Development of High Ash Paper to Reduce Fiber Input as well as Cost

CESS Sponsored

Implementing Agencies:

ACIRD, Yamuna Nagar

CPPRI, Saharanpur

February 20, 2014

Budget (Rs. in Lacs)

Project Budget	**: 39.4**
CESS Contribution	**: 25.4 (20.9 - ACIRD, 4.5 - CPPRI)**
ACIRD Contribution	**: 14.0**

Time Frame: 18 months (Nov. 2010 to April 2012)

Background

- Papermakers always desire to increase ash in paper for making ‘high ash paper’ replacing the expensive and scarce fiber by filler.
- Major constraint in making high ash paper is the impairment of fiber-fiber bonding, and the resulting decrease in paper strength.
- The filler addition to paper mainly adds positively to sheet formation, smoothness, brightness, opacity, dimensional stability and printing characteristics.
- In abroad, papermakers are producing fine paper with higher filler level (~25% or more) due to the availability of strong fiber. Still, they are continuously working to increase it further.
- In India, it is difficult to increase filler content beyond a certain limit (~15%) which is much lower as compared to filler content in paper manufactured abroad.

Background

- The main reasons could be short fibered pulp and suitability of filler with wet-end chemicals and fiber i.e. short hardwood fiber, agro-residues fiber and recycled fibers.
- The morphology and ionic behavior are also very important in fillers' selection.
- The length of Indigenous fibers is comparatively less, thus strength drop with addition of filler is more.
- New developments on pre-treatment of filler to retain more filler in paper without adversely affecting strength properties are also current areas of interest. These methods may also be useful to increase filler in Indian fine papers without compromising paper strength.
- To optimize above factors in selection of a suitable filler (talc, GCC, PCC), a detailed study on Indian pulp furnishes (mixed hardwood blended with bamboo, mixed hardwood, wheat straw, bagasse, recycled pulp) is desired.

Objectives

- Optimization of suitable process to develop high ash paper without strength loss
  - Determination of physico-chemical properties of various fillers
  - Study the effect of various fillers on paper properties
  - Study on different processes and wet end chemicals for increasing paper ash without affecting strength
  - To add knowledge and value to the industries

Salient Findings

- First pass ash retention (FPAR): Talc > PCC > GCC
- FPAR of talc slightly increased with increasing dose of strength additives. Polymeric strength additive had a negative effect on FPAR in case of both GCC and PCC.
- Increasing amount of ash in paper, the paper strength was decreased whereas optical properties were increased.
- Polymeric strength additive was the most effective with talc filler in terms of increasing paper strength at same ash level.
- For GCC and PCC fillers, cationic and amphoteric strength additives, respectively were better for increasing breaking length at same ash level.

Salient Findings

- **Tear index of paper: Talc > GCC > PCC (with 5 kg/t dose of cationic/amphoteric strength additive).**
- **Increasing dose of strength additives slightly increased the tear index.**
- **Bulk and stiffness were the highest with PCC filler. With GCC and talc, those were comparable.**
- **Opacity was comparable with PCC and GCC filler and higher than that with talc.**

Salient Findings

Increasing ash in paper

- **With talc, ash could be increased by 3-5% from 16% ash level using 10 kg/t dose of any of the strength additives used in this study depending upon fiber furnish.**
- **With PCC, ash could be increased by 3-4% from 15% ash level using 10 kg/t of strength additive; little drop in tear index and ZD tensile strength.**
- **With GCC, ash could be increased by 3-4% from 15% ash level using 10 kg/t of cationic/amphoteric strength additive; little drop in tear index.**
- **Pretreatment of fillers (GCC, PCC) further could increase the ash by 2-3% without adversely affecting the paper strength.**

Salient Findings

Increasing ash in paper

- **Agro-residue pulps (bagasse, wheat straw) need some blending of long fibers for good machine runnability.**
- **Benefits of increasing ash in paper are low cost of papermaking and higher optical properties (brightness, opacity, scattering coefficient).**

Other anticipated benefits

- **Better dimensional stability, formation, reduced pollution load and energy requirement at different areas of pulp and papermaking process due to less usage of fibrous mass.**

Mill Trials

- Demonstrated the outcome of the project in four mills through plant scale trials; about 2-4% ash could be increased without adversely affecting the paper strength and maintaining the optical properties of paper.

Mill	Initial ash, %	Target ash, %	Filler saving, kg/t paper	Fiber saving, kg/t paper
Mill-A	17	21	-	40
Mill-B	14	16	-	20
Mill-C	15	15	30	-
Mill-D	16	19	-	30

- Minimum saving potential = Rs. 500/t paper

Scientific Development

Publication

- Sharma, A., Kumar, S., Chauhan, V. S., Chakrabarti, S. K. & Varadhan, R. (2012). Role of strength aids in increasing ash in paper prepared from bleached wheat straw pulp. *Ippta J., 24(3), 87–91.*
- Chauhan, V. S., Kumar, S., Rana, D., Chakrabarti, S. K. & Varadhan, R. (2011). Effect of filler on paper properties in alkaline sizing with different strength additives. *Proc. of 10th International Technical Conference on Pulp, Paper and Allied Industry (Paperex-2011), December 10-12, 2011, New Delhi, pp. 223–236.*
- Chauhan, V. S., Sharma, A. & Chakrabarti, S. K. (2011). Energy savings through increased filler loading in paper. *Ippta J., 23(3), 171–176.*

Scientific Development....contd.

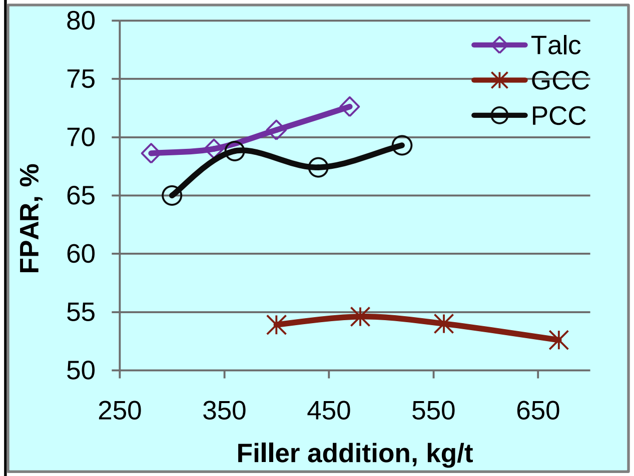
Fundamental Research

- A part of the project was used in a doctoral thesis entitled 'Talc filler for improvement of paper properties in alkaline condition'.
- Another part was used in the master thesis of a student of I.I.T. Roorkee.
- A part was also used in the project work of a Chemical Engineering student of Banasthali Vidyapith, Rajasthan.

