Raw data for Tensile index estimations from a CD72-refiner

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Abstract

This report presents measurement from a CD72-refiner taken under a five day period. Moreover the data processing steps taken are discussed. The data sets contain measurements of tensile index, specific energy, maximum temperature, dilution water feed rates and plate gaps taken on 19 different occasions. Separate measurements are available from the flat and conical zones.

Moreover the data sets included also contains estimated variables, namely consistencies and residence times in the different zones.

Introduction

Tensile index is a commonly used property when evaluating pulp quality. However measurements are time consuming and unreliable; often requiring repeated measurements to derive a reliable result. Hence it is beneficial to derive tensile index from models.

Here we present the data that will be utilized for deriving models of tensile index. The data was collected over a period of five days from a CD72-refiner. It includes measured variables such as dilution water feed rates, production specific energy, and plate gaps as well as estimated variables such as consistencies and residence times.

Furthermore how this raw data can be processed so that models can be derived from it is discussed. Finally the processed data is presented for all measured and estimated variables.

Test procedure,

The test was performed during five days where all process variables are segmented around the periods for pulp sampling. In total the pulp was sampled at 19 separate occasions during the five day period.

Measurement of tensile index

The pulp samples were taken from the blow-line valve over a period of 3 minutes each. Twenty handsheets were formed to test tensile index resulting in twenty separate measurements at each sampling occupation.

The tensile measurements are presented in *Fig 1*. It can be seen from this figure that there is considerable spread among the tensile measurements for each sample. This is due to that shives etc. affect the handsheets and thereby the measurement accuracy. This is potentially problematic as too many handsheets with excess of shives will mislead the analysis to find a good enough estimate of the tensile index.

By defining the measurements outside the 25th and 75th percentiles as outliers see *Table 1* a reduced set of tensile indices can be obtained which hopefully can be used for further analysis.

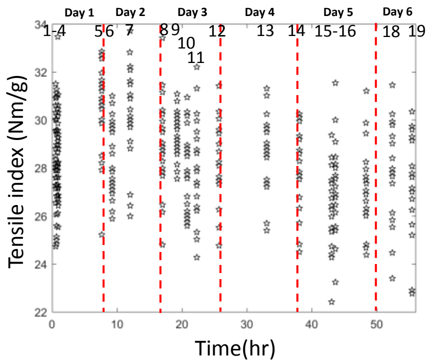

Fig 1 - Tensile index measurements from 20 handsheets obtained from each pulp sample according to the 5-days test period.

Table 1 – All samples of tensile indices used before the outlier rejection. The outliers are marked in red.

