	25	15	4.03 ± 0.13	0.6018 ± 0.0093	6.45 ± 0.01	73.28 ± 0.11	365
16	150	25	20	5.58 ± 0.16	0.5067 ± 0.0093	6.78 ± 0.02	70.03 ± 0.1	212
17	150	75	5	1.36 ± 0.08	0.702 ± 0.0088	6.4 ± 0.01	90.97 ± 0.12	365
18	150	75	10	2.62 ± 0.04	0.7609 ± 0.0093	6.12 ± 0.01	95.91 ± 0.98	365
19	150	75	15	3.02 ± 0.04	0.7795 ± 0.0082	7.02 ± 0.03	93.16 ± 0.11	365
20	150	75	20	3.98 ± 3.65	0.7568 ± 0.0106	6.26 ± 0.25	90.58 ± 0.1	365
21	150	100	5	1.02 ± 1.89	0.7326 ± 0.0088	6.83 ± 0.43	95.85 ± 0.12	365
22	150	100	10	1.88 ± 0.99	0.7705 ± 0.0094	6.76 ± 0.34	98.86 ± 0.98	365
23	150	100	15	2.12 ± 0.97	0.8111 ± 0.0094	6.1 ± 0.14	95.94 ± 0.12	365
24	150	100	20	2.42 ± 0.73	0.7741 ± 0.0065	6.3 ± 0.1	92.68 ± 0.1	365
25	200	25	5	1.53 ± 4.06	0.7057 ± 0.0093	6.76 ± 0.45	75.56 ± 0.11	365
26	200	25	10	2.85 ± 0.12	0.7557 ± 0.0094	6.12 ± 0.36	77.73 ± 0.12	365
27	200	25	15	3.86 ± 0.13	0.6378 ± 0.0099	6.24 ± 0.13	75.12 ± 0.98	365
28	200	25	20	4.42 ± 0.12	0.5711 ± 0.0094	6.45 ± 0.16	72.19 ± 0.11	212
29	200	75	5	1.17 ± 0.08	0.7852 ± 0.0093	6.1 ± 0.46	92.21 ± 0.12	365
30	200	75	10	2.34 ± 0.11	0.8584 ± 0.0099	6.63 ± 0.09	97.84 ± 0.9	365
31	200	75	15	2.97 ± 0.12	0.7811 ± 0.0088	6.13 ± 0.51	95.15 ± 0.1	365
32	200	75	20	3.65 ± 0.12	0.767 ± 0.0086	6.34 ± 0.08	92.02 ± 0.9	365
33	200	100	5	0.94 ± 0.11	0.8509 ± 0.0007	6.18 ± 0.12	96.62 ± 0.12	365
34	200	100	10	1.13 ± 0.1	0.9954 ± 0.0086	6.38 ± 0.09	98.47 ± 0.9	365
35	200	100	15	1.98 ± 0.13	0.8298 ± 0.0111	6 ± 0.12	96.11 ± 0.12	365
36	200	100	20	2.11 ± 0.11	0.7805 ± 0.0094	5.29 ± 0.72	93.4 ± 0.9	365

Remark : The stability can not represent the result in term of average ± STD. Because the experimental of pellet stability is tested for only one trial.

Table 6 Table of chemical characteristics of pellet from mixed plastic waste and corn stover at 55:45 %w/w with the size of corn stover between 1-2 mm.

No.	P (MPa)	T (°C)	H (%)	HV (MJ/kg)	S (%)	Cl (%)	C (%)	H (%)	N (%)	O (%)
1	100	25	5	26.65 ± 0.86	0.1194 ± 0.0014	0.12 ± 0.03	64.56 ± 7.3	13.82 ± 0.23	0.2 ± 0.04	21.38 ± 7.11
2	100	25	10	27.53 ± 0.53	0.1205 ± 0.0011	0.19 ± 0.03	67.9 ± 0.11	13.13 ± 0.39	0.22 ± 0.06	18.68 ± 0.49
3	100	25	15	28.22 ± 0.2	0.1303 ± 0.0008	0.08 ± 0.03	66.25 ± 0.11	13.43 ± 0.04	0.25 ± 0.13	20.12 ± 0.04
4	100	25	20	27.15 ± 0.13	0.1212 ± 0.0011	0.12 ± 0.04	66.22 ± 0.25	13.41 ± 0.37	0.19 ± 0.05	20.15 ± 0.13
5	100	75	5	26.65 ± 0.86	0.1194 ± 0.0014	0.12 ± 0.03	64.56 ± 7.3	13.82 ± 0.23	0.2 ± 0.04	21.38 ± 7.11
6	100	75	10	27.53 ± 0.53	0.1205 ± 0.0011	0.19 ± 0.03	67.9 ± 0.11	13.13 ± 0.39	0.22 ± 0.06	18.68 ± 0.49
7	100	75	15	28.22 ± 0.2	0.1303 ± 0.0008	0.08 ± 0.03	66.25 ± 0.11	13.43 ± 0.04	0.25 ± 0.13	20.12 ± 0.04
8	100	75	20	27.15 ± 0.13	0.1212 ± 0.0011	0.12 ± 0.04	66.22 ± 0.25	13.41 ± 0.37	0.19 ± 0.05	20.15 ± 0.13
9	100	100	5	26.65 ± 0.86	0.1194 ± 0.0014	0.12 ± 0.03	64.56 ± 7.3	13.82 ± 0.23	0.2 ± 0.04	21.38 ± 7.11
10	100	100	10	27.53 ± 0.53	0.1205 ± 0.0011	0.19 ± 0.03	67.9 ± 0.11	13.13 ± 0.39	0.22 ± 0.06	18.68 ± 0.49
11	100	100	15	28.22 ± 0.2	0.1303 ± 0.0008	0.08 ± 0.03	66.25 ± 0.11	13.43 ± 0.04	0.25 ± 0.13	20.12 ± 0.04
12	100	100	20	27.15 ± 0.13	0.1212 ± 0.0011	0.12 ± 0.04	66.22 ± 0.25	13.41 ± 0.37	0.19 ± 0.05	20.15 ± 0.13
13	150	25	5	26.65 ± 0.86	0.1194 ± 0.0014	0.12 ± 0.03	64.56 ± 7.3	13.82 ± 0.23	0.2 ± 0.04	21.38 ± 7.11
14	150	25	10	27.53 ± 0.53	0.1205 ± 0.0011	0.19 ± 0.03	67.9 ± 0.11	13.13 ± 0.39	0.22 ± 0.06	18.68 ± 0.49
15	150	25	15	28.22 ± 0.2	0.1303 ± 0.0008	0.08 ± 0.03	66.25 ± 0.11	13.43 ± 0.04	0.25 ± 0.13	20.12 ± 0.04
16	150	25	20	27.15 ± 0.13	0.1212 ± 0.0011	0.12 ± 0.04	66.22 ± 0.25	13.41 ± 0.37	0.19 ± 0.05	20.15 ± 0.13
17	150	75	5	26.65 ± 0.86	0.1194 ± 0.0014	0.12 ± 0.03	64.56 ± 7.3	13.82 ± 0.23	0.2 ± 0.04	21.38 ± 7.11
18	150	75	10	27.53 ± 0.53	0.1205 ± 0.0011	0.19 ± 0.03	67.9 ± 0.11	13.13 ± 0.39	0.22 ± 0.06	18.68 ± 0.49
19	150	75	15	28.22 ± 0.2	0.1303 ± 0.0008	0.08 ± 0.03	66.25 ± 0.11	13,43 ± 0.04	0.25 ± 0.13	20.12 ± 0.04
20	150	75	20	27.15 ± 0.13	0.1212 ± 0.0011	0.12 ± 0.04	66.22 ± 0.25	13.41 ± 0.37	0.19 ± 0.05	20.15 ± 0.13
21	150	100	5	26.65 ± 0.86	0.1194 ± 0.0014	0.12 ± 0.03	64.56 ± 7.3	13.82 ± 0.23	0.2 ± 0.04	21.38 ± 7.11
22	150	100	10	27.53 ± 0.53	0.1205 ± 0.0011	0.19 ± 0.03	67.9 ± 0.11	13.13 ± 0.39	0.22 ± 0.06	18.68 ± 0.49
23	150	100	15	28.22 ± 0.2	0.1303 ± 0.0008	0.08 ± 0.03	66.25 ± 0.11	13.43 ± 0.04	0.25 ± 0.13	20.12 ± 0.04
24	150	100	20	27.15 ± 0.13	0.1212 ± 0.0011	0.12 ± 0.04	66.22 ± 0.25	13.41 ± 0.37	0.19 ± 0.05	20.15 ± 0.13
25	200	25	5	26.65 ± 0.86	0.1194 ± 0.0014	0.12 ± 0.03	64.56 ± 7.3	13.82 ± 0.23	0.2 ± 0.04	21.38 ± 7.11
26	200	25	10	27.53 ± 0.53	0.1205 ± 0.0011	0.19 ± 0.03	67.9 ± 0.11	13.13 ± 0.39	0.22 ± 0.06	18.68 ± 0.49
27	200	25	15	28.22 ± 0.2	0.1303 ± 0.0008	0.08 ± 0.03	66.25 ± 0.11	13.43 ± 0.04	0.25 ± 0.13	20.12 ± 0.04
28	200	25	20	27.15 ± 0.13	0.1212 ± 0.0011	0.12 ± 0.04	66.22 ± 0.25	13.41 ± 0.37	0.19 ± 0.05	20.15 ± 0.13
29	200	75	5	26.65 ± 0.86	0.1194 ± 0.0014	0.12 ± 0.03	64.56 ± 7.3	13.82 ± 0.23	0.2 ± 0.04	21.38 ± 7.11
30	200	75	10	27.53 ± 0.53	0.1205 ± 0.0011	0.19 ± 0.03	67.9 ± 0.11	13.13 ± 0.39	0.22 ± 0.06	18.68 ± 0.49
31	200	75	15	28.22 ± 0.2	0.1303 ± 0.0008	0.08 ± 0.03	66.25 ± 0.11	13.43 ± 0.04	0.25 ± 0.13	20.12 ± 0.04
32	200	75	20	27.15 ± 0.13	0.1212 ± 0.0011	0.12 ± 0.04	66.22 ± 0.25	13.41 ± 0.37	0.19 ± 0.05	20.15 ± 0.13
33	200	100	5	26.65 ± 0.86	0.1194 ± 0.0014	0.12 ± 0.03	64.56 ± 7.3	13.82 ± 0.23	0.2 ± 0.04	21.38 ± 7.11
34	200	100	10	27.53 ± 0.53	0.1205 ± 0.0011	0.19 ± 0.03	67.9 ± 0.11	13.13 ± 0.39	0.22 ± 0.06	18.68 ± 0.49
35	200	100	15	28.22 ± 0.2	0.1303 ± 0.0008	0.08 ± 0.03	66.25 ± 0.11	13.43 ± 0.04	0.25 ± 0.13	20.12 ± 0.04
36	200	100	20	27.15 ± 0.13	0.1212 ± 0.0011	0.12 ± 0.04	66.22 ± 0.25	13.41 ± 0.37	0.19 ± 0.05	20.15 ± 0.13

Table 7 Table of physical characteristics of pellet from mixed plastic waste and corn stover at 65:35 %w/w with the size of corn stover less than 0.5 mm.

No.	P (MPa)	T (°C)	H (%)	M (%)	ρ (g/cm^3)	Ash (%)	Durability (%)	Stability (day)
1	100	25	5	2.36 ± 0.12	0.5739 ± 0.0065	3.21 ± 0.13	63.34 ± 0.1	365
2	100	25	10	2.13 ± 0.09	0.5924 ± 0.0082	3.54 ± 0.08	72.21 ± 0.11	365
3	100	25	15	2.05 ± 0.11	0.46 ± 0.0094	3.22 ± 0.11	65.08 ± 0.9	242
4	100	25	20	2.43 ± 0.05	0.3599 ± 0.0082	3.42 ± 0.12	59.02 ± 0.1	122
5	100	75	5	1.28 ± 0.08	0.5956 ± 0.0093	3.5 ± 0.04	83.82 ± 0.9	365
6	100	75	10	1.22 ± 0.05	0.5979 ± 0.0093	3.22 ± 0.03	85.54 ± 0.12	365
7	100	75	15	1.69 ± 0.09	0.5327 ± 0.0082	3.32 ± 0.03	80.57 ± 0.11	365
8	100	75	20	2.01 ± 0.1	0.4393 ± 0.0007	3.65 ± 0.02	75.46 ± 0.11	365
9	100	100	5	1.44 ± 0.08	0.5472 ± 0.0086	3.23 ± 0.02	81.02 ± 0.9	365
10	100	100	10	1.21 ± 0.1	0.5992 ± 0.0093	3.18 ± 0.02	86.88 ± 0.12	365
11	100	100	15	1.72 ± 0.05	0.5008 ± 0.0094	3.1 ± 0.12	77.3 ± 0.9	365
12	100	100	20	1.8 ± 0.11	0.4512 ± 0.0088	3.29 ± 0.06	75.3 ± 0.9	365
13	150	25	5	1.58 ± 0.12	0.5877 ± 0.0093	3.24 ± 0.03	64.06 ± 0.12	365
14	150	25	10	2.35 ± 0.07	0.6107 ± 0.0086	3.62 ± 0.17	78.56 ± 0.98	365
15	150	25	15	6.08 ± 0.1	0.4872 ± 0.0093	3.82 ± 0.01	68.41 ± 0.11	365
16	150	25	20	5.94 ± 0.09	0.4301 ± 0.0099	3.03 ± 0.01	65.23 ± 0.9	212
17	150	75	5	1.2 ± 0.09	0.606 ± 0.0094	3.12 ± 0.01	85.87 ± 0.9	365
18	150	75	10	2.02 ± 0.1	0.6263 ± 0.0088	3.54 ± 1.03	88.02 ± 0.12	365
19	150	75	15	2.56 ± 0.09	0.5589 ± 0.0094	3.46 ± 0.04	82.94 ± 0.11	365
20	150	75	20	5.72 ± 0.11	0.5112 ± 0.0088	3.82 ± 0.03	81.13 ± 0.11	365
21	150	100	5	0.71 ± 0.08	0.6561 ± 0.0094	3.44 ± 0.01	85.8 ± 3.47	365
22	150	100	10	1.04 ± 0.13	0.6855 ± 0.0093	3.18 ± 0.02	87.12 ± 0.11	365
23	150	100	15	2.32 ± 0.1	0.5699 ± 0.0088	3.42 ± 0.03	82.93 ± 0.9	365
24	150	100	20	4.23 ± 0.1	0.5412 ± 0.0086	3.62 ± 0.03	81.41 ± 0.11	365
25	200	25	5	2.17 ± 0.09	0.6268 ± 0.0093	3.46 ± 0.03	74.61 ± 1.04	365
26	200	25	10	2.51 ± 0.09	0.7339 ± 0.0082	3.21 ± 0.03	80.63 ± 0.11	365
27	200	25	15	4.39 ± 0.12	0.5388 ± 0.0088	3.45 ± 0.02	73.02 ± 0.1	365
28	200	25	20	5.07 ± 0.1	0.5041 ± 0.0082	3.21 ± 0.02	68.87 ± 0.1	212
29	200	75	5	1.53 ± 0.17	0.6449 ± 0.0093	3.3 ± 0.05	90.98 ± 0.9	365
30	200	75	10	2.1 ± 0.1	0.7307 ± 0.0082	3.24 ± 0.03	94.25 ± 2.05	365
31	200	75	15	2.31 ± 0.11	0.5822 ± 0.0094	3.43 ± 0.02	85.43 ± 0.9	365
32	200	75	20	4.72 ± 0.11	0.5823 ± 0.0065	3.02 ± 0.04	84.14 ± 0.9	365
33	200	100	5	0.77 ± 0.11	0.8282 ± 0.0088	3.11 ± 0.07	93.12 ± 0.12	365
34	200	100	10	1.84 ± 0.1	0.8543 ± 0.0093	3.26 ± 0.03	96.09 ± 0.12	365
35	200	100	15	1.96 ± 0.09	0.7062 ± 0.0086	3.76 ± 0.01	86.89 ± 0.9	365
36	200	100	20	3.01 ± 0.11	0.6728 ± 0.0088	3.81 ± 0.03	87.37 ± 6.99	365

Remark : The stability can not represent the result in term of average ± STD. Because the experimental of pellet stability is tested for only one trial.