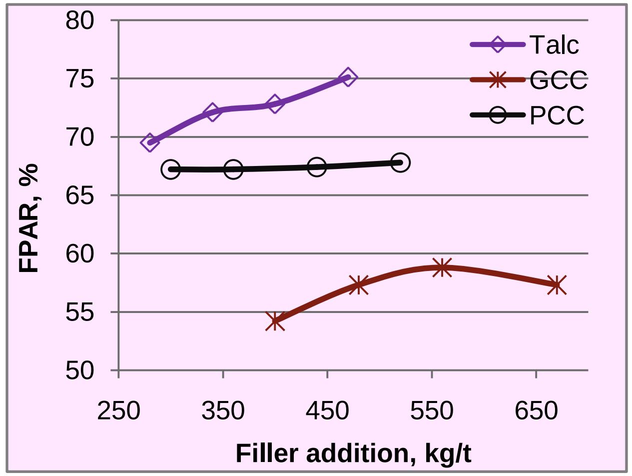
Avantha Centre for Industrial Research & Development , Yamuna Nagar

Thank You

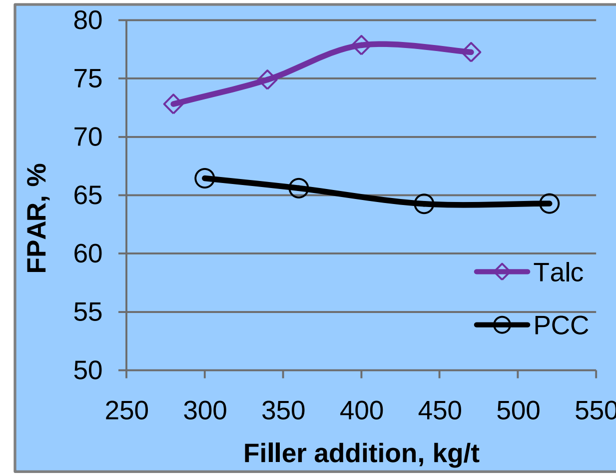
Filler addition vs. FPAR of MHW blended with bamboo pulp with different fillers



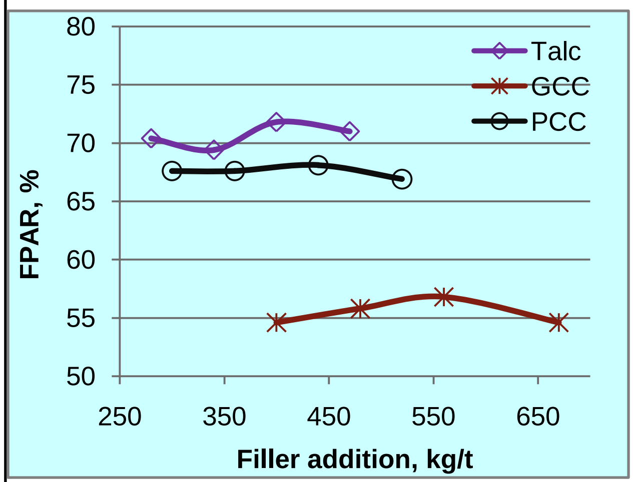
CS, 5 kg/t



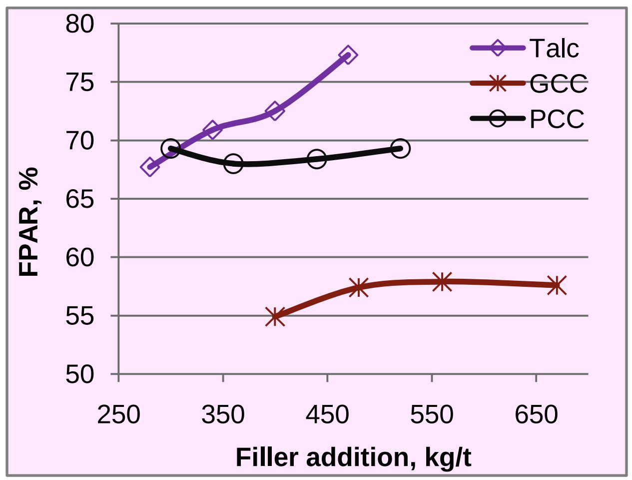
AS, 5 kg/t



PS, 5 kg/t



CS, 10 kg/t



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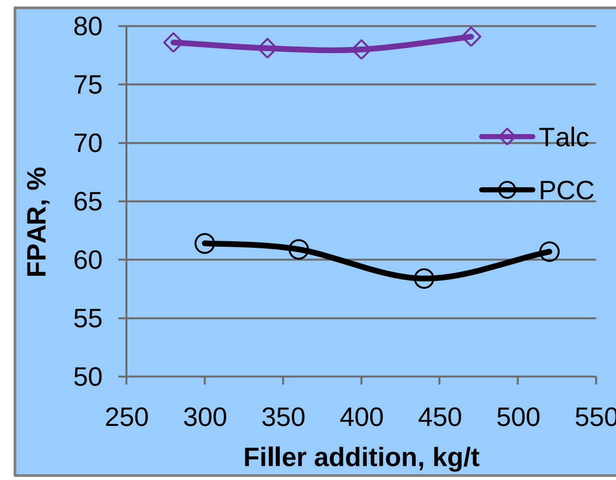
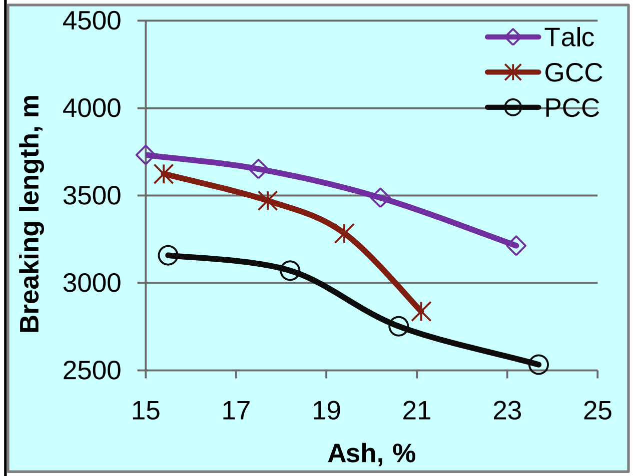


PS, 10 kg/t

Ash vs. breaking length of MHW blended with bamboo pulp with different fillers



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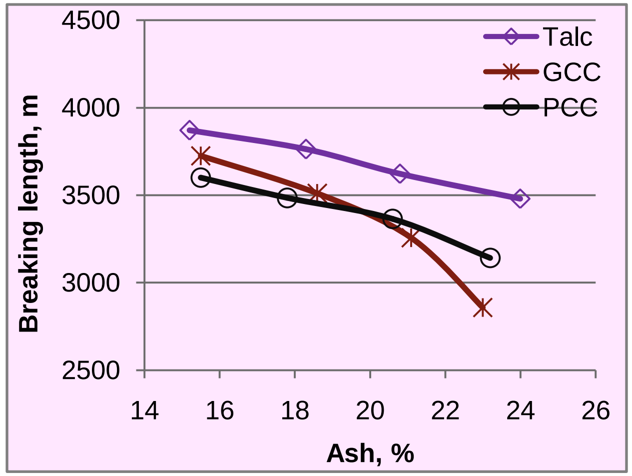

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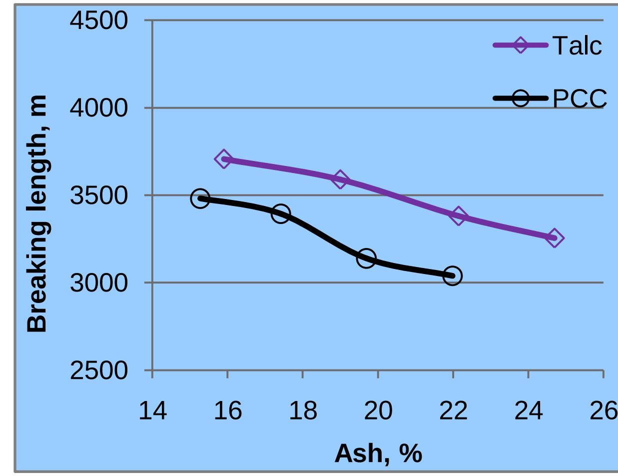