	Tensile index measurements (All data included)																		
Sample/Pulp sample	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**
1	24.73	24.83	26.10	25.53	25.21	25.88	25.99	24.80	27.55	25.58	24.27	24.76	25.39	24.50	23.23	22.41	24.38	21.73	22.76
2	26.54	24.98	26.85	26.43	27.91	26.18	26.43	26.16	27.85	25.74	25.02	25.52	25.69	24.81	24.62	24.26	24.67	23.40	22.91
3	27.14	25.13	27.15	26.57	28.21	26.63	26.88	26.46	28.14	25.89	25.32	26.27	27.21	25.71	25.39	24.41	24.82	24.46	25.19
4	27.29	25.59	27.30	26.72	28.51	26.94	28.81	27.67	28.58	26.04	26.22	27.33	27.36	25.71	25.54	24.72	24.82	25.53	25.64
5	27.59	26.05	27.90	26.87	29.86	27.09	28.81	27.82	28.73	26.20	26.37	27.48	27.51	26.32	26.15	25.34	26.01	25.83	25.64
6	27.89	26.82	27.90	27.17	30.01	27.24	29.11	27.98	28.73	26.50	26.81	27.63	28.43	26.77	26.46	25.50	26.16	26.13	26.25
7	27.89	27.28	28.05	27.17	30.46	27.39	29.70	28.28	28.88	26.81	27.26	28.09	28.43	27.53	26.77	25.96	26.31	26.13	26.71
8	28.05	27.59	28.20	27.62	30.61	27.54	29.85	28.58	29.03	27.57	27.41	28.09	28.58	27.68	26.92	25.96	26.61	27.35	27.01
9	28.20	27.59	28.20	27.62	30.76	27.84	30.00	28.73	29.17	27.73	27.41	28.09	28.73	27.83	27.23	26.27	26.61	27.65	27.01
10	28.35	27.59	28.65	28.22	30.76	27.84	30.15	28.73	29.17	27.88	27.86	28.09	28.88	28.28	27.54	26.42	26.90	27.80	27.16
11	28.50	27.59	28.65	28.22	30.91	27.99	30.44	28.88	29.17	28.49	28.01	28.24	29.03	28.28	27.69	26.42	27.05	27.80	27.62
12	28.80	27.89	29.10	28.81	31.21	28.59	30.89	29.03	29.32	28.49	28.61	28.69	29.03	28.28	27.69	26.73	27.35	27.96	27.77
13	29.55	28.05	29.26	28.96	31.36	28.89	31.04	29.49	29.62	28.65	28.76	28.99	29.49	28.59	27.69	26.73	27.50	28.41	27.77
14	29.55	28.97	29.26	28.96	31.51	29.49	31.04	29.64	29.76	28.80	29.21	29.44	29.49	28.74	28.00	27.04	27.65	29.02	28.07
15	30.01	29.43	29.56	28.96	31.66	29.64	31.48	29.94	29.91	28.95	29.51	29.44	29.64	29.19	28.16	27.35	27.94	29.32	29.13
16	30.01	29.58	29.86	29.26	31.96	29.79	31.63	30.24	30.06	29.87	29.51	29.60	29.79	29.19	28.16	27.50	28.24	29.32	29.13
17	30.31	30.04	30.16	29.41	32.56	29.95	32.08	30.40	30.20	29.87	29.96	30.05	30.25	29.34	28.46	28.12	29.43	29.78	29.29
18	30.61	30.96	30.46	30.31	32.56	30.25	32.22	31.15	30.35	30.18	30.26	30.05	31.01	29.95	29.08	28.12	29.88	29.93	29.59
19	30.91	31.11	30.46	30.61	32.71	30.70	32.82	31.45	30.79	30.33	31.31	30.35	31.31	30.10	30.00	28.43	29.88	30.24	29.74
20	31.51	31.27	33.46	31.05	32.86	31.00	33.71	33.42	31.09	30.94	32.21	31.41	31.31	30.25	31.54	29.36	31.21	31.45	30.35
Median	28.43	27.59	28.65	28.22	30.84	27.92	30.30	28.81	29.17	28.19	27.94	28.17	28.96	28.28	27.62	26.42	26.98	27.80	27.39
Min	24.73	24.83	26.10	25.53	25.21	25.88	25.99	24.80	27.55	25.58	24.27	24.76	25.39	24.50	23.23	22.41	24.38	21.73	22.76
Max	31.51	31.27	33.46	31.05	32.86	31.00	33.71	33.42	31.09	30.94	32.21	31.41	31.31	30.25	31.54	29.36	31.21	31.45	30.35

From this data either the median and mean values of tensile index on each test point can be calculated. These values can then be utilized to design models.

Measured Variables

As mentioned previously the pulp samples were taken from the blow-line valve over a period of 3 minutes each. However the process sampling rate for the measured variables was 1 second. The sampling procedures must to be consistent in time-domain to allow for comparison between their measurements. Therefore, we use the average process conditions based on the 180 measurements taken in the sampling period. This set of data was treated in the same way as the tensile index data; i.e. outliers were removed, then a single measurement was derived for each test point before taking the median or mean of the remaining data points.

The variables that were measured and utilized were the specific energy, maximum temperature, dilution water feed rates and plate gaps. Measurements were taken from both the flat and conical zones. The 3 minute means and medians for each sample time are presented in *Table 2* and *Table 3*.

Internal Variables

As well as the variables that are measured directly we have access to variables that are estimated from process measurements using the extended entropy model presented in (Karlström and Eriksson (2014,a,b,c,d)).

The variables that are estimated are the resident times and consistencies in the different zones. The 3 minute means and medians after outliers have been removed for each sampling time are presented in *Table 2* and *Table 3*.

Table 2 –Measured and estimated median values of measured and estimated variables.

Pulp sample	TI (Nm/g)	Sp.En.(kWh/T)	ConsFZ(%)	ConsCD(%)	R.timeFZ(sec)	R.timeCD(sec)
1	28.5	1383.8	39.73	46.97	1.86	0.35
2	27.6	1378.0	39.51	46.71	1.86	0.35
3	28.7	1378.9	40.01	47.14	1.86	0.35
4	28.2	1376.4	40.06	46.86	1.86	0.35
5	30.8	1415.4	40.89	47.88	1.76	0.36
6	27.9	1389.2	39.35	45.48	1.82	0.36
7	30.3	1378.5	41.27	47.66	1.77	0.36
8	28.8	1389.1	40.87	47.41	1.73	0.37
9	29.2	1361.9	41.62	47.84	1.72	0.37
10	28.2	1336.1	41.28	47.86	1.65	0.36
11	28.0	1302.2	42.46	49.25	1.60	0.34
12	28.2	1287.7	42.70	51.22	1.53	0.33
13	29.0	1328.1	41.89	50.13	1.61	0.34
14	28.3	1305.8	41.74	48.96	1.60	0.35
15	27.7	1284.7	41.98	50.25	1.59	0.34
16	26.4	1283.5	41.12	49.55	1.59	0.34
17	27.0	1258.5	40.81	49.37	1.59	0.34
18	27.8	1337.7	39.99	49.73	1.60	0.35
19	27.6	1343.2	40.03	50.38	1.59	0.34