Table 8 Table of chemical characteristics of pellet from mixed plastic waste and corn stover at 65:35 %w/w with the size of corn stover less than 0.5 mm.

No.	P (MPa)	T (°C)	H (%)	HV (MJ/kg)	S (%)	Cl (%)	C (%)	H (%)	N (%)	O (%)
1	100	25	5	36.42 ± 0.12	0.144 ± 0.0008	0.14 ± 0.01	73.43 ± 0.27	13.9 ± 0.15	0.15 ± 0.06	12.39 ± 0.11
2	100	25	10	35.17 ± 0.77	0.1403 ± 0.0007	0.13 ± 0.02	69.14 ± 0.16	13.2 ± 0.19	0.2 ± 0	17.4 ± 0.01
3	100	25	15	36.22 ± 0.73	0.1498 ± 0.0006	0.14 ± 0.01	67.9 ± 0.13	14.34 ± 0.06	0.21 ± 0	17.48 ± 0.19
4	100	25	20	34.9 ± 0.58	0.1424 ± 0.0006	0.13 ± 0.01	70.54 ± 0.19	15.21 ± 0.4	0.1 ± 0.02	13.98 ± 0.22
5	100	75	5	36.42 ± 0.12	0.144 ± 0.0008	0.14 ± 0.01	73.43 ± 0.27	13.9 ± 0.15	0.15 ± 0.06	12.39 ± 0.11
6	100	75	10	35.17 ± 0.77	0.1403 ± 0.0007	0.13 ± 0.02	69.14 ± 0.16	13.2 ± 0.19	0.2 ± 0	17.4 ± 0.01
7	100	75	15	36.22 ± 0.73	0.1498 ± 0.0006	0.14 ± 0.01	67.9 ± 0.13	14.34 ± 0.06	0.21 ± 0	17.48 ± 0.19
8	100	75	20	34.9 ± 0.58	0.1424 ± 0.0006	0.13 ± 0.01	70.54 ± 0.19	15.21 ± 0.4	0.1 ± 0.02	13.98 ± 0.22
9	100	100	5	36.42 ± 0.12	0.144 ± 0.0008	0.14 ± 0.01	73.43 ± 0.27	13.9 ± 0.15	0.15 ± 0.06	12.39 ± 0.11
10	100	100	10	35.17 ± 0.77	0.1403 ± 0.0007	0.13 ± 0.02	69.14 ± 0.16	13.2 ± 0.19	0.2 ± 0	17.4 ± 0.01
11	100	100	15	36.22 ± 0.73	0.1498 ± 0.0006	0.14 ± 0.01	67.9 ± 0.13	14.34 ± 0.06	0.21 ± 0	17.48 ± 0.19
12	100	100	20	34.9 ± 0.58	0.1424 ± 0.0006	0.13 ± 0.01	70.54 ± 0.19	15.21 ± 0.4	0.1 ± 0.02	13.98 ± 0.22
13	150	25	5	36.42 ± 0.12	0.144 ± 0.0008	0.14 ± 0.01	73.43 ± 0.27	13.9 ± 0.15	0.15 ± 0.06	12.39 ± 0.11
14	150	25	10	35.17 ± 0.77	0.1403 ± 0.0007	0.13 ± 0.02	69.14 ± 0.16	13.2 ± 0.19	0.2 ± 0	17.4 ± 0.01
15	150	25	15	36.22 ± 0.73	0.1498 ± 0.0006	0.14 ± 0.01	67.9 ± 0.13	14.34 ± 0.06	0.21 ± 0	17.48 ± 0.19
16	150	25	20	34.9 ± 0.58	0.1424 ± 0.0006	0.13 ± 0.01	70.54 ± 0.19	15.21 ± 0.4	0.1 ± 0.02	13.98 ± 0.22
17	150	75	5	36.42 ± 0.12	0.144 ± 0.0008	0.14 ± 0.01	73.43 ± 0.27	13.9 ± 0.15	0.15 ± 0.06	12.39 ± 0.11
18	150	75	10	35.17 ± 0.77	0.1403 ± 0.0007	0.13 ± 0.02	69.14 ± 0.16	13.2 ± 0.19	0.2 ± 0	17.4 ± 0.01
19	150	75	15	36.22 ± 0.73	0.1498 ± 0.0006	0.14 ± 0.01	67.9 ± 0.13	14.34 ± 0.06	0.21 ± 0	17.48 ± 0.19
20	150	75	20	34.9 ± 0.58	0.1424 ± 0.0006	0.13 ± 0.01	70.54 ± 0.19	15.21 ± 0.4	0.1 ± 0.02	13.98 ± 0.22
21	150	100	5	36.42 ± 0.12	0.144 ± 0.0008	0.14 ± 0.01	73.43 ± 0.27	13.9 ± 0.15	0.15 ± 0.06	12.39 ± 0.11
22	150	100	10	35.17 ± 0.77	0.1403 ± 0.0007	0.13 ± 0.02	69.14 ± 0.16	13.2 ± 0.19	0.2 ± 0	17.4 ± 0.01
23	150	100	15	36.22 ± 0.73	0.1498 ± 0.0006	0.14 ± 0.01	67.9 ± 0.13	14.34 ± 0.06	0.21 ± 0	17.48 ± 0.19
24	150	100	20	34.9 ± 0.58	0.1424 ± 0.0006	0.13 ± 0.01	70.54 ± 0.19	15.21 ± 0.4	0.1 ± 0.02	13.98 ± 0.22
25	200	25	5	36.42 ± 0.12	0.144 ± 0.0008	0.14 ± 0.01	73.43 ± 0.27	13.9 ± 0.15	0.15 ± 0.06	12.39 ± 0.11
26	200	25	10	35.17 ± 0.77	0.1403 ± 0.0007	0.13 ± 0.02	69.14 ± 0.16	13.2 ± 0.19	0.2 ± 0	17.4 ± 0.01
27	200	25	15	36.22 ± 0.73	0.1498 ± 0.0006	0.14 ± 0.01	67.9 ± 0.13	14.34 ± 0.06	0.21 ± 0	17.48 ± 0.19
28	200	25	20	34.9 ± 0.58	0.1424 ± 0.0006	0.13 ± 0.01	70.54 ± 0.19	15.21 ± 0.4	0.1 ± 0.02	13.98 ± 0.22
29	200	75	5	36.42 ± 0.12	0.144 ± 0.0008	0.14 ± 0.01	73.43 ± 0.27	13.9 ± 0.15	0.15 ± 0.06	12.39 ± 0.11
30	200	75	10	35.17 ± 0.77	0.1403 ± 0.0007	0.13 ± 0.02	69.14 ± 0.16	13.2 ± 0.19	0.2 ± 0	17.4 ± 0.01
31	200	75	15	36.22 ± 0.73	0.1498 ± 0.0006	0.14 ± 0.01	67.9 ± 0.13	14.34 ± 0.06	0.21 ± 0	17.48 ± 0.19
32	200	75	20	34.9 ± 0.58	0.1424 ± 0.0006	0.13 ± 0.01	70.54 ± 0.19	15.21 ± 0.4	0.1 ± 0.02	13.98 ± 0.22
33	200	100	5	36.42 ± 0.12	0.144 ± 0.0008	0.14 ± 0.01	73.43 ± 0.27	13.9 ± 0.15	0.15 ± 0.06	12.39 ± 0.11
34	200	100	10	35.17 ± 0.77	0.1403 ± 0.0007	0.13 ± 0.02	69.14 ± 0.16	13.2 ± 0.19	0.2 ± 0	17.4 ± 0.01
35	200	100	15	36.22 ± 0.73	0.1498 ± 0.0006	0.14 ± 0.01	67.9 ± 0.13	14.34 ± 0.06	0.21 ± 0	17.48 ± 0.19
36	200	100	20	34.9 ± 0.58	0.1424 ± 0.0006	0.13 ± 0.01	70.54 ± 0.19	15.21 ± 0.4	0.1 ± 0.02	13.98 ± 0.22

Table 9 Table of physical characteristics of pellet from mixed plastic waste and corn stover at 65:35 %w/w with the size of corn stover between 0.5-1 mm.

No.	P (MPa)	T (°C)	H (%)	M (%)	ρ (g/cm^3)	Ash (%)	Durability (%)	Stability (day)
1	100	25	5	2.14 ± 0.11	0.5963 ± 0.0086	3.48 ± 0.03	65.06 ± 0.1	365
2	100	25	10	2.51 ± 0.12	0.6195 ± 0.0088	3.52 ± 0.03	74.87 ± 0.1	365
3	100	25	15	3.37 ± 0.12	0.4835 ± 0.0065	3.1 ± 0.13	69.04 ± 0.12	242
4	100	25	20	4.66 ± 0.09	0.3727 ± 0.0094	3.23 ± 0.02	57.2 ± 0.9	122
5	100	75	5	1.75 ± 0.1	0.6423 ± 0.0086	3.14 ± 0.03	84.98 ± 0.91	365
6	100	75	10	2.1 ± 0.09	0.6507 ± 0.0065	3.78 ± 0.03	94.25 ± 0.9	365
7	100	75	15	2.79 ± 0.11	0.5551 ± 0.0094	3.38 ± 0.02	81.38 ± 0.9	365
8	100	75	20	2.89 ± 0.09	0.4823 ± 0.0065	3.31 ± 0.66	76.09 ± 1	365
9	100	100	5	1.56 ± 0.12	0.6682 ± 0.0088	3.37 ± 0.03	87.12 ± 0.1	365
10	100	100	10	2.06 ± 0.13	0.6743 ± 0.0094	3.45 ± 1.03	88.03 ± 0.9	365
11	100	100	15	2.09 ± 0.15	0.6368 ± 0.0093	3.08 ± 0.06	84.89 ± 0.1	365
12	100	100	20	2.18 ± 0.15	0.5928 ± 0.0094	3.27 ± 0.02	80.37 ± 0.9	365
13	150	25	5	1.77 ± 0.06	0.6048 ± 0.0088	3.42 ± 0.03	76.53 ± 0.1	365
14	150	25	10	1.98 ± 0.17	0.7953 ± 0.0093	3.23 ± 0.02	74.32 ± 0.9	365
15	150	25	15	2.97 ± 0.12	0.5917 ± 0.0086	3.42 ± 0.03	73.21 ± 0.1	365
16	150	25	20	1.34 ± 0.14	0.5646 ± 0.0088	3.57 ± 0.04	70.28 ± 0.11	212
17	150	75	5	1.61 ± 0.02	0.6722 ± 0.0086	3.29 ± 0.03	88.46 ± 0.11	365
18	150	75	10	1.87 ± 0.03	0.8919 ± 0.0088	3.77 ± 0.02	96.21 ± 0.9	365
19	150	75	15	2.52 ± 0.03	0.6644 ± 0.0093	3.43 ± 0.02	88.03 ± 0.1	365
20	150	75	20	3.08 ± 0.03	0.6022 ± 0.0094	3.12 ± 0.03	86.44 ± 0.12	365
21	150	100	5	0.68 ± 0.06	0.6862 ± 0.0088	3.24 ± 0.03	86.08 ± 0.1	365
22	150	100	10	0.89 ± 0.1	0.6961 ± 0.0086	3.46 ± 0.03	96.97 ± 0.21	365
23	150	100	15	2.28 ± 0.1	0.6876 ± 0.0065	3.3 ± 0.03	86.65 ± 0.1	365
24	150	100	20	2.86 ± 0.03	0.6156 ± 0.0094	3.38 ± 0.03	84.23 ± 0.11	365
25	200	25	5	1.66 ± 0.04	0.7831 ± 0.0065	3.62 ± 0.05	77.64 ± 0.9	365
26	200	25	10	1.78 ± 0.04	0.8027 ± 0.0093	3.1 ± 0.04	79.02 ± 0.11	365
27	200	25	15	2.39 ± 0.07	0.6066 ± 0.0082	3.34 ± 0.02	75.43 ± 0.1	365
28	200	25	20	3.04 ± 0.06	0.5835 ± 0.0094	3.46 ± 0.03	72.75 ± 0.9	212
29	200	75	5	1.52 ± 0.04	0.8719 ± 0.0111	3.52 ± 0	93.51 ± 0.11	365
30	200	75	10	1.63 ± 0.02	0.9005 ± 0.0093	3.37 ± 0.01	97.84 ± 0.1	365
31	200	75	15	2.37 ± 0.04	0.7613 ± 0.0093	3.12 ± 0.03	90.45 ± 0.89	365
32	200	75	20	2.93 ± 0.03	0.6298 ± 0.0065	3.38 ± 0.04	88.54 ± 0.12	365
33	200	100	5	0.59 ± 0.06	0.8904 ± 0.0094	3.29 ± 0.02	95.48 ± 0.11	365
34	200	100	10	0.72 ± 0.04	0.9245 ± 0.0086	3.42 ± 0.03	98.32 ± 0.9	365
35	200	100	15	2.11 ± 0.02	0.7621 ± 0.0093	3.57 ± 0.02	93.01 ± 0.9	365
36	200	100	20	2.61 ± 0.04	0.7058 ± 0.0111	3.27 ± 0.01	89.17 ± 0.1	365

Remark : The stability can not represent the result in term of average ± STD. Because the experimental of pellet stability is tested for only one trial.

Table 10 Table of chemical characteristics of pellet from mixed plastic waste and corn stover at 65:35 %w/w with the size of corn stover between 0.5-1 mm.