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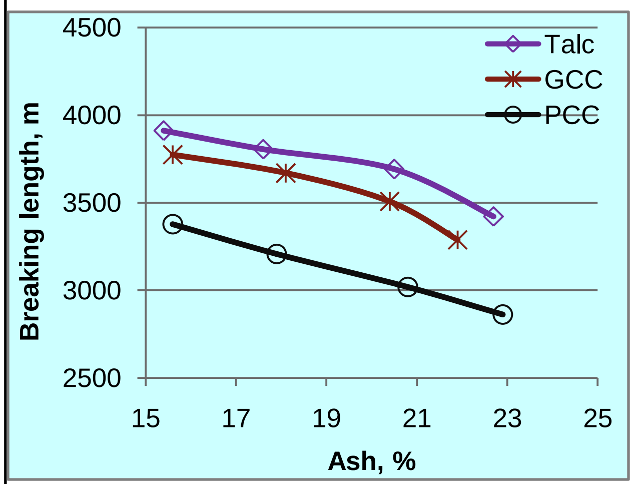

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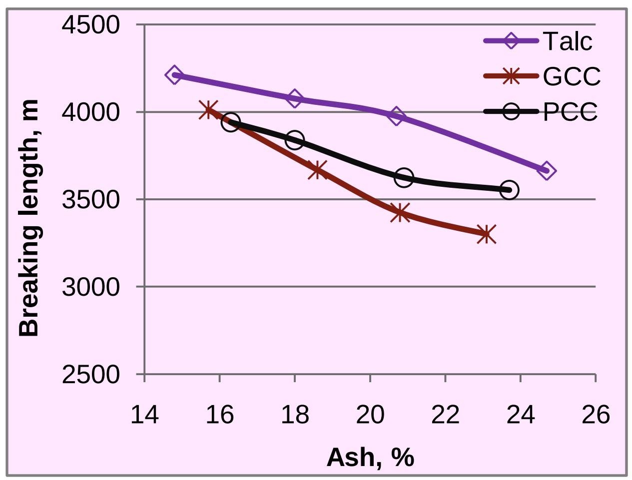

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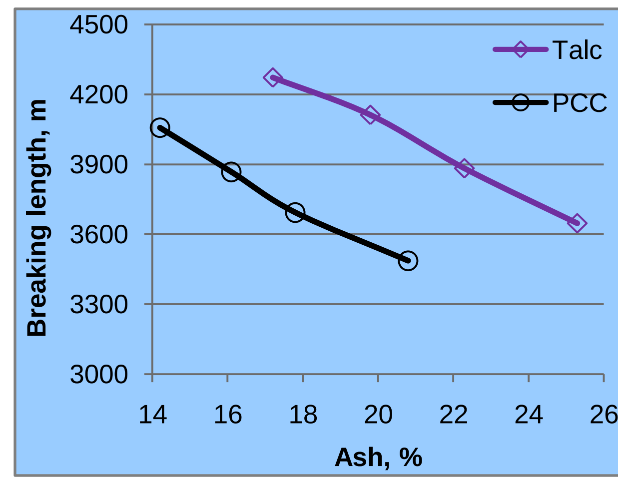
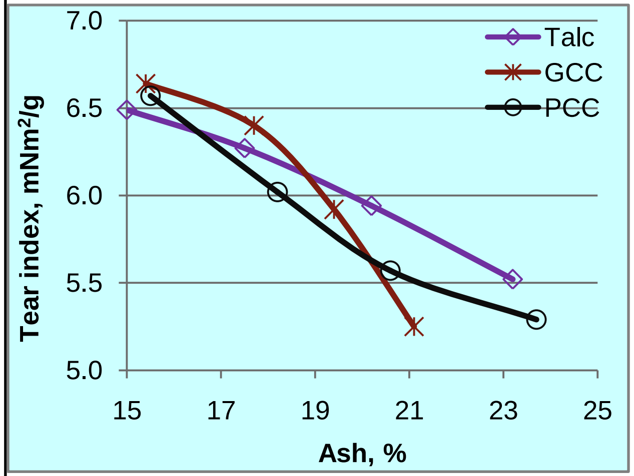
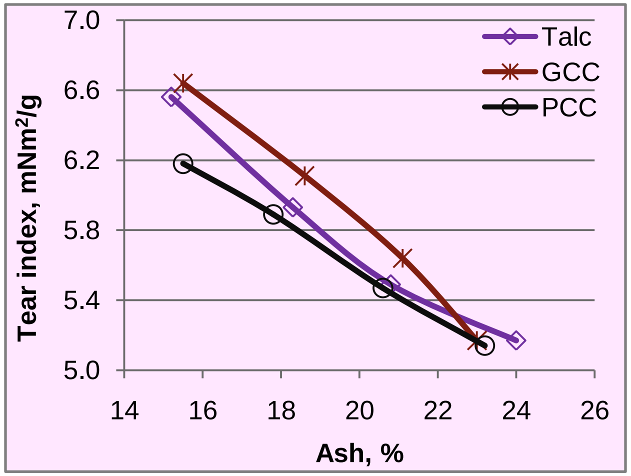


PS, 10 kg/t

Ash vs. tear index of MHW blended with bamboo pulp with different fillers



CS, 5 kg/t



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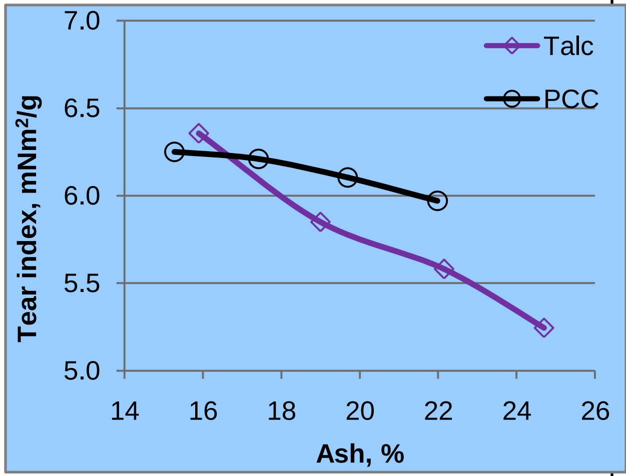

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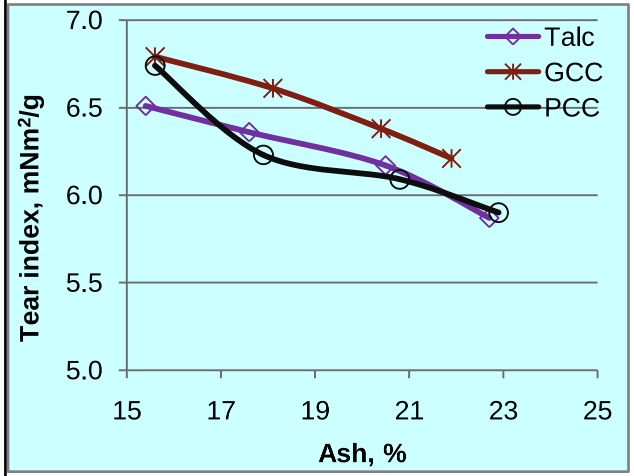