Pulp sample	TmaxFZ(C)	TmaxCD(C)	Dil.w.FZ(l/s)	Dil.w.CD(l/s)	Pl.gapFZ(mm)	Pl.gapCD(mm)
1	171.13	162.45	2.53	3.45	1.61	0.77
2	170.90	167.16	2.50	3.46	1.60	0.77
3	170.97	167.72	2.47	3.46	1.60	0.77
4	170.79	168.13	2.47	3.46	1.60	0.77
5	173.03	169.87	2.52	3.45	1.14	0.89
6	171.89	170.47	2.55	3.45	1.40	0.82
7	171.72	169.28	2.33	3.45	1.18	0.91
8	171.93	168.57	2.56	3.35	1.02	1.01
9	171.83	168.23	2.43	3.36	0.98	1.00
10	172.81	169.04	2.47	3.36	1.00	1.01
11	172.97	169.56	2.47	3.36	1.08	1.01
12	174.15	160.28	2.48	3.36	1.09	1.01
13	173.07	169.71	2.70	3.25	1.15	1.01
14	172.87	169.85	2.74	3.25	1.09	1.02
15	173.00	170.10	2.68	3.00	1.07	1.02
16	173.17	170.25	2.66	2.99	1.07	1.02
17	172.83	170.96	2.71	2.80	1.06	1.01
18	173.57	162.19	2.95	2.90	1.02	0.98
19	174.21	162.59	2.90	2.90	1.02	0.99

Table 3 – Measured and estimated median values of measured and estimated variables.

Pulp sample	TI (Nm/g)	Sp.En.(kWh/T)	ConsFZ(%)	ConsCD(%)	R.timeFZ(sec)	R.timeCD(sec)
1	28.7	1382.7	39.56	46.77	1.86	0.35
2	27.9	1374.9	39.53	46.54	1.86	0.35
3	28.8	1377.7	39.82	47.01	1.86	0.35
4	28.2	1376.4	39.90	47.01	1.86	0.35
5	30.6	1413.8	40.85	47.77	1.76	0.36
6	28.3	1388.6	39.18	45.43	1.82	0.36
7	30.2	1377.1	41.33	47.50	1.77	0.36
8	28.9	1388.5	40.96	47.52	1.73	0.37
9	29.3	1356.0	41.70	47.67	1.72	0.37
10	28.0	1336.2	42.11	48.82	1.65	0.36
11	28.1	1300.8	42.20	49.10	1.60	0.34
12	28.4	1285.6	42.61	51.17	1.53	0.33
13	28.8	1325.4	40.92	49.02	1.61	0.34
14	27.9	1305.4	40.73	47.81	1.60	0.35
15	27.3	1283.7	41.00	49.10	1.59	0.34
16	26.4	1283.1	41.10	49.42	1.59	0.34
17	27.2	1257.9	40.81	49.36	1.59	0.34
18	27.5	1335.9	39.92	49.61	1.60	0.35
19	27.2	1345.3	40.03	50.21	1.59	0.34

Pulp sample	TmaxFZ(C)	TmaxCD(C)	Dil.w.FZ(l/s)	Dil.w.CD(l/s)	Pl.gapFZ(mm)	Pl.gapCD(mm)
1	171.04	162.41	2.53	3.45	1.61	0.77
2	170.83	167.11	2.49	3.45	1.60	0.77
3	170.94	167.70	2.47	3.45	1.60	0.77
4	170.64	168.00	2.46	3.45	1.60	0.77
5	172.85	169.80	2.52	3.45	1.14	0.89
6	171.90	170.46	2.55	3.45	1.40	0.82
7	171.67	169.18	2.34	3.45	1.18	0.91
8	171.96	168.60	2.56	3.35	1.02	1.01
9	171.74	168.10	2.43	3.35	0.98	1.00
10	172.70	169.01	2.46	3.35	0.99	1.01
11	172.97	169.54	2.47	3.35	1.08	1.01
12	174.03	160.25	2.47	3.36	1.09	1.01
13	172.93	169.63	2.70	3.25	1.15	1.01
14	172.78	169.86	2.74	3.25	1.09	1.02
15	172.89	170.08	2.69	3.00	1.07	1.02
16	173.03	170.17	2.66	2.99	1.07	1.02
17	172.76	170.94	2.71	2.80	1.05	1.01
18	173.48	162.12	2.95	2.90	1.02	0.98
19	174.14	162.60	2.91	2.90	1.02	0.99

Literature

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