No.	P (MPa)	T (°C)	H (%)	HV (MJ/kg)	S (%)	Cl (%)	C (%)	H (%)	N (%)	O (%)
1	100	25	5	36.42 ± 0.12	0.144 ± 0.0008	0.14 ± 0.01	73.43 ± 0.27	13.9 ± 0.15	0.15 ± 0.06	12.39 ± 0.11
2	100	25	10	35.17 ± 0.77	0.1403 ± 0.0007	0.13 ± 0.02	69.14 ± 0.16	13.2 ± 0.19	0.2 ± 0	17.4 ± 0.01
3	100	25	15	36.22 ± 0.73	0.1498 ± 0.0006	0.14 ± 0.01	67.9 ± 0.13	14.34 ± 0.06	0.21 ± 0	17.48 ± 0.19
4	100	25	20	34.9 ± 0.58	0.1424 ± 0.0006	0.13 ± 0.01	70.54 ± 0.19	15.21 ± 0.4	0.1 ± 0.02	13.98 ± 0.22
5	100	75	5	36.42 ± 0.12	0.144 ± 0.0008	0.14 ± 0.01	73.43 ± 0.27	13.9 ± 0.15	0.15 ± 0.06	12.39 ± 0.11
6	100	75	10	35.17 ± 0.77	0.1403 ± 0.0007	0.13 ± 0.02	69.14 ± 0.16	13.2 ± 0.19	0.2 ± 0	17.4 ± 0.01
7	100	75	15	36.22 ± 0.73	0.1498 ± 0.0006	0.14 ± 0.01	67.9 ± 0.13	14.34 ± 0.06	0.21 ± 0	17.48 ± 0.19
8	100	75	20	34.9 ± 0.58	0.1424 ± 0.0006	0.13 ± 0.01	70.54 ± 0.19	15.21 ± 0.4	0.1 ± 0.02	13.98 ± 0.22
9	100	100	5	36.42 ± 0.12	0.144 ± 0.0008	0.14 ± 0.01	73.43 ± 0.27	13.9 ± 0.15	0.15 ± 0.06	12.39 ± 0.11
10	100	100	10	35.17 ± 0.77	0.1403 ± 0.0007	0.13 ± 0.02	69.14 ± 0.16	13.2 ± 0.19	0.2 ± 0	17.4 ± 0.01
11	100	100	15	36.22 ± 0.73	0.1498 ± 0.0006	0.14 ± 0.01	67.9 ± 0.13	14.34 ± 0.06	0.21 ± 0	17.48 ± 0.19
12	100	100	20	34.9 ± 0.58	0.1424 ± 0.0006	0.13 ± 0.01	70.54 ± 0.19	15.21 ± 0.4	0.1 ± 0.02	13.98 ± 0.22
13	150	25	5	36.42 ± 0.12	0.144 ± 0.0008	0.14 ± 0.01	73.43 ± 0.27	13.9 ± 0.15	0.15 ± 0.06	12.39 ± 0.11
14	150	25	10	35.17 ± 0.77	0.1403 ± 0.0007	0.13 ± 0.02	69.14 ± 0.16	13.2 ± 0.19	0.2 ± 0	17.4 ± 0.01
15	150	25	15	36.22 ± 0.73	0.1498 ± 0.0006	0.14 ± 0.01	67.9 ± 0.13	14.34 ± 0.06	0.21 ± 0	17.48 ± 0.19
16	150	25	20	34.9 ± 0.58	0.1424 ± 0.0006	0.13 ± 0.01	70.54 ± 0.19	15.21 ± 0.4	0.1 ± 0.02	13.98 ± 0.22
17	150	75	5	36.42 ± 0.12	0.144 ± 0.0008	0.14 ± 0.01	73.43 ± 0.27	13.9 ± 0.15	0.15 ± 0.06	12.39 ± 0.11
18	150	75	10	35.17 ± 0.77	0.1403 ± 0.0007	0.13 ± 0.02	69.14 ± 0.16	13.2 ± 0.19	0.2 ± 0	17.4 ± 0.01
19	150	75	15	36.22 ± 0.73	0.1498 ± 0.0006	0.14 ± 0.01	67.9 ± 0.13	14.34 ± 0.06	0.21 ± 0	17.48 ± 0.19
20	150	75	20	34.9 ± 0.58	0.1424 ± 0.0006	0.13 ± 0.01	70.54 ± 0.19	15.21 ± 0.4	0.1 ± 0.02	13.98 ± 0.22
21	150	100	5	36.42 ± 0.12	0.144 ± 0.0008	0.14 ± 0.01	73.43 ± 0.27	13.9 ± 0.15	0.15 ± 0.06	12.39 ± 0.11
22	150	100	10	35.17 ± 0.77	0.1403 ± 0.0007	0.13 ± 0.02	69.14 ± 0.16	13.2 ± 0.19	0.2 ± 0	17.4 ± 0.01
23	150	100	15	36.22 ± 0.73	0.1498 ± 0.0006	0.14 ± 0.01	67.9 ± 0.13	14.34 ± 0.06	0.21 ± 0	17.48 ± 0.19
24	150	100	20	34.9 ± 0.58	0.1424 ± 0.0006	0.13 ± 0.01	70.54 ± 0.19	15.21 ± 0.4	0.1 ± 0.02	13.98 ± 0.22
25	200	25	5	36.42 ± 0.12	0.144 ± 0.0008	0.14 ± 0.01	73.43 ± 0.27	13.9 ± 0.15	0.15 ± 0.06	12.39 ± 0.11
26	200	25	10	35.17 ± 0.77	0.1403 ± 0.0007	0.13 ± 0.02	69.14 ± 0.16	13.2 ± 0.19	0.2 ± 0	17.4 ± 0.01
27	200	25	15	36.22 ± 0.73	0.1498 ± 0.0006	0.14 ± 0.01	67.9 ± 0.13	14.34 ± 0.06	0.21 ± 0	17.48 ± 0.19
28	200	25	20	34.9 ± 0.58	0.1424 ± 0.0006	0.13 ± 0.01	70.54 ± 0.19	15.21 ± 0.4	0.1 ± 0.02	13.98 ± 0.22
29	200	75	5	36.42 ± 0.12	0.144 ± 0.0008	0.14 ± 0.01	73.43 ± 0.27	13.9 ± 0.15	0.15 ± 0.06	12.39 ± 0.11
30	200	75	10	35.17 ± 0.77	0.1403 ± 0.0007	0.13 ± 0.02	69.14 ± 0.16	13.2 ± 0.19	0.2 ± 0	17.4 ± 0.01
31	200	75	15	36.22 ± 0.73	0.1498 ± 0.0006	0.14 ± 0.01	67.9 ± 0.13	14.34 ± 0.06	0.21 ± 0	17.48 ± 0.19
32	200	75	20	34.9 ± 0.58	0.1424 ± 0.0006	0.13 ± 0.01	70.54 ± 0.19	15.21 ± 0.4	0.1 ± 0.02	13.98 ± 0.22
33	200	100	5	36.42 ± 0.12	0.144 ± 0.0008	0.14 ± 0.01	73.43 ± 0.27	13.9 ± 0.15	0.15 ± 0.06	12.39 ± 0.11
34	200	100	10	35.17 ± 0.77	0.1403 ± 0.0007	0.13 ± 0.02	69.14 ± 0.16	13.2 ± 0.19	0.2 ± 0	17.4 ± 0.01
35	200	100	15	36.22 ± 0.73	0.1498 ± 0.0006	0.14 ± 0.01	67.9 ± 0.13	14.34 ± 0.06	0.21 ± 0	17.48 ± 0.19
36	200	100	20	34.9 ± 0.58	0.1424 ± 0.0006	0.13 ± 0.01	70.54 ± 0.19	15.21 ± 0.4	0.1 ± 0.02	13.98 ± 0.22

Table 11 Table of physical characteristics of pellet from mixed plastic waste and corn stover at 65:35 %w/w with the size of corn stover between 1-2 mm.

No.	P (MPa)	T (°C)	H (%)	M (%)	ρ (g/cm^3)	Ash (%)	Durability (%)	Stability (day)
1	100	25	5	2.52 ± 0.1	0.5143 ± 0.0093	3.38 ± 0.04	73.62 ± 0.9	365
2	100	25	10	3.14 ± 0.1	0.5904 ± 0.0086	3.51 ± 0.03	76.82 ± 0.1	365
3	100	25	15	3.31 ± 0.13	0.3551 ± 0.0082	3.21 ± 0.04	65.87 ± 0.11	242
4	100	25	20	4.04 ± 0.14	0.3035 ± 0.0093	3.28 ± 0.05	55.98 ± 0.9	122
5	100	75	5	2.47 ± 0.11	0.5352 ± 0.0094	3.42 ± 0.01	78.97 ± 0.9	365
6	100	75	10	2.53 ± 0.08	0.6504 ± 0.0094	3.27 ± 0.03	85.04 ± 0.9	365
7	100	75	15	2.84 ± 0.11	0.5139 ± 0.0094	3.08 ± 0.02	80.56 ± 0.11	365
8	100	75	20	2.86 ± 0.1	0.4095 ± 0.0093	3.45 ± 0.03	75.81 ± 0.1	365
9	100	100	5	2.1 ± 0.08	0.6646 ± 0.0094	3.4 ± 0.04	96.35 ± 0.11	365
10	100	100	10	2.15 ± 0.07	0.6476 ± 0.0094	3.29 ± 0.06	87.23 ± 0.98	365
11	100	100	15	2.72 ± 0.07	0.6276 ± 0.0065	3.53 ± 0.02	83.22 ± 0.9	365
12	100	100	20	3.11 ± 0.11	0.5192 ± 0.0106	3.76 ± 0.02	80.23 ± 0.9	365
13	150	25	5	2.48 ± 0.13	0.4717 ± 0.0088	3.08 ± 0.03	69.08 ± 0.11	365
14	150	25	10	3.27 ± 0.14	0.5191 ± 0.0094	3.38 ± 0.05	68.47 ± 0.1	365
15	150	25	15	3.44 ± 0.08	0.5165 ± 0.0065	3.45 ± 0.04	67.84 ± 0.11	365
16	150	25	20	3.98 ± 0.03	0.4921 ± 0.0065	3.12 ± 0.03	67.03 ± 0.9	212
17	150	75	5	1.9 ± 0.08	0.5537 ± 0.0082	3.53 ± 0.02	88.97 ± 0.09	365
18	150	75	10	2.09 ± 0.1	0.6791 ± 0.0088	3.3 ± 0.03	94.56 ± 1.74	365
19	150	75	15	3.11 ± 0.16	0.5351 ± 0.0093	3.24 ± 0.03	88.79 ± 0.12	365
20	150	75	20	3.76 ± 0.1	0.4176 ± 0.0104	3.11 ± 0.02	86.56 ± 0.1	365
21	150	100	5	1.27 ± 0.07	0.6828 ± 0.0065	3.15 ± 0.03	90.79 ± 0.11	365
22	150	100	10	1.86 ± 0.1	0.6583 ± 0.0094	3.37 ± 0.04	93.56 ± 0.11	365
23	150	100	15	2.96 ± 0.11	0.6462 ± 0.0088	3.49 ± 0.07	91.03 ± 0.9	365
24	150	100	20	3.52 ± 0.08	0.5883 ± 0.0094	3.53 ± 0.02	87.21 ± 0.11	365
25	200	25	5	2.46 ± 0.08	0.5748 ± 0.0099	3.45 ± 0.03	71.32 ± 0.9	365
26	200	25	10	3.24 ± 0.06	0.7047 ± 0.0093	3.3 ± 0.04	70.2 ± 0.11	365
27	200	25	15	3.39 ± 0.07	0.5418 ± 0.0104	3.29 ± 0.05	68.45 ± 0.11	365
28	200	25	20	3.87 ± 0.04	0.523 ± 0.0093	3.36 ± 0.05	70.76 ± 0.9	212
29	200	75	5	2.43 ± 0.07	0.7037 ± 0.0065	3.18 ± 0.05	90.03 ± 0.9	365
30	200	75	10	3.18 ± 0.06	0.8023 ± 0.0096	3.13 ± 0.05	96.09 ± 0.11	365
31	200	75	15	3.39 ± 0.07	0.6725 ± 0.0104	3.62 ± 0.03	90.87 ± 0.11	365
32	200	75	20	3.67 ± 0.03	0.5531 ± 0.0093	3.23 ± 0.06	87.45 ± 0.9	365
33	200	100	5	1.13 ± 0.09	0.8059 ± 0.0086	3.76 ± 0.01	92.23 ± 0.12	365
34	200	100	10	3.03 ± 0.07	0.8526 ± 0.0104	3.34 ± 0.05	95.11 ± 0.98	365
35	200	100	15	3.24 ± 0.04	0.6925 ± 0.0093	3.62 ± 0.05	92.83 ± 0.12	365
36	200	100	20	3.49 ± 0.03	0.6124 ± 0.0093	3.33 ± 0.02	89.26 ± 0.1	365

Remark : The stability can not represent the result in term of average ± STD. Because the experimental of pellet stability is tested for only one trial.

Table 12 Table of chemical characteristics of pellet from mixed plastic waste and corn stover at 65:35 %w/w with the size of corn stover between 1-2 mm.