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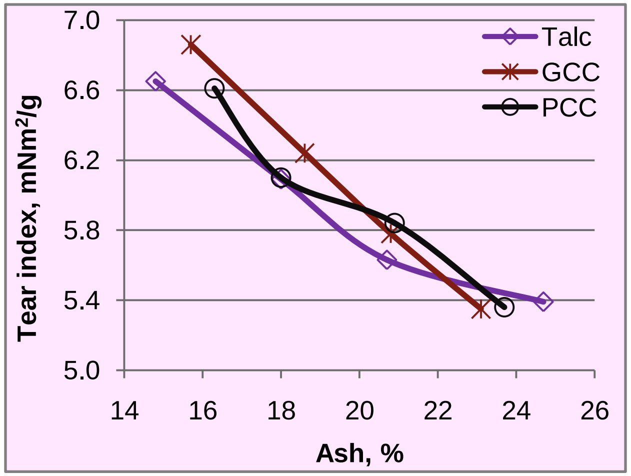

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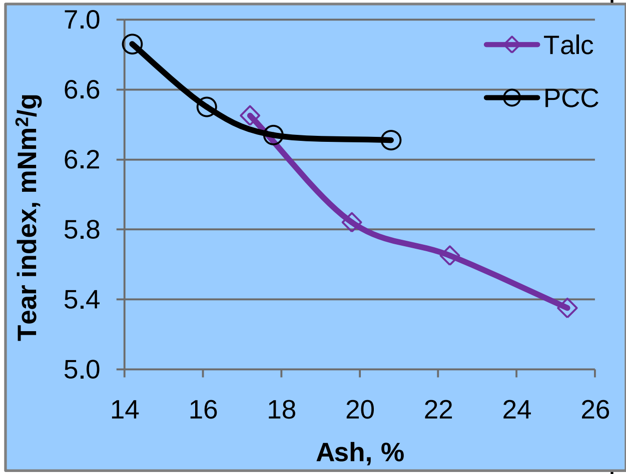

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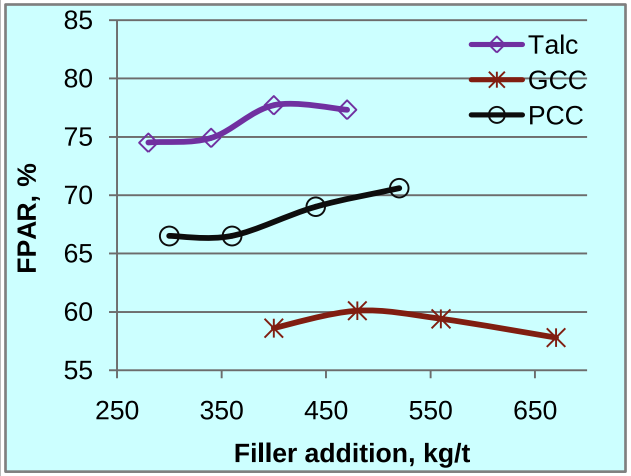

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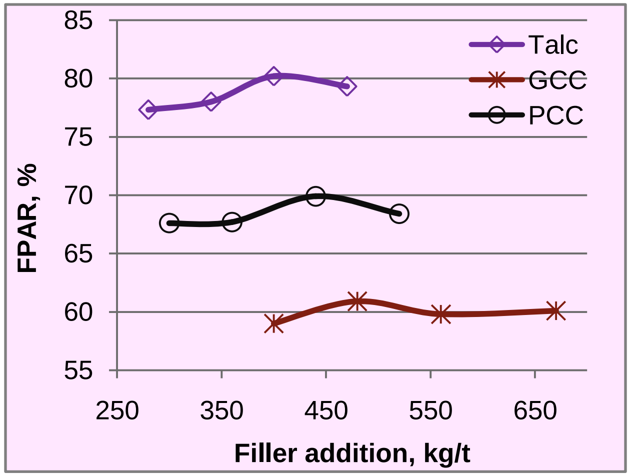

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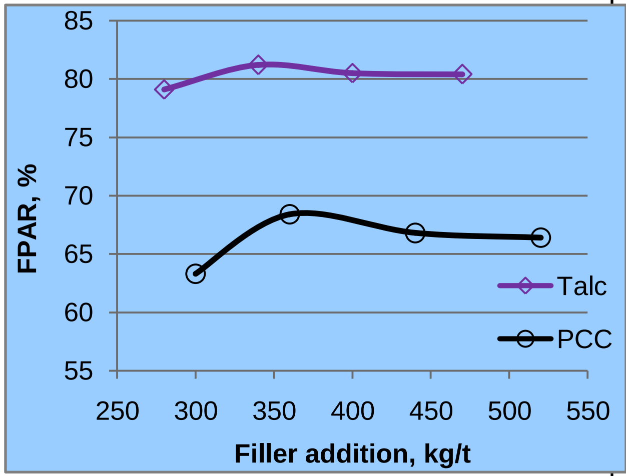

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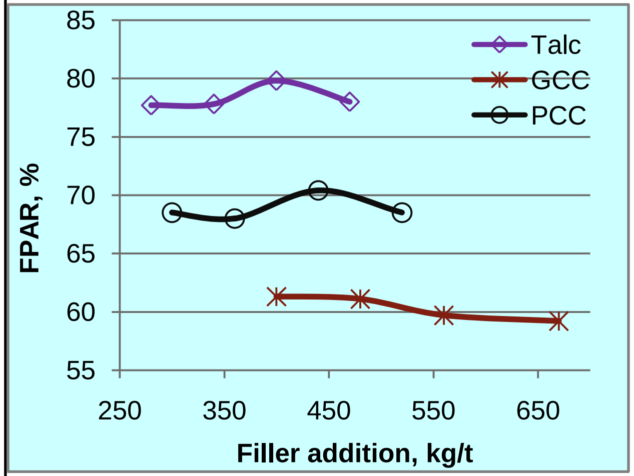

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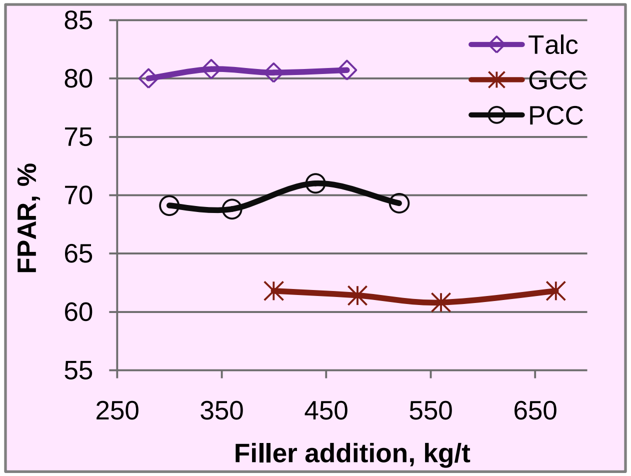

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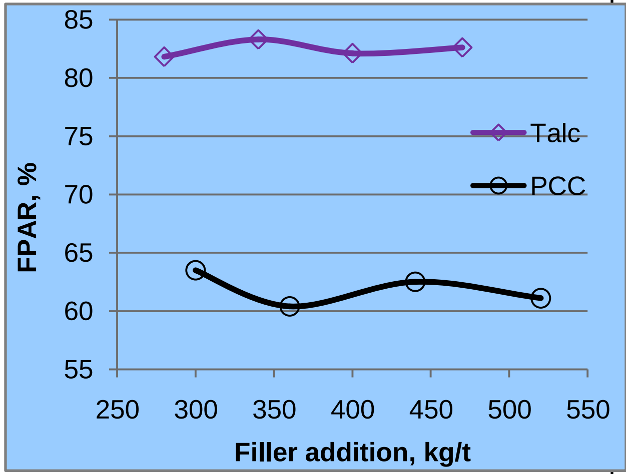

PS, 10 kg/t

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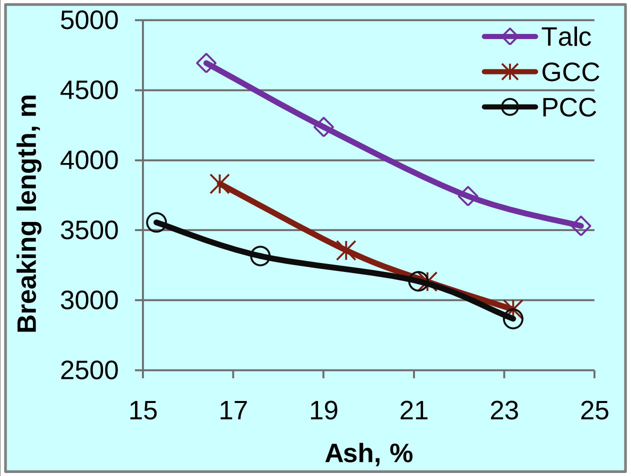

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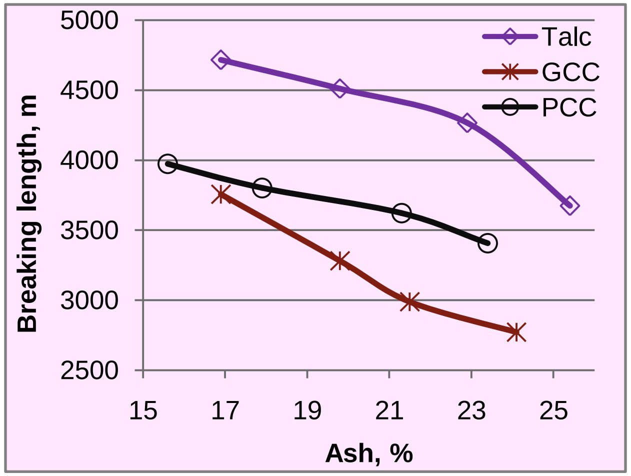

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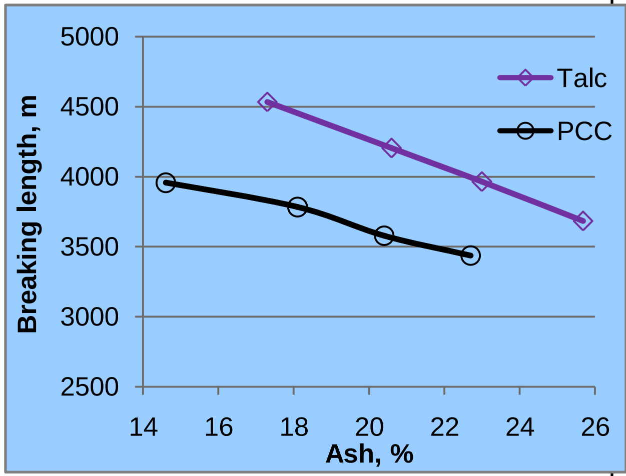

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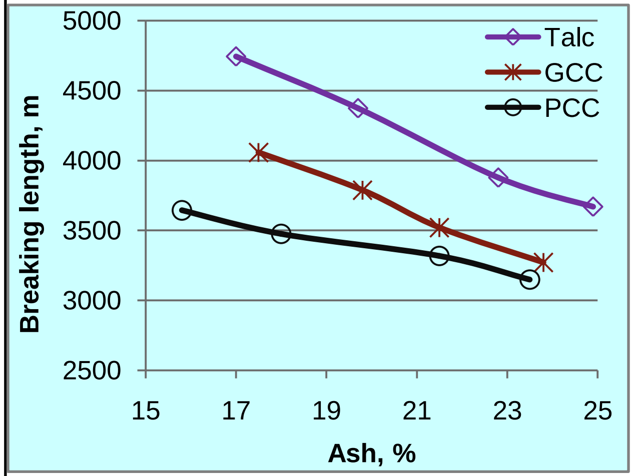

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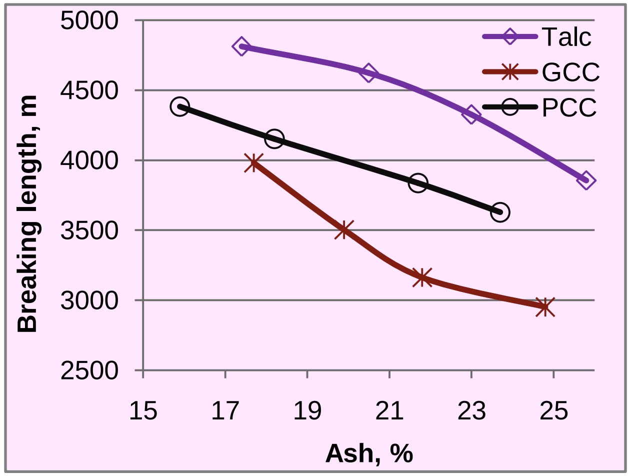

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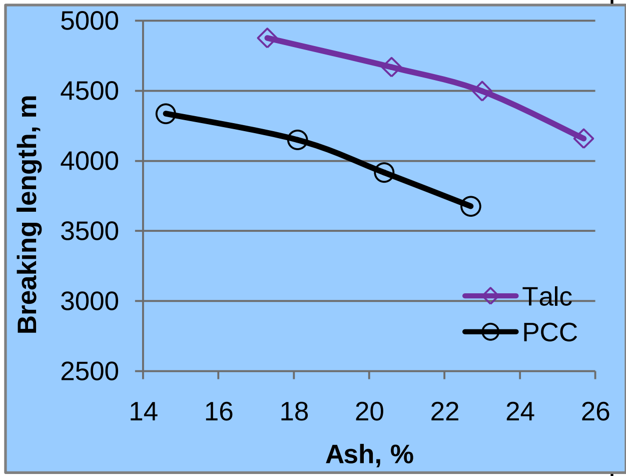
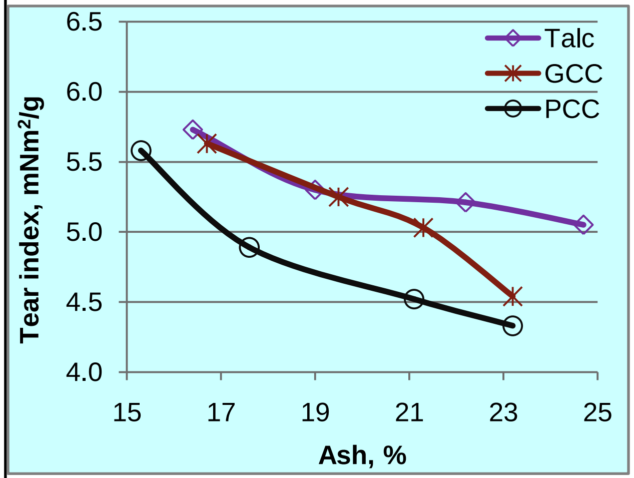
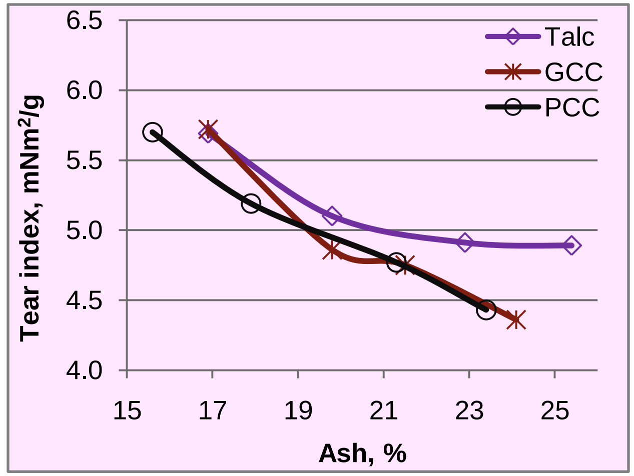