No.	P (MPa)	T (°C)	H (%)	HV (MJ/kg)	S (%)	Cl (%)	C (%)	H (%)	N (%)	O (%)
1	100	25	5	36.42 ± 0.12	0.144 ± 0.0008	0.14 ± 0.01	73.43 ± 0.27	13.9 ± 0.15	0.15 ± 0.06	12.39 ± 0.11
2	100	25	10	35.17 ± 0.77	0.1403 ± 0.0007	0.13 ± 0.02	69.14 ± 0.16	13.2 ± 0.19	0.2 ± 0	17.4 ± 0.01
3	100	25	15	36.22 ± 0.73	0.1498 ± 0.0006	0.14 ± 0.01	67.9 ± 0.13	14.34 ± 0.06	0.21 ± 0	17.48 ± 0.19
4	100	25	20	34.9 ± 0.58	0.1424 ± 0.0006	0.13 ± 0.01	70.54 ± 0.19	15.21 ± 0.4	0.1 ± 0.02	13.98 ± 0.22
5	100	75	5	36.42 ± 0.12	0.144 ± 0.0008	0.14 ± 0.01	73.43 ± 0.27	13.9 ± 0.15	0.15 ± 0.06	12.39 ± 0.11
6	100	75	10	35.17 ± 0.77	0.1403 ± 0.0007	0.13 ± 0.02	69.14 ± 0.16	13.2 ± 0.19	0.2 ± 0	17.4 ± 0.01
7	100	75	15	36.22 ± 0.73	0.1498 ± 0.0006	0.14 ± 0.01	67.9 ± 0.13	14.34 ± 0.06	0.21 ± 0	17.48 ± 0.19
8	100	75	20	34.9 ± 0.58	0.1424 ± 0.0006	0.13 ± 0.01	70.54 ± 0.19	15.21 ± 0.4	0.1 ± 0.02	13.98 ± 0.22
9	100	100	5	36.42 ± 0.12	0.144 ± 0.0008	0.14 ± 0.01	73.43 ± 0.27	13.9 ± 0.15	0.15 ± 0.06	12.39 ± 0.11
10	100	100	10	35.17 ± 0.77	0.1403 ± 0.0007	0.13 ± 0.02	69.14 ± 0.16	13.2 ± 0.19	0.2 ± 0	17.4 ± 0.01
11	100	100	15	36.22 ± 0.73	0.1498 ± 0.0006	0.14 ± 0.01	67.9 ± 0.13	14.34 ± 0.06	0.21 ± 0	17.48 ± 0.19
12	100	100	20	34.9 ± 0.58	0.1424 ± 0.0006	0.13 ± 0.01	70.54 ± 0.19	15.21 ± 0.4	0.1 ± 0.02	13.98 ± 0.22
13	150	25	5	36.42 ± 0.12	0.144 ± 0.0008	0.14 ± 0.01	73.43 ± 0.27	13.9 ± 0.15	0.15 ± 0.06	12.39 ± 0.11
14	150	25	10	35.17 ± 0.77	0.1403 ± 0.0007	0.13 ± 0.02	69.14 ± 0.16	13.2 ± 0.19	0.2 ± 0	17.4 ± 0.01
15	150	25	15	36.22 ± 0.73	0.1498 ± 0.0006	0.14 ± 0.01	67.9 ± 0.13	14.34 ± 0.06	0.21 ± 0	17.48 ± 0.19
16	150	25	20	34.9 ± 0.58	0.1424 ± 0.0006	0.13 ± 0.01	70.54 ± 0.19	15.21 ± 0.4	0.1 ± 0.02	13.98 ± 0.22
17	150	75	5	36.42 ± 0.12	0.144 ± 0.0008	0.14 ± 0.01	73.43 ± 0.27	13.9 ± 0.15	0.15 ± 0.06	12.39 ± 0.11
18	150	75	10	35.17 ± 0.77	0.1403 ± 0.0007	0.13 ± 0.02	69.14 ± 0.16	13.2 ± 0.19	0.2 ± 0	17.4 ± 0.01
19	150	75	15	36.22 ± 0.73	0.1498 ± 0.0006	0.14 ± 0.01	67.9 ± 0.13	14.34 ± 0.06	0.21 ± 0	17.48 ± 0.19
20	150	75	20	34.9 ± 0.58	0.1424 ± 0.0006	0.13 ± 0.01	70.54 ± 0.19	15.21 ± 0.4	0.1 ± 0.02	13.98 ± 0.22
21	150	100	5	36.42 ± 0.12	0.144 ± 0.0008	0.14 ± 0.01	73.43 ± 0.27	13.9 ± 0.15	0.15 ± 0.06	12.39 ± 0.11
22	150	100	10	35.17 ± 0.77	0.1403 ± 0.0007	0.13 ± 0.02	69.14 ± 0.16	13.2 ± 0.19	0.2 ± 0	17.4 ± 0.01
23	150	100	15	36.22 ± 0.73	0.1498 ± 0.0006	0.14 ± 0.01	67.9 ± 0.13	14.34 ± 0.06	0.21 ± 0	17.48 ± 0.19
24	150	100	20	34.9 ± 0.58	0.1424 ± 0.0006	0.13 ± 0.01	70.54 ± 0.19	15.21 ± 0.4	0.1 ± 0.02	13.98 ± 0.22
25	200	25	5	36.42 ± 0.12	0.144 ± 0.0008	0.14 ± 0.01	73.43 ± 0.27	13.9 ± 0.15	0.15 ± 0.06	12.39 ± 0.11
26	200	25	10	35.17 ± 0.77	0.1403 ± 0.0007	0.13 ± 0.02	69.14 ± 0.16	13.2 ± 0.19	0.2 ± 0	17.4 ± 0.01
27	200	25	15	36.22 ± 0.73	0.1498 ± 0.0006	0.14 ± 0.01	67.9 ± 0.13	14.34 ± 0.06	0.21 ± 0	17.48 ± 0.19
28	200	25	20	34.9 ± 0.58	0.1424 ± 0.0006	0.13 ± 0.01	70.54 ± 0.19	15.21 ± 0.4	0.1 ± 0.02	13.98 ± 0.22
29	200	75	5	36.42 ± 0.12	0.144 ± 0.0008	0.14 ± 0.01	73.43 ± 0.27	13.9 ± 0.15	0.15 ± 0.06	12.39 ± 0.11
30	200	75	10	35.17 ± 0.77	0.1403 ± 0.0007	0.13 ± 0.02	69.14 ± 0.16	13.2 ± 0.19	0.2 ± 0	17.4 ± 0.01
31	200	75	15	36.22 ± 0.73	0.1498 ± 0.0006	0.14 ± 0.01	67.9 ± 0.13	14.34 ± 0.06	0.21 ± 0	17.48 ± 0.19
32	200	75	20	34.9 ± 0.58	0.1424 ± 0.0006	0.13 ± 0.01	70.54 ± 0.19	15.21 ± 0.4	0.1 ± 0.02	13.98 ± 0.22
33	200	100	5	36.42 ± 0.12	0.144 ± 0.0008	0.14 ± 0.01	73.43 ± 0.27	13.9 ± 0.15	0.15 ± 0.06	12.39 ± 0.11
34	200	100	10	35.17 ± 0.77	0.1403 ± 0.0007	0.13 ± 0.02	69.14 ± 0.16	13.2 ± 0.19	0.2 ± 0	17.4 ± 0.01
35	200	100	15	36.22 ± 0.73	0.1498 ± 0.0006	0.14 ± 0.01	67.9 ± 0.13	14.34 ± 0.06	0.21 ± 0	17.48 ± 0.19
36	200	100	20	34.9 ± 0.58	0.1424 ± 0.0006	0.13 ± 0.01	70.54 ± 0.19	15.21 ± 0.4	0.1 ± 0.02	13.98 ± 0.22

Table 13 Table of physical characteristics of pellet from mixed plastic waste and corn stover at 75:25 %w/w with the size of corn stover less than 0.5 mm.

No.	P (MPa)	T (°C)	H (%)	M (%)	ρ (g/cm^3)	Ash (%)	Durability (%)	Stability (day)
1	100	25	5	1.79 ± 0.06	0.4351 ± 0.0093	1.24 ± 0.03	54.5 ± 0.9	365
2	100	25	10	2.41 ± 0.1	0.4709 ± 0.0082	1.41 ± 0.03	60.25 ± 0.12	365
3	100	25	15	4.56 ± 0.07	0.4222 ± 0.0093	1.32 ± 0.05	59.78 ± 0.9	242
4	100	25	20	4.77 ± 0.06	0.3225 ± 0.0086	1.38 ± 0.03	52.97 ± 0.9	122
5	100	75	5	0.98 ± 0.05	0.5127 ± 0.0103	1.27 ± 0.04	75.9 ± 0.9	365
6	100	75	10	1.05 ± 0.06	0.5917 ± 0.0007	1.21 ± 0.02	80.65 ± 0.11	365
7	100	75	15	1.36 ± 0.05	0.5157 ± 0.0086	1.26 ± 0.02	73.03 ± 0.12	365
8	100	75	20	2.52 ± 0.06	0.3326 ± 0.0103	1.3 ± 0.05	58.47 ± 0.9	365
9	100	100	5	1.09 ± 0.07	0.5031 ± 0.0093	1.36 ± 0.04	75.83 ± 0.1	365
10	100	100	10	1.06 ± 0.05	0.5516 ± 0.0082	1.24 ± 0.03	78.78 ± 0.9	365
11	100	100	15	1.93 ± 0.03	0.408 ± 0.0094	1.2 ± 0.04	70.46 ± 0.1	365
12	100	100	20	N	N	N	N	N
13	150	25	5	1.1 ± 0.1	0.4695 ± 0.0093	1.19 ± 0.03	56.43 ± 0.1	365
14	150	25	10	1.62 ± 0.05	0.4921 ± 0.0093	1.2 ± 0.03	57.82 ± 0.9	365
15	150	25	15	3.92 ± 0.04	0.4644 ± 0.0094	1.23 ± 0.04	61.23 ± 0.11	365
16	150	25	20	4.23 ± 0.05	0.371 ± 0.0088	1.31 ± 0.04	54.32 ± 0.11	212
17	150	75	5	0.8 ± 0.06	0.5572 ± 0.0094	1.45 ± 0.04	78.34 ± 0.9	365
18	150	75	10	1.31 ± 0.07	0.6079 ± 0.0093	1.22 ± 0.03	85.57 ± 0.12	365
19	150	75	15	2.15 ± 0.04	0.5493 ± 0.0082	1.46 ± 0.04	75.06 ± 0.98	365
20	150	75	20	2.96 ± 0.05	0.5021 ± 0.0101	1.26 ± 0.02	73.41 ± 0.12	365
21	150	100	5	0.63 ± 0.04	0.5932 ± 0.0065	1.19 ± 0.02	80.12 ± 0.9	365
22	150	100	10	1.11 ± 0.06	0.6087 ± 0.0093	1.29 ± 0.06	81.09 ± 1.71	365
23	150	100	15	1.87 ± 0.03	0.5532 ± 0.0094	1.24 ± 0.03	79.93 ± 0.11	365
24	150	100	20	N	N	N	N	N
25	200	25	5	1.12 ± 0.04	0.5108 ± 0.0065	1.54 ± 0.03	70.46 ± 0.12	365
26	200	25	10	1.5 ± 0.09	0.6148 ± 0.0093	1.46 ± 0.04	76.54 ± 0.1	365
27	200	25	15	2.54 ± 0.05	0.5137 ± 0.0094	1.32 ± 0.03	65.87 ± 0.12	365
28	200	25	20	3.94 ± 0.07	0.4111 ± 0.0094	1.26 ± 0.01	63.08 ± 0.9	212
29	200	75	5	1.04 ± 0.03	0.6123 ± 0.0088	1.38 ± 0.03	87.09 ± 0.9	365
30	200	75	10	1.37 ± 0.03	0.6805 ± 0.0093	1.35 ± 0.04	89.56 ± 0.1	365
31	200	75	15	2.01 ± 0.05	0.5612 ± 0.0094	1.23 ± 0.04	82.43 ± 0.1	365
32	200	75	20	1.72 ± 0.06	0.5344 ± 0.0065	1.54 ± 0.06	81.09 ± 0.9	365
33	200	100	5	0.89 ± 0.05	0.6931 ± 0.0094	1.26 ± 0.05	89.53 ± 0.9	365
34	200	100	10	1.13 ± 0.04	0.7843 ± 0.0094	1.53 ± 0.05	92.09 ± 0.1	365
35	200	100	15	1.76 ± 0.04	0.6692 ± 0.0093	1.47 ± 0.05	81.98 ± 0.11	365
36	200	100	20	N	N	N	N	N

Remark : The stability can not represent the result in term of average ± STD. Because the experimental of pellet stability is tested for only one trial.

Table 14 Table of chemical characteristics of pellet from mixed plastic waste and corn stover at 75:25 %w/w with the size of corn stover less than 0.5 mm.

No.	P (MPa)	T (°C)	H (%)	HV (MJ/kg)	S (%)	Cl (%)	C (%)	H (%)	N (%)	O (%)
1	100	25	5	40.52 ± 0.08	0.163 ± 0.0008	0.16 ± 0.01	79.38 ± 0.13	14.97 ± 0.18	0.02 ± 0.01	5.34 ± 0.31
2	100	25	10	39.99 ± 0.12	0.1603 ± 0.0011	0.16 ± 0.01	76.65 ± 0.4	15.62 ± 0.22	0.01 ± 0.01	7.41 ± 0.6
3	100	25	15	39.86 ± 0.09	0.1611 ± 0.0008	0.16 ± 0.01	75.22 ± 0.04	14.97 ± 0.28	0.07 ± 0.01	9.5 ± 0.33
4	100	25	20	39.17 ± 0.14	0.1642 ± 0.001	0.16 ± 0.01	74.58 ± 0.18	15.48 ± 0.44	0.02 ± 0.03	9.62 ± 0.25
5	100	75	5	40.52 ± 0.08	0.163 ± 0.0008	0.16 ± 0.01	79.38 ± 0.13	14.97 ± 0.18	0.02 ± 0.01	5.34 ± 0.31
6	100	75	10	39.99 ± 0.12	0.1603 ± 0.0011	0.16 ± 0.01	76.65 ± 0.4	15.62 ± 0.22	0.01 ± 0.01	7.41 ± 0.6
7	100	75	15	39.86 ± 0.09	0.1611 ± 0.0008	0.16 ± 0.01	75.22 ± 0.04	14.97 ± 0.28	0.07 ± 0.01	9.5 ± 0.33
8	100	75	20	39.17 ± 0.14	0.1642 ± 0.001	0.16 ± 0.01	74.58 ± 0.18	15.48 ± 0.44	0.02 ± 0.03	9.62 ± 0.25
9	100	100	5	40.52 ± 0.08	0.163 ± 0.0008	0.16 ± 0.01	79.38 ± 0.13	14.97 ± 0.18	0.02 ± 0.01	5.34 ± 0.31
10	100	100	10	39.99 ± 0.12	0.1603 ± 0.0011	0.16 ± 0.01	76.65 ± 0.4	15.62 ± 0.22	0.01 ± 0.01	7.41 ± 0.6
11	100	100	15	39.86 ± 0.09	0.1611 ± 0.0008	0.16 ± 0.01	75.22 ± 0.04	14.97 ± 0.28	0.07 ± 0.01	9.5 ± 0.33
12	100	100	20	39.17 ± 0.14	0.1642 ± 0.001	0.16 ± 0.01	74.58 ± 0.18	15.48 ± 0.44	0.02 ± 0.03	9.62 ± 0.25
13	150	25	5	40.52 ± 0.08	0.163 ± 0.0008	0.16 ± 0.01	79.38 ± 0.13	14.97 ± 0.18	0.02 ± 0.01	5.34 ± 0.31
14	150	25	10	39.99 ± 0.12	0.1603 ± 0.0011	0.16 ± 0.01	76.65 ± 0.4	15.62 ± 0.22	0.01 ± 0.01	7.41 ± 0.6
15	150	25	15	39.86 ± 0.09	0.1611 ± 0.0008	0.16 ± 0.01	75.22 ± 0.04	14.97 ± 0.28	0.07 ± 0.01	9.5 ± 0.33
16	150	25	20	39.17 ± 0.14	0.1642 ± 0.001	0.16 ± 0.01	74.58 ± 0.18	15.48 ± 0.44	0.02 ± 0.03	9.62 ± 0.25
17	150	75	5	40.52 ± 0.08	0.163 ± 0.0008	0.16 ± 0.01	79.38 ± 0.13	14.97 ± 0.18	0.02 ± 0.01	5.34 ± 0.31
18	150	75	10	39.99 ± 0.12	0.1603 ± 0.0011	0.16 ± 0.01	76.65 ± 0.4	15.62 ± 0.22	0.01 ± 0.01	7.41 ± 0.6
19	150	75	15	39.86 ± 0.09	0.1611 ± 0.0008	0.16 ± 0.01	75.22 ± 0.04	14.97 ± 0.28	0.07 ± 0.01	9.5 ± 0.33
20	150	75	20	39.17 ± 0.14	0.1642 ± 0.001	0.16 ± 0.01	74.58 ± 0.18	15.48 ± 0.44	0.02 ± 0.03	9.62 ± 0.25
21	150	100	5	40.52 ± 0.08	0.163 ± 0.0008	0.16 ± 0.01	79.38 ± 0.13	14.97 ± 0.18	0.02 ± 0.01	5.34 ± 0.31
22	150	100	10	39.99 ± 0.12	0.1603 ± 0.0011	0.16 ± 0.01	76.65 ± 0.4	15.62 ± 0.22	0.01 ± 0.01	7.41 ± 0.6
23	150	100	15	39.86 ± 0.09	0.1611 ± 0.0008	0.16 ± 0.01	75.22 ± 0.04	14.97 ± 0.28	0.07 ± 0.01	9.5 ± 0.33
24	150	100	20	39.17 ± 0.14	0.1642 ± 0.001	0.16 ± 0.01	74.58 ± 0.18	15.48 ± 0.44	0.02 ± 0.03	9.62 ± 0.25
25	200	25	5	40.52 ± 0.08	0.163 ± 0.0008	0.16 ± 0.01	79.38 ± 0.13	14.97 ± 0.18	0.02 ± 0.01	5.34 ± 0.31
26	200	25	10	39.99 ± 0.12	0.1603 ± 0.0011	0.16 ± 0.01	76.65 ± 0.4	15.62 ± 0.22	0.01 ± 0.01	7.41 ± 0.6
27	200	25	15	39.86 ± 0.09	0.1611 ± 0.0008	0.16 ± 0.01	75.22 ± 0.04	14.97 ± 0.28	0.07 ± 0.01	9.5 ± 0.33
28	200	25	20	39.17 ± 0.14	0.1642 ± 0.001	0.16 ± 0.01	74.58 ± 0.18	15.48 ± 0.44	0.02 ± 0.03	9.62 ± 0.25
29	200	75	5	40.52 ± 0.08	0.163 ± 0.0008	0.16 ± 0.01	79.38 ± 0.13	14.97 ± 0.18	0.02 ± 0.01	5.34 ± 0.31
30	200	75	10	39.99 ± 0.12	0.1603 ± 0.0011	0.16 ± 0.01	76.65 ± 0.4	15.62 ± 0.22	0.01 ± 0.01	7.41 ± 0.6
31	200	75	15	39.86 ± 0.09	0.1611 ± 0.0008	0.16 ± 0.01	75.22 ± 0.04	14.97 ± 0.28	0.07 ± 0.01	9.5 ± 0.33
32	200	75	20	39.17 ± 0.14	0.1642 ± 0.001	0.16 ± 0.01	74.58 ± 0.18	15.48 ± 0.44	0.02 ± 0.03	9.62 ± 0.25
33	200	100	5	40.52 ± 0.08	0.163 ± 0.0008	0.16 ± 0.01	79.38 ± 0.13	14.97 ± 0.18	0.02 ± 0.01	5.34 ± 0.31
34	200	100	10	39.99 ± 0.12	0.1603 ± 0.0011	0.16 ± 0.01	76.65 ± 0.4	15.62 ± 0.22	0.01 ± 0.01	7.41 ± 0.6
35	200	100	15	39.86 ± 0.09	0.1611 ± 0.0008	0.16 ± 0.01	75.22 ± 0.04	14.97 ± 0.28	0.07 ± 0.01	9.5 ± 0.33
36	200	100	20	39.17 ± 0.14	0.1642 ± 0.001	0.16 ± 0.01	74.58 ± 0.18	15.48 ± 0.44	0.02 ± 0.03	9.62 ± 0.25

Table 15 Table of physical characteristics of pellet from mixed plastic waste and corn stover at 75:25 %w/w with the size of corn stover between 0.5-1 mm.