PS, 10 kg/t

Ash vs. tear index of MHW pulp with different fillers



CS, 5 kg/t



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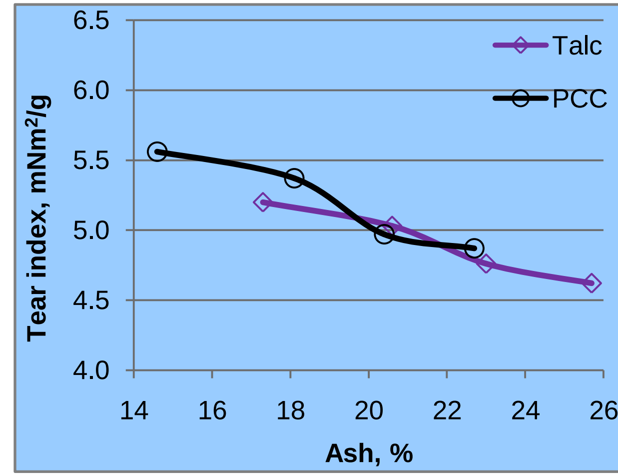

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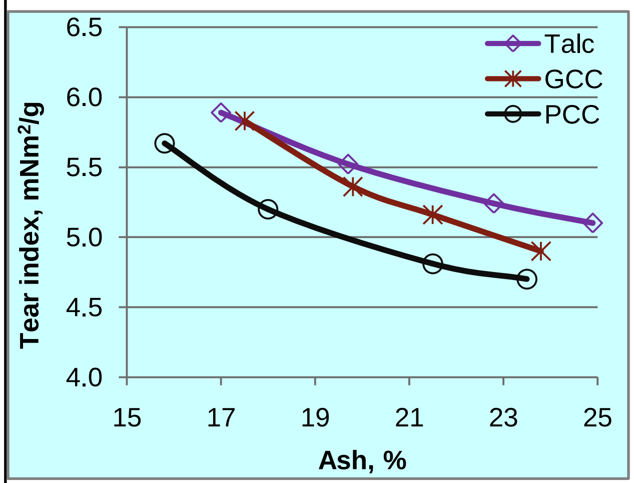

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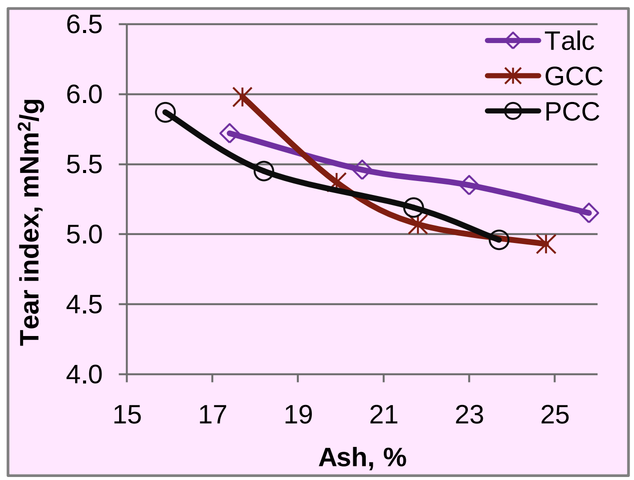

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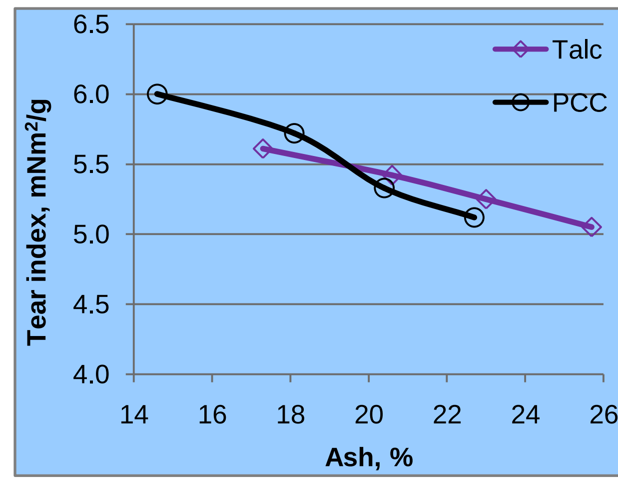
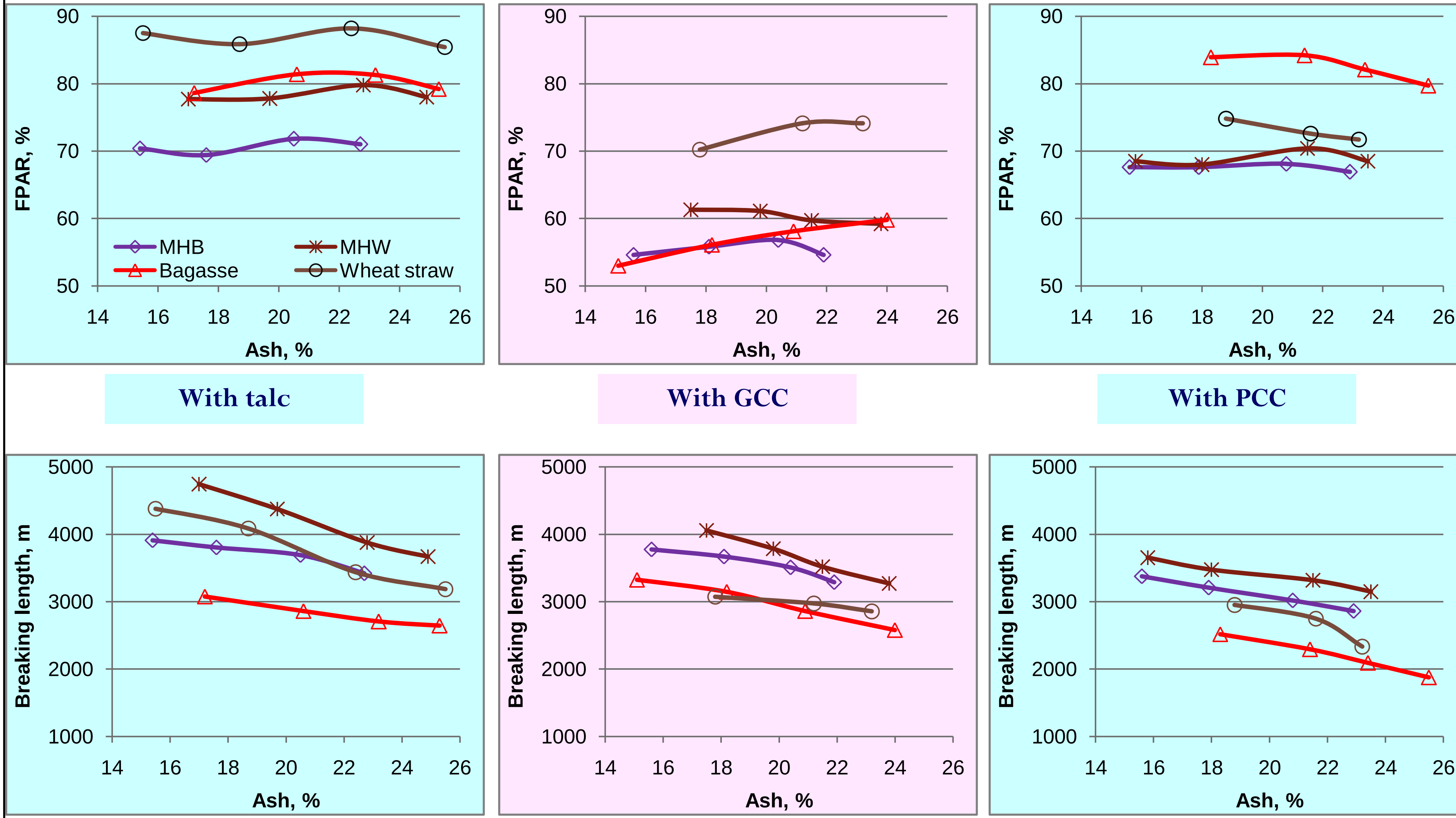