No.	P (MPa)	T (°C)	H (%)	M (%)	ρ (g/cm^3)	Ash (%)	Durability (%)	Stability (day)
1	100	25	5	1.71 ± 0.03	0.5741 ± 0.0088	1.23 ± 0.04	62.33 ± 0.12	365
2	100	25	10	1.86 ± 0.04	0.5417 ± 0.0088	1.32 ± 0.04	72.17 ± 0.9	365
3	100	25	15	1.86 ± 0.04	0.4287 ± 0.0094	1.18 ± 0.07	60.21 ± 0.1	242
4	100	25	20	3.28 ± 0.05	0.2929 ± 0.0088	1.52 ± 0.05	54.32 ± 0.98	122
5	100	75	5	1.43 ± 0.04	0.5829 ± 0.0093	1.09 ± 0.08	78.59 ± 0.12	365
6	100	75	10	1.73 ± 0.04	0.5964 ± 0.0082	1.42 ± 0.05	86.68 ± 0.1	365
7	100	75	15	1.76 ± 0.05	0.5366 ± 0.0065	1.38 ± 0.04	79.51 ± 0.12	365
8	100	75	20	1.57 ± 0.05	0.4365 ± 0.0065	1.4 ± 0.05	69.76 ± 0.12	365
9	100	100	5	1.46 ± 0.04	0.6142 ± 0.0088	1.1 ± 0.05	78.65 ± 0.9	365
10	100	100	10	1.07 ± 0.05	0.5853 ± 0.0094	1.34 ± 0.06	73.58 ± 0.98	365
11	100	100	15	1.31 ± 0.04	0.5776 ± 0.0007	1.44 ± 0.03	73.03 ± 0.12	365
12	100	100	20	N	N	N	N	N
13	150	25	5	1.25 ± 0.04	0.5812 ± 0.0093	1.26 ± 0.05	74.02 ± 0.11	365
14	150	25	10	2.43 ± 0.04	0.6349 ± 0.0065	1.23 ± 0.04	74.64 ± 0.9	365
15	150	25	15	2.43 ± 0.03	0.4303 ± 0.0093	1.34 ± 0.03	72.34 ± 0.12	365
16	150	25	20	3.22 ± 0.05	0.3912 ± 0.0082	1.42 ± 0.04	70.53 ± 0.9	212
17	150	75	5	1.13 ± 0.02	0.6023 ± 0.0094	1.22 ± 0.04	80.23 ± 0.1	365
18	150	75	10	1.44 ± 0.02	0.6823 ± 0.0082	1.38 ± 0.04	96.08 ± 0.1	365
19	150	75	15	1.99 ± 0.03	0.5738 ± 0.0093	1.29 ± 0.02	86.78 ± 0.98	365
20	150	75	20	2.81 ± 0.04	0.5571 ± 0.0093	1.31 ± 0.05	85.42 ± 0.1	365
21	150	100	5	0.94 ± 0.03	0.6185 ± 0.0082	1.38 ± 0.04	90.83 ± 0.12	365
22	150	100	10	1.01 ± 0.02	0.6281 ± 0.0007	1.22 ± 0.04	87.56 ± 0.1	365
23	150	100	15	1.46 ± 0.01	0.617 ± 0.0093	1.33 ± 0.02	85.12 ± 0.11	365
24	150	100	20	N	N	N	N	N
25	200	25	5	1.26 ± 0.04	0.6023 ± 0.0094	1.26 ± 0.03	75.54 ± 0.12	365
26	200	25	10	1.58 ± 0.03	0.6867 ± 0.0094	1.32 ± 0.04	77.78 ± 0.1	365
27	200	25	15	2.52 ± 0.04	0.5612 ± 0.0093	1.41 ± 0.04	72.32 ± 0.12	365
28	200	25	20	3.18 ± 0.03	0.5235 ± 0.0091	1.53 ± 0.04	71.04 ± 0.9	212
29	200	75	5	1.49 ± 0.02	0.7087 ± 0.0093	1.37 ± 0.05	85.48 ± 0.1	365
30	200	75	10	1.43 ± 0.02	0.7828 ± 0.0093	1.25 ± 0.04	96.18 ± 0.9	365
31	200	75	15	1.86 ± 0.03	0.6855 ± 0.0082	1.29 ± 0.04	87.78 ± 0.98	365
32	200	75	20	2.94 ± 0.03	0.5657 ± 0.0094	1.26 ± 0.03	86.65 ± 0.12	365
33	200	100	5	1.16 ± 0.02	0.7696 ± 0.0065	1.3 ± 0.03	91.06 ± 0.9	365
34	200	100	10	1.22 ± 0.02	0.8503 ± 0.0091	1.28 ± 0.05	97.08 ± 0.1	365
35	200	100	15	1.53 ± 0.03	0.7481 ± 0.0007	1.34 ± 0.03	90.32 ± 0.1	365
36	200	100	20	N	N	N	N	N

Remark : The stability can not represent the result in term of average ± STD. Because the experimental of pellet stability is tested for only one trial.

Table 16 Table of chemical characteristics of pellet from mixed plastic waste and corn stover at 75:25 %w/w with the size of corn stover between 0.5-1 mm.

No.	P (MPa)	T (°C)	H (%)	HV (MJ/kg)	S (%)	Cl (%)	C (%)	H (%)	N (%)	O (%)
1	100	25	5	40.52 ± 0.08	0.163 ± 0.0008	0.16 ± 0.01	79.38 ± 0.13	14.97 ± 0.18	0.02 ± 0.01	5.34 ± 0.31
2	100	25	10	39.99 ± 0.12	0.1603 ± 0.0011	0.16 ± 0.01	76.65 ± 0.4	15.62 ± 0.22	0.01 ± 0.01	7.41 ± 0.6
3	100	25	15	39.86 ± 0.09	0.1611 ± 0.0008	0.16 ± 0.01	75.22 ± 0.04	14.97 ± 0.28	0.07 ± 0.01	9.5 ± 0.33
4	100	25	20	39.17 ± 0.14	0.1642 ± 0.001	0.16 ± 0.01	74.58 ± 0.18	15.48 ± 0.44	0.02 ± 0.03	9.62 ± 0.25
5	100	75	5	40.52 ± 0.08	0.163 ± 0.0008	0.16 ± 0.01	79.38 ± 0.13	14.97 ± 0.18	0.02 ± 0.01	5.34 ± 0.31
6	100	75	10	39.99 ± 0.12	0.1603 ± 0.0011	0.16 ± 0.01	76.65 ± 0.4	15.62 ± 0.22	0.01 ± 0.01	7.41 ± 0.6
7	100	75	15	39.86 ± 0.09	0.1611 ± 0.0008	0.16 ± 0.01	75.22 ± 0.04	14.97 ± 0.28	0.07 ± 0.01	9.5 ± 0.33
8	100	75	20	39.17 ± 0.14	0.1642 ± 0.001	0.16 ± 0.01	74.58 ± 0.18	15.48 ± 0.44	0.02 ± 0.03	9.62 ± 0.25
9	100	100	5	40.52 ± 0.08	0.163 ± 0.0008	0.16 ± 0.01	79.38 ± 0.13	14.97 ± 0.18	0.02 ± 0.01	5.34 ± 0.31
10	100	100	10	39.99 ± 0.12	0.1603 ± 0.0011	0.16 ± 0.01	76.65 ± 0.4	15.62 ± 0.22	0.01 ± 0.01	7.41 ± 0.6
11	100	100	15	39.86 ± 0.09	0.1611 ± 0.0008	0.16 ± 0.01	75.22 ± 0.04	14.97 ± 0.28	0.07 ± 0.01	9.5 ± 0.33
12	100	100	20	39.17 ± 0.14	0.1642 ± 0.001	0.16 ± 0.01	74.58 ± 0.18	15.48 ± 0.44	0.02 ± 0.03	9.62 ± 0.25
13	150	25	5	40.52 ± 0.08	0.163 ± 0.0008	0.16 ± 0.01	79.38 ± 0.13	14.97 ± 0.18	0.02 ± 0.01	5.34 ± 0.31
14	150	25	10	39.99 ± 0.12	0.1603 ± 0.0011	0.16 ± 0.01	76.65 ± 0.4	15.62 ± 0.22	0.01 ± 0.01	7.41 ± 0.6
15	150	25	15	39.86 ± 0.09	0.1611 ± 0.0008	0.16 ± 0.01	75.22 ± 0.04	14.97 ± 0.28	0.07 ± 0.01	9.5 ± 0.33
16	150	25	20	39.17 ± 0.14	0.1642 ± 0.001	0.16 ± 0.01	74.58 ± 0.18	15.48 ± 0.44	0.02 ± 0.03	9.62 ± 0.25
17	150	75	5	40.52 ± 0.08	0.163 ± 0.0008	0.16 ± 0.01	79.38 ± 0.13	14.97 ± 0.18	0.02 ± 0.01	5.34 ± 0.31
18	150	75	10	39.99 ± 0.12	0.1603 ± 0.0011	0.16 ± 0.01	76.65 ± 0.4	15.62 ± 0.22	0.01 ± 0.01	7.41 ± 0.6
19	150	75	15	39.86 ± 0.09	0.1611 ± 0.0008	0.16 ± 0.01	75.22 ± 0.04	14.97 ± 0.28	0.07 ± 0.01	9.5 ± 0.33
20	150	75	20	39.17 ± 0.14	0.1642 ± 0.001	0.16 ± 0.01	74.58 ± 0.18	15.48 ± 0.44	0.02 ± 0.03	9.62 ± 0.25
21	150	100	5	40.52 ± 0.08	0.163 ± 0.0008	0.16 ± 0.01	79.38 ± 0.13	14.97 ± 0.18	0.02 ± 0.01	5.34 ± 0.31
22	150	100	10	39.99 ± 0.12	0.1603 ± 0.0011	0.16 ± 0.01	76.65 ± 0.4	15.62 ± 0.22	0.01 ± 0.01	7.41 ± 0.6
23	150	100	15	39.86 ± 0.09	0.1611 ± 0.0008	0.16 ± 0.01	75.22 ± 0.04	14.97 ± 0.28	0.07 ± 0.01	9.5 ± 0.33
24	150	100	20	39.17 ± 0.14	0.1642 ± 0.001	0.16 ± 0.01	74.58 ± 0.18	15.48 ± 0.44	0.02 ± 0.03	9.62 ± 0.25
25	200	25	5	40.52 ± 0.08	0.163 ± 0.0008	0.16 ± 0.01	79.38 ± 0.13	14.97 ± 0.18	0.02 ± 0.01	5.34 ± 0.31
26	200	25	10	39.99 ± 0.12	0.1603 ± 0.0011	0.16 ± 0.01	76.65 ± 0.4	15.62 ± 0.22	0.01 ± 0.01	7.41 ± 0.6
27	200	25	15	39.86 ± 0.09	0.1611 ± 0.0008	0.16 ± 0.01	75.22 ± 0.04	14.97 ± 0.28	0.07 ± 0.01	9.5 ± 0.33
28	200	25	20	39.17 ± 0.14	0.1642 ± 0.001	0.16 ± 0.01	74.58 ± 0.18	15.48 ± 0.44	0.02 ± 0.03	9.62 ± 0.25
29	200	75	5	40.52 ± 0.08	0.163 ± 0.0008	0.16 ± 0.01	79.38 ± 0.13	14.97 ± 0.18	0.02 ± 0.01	5.34 ± 0.31
30	200	75	10	39.99 ± 0.12	0.1603 ± 0.0011	0.16 ± 0.01	76.65 ± 0.4	15.62 ± 0.22	0.01 ± 0.01	7.41 ± 0.6
31	200	75	15	39.86 ± 0.09	0.1611 ± 0.0008	0.16 ± 0.01	75.22 ± 0.04	14.97 ± 0.28	0.07 ± 0.01	9.5 ± 0.33
32	200	75	20	39.17 ± 0.14	0.1642 ± 0.001	0.16 ± 0.01	74.58 ± 0.18	15.48 ± 0.44	0.02 ± 0.03	9.62 ± 0.25
33	200	100	5	40.52 ± 0.08	0.163 ± 0.0008	0.16 ± 0.01	79.38 ± 0.13	14.97 ± 0.18	0.02 ± 0.01	5.34 ± 0.31
34	200	100	10	39.99 ± 0.12	0.1603 ± 0.0011	0.16 ± 0.01	76.65 ± 0.4	15.62 ± 0.22	0.01 ± 0.01	7.41 ± 0.6
35	200	100	15	39.86 ± 0.09	0.1611 ± 0.0008	0.16 ± 0.01	75.22 ± 0.04	14.97 ± 0.28	0.07 ± 0.01	9.5 ± 0.33
36	200	100	20	39.17 ± 0.14	0.1642 ± 0.001	0.16 ± 0.01	74.58 ± 0.18	15.48 ± 0.44	0.02 ± 0.03	9.62 ± 0.25

Table 17 Table of physical characteristics of pellet from mixed plastic waste and corn stover at 75:25 %w/w with the size of corn stover between 1-2 mm.