PS, 10 kg/t

Comparison of properties of different pulps with 10 kg/t dose of CS



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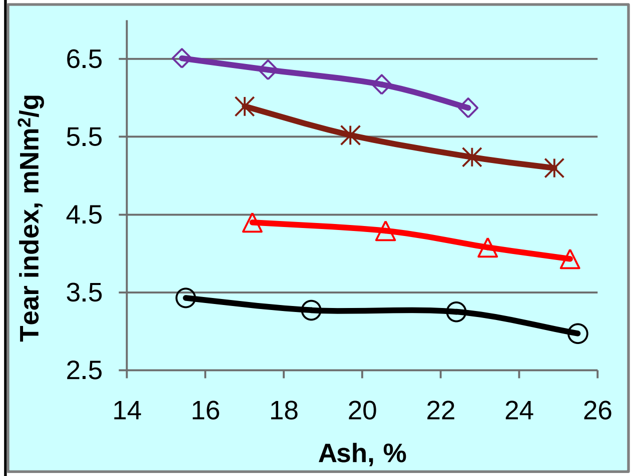
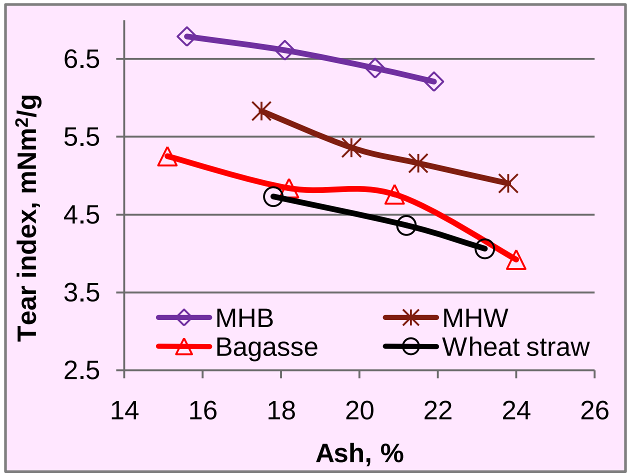
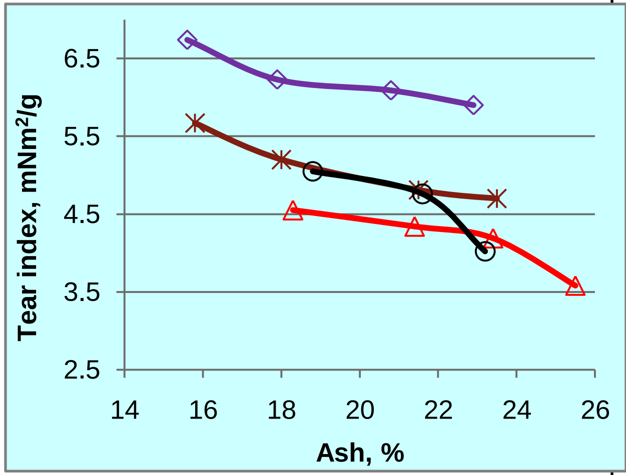