No.	P (MPa)	T (°C)	H (%)	M (%)	ρ (g/cm^3)	Ash (%)	Durability (%)	Stability (day)
1	100	25	5	1.35 ± 0.02	0.4527 ± 0.0093	1.38 ± 0.05	54.78 ± 0.12	365
2	100	25	10	1.64 ± 0.03	0.4675 ± 0.0088	1.18 ± 0.05	57.04 ± 0.1	365
3	100	25	15	1.9 ± 0.11	0.3221 ± 0.0094	1.29 ± 0.06	56.78 ± 0.12	242
4	100	25	20	4.46 ± 0.04	0.2668 ± 0.0065	1.24 ± 0.03	50.02 ± 0.1	122
5	100	75	5	1.14 ± 0.02	0.4791 ± 0.0065	1.21 ± 0.03	77.26 ± 0.9	365
6	100	75	10	1.48 ± 0.04	0.5081 ± 0.0069	1.4 ± 0.06	78.74 ± 0.12	365
7	100	75	15	1.79 ± 0.03	0.4969 ± 0.0086	1.32 ± 0.04	77.48 ± 0.1	365
8	100	75	20	2.28 ± 0.04	0.3573 ± 1.9135	1.62 ± 0.2	75.47 ± 0.12	365
9	100	100	5	0.76 ± 0.02	0.5221 ± 0.0088	1.42 ± 0.04	81.44 ± 0.1	365
10	100	100	10	1.02 ± 0.03	0.5378 ± 0.0093	1.27 ± 0.05	73.71 ± 0.12	365
11	100	100	15	1.62 ± 0.04	0.5622 ± 0.0093	1.3 ± 0.05	72.92 ± 0.9	365
12	100	100	20	N	N	N	N	N
13	150	25	5	2.7 ± 0.02	0.3887 ± 0.0088	1.22 ± 0.03	64.76 ± 0.1	365
14	150	25	10	2.31 ± 0.03	0.4788 ± 0.0094	1.46 ± 0.05	65.46 ± 0.9	365
15	150	25	15	2.67 ± 0.06	0.5124 ± 0.0104	1.38 ± 0.04	64.08 ± 0.9	365
16	150	25	20	4.21 ± 0.03	0.4119 ± 0.0093	1.4 ± 0.08	58.97 ± 0.1	212
17	150	75	5	1.65 ± 0.02	0.4875 ± 0.0093	1.18 ± 0.02	68.9 ± 0.94	365
18	150	75	10	1.58 ± 0.03	0.5261 ± 0.0093	1.29 ± 0.08	88.71 ± 0.12	365
19	150	75	15	3.26 ± 0.02	0.5295 ± 0.0088	1.53 ± 0.06	87.47 ± 0.1	365
20	150	75	20	4.02 ± 0.04	0.3978 ± 0.0094	1.12 ± 0.03	84.88 ± 0.9	365
21	150	100	5	1.29 ± 0.02	0.5796 ± 0.0088	1.26 ± 0.03	81.24 ± 0.12	365
22	150	100	10	1.38 ± 0.03	0.5954 ± 0.0094	1.3 ± 0.03	90.34 ± 0.1	365
23	150	100	15	2.72 ± 0.03	0.5102 ± 0.0065	1.24 ± 0.03	86.9 ± 0.98	365
24	150	100	20	N	N	N	N	N
25	200	25	5	1.75 ± 0.03	0.5395 ± 0.0065	1.13 ± 0.02	65.32 ± 0.9	365
26	200	25	10	1.97 ± 0.03	0.5544 ± 0.0065	1.34 ± 0.03	67.92 ± 0.1	365
27	200	25	15	2.93 ± 0.04	0.5218 ± 0.0094	1.28 ± 0.06	65.43 ± 0.2	365
28	200	25	20	4.08 ± 0.05	0.4932 ± 0.0082	1.39 ± 0.05	60.76 ± 0.9	212
29	200	75	5	1.76 ± 0.03	0.6037 ± 0.0093	1.24 ± 0.03	80.25 ± 0.1	365
30	200	75	10	1.89 ± 0.03	0.7282 ± 0.0083	1.35 ± 0.03	90.04 ± 0.9	365
31	200	75	15	2.29 ± 0.03	0.5897 ± 0.0082	1.28 ± 0.02	88.43 ± 0.1	365
32	200	75	20	3.16 ± 0.03	0.4208 ± 0.0065	1.25 ± 0.04	86.78 ± 0.11	365
33	200	100	5	1.08 ± 0.03	0.7131 ± 0.0093	1.42 ± 0.03	88.32 ± 9.48	365
34	200	100	10	1.63 ± 0.03	0.8041 ± 0.0065	1.38 ± 0.02	90.77 ± 0.98	365
35	200	100	15	1.97 ± 0.02	0.1642 ± 0.001	1.2 ± 0.02	88.53 ± 0.12	365
36	200	100	20	N	N	N	N	N

Remark : The stability can not represent the result in term of average ± STD. Because the experimental of pellet stability is tested for only one trial.

Table 18 Table of chemical characteristics of pellet from mixed plastic waste and corn stover at 75:25 %w/w with the size of corn stover between 1-2 mm.

No.	P (MPa)	T (°C)	H (%)	HV (MJ/kg)	S (%)	Cl (%)	C (%)	H (%)	N (%)	O (%)
1	100	25	5	40.52 ± 0.08	0.163 ± 0.0008	0.16 ± 0.01	79.38 ± 0.13	14.97 ± 0.18	0.02 ± 0.01	5.34 ± 0.31
2	100	25	10	39.99 ± 0.12	0.1603 ± 0.0011	0.16 ± 0.01	76.65 ± 0.4	15.62 ± 0.22	0.01 ± 0.01	7.41 ± 0.6
3	100	25	15	39.86 ± 0.09	0.1611 ± 0.0008	0.16 ± 0.01	75.22 ± 0.04	14.97 ± 0.28	0.07 ± 0.01	9.5 ± 0.33
4	100	25	20	39.17 ± 0.14	0.1642 ± 0.001	0.16 ± 0.01	74.58 ± 0.18	15.48 ± 0.44	0.02 ± 0.03	9.62 ± 0.25
5	100	75	5	40.52 ± 0.08	0.163 ± 0.0008	0.16 ± 0.01	79.38 ± 0.13	14.97 ± 0.18	0.02 ± 0.01	5.34 ± 0.31
6	100	75	10	39.99 ± 0.12	0.1603 ± 0.0011	0.16 ± 0.01	76.65 ± 0.4	15.62 ± 0.22	0.01 ± 0.01	7.41 ± 0.6
7	100	75	15	39.86 ± 0.09	0.1611 ± 0.0008	0.16 ± 0.01	75.22 ± 0.04	14.97 ± 0.28	0.07 ± 0.01	9.5 ± 0.33
8	100	75	20	39.17 ± 0.14	0.1642 ± 0.001	0.16 ± 0.01	74.58 ± 0.18	15.48 ± 0.44	0.02 ± 0.03	9.62 ± 0.25
9	100	100	5	40.52 ± 0.08	0.163 ± 0.0008	0.16 ± 0.01	79.38 ± 0.13	14.97 ± 0.18	0.02 ± 0.01	5.34 ± 0.31
10	100	100	10	39.99 ± 0.12	0.1603 ± 0.0011	0.16 ± 0.01	76.65 ± 0.4	15.62 ± 0.22	0.01 ± 0.01	7.41 ± 0.6
11	100	100	15	39.86 ± 0.09	0.1611 ± 0.0008	0.16 ± 0.01	75.22 ± 0.04	14.97 ± 0.28	0.07 ± 0.01	9.5 ± 0.33
12	100	100	20	39.17 ± 0.14	0.1642 ± 0.001	0.16 ± 0.01	74.58 ± 0.18	15.48 ± 0.44	0.02 ± 0.03	9.62 ± 0.25
13	150	25	5	40.52 ± 0.08	0.163 ± 0.0008	0.16 ± 0.01	79.38 ± 0.13	14.97 ± 0.18	0.02 ± 0.01	5.34 ± 0.31
14	150	25	10	39.99 ± 0.12	0.1603 ± 0.0011	0.16 ± 0.01	76.65 ± 0.4	15.62 ± 0.22	0.01 ± 0.01	7.41 ± 0.6
15	150	25	15	39.86 ± 0.09	0.1611 ± 0.0008	0.16 ± 0.01	75.22 ± 0.04	14.97 ± 0.28	0.07 ± 0.01	9.5 ± 0.33
16	150	25	20	39.17 ± 0.14	0.1642 ± 0.001	0.16 ± 0.01	74.58 ± 0.18	15.48 ± 0.44	0.02 ± 0.03	9.62 ± 0.25
17	150	75	5	40.52 ± 0.08	0.163 ± 0.0008	0.16 ± 0.01	79.38 ± 0.13	14.97 ± 0.18	0.02 ± 0.01	5.34 ± 0.31
18	150	75	10	39.99 ± 0.12	0.1603 ± 0.0011	0.16 ± 0.01	76.65 ± 0.4	15.62 ± 0.22	0.01 ± 0.01	7.41 ± 0.6
19	150	75	15	39.86 ± 0.09	0.1611 ± 0.0008	0.16 ± 0.01	75.22 ± 0.04	14.97 ± 0.28	0.07 ± 0.01	9.5 ± 0.33
20	150	75	20	39.17 ± 0.14	0.1642 ± 0.001	0.16 ± 0.01	74.58 ± 0.18	15.48 ± 0.44	0.02 ± 0.03	9.62 ± 0.25
21	150	100	5	40.52 ± 0.08	0.163 ± 0.0008	0.16 ± 0.01	79.38 ± 0.13	14.97 ± 0.18	0.02 ± 0.01	5.34 ± 0.31
22	150	100	10	39.99 ± 0.12	0.1603 ± 0.0011	0.16 ± 0.01	76.65 ± 0.4	15.62 ± 0.22	0.01 ± 0.01	7.41 ± 0.6
23	150	100	15	39.86 ± 0.09	0.1611 ± 0.0008	0.16 ± 0.01	75.22 ± 0.04	14.97 ± 0.28	0.07 ± 0.01	9.5 ± 0.33
24	150	100	20	39.17 ± 0.14	0.1642 ± 0.001	0.16 ± 0.01	74.58 ± 0.18	15.48 ± 0.44	0.02 ± 0.03	9.62 ± 0.25
25	200	25	5	40.52 ± 0.08	0.163 ± 0.0008	0.16 ± 0.01	79.38 ± 0.13	14.97 ± 0.18	0.02 ± 0.01	5.34 ± 0.31
26	200	25	10	39.99 ± 0.12	0.1603 ± 0.0011	0.16 ± 0.01	76.65 ± 0.4	15.62 ± 0.22	0.01 ± 0.01	7.41 ± 0.6
27	200	25	15	39.86 ± 0.09	0.1611 ± 0.0008	0.16 ± 0.01	75.22 ± 0.04	14.97 ± 0.28	0.07 ± 0.01	9.5 ± 0.33
28	200	25	20	39.17 ± 0.14	0.1642 ± 0.001	0.16 ± 0.01	74.58 ± 0.18	15.48 ± 0.44	0.02 ± 0.03	9.62 ± 0.25
29	200	75	5	40.52 ± 0.08	0.163 ± 0.0008	0.16 ± 0.01	79.38 ± 0.13	14.97 ± 0.18	0.02 ± 0.01	5.34 ± 0.31
30	200	75	10	39.99 ± 0.12	0.1603 ± 0.0011	0.16 ± 0.01	76.65 ± 0.4	15.62 ± 0.22	0.01 ± 0.01	7.41 ± 0.6
31	200	75	15	39.86 ± 0.09	0.1611 ± 0.0008	0.16 ± 0.01	75.22 ± 0.04	14.97 ± 0.28	0.07 ± 0.01	9.5 ± 0.33
32	200	75	20	39.17 ± 0.14	0.1642 ± 0.001	0.16 ± 0.01	74.58 ± 0.18	15.48 ± 0.44	0.02 ± 0.03	9.62 ± 0.25
33	200	100	5	40.52 ± 0.08	0.163 ± 0.0008	0.16 ± 0.01	79.38 ± 0.13	14.97 ± 0.18	0.02 ± 0.01	5.34 ± 0.31
34	200	100	10	39.99 ± 0.12	0.1603 ± 0.0011	0.16 ± 0.01	76.65 ± 0.4	15.62 ± 0.22	0.01 ± 0.01	7.41 ± 0.6
35	200	100	15	39.86 ± 0.09	0.1611 ± 0.0008	0.16 ± 0.01	75.22 ± 0.04	14.97 ± 0.28	0.07 ± 0.01	9.5 ± 0.33
36	200	100	20	39.17 ± 0.14	0.1642 ± 0.001	0.16 ± 0.01	74.58 ± 0.18	15.48 ± 0.44	0.02 ± 0.03	9.62 ± 0.25

*Remark N = Not detected

APPENDIX B

Publication

A Review of Refuse Derived Fuel

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Abstract: Nowadays, various technologies for eliminating garbage and producing waste products have been improved. One of the well-known waste products is Refuse Derived Fuel (RDF). It is an alternative fuel replacing other commercial ones such as coal, diesel and fuel oil. The use of RDFs reduces amount of waste that dispersed to the environment. The RDFs are produced as either briquette or pellet for usage in household and industry. Several parameters are concerned in producing the RDFs, and providing acceptable physical and mechanical properties that are advantages for usage and storage. This paper presented the processing technology for RDF production. Details of briquetting or pelletizing technique including the empirical processing model were discussed. Several processing parameters were summed up, i.e. processing temperature and pressure, moisture content, and the ratio of mixture between waste and binder agent. The properties of RDFs for each processing parameters were explained. These properties were chemical composition, calorific value, mechanical strength, bulk density, durability of briquette form, and combustion characteristic. Types of binder agent resulted in the properties of the RDFs were explained. Economic analysis to energy efficiency of each processing parameters was also presented. This review paper was a basis for selecting an appropriate method to produce the RDF.

INTRODUCTION

There is a large amount of solid waste disposing to the environment. Its quantity is increased every year. Several methods of eliminating the waste and recovering energy have been studied. The well-known technique is to produce a high quality fuel called "RDF". Solid waste disposal, i.e., plastic waste and agriculture waste, are transformed into cubette, briquette, and pellet by densification. Physical and chemical properties of the waste are improved. For example, RDF has high calorific value comparing with other commercial fuels such as coal and natural gas. Moreover, its durability and strength makes advantages over handling, storage, usage, and cost reduction of transportation. The densified RDF is specified by ASTM standard in class 5 or RDF-5.

RDF is ongoing study for quality improvement to meet European (EU) standard [1]. Its qualities depend on processing parameters and fuel composition. These are binding agent, composition materials, densification pressure, processing temperature, moisture content, percent of binding agent, type of equipment, and particle size.

This paper reviews in-depth details of briquetting or pelletizing technique. The empirical processing model is also included. Several processing parameters are summed up. Properties of the RDFs affected by several processing parameters are explained. In addition, it is a basis for selecting the appropriate method to produce RDF from plastic waste and biomass.

DEFINITION AND CLASSIFICATION OF RDF

Definition of RDF

RDF or densified fuel is the dense of plastic and waste such as plastic waste, textile, wood, soil, etc. [2, 4]. ASTM [5] states that RDF is energy recovery sources from shredding municipal solid waste (MSW) which is removed for non-combustible materials (metal glass). The majority components of RDF usually consist of plastics and biodegradable waste. Gendebien et al. [6] defined RDF as the high calorific fraction of derived MSW. The other terms of MSW derived fuel are REcovered Fuel (REF), Packaging Derived Fuel (PDF), Paper and Plastic Fraction (PPF), and Processed Engineered Fuel (PEF).

Classification of RDF

RDF can be classified into 7 categories as shown details in Table 1. As seen in the table, the class of RDF is defined by processing method, form of RDF, material compositions, and mesh size of RDF. It can be found that raw of MSW is classified as RDF-1. Transformed MSW are classified as RDF-2 to RDF-7. RDF-2, RDF-3, and RDF-4 are in square shape which RDF-4 is in powered form with the size of 0.035 in. or 0.889 mm. Pellet and similar forms of RDF is RDF-5. RDF-6 and RDF-7 are liquid fuel and gaseous, respectively.

Table 1 Categories of RDF by ASTM [5]

Class	Form	Description	Mesh size
RDF-1	Raw (MSW)	MSW fuel as discarded form.	N.A.
RDF-2	Coarse (c-RDF)	Coarse particle size of MSW processed with or without ferrous metal separation such that 95% by weight	6 in. (square shape)
RDF-3	Fluff (f-RDF)	Shredded fuel derived from MSW processed for the removal of metal glass and inorganic materials. The particle size of this shredded material is such that 95% by weight	2 in. (square shape)
RDF-4	Powder (p-RDF)	Combustible waste processed into powdered form	0.035 in. (square shape)
RDF-5	Densified (d – RDF)	Combustible waste densified (compressed) into pellets, slugs, cubettes, briquettes, or similar forms.	N.A.
RDF-6	Liquid	Combustible waste processed into liquid fuel.	N.A.
RDF-7	Gas	Combustible waste processed into gaseous	N.A.

Quality Standard of RDF

RDF can be used as a commercial fuel. Therefore, there is the EU standard for many countries. Table 2 presents the qualify properties of RDF that are designed for European and other countries. It is notice that the standard requires the important properties of RDF which are calorific value, moisture content, remaining ash, and matter contaminate.

Table 2 Quality standard by Australia, Sweden, German and European country.

Property	RDF quality of each country					
	Australia	Sweden	German	European country		
				Class A1	Class A2	Class B
Calorific value (MJ/kg)	≥ 18.0	≥ 16.9	17.5 – 19.5	16.5 – 19.0	16.3 – 19.0	16.0 - 19.0
Moisture (%)	≤ 10	≤ 10	≤ 12	≤ 10	≤ 10	≤ 10
Ash (%)	≤ 0.5	≤ 0.7	≤ 1.5	≤ 0.7	≤ 1.5	≤ 3.5
Chlorine-Cl (%)	≤ 0.02	≤ 0.03	≤ 0.03	≤ 0.02	≤ 0.02	≤ 0.03
Sulfur-S (%)	≤ 0.04	≤ 0.08	≤ 0.08	≤ 0.03	≤ 0.03	≤ 0.04
Lead-Pb (mg/kg)	N.A.	N.A.	≤ 10	≤ 10	≤ 10	≤ 10
Chromium-Cr (mg/kg)	N.A.	N.A.	≤ 8	≤ 10	≤ 10	≤ 10
Copper-Cu (mg/kg)	N.A.	N.A.	≤ 5	≤ 10	≤ 10	≤ 10
Nikel-Ni (mg/kg)	N.A.	N.A.	N.A.	≤ 10	≤ 10	≤ 10
Arsenic-As (mg/kg)	N.A.	N.A.	≤ 0.8	≤ 1	≤ 1	≤ 1
Mercury-Hg (mg/kg)	N.A.	N.A.	≤ 0.05	≤ 0.1	≤ 0.1	≤ 0.1
Cadmium-Cd (mg/kg)	N.A.	N.A.	≤ 0.5	≤ 0.5	≤ 0.5	≤ 0.5
Zinc-Zn (mg/kg)	N.A.	N.A.	≤ 100	≤ 100	≤ 100	≤ 100

Source: ObernbergerIngwald and ThekGerold, The Pellet Handbook, and The production and thermal utilization of biomass pellets 2010.

FUNDEMENTAL OF DENSIFICATON AND COMPACATION MODEL

Basic of compaction or densification of RDF can be divided into three types depending on the processing pressure, that are high pressure compaction, medium pressure compaction with heating device, and low pressure compaction with binder. Strength of compacted RDF is caused by binding mechanism as shown in Figure 1. Material compositions are fixed together with molecular forces, attractive forces between solid particles, and interlocking. Typical compaction process is shown in Figure 2. In the first stage of compression, particles are preheated, and then they rearrange themselves to form closely packed mass. During this stage, energy caused by wall friction between inter-particle and particle is dissipated. At high pressure, particles are forced against each other and deformed to elastic and plastic matters. This lets to increase the each other inter-particle contact.

The relation of densification factors of the selected compaction process can be determined by testing. The parameters, such as pressure, moisture content, and density, can be related by using empirical formulation. The empirical models from previous researches are shown in Table 3.

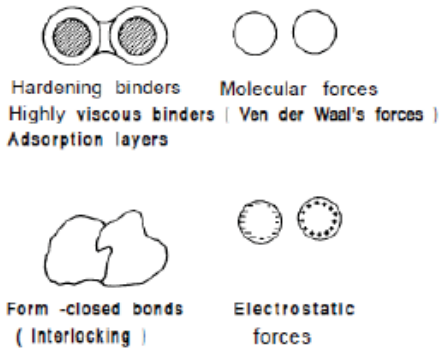

Figure 1 Binding mechanism. [8]

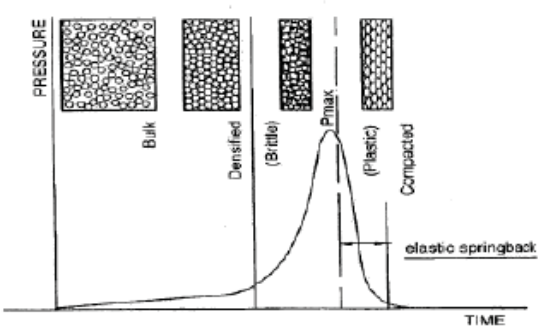

Figure 2 Typical compaction process. [9]

Constitutive model can be used to simulate the compaction process. The model is based on rheological phenomena that explain the behavior of material deformation during compression. Under processing, composition of RDF can change into three phases which are

elastic, plastic and viscous. Typically for compression processes, the constitutive equation shows the relations of stress, strain and temperature. Various model of micro- and macro-structure can be used to construct the relation. Maxwell viscoelastic fluid is the commonly used model that can explain material behavior correctly. Constitutive models from previous researches are summarized in Table 4.

Table 3 Empirical models of compaction processes. [9]

Author	Equation	Relation
Heckel	$\ln\frac{1}{1-\rho_f} = mP + b$	Pressure and density
Kawakita	$\frac{P}{C} = \frac{1}{ab} + \frac{P}{a}, C = \frac{V_0 - V}{V_0}$	Pressure and volume
Jones	$\ln\rho = m\ \ln P + b$	Pressure and density

Table 4 Constitutive models of compaction processes. [10]

Author	Equation	Relation
Kaliyan	$\sigma = E\varepsilon + R\varepsilon^n + \eta\frac{d\varepsilon}{dt} + \sigma_f$	Stress, strain, coulomb friction and modulus
Peleg	$s = Ee + Re^n + h\frac{de}{dt} + s_f$	Stress, strain, coulomb friction and modulus
Suched	$\varepsilon^R = \frac{R}{E_R}\left\{E_\alpha t + E\rho\left[\frac{\left(1+\frac{t}{\rho}\right)^{1-m} - 1}{1-m}\right]\right\}$	Stress, strain, time and modulus

FACTOR AFFECTING TO RDF

Many factors have influenced the RDF quality and properties. The properties of RDF are mechanical strength, calorific value, density, durability of briquette, and characteristic of combustion. The most mentioned factors are as follows:

Type of Binding Agent

Natural binding agent

Natural binding agents found in previous researches are biomass, organic substances and inorganic substances. Biomass binding agent consists of starch, protein, fiber, cellulose and hemicellulose, fat, lignin, and extractives [10]. Organic and inorganic substances are asphalt, sawdust, shell of sunflower seed, cassava starch, tar, clay, gum, molasses, starch solution, paraffin, glue, organic oil waste, limestone, etc. [11, 12]. Strength and durability of RDF can be improved by adding a binding agent. This makes the material particles of the RDF tighten together to form a briquette. RDF with high compressive strength are easily to pile up and transport without damage [13, 14].

Chemical binding agent

Chemical binding agent improves combustion property and durability of RDF. The agents found in previous researches are calcium oxide (CaO), calcium hydroxide ($Ca(OH)_2$), calcined dolomite (CaO.MgO), and calcium lignosulfonate [15, 16]. It reacts with chlorine to

form ash, e.g. $CaCl_2$, $MgCl_2$ and $CaCl_2$ [17, 18]. For example, reaction of calcium hydroxide is shown as follows:

$$Ca(OH)_2 \xrightarrow{\Delta} CaO + H_2O \quad (1)$$

$$CaO + 2HCl \xrightarrow{\Delta} CaCl_2 + H_2O \quad (2)$$

Type of Material

Materials that rich of cellulose can improve the durability, combustion property and ash volume [9].

Pressure of Densification

High pressure can increase density and mechanical properties such as scatter index and water resistance [19].

Moisture Content

High moisture content can increase strength and density. Meanwhile, it can decrease calorific value of RDF [20].

Ratio of Material and Binding Agent

The appropriate binding agent is more than 10%. Ratio of material and binding agent effects mechanical strength of RDF [12, 21].

Type of Equipment

Densification equipment can divide into 4 types which are piston press, screw press, roll press and pellet mill. Density and strength of RDF are upon to equipment. The density obtained from piston press, screw press, roll press and pellet mill are 0.9-1.3 g/cm^3, 1-1.4 g/cm^3, 0.45-0.55 g/cm^3 and 1.1-1.9 g/cm^3, respectively [22, 23].

Particle Size

Small particle size tends to have more density and durability than large size. The reason is that small particle size has higher contacting area than that of the large one [9].

Preheating Temperature

Preheating of feed material can help easier compression. The reason is that it takes fewer loads and makes soften natural binder during compaction process. Appropriate temperature is in range of glass temperature of lignin [10].

CONCLUSION

RDF is an alternative fuel produced from waste. Usage of RDF as fuel is the other way to recover energy and reduce disposal waste. Combustion property of this fuel has been improved that it can be used as a commercial fuel. According to EU standard, their important properties are calorific value, durability, density, and moisture content. Many factors are related to RDF production. These are equipment, production factors such as temperature and pressure, material factors such as moisture and particle size, and material composition such as starch, protein, fat, fiber, lignin and extractives.

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REFERENCES

1. I.O.a.G. Thek, "The Pellet Handbook (The production and thermal utilisation of biomass pellets)", Earthscan, MPG Books, **2010**.
2. N.-B. Chang, Y.-H. Chang and W.C. Chen, "Evaluation of heat value and its prediction for refuse-derived fuel", *J. Science of The Total Environment*, **1997**, *197*, 139-148.
3. V. S. Rotter, T. Kost, J. Winkler and B. Bilitewski, "Material flow analysis of RDF-production processes", *J. Waste Management*, **2004**, *24*, 1005-1021.
4. C. A. Velis, P. J. Longhurst, G. H. Drew, R. Smith and S. J. J. Polland, "Production and Quality Assurance of Solid Recovered Fuels Using Mechanical-Biological Treatment(MBT) of Waste : A Comprehensive Assessment", Critical Reviews in Environmental Science and Technology, **2010**, *40*, 979-1105.
5. ASTM, "Standard Definitions of Terms and abbrevation Relating to Physical and Chemical Characteristics of Refuse Derived Fuel", Annual Book of ASTM Standards 2000, ASTM International, **2000**.
6. A. Gendebien, A. Leavens, K. Blackmore, A. Godley, K. Lewin, K. J. Whiting and R. Davis, "Refuse Derived Fuel, Current Practice and Perspectives", Final Report, European Commision Directorate General Environment, **2003**.
7. D. J. Bushnell, C. Haluzoke and A. Nikoo Dadkhah, "Biomass Fuel Characterization: Testing and Evaluating the Combustion Characteristics of Selected Biomass Fuels", Final Report, Department of Mechanical Engineering Oregon University, **1989**.
8. P. D. Grover and S. K. Mishra, "Biomass Briquetting: Technology and Practices", Food and Agriculture Organization of the United Nations, Bangkok, Regional Wood Energy Development Programme in Asia GCP/RAS/154/NET, http://wgbis.ces.iisc.ernet.in/energy/ HC270799/RWEDP/acrobat/fd46.pdf, **1996**.
9. S. Mani, "A System Analysis of Biomass Densification Process", Chemical & Biological Engineering, The University of British Columbia, The University of British Columbia, **2005**.
10. K. Nalladurai and M. R. Vance, "Densification of Biomass", VDM Verlag Dr. Muller Aktiengesellschaft & Co. KG, Germany, **2008**.
11. J. Lope and G.Tabil, "Binding and Pelleting Characteristics of Alfalfa", Agricultural and Bioresource Engineering, University of Saskatchewan, University of Saskatchewan, Cananda, **1996**.
12. S. Yaman, M. SahanŞahan, H. Haykiri-Açma, K. Şeşen and S. Küçükbayrak, "Fuel briquettes from biomass–lignite blends", *J. Fuel Processing Technology*, **2001**, *72*, 1-8.
13. W. S. Chen, F. C. Chang, Y. H. Shen and M. S. Tsai, "The characteristics of organic sludge/sawdust derived fuel", *J. Bioresource Technology*, **2011**, *102*, 5406-5410.
14. O. A. Sotannde, A. O. Oluyege and G.B. Abah, "Physical and Combustion Properties of Briquettes from Sawdust of Azadirachtaindica", *J. Forestry Research*, **2010**, *21*, 63-67.

15. P. Adapa, L. Tabil and G. Schoenau, "Grinding performance and physical properties of non-treated and steam exploded barley, canola, oat and wheat straw", *J. Biomass and Bioenergy*, **2011**, *35*, 549-561.
16. G. Piao, S. Aono, S. Mori, S. Deguchi, Y. Fujima, M. Kondoh and M. Yamaguchi, "Combustion of refuse derived fuel in a fluidized bed", *J. Waste Management*, **1998**, *18*, 509-512.
17. J. Corella, J. M. Toledo and G. Molina, "Performance of CaO and MgO for the hot gas clean up in gasification of a chlorine-containing (RDF) feedstock", *J. Bioresource Technology*, **2008**, *99*, 7539-7544.
18. G.-Q. Liu, Y. Itaya, R. Yamazaki, S. Mori, M. Yamaguchi and M. Kondoh, "Fundamental study of the behavior of chlorine during the combustion of single RDF", *J. Waste Management*, **2001**, *21*, 427-433.
19. Y. Li and H. Liu, "High-pressure binderless compaction of waste paper to form useful fuel", *J. Fuel Processing Technology*, **2000**, *67*, 11-21.
20. S. Yaman, M. Şahan, H. Haykiri-açma, K. Şeşen and S. Küçükbayrak, "Production of fuel briquettes from olive refuse and paper mill waste", *J. Fuel Processing Technology*, **2000**, *68*, 23-31.
21. C. Chiemchaisri, B. Charnnok and C. Visvanathan, "Recovery of plastic wastes from dumpsite as refuse-derived fuel and its utilization in small gasification system", *J. Bioresource Technology*, **2010**, *101*, 1522-1527.
22. J. S. Jumuluru, C. T. Wright, K. L. Kenny and J. Richard, "A Review of Biomass Densification Technologies for Energy Application", Idaho National Laboratory, http://www.inl.gov/ technicalpublications/documents/4886679.pdf, **2010**.
23. J. S. Tumuluru, C. T. Wright, J. R. Hess and K. L. Kenney, "A review of biomass densification systems to develop uniform feedstock commodities for bioenergy application", *J. Biofuels Bioproducts & Biorefining*, **2011**, *5*, 683-707.

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Densified Fuels from Mixed Plastic Wastes and Corn Stover

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Keyword: biomass, densification, RDF, renewable energy, waste-to-energy

Abstract

Mixed plastic wastes recovered from dumpsites may be utilized as densified solid fuel. However, it is commonly known that plastic materials may not bind together under compaction. Corn stover can be used as natural binder in this case. It can improve chemical composition (reducing sulfur and chlorine content) and mechanical strength of the fuel pellet. In this paper, densification of mixed plastic wastes and corn stover was investigated. Compression pressure was conducted at 150 MPa. The pellet size was 8 mm in diameter and 20 mm long. Effects of moisture content (5-20%), types of material, and preheating temperatures (75 and 100°C) on the fuel properties were studied. The pellets from mixed materials were found to have higher calorific value, carbon content and durability index than corn stover pellet.

Introduction

Solid waste generation is an unavoidable byproduct of economic and population growth. Municipal solid wastes (MSW) are increasing every year. These wastes have to be disposed of appropriately. Conventional disposal methods include sanitary land-filling, open dumping and burning, and mass incineration. For Thailand, most MSWs are disposed of by open dumping (64%) and sanitary landfill (35%). There are many problems associated with waste disposal, including lack of landfill sites, waste and logistics management, budgeting, labor shortage, public opposition, and others [1]. These wastes may be utilized as fuel. There are several waste to energy conversion techniques, including densification into refuse derived fuel (RDF), thermal conversion into heat, gaseous or liquid fuels.

With regards to Thailand's national energy policy, energy development plan will promote renewable energy to account for at least 20% within 2022. Under this goal, energy from solid waste is included. The rate of energy consumption of Thailand of 2012 is increased by 3.9%, compare to 2011 [2]. The important energy sources are natural gas, coal and oil. They are usually used for electricity generation and thermal production and transportation [3]. For energy security reason, we must reduce our reliance on fossil fuels, and identify new renewable energy sources.

Waste to energy offers an alternative solution. MSW may be converted into RDF. Normally, RDF consists of the combustible fraction recovered from MSW such as waste plastic, wood, paper, textile, leather, and rubber [4; 5; 6]. ASTM [7] defines RDF as energy recovery source from shredding MSW whose non-combustible materials have been removed. The majority components of RDF usually comprise plastic and biodegradable wastes. For Gendebien's definition [8], RDF is the

high calorific fraction of derived MSW. The other terms for MSW derived fuel include recovered engineered fuel (REF), packaging derived fuel (PDF), paper and plastic fraction (PPF) and processed engineered fuel (PEF). Densified fuel has several forms such as pellets, slugs, cubettes and briquettes. It possesses improved physical and chemical properties, compared to raw MSW. It can be used as solid fuel like other commercial fuels for energy production in cement kiln plants, power generation plants, etc. The important benefits of densified fuel are higher calorific value, homogeneity of physical-chemical composition, convenience of storage, ease of handling and transportation, and lower pollutant emissions. It can be accepted as a substitute or auxiliary fuel in most combustion systems [9].

In this work, pelletization of mixed plastic wastes and corn stover was carried out. Effects of moisture content, types of material, and preheating temperatures on the fuel properties were investigated.

Experimental methodology

Materials

Plastic wastes were collected from Chiangrai Rajabhat University's dumpsite. The age of dumpsite is 5 years old. All plastic waste samples were shredded into small pieces, less than 3 mm in overall size. Corn stover was obtained from a local corn field after harvested and sun-dried for 3 weeks. The biomass sample was shredded to about 1.5 mm in size using an agricultural shredding machine. Both materials were sent for analysis of their properties.

Pelletization

Pelletization was carried out using a hydraulic compactor, shown in Fig. 1. Shredded plastic wastes and corn stover (total 1.4 g) were mixed at ratio of 55:45 w/w, 1.4 g in total weight. The pelletized fuel was 8 mm in diameter and 20 mm long. The die wall was heated by hot water. Various pelletizing conditions were investigated. The moisture content was varied between 5, 10, 15 and 20%. The die wall temperature was varied between 75 and 100°C. The applied pressure was fixed at 150 MPa. All pellet products were kept in the zip lock and stored in controlled room.

Physico-chemical analysis

The raw materials and the pelletized fuel were analyzed for density (ASABE standard S269.4), moisture (ASABE standard 358.2), ash (ASTM standard E830-87) and durability (EN standard 15210), as well as sulfur (ASTM standard E775-87), chlorine (Energy dispersive X-ray spectrometer), calorific value (ASTM standard E711-87) and other elements (Energy dispersive X-ray spectrometer).

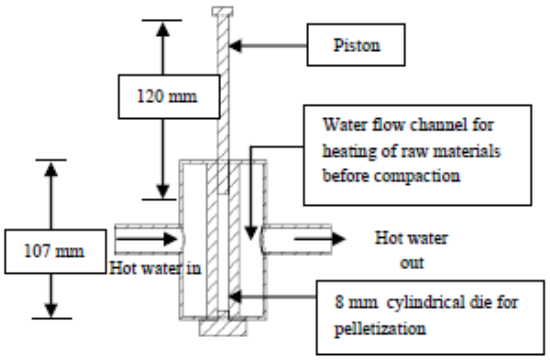

Figure 1: Compaction apparatus.

Results and discussion

Samples of pellets from corn stover and mixture between plastic wastes and corn stover are shown in Figs. 2 and 3, respectively. Under the same applied pressure, pellets from sole biomass can be made in more compact form than those from mixture of plastic waste and corn stover. Analysis results of chemical characteristics of plastic wastes and corn stover are shown in Table 1. Plastic wastes appeared to have lower moisture and ash content than corn stover, but, significantly higher calorific value than the biomass. Tables 2 and 3 show the characteristics of the pelletized fuels from corn stover only, and from a mixture between plastic wastes and corn stover. It was found that calorific value of corn stover pellet was between 15.64 – 16.60 MJ/kg. Carbon content was contained 52.17 – 53.72%. Ash content was 8 – 9%. Moisture content of corn stover pellet was found to increase with the moisture content of feed materials, as expected. The calorific value of plastic waste and corn stover pellets (26.38 – 29.56 MJ/Kg) were much higher than corn stover pellet, because of higher carbon content. Sulfur content and chlorine content were 0.12 – 0.13% and 0.07 – 0.19%, respectively. The calorific value of plastic waste and corn stover pellets were similar with other current power generation fuels including coal (10 – 32 MJ/kg)[10], diesel (36.42 MJ/lit)[10] and fuel oil (39.77 MJ/lit)[10].

Figure 2: Examples of corn stover pellets.

Figure 3: Examples of plastic waste and corn stover pellets.

Table 1: Characteristics of plastic waste and corn stover.

	Moisture (%)	Ash (%)	Sulfur (%)	Chlorine (%)	Calorific value (MJ/kg)
Plastic wastes	0.35	0.22	0.17	0.15	58.0
Corn stover	8.47	8.62	0.08	0.11	15.4

Table 2: Characteristics of pellet from corn stover.

Preheating temperature (°C)	Moisture content of material (%)	Pellet characteristics						
		Moisture content (%)	Ash (%)	Sulfur (%)	Chlorine (%)	Carbon (%)	Oxygen (%)	Calorific value (MJ/kg)
75	5	3.95	8.39	0.08	0.11	53.19	43.79	16.3
75	10	4.43	8.63	0.09	0.13	52.17	44.81	15.6
75	15	6.53	8.41	0.08	0.11	53.04	43.94	16.6
75	20	7.26	8.11	0.08	0.12	53.77	43.21	16.4
100	5	0.96	9.12	0.08	0.11	53.19	43.79	16.1
100	10	1.05	8.02	0.08	0.13	52.17	44.81	16.3
100	15	2.37	8.52	0.08	0.11	53.04	43.94	16.4
100	20	5.50	8.65	0.08	0.12	53.77	43.21	16.3

Moisture content affected to calorific value and durability index of the densified fuel. At 75°C and 100°C, increasing moisture content from 5% to 10% led to increased durability of corn stover pellet from 85 – 87%, but decreased calorific value. From Figs. 4 and 5, moisture content was not found to significantly affect the pellet density, but have direct impact on durability. For the mixture of plastic and biomass, preheating temperature did not affect change in density or

durability, But, for biomass only, higher preheating temperature (100°C) seemed to result in higher pellet density and durability index. Material type had important effect on ash, sulfur, carbon and chlorine content as well as calorific value. Calorific value of corn stover was increased when it was mixed with plastic waste. While plastic waste has high sulfur and chlorine content, they can be reduced by mixing with corn stover, similar to that reported in [11]. Li et al. [12] and Yaman et al. [13] found that mixed paper briquette had low HHV because of high ash content. When the briquette made from mixed paper and plastics, their properties were improved. Preheating temperature can affect mechanical strength in terms of durability index and pellet density and moisture content of pellet. The pellet density with 100°C of preheating temperature was higher than 75°C. Furthermore, there was some moisture loss during compression process which reduced moisture content of pellet. Increasing preheating temperature from 75 to 100°C was found to increase durability index from 97 – 99% and 89 – 99% for mixed plastic waste and corn stover pellet and corn stover pellet, respectively.

Table 3: Characteristics of pellet from mixed plastic waste and corn stover.

Preheating temperature (°C)	Moisture content of material (%)	Pellet characteristics						
		Moisture content (%)	Ash (%)	Sulfur (%)	Chlorine (%)	Carbon (%)	Oxygen (%)	Calorific value (MJ/kg)
75	5	1.36	6.40	0.13	0.12	82.83	15.12	26.4
75	10	2.62	6.12	0.12	0.19	86.65	12.03	27.2
75	15	3.02	7.02	0.12	0.07	86.13	12.69	28.4
75	20	3.98	6.26	0.12	0.12	84.33	12.52	28.1
100	5	1.02	6.83	0.12	0.12	82.83	15.12	27.8
100	10	1.88	6.76	0.12	0.19	86.65	12.03	27.2
100	15	2.12	6.10	0.12	0.07	86.13	12.69	29.6
100	20	2.42	6.30	0.12	0.12	84.33	12.52	28.9

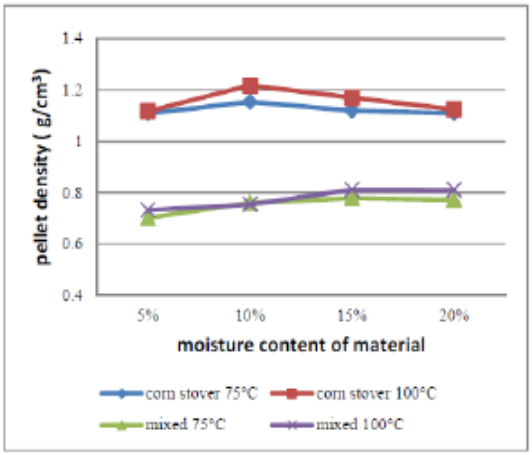

Figure 4: Relation of pellet density and moisture content of material.

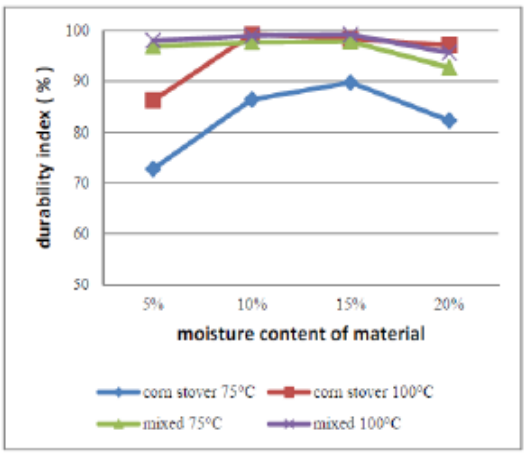

Figure 5: Relation of durability index and moisture content of material.

Summary

Plastic waste and agriculture waste can be upgraded to densified fuel. Properties and quality of the pelletized fuel depended on type of material, moisture content, and preheating temperature. Type of feed material affected quality of densified fuel in terms of density, durability index, calorific value, and sulfur and chlorine components. Mixing plastic waste with corn stover offered densified fuel with higher calorific value and lower ash content, hence improved quality. Furthermore, starting moisture content of the feed and preheating temperature before compaction were observed to have influence on density and durability index of the pellets. This research found that optimum moisture content was 5-15%, and higher preheating temperature can result in higher pellet density and durability index.

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References

[1] Thailand State of Pollution Report, Pollution Control Department, 2009, pp. 43-50.
[2] Thailand Energy Statistics (preliminary), in: E.D.a.e.D. Department of Alternative (Ed.), Ministry of Energy, 2012.
[3] The Situation of Energy Consumption of Thailand on 1997-1999, in: N.E.P.O. Energy Policy and Planning Office (Ed.), www.eppo.go.th/doc/doc-EDP-R-3.html, 1999.
[4] N.-B. Chang, Y.-H. Chang, W.C. Chen, Evaluation of heat value and its prediction for refuse-derived fuel. Science of The Total Environment 197 (1997) 139-148.
[5] V.S. Rotter, T. Kost, J. Winkler, B. Bilitewski, Material flow analysis of RDF-production processes. Waste Management 24 (2004) 1005-1021.
[6] C.A. Velis, P.J. Longhurst, G.H. Drew, R. Smith, S.J.J. Polland, Production and Quality Assurance of Solid Recovered Fuels Using Mechanical-Biological Treatment(MBT) of Waste : A Comprehensive Assessment. Critical Reviews in Environmental Science and Technology 40 (2010) 979-1105.
[7] A.S.f.T.a.M. (ASTM), Standard Definitions of Terms and abbrevation Relating to Physical and Chemical Characteristics of Refuse Derived Fuel, Annual Book of ASTM Standards 2000, ASTM International, 2000.
[8] A. Gendebien, A. Leavens, K. Blackmore, A. Godley, K. Lewin, K.J. Whiting, R. Davis, Refuse Derived Fuel, Current Practice and Perspectives, Final Report, European Commision Directorate General Environment, 2003.
[9] A.C. Caputo, P.M. Pelagagge, RDF production plants: I Design and costs. Applied Thermal Engineering 22 (2002) 423-437.
[10] Energy Statistics of Thailand 2012 ,The Energy Policy Office (EPPO) Ministry of Energy, information on www.eppo.go.th.
[11] W.S. Chen, F.C. Chang, Y.H. Shen, M.S. Tsai, The characteristics of organic sludge/sawdust derived fuel. Bioresource Technology 102 (2011) 5406-5410.
[12] Y. Li, H. Liu, O. Zhang, High-pressure compaction of municipal solid waste to form densified fuel. Fuel Processing Technology 74 (2001) 81-91.
[13] S. Yaman, M. Şahan, H. Haykiri-açma, K. Şeşen, S. Küçükbayrak, Production of fuel briquettes from olive refuse and paper mill waste. Fuel Processing Technology 68 (2000) 23-31.

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