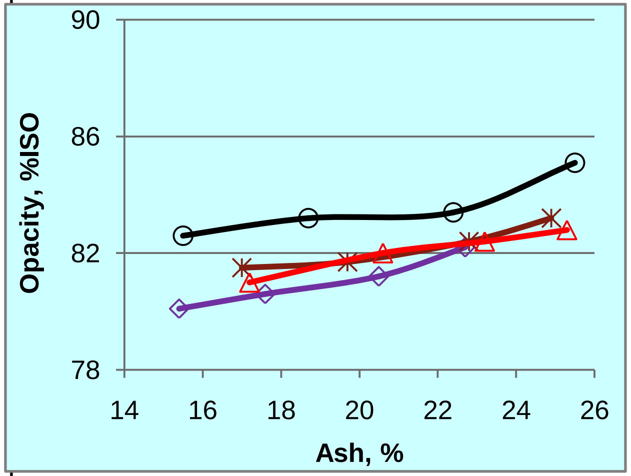


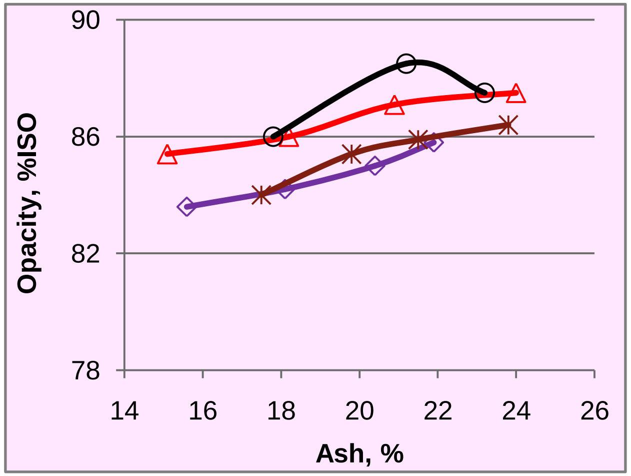


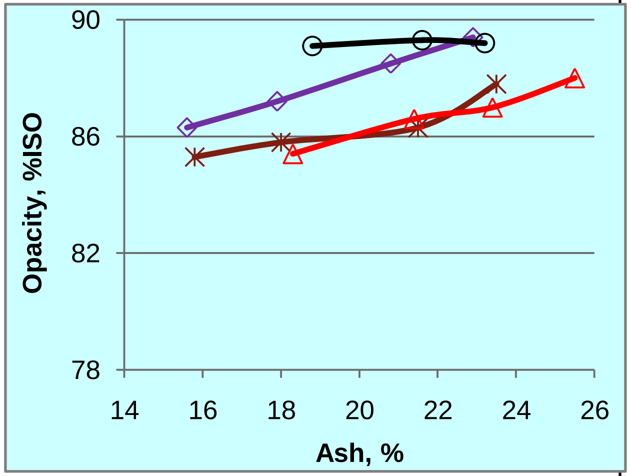
With talc

With GCC

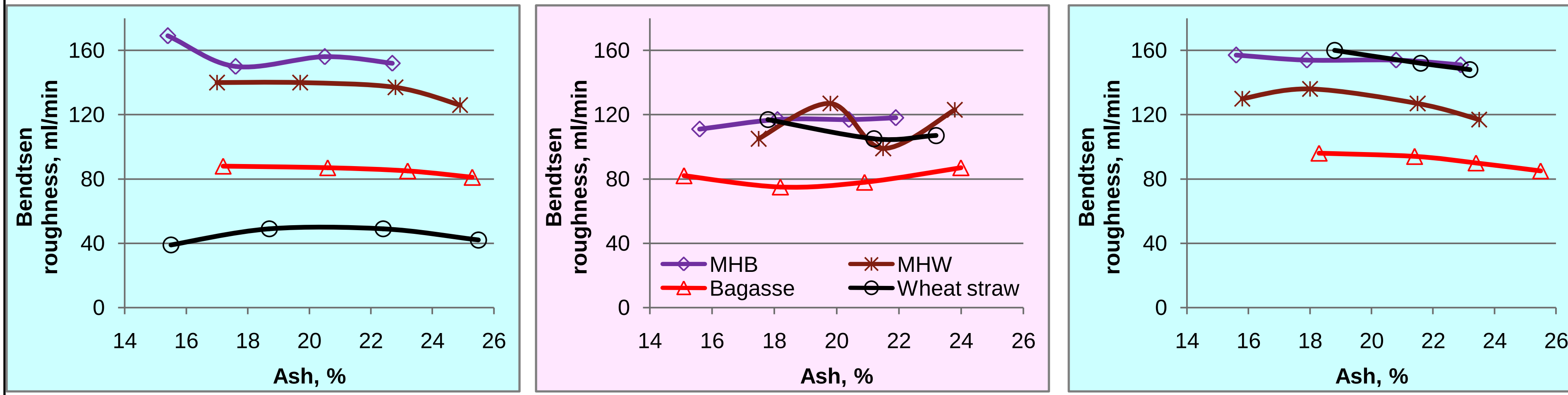
With PCC



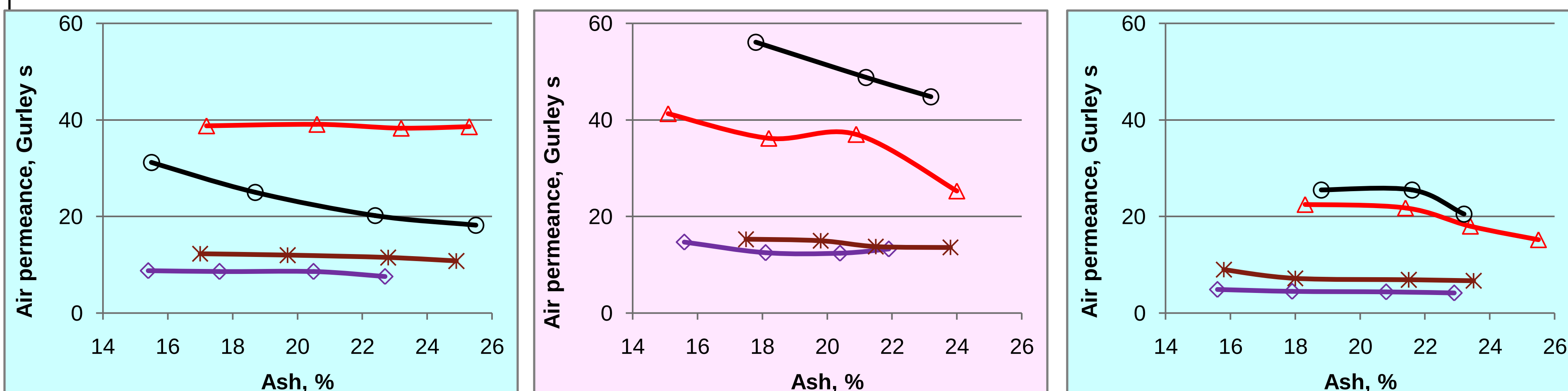




Comparison of properties of different pulps with 10 kg/t dose of CS



With talc | With GCC | With PCC



Direct filler loading of talc with MHW pulp

Particular	Ref. (CS, 5 kg/t)	CS, 10 kg/t	AS, 10 kg/t	PS, 10 kg/t
Filler addition, %	28	34	34	34
Retained ash, %	16.4	20.5	21.1	19.7
FPAR, %	74.5	80.8	83.3	77.8
Charge demand, µeq/l	5.6	3.8	8.5	5.6
Zeta potential, mV	-13.7	-7.0	-13.9	-12.8
Bulk, cc/g	1.32	1.31	1.30	1.33
Breaking length, m	4694	4621	4668	4374
Burst index, kN/g	2.68	2.90	2.59	2.65
Tear index, mNm^2/g	5.73	5.46	5.52	5.52
Bending stiffness, mNm	0.179	0.176	0.179	0.185
Double fold, no.	16	16	14	16
ZD tensile strength, kPa	797	739	763	768
Air permeance, Gurley s	15.8	12.9	13.2	12.0
Bendtsen roughness, ml/min	140	130	119	140
Brightness, %ISO	84.3	84.3	84.6	84.7
Opacity, %ISO	80.6	81.7	81.9	81.7
Scattering coefficient, m^2/kg	38.2	40.5	40.3	40.4
CIE whiteness	71.7	72.5	73.1	72.3

CS = Cationic strength additive; AS Amphoteric strength additive; PS = Polymeric strength additive

Direct loading of PCC with MHW pulp

Particular	Ref. (CS, 5 kg/t)	CS, 10 kg/t	AS, 10 kg/t	AS, 10 kg/t	PS, 8 kg/t	PS, 10 kg/t
Filler addition, %	30	36	36	44	36	44
Retained ash, %	15.3	18.0	18.2	21.7	17.1	19.1
FPAR, %	66.5	68.0	68.8	71.0	64.8	62.5
Charge demand, µeq/l	8.1	5.9	6.1	6.1	7.8	8.0
Zeta potential, mV	-18.2	-14.7	-7.1	-6.1	-14.0	-13.2
Bulk, cc/g	1.46	1.50	1.47	1.50	1.44	1.45
Breaking length, m	3555	3475	4151	3836	4014	3916
Burst index, kN/g	1.99	1.90	2.50	2.33	2.45	2.35
Tear index, mNm^2/g	5.58	5.20	5.45	5.19	5.57	5.33
Bending stiffness, mNm	0.180	0.182	0.200	0.197	0.200	0.201
Double fold, no.	8	9	12	9	7	7
ZD tensile strength, kPa	730	733	775	768	715	711
Air permeance, Gurley s	10.6	7.2	7.8	7.7	9.1	8.4
Bendtsen roughness, ml/min	136	136	123	124	120	115
Brightness, %ISO	86.5	86.9	87.0	87.5	87.3	87.4
Opacity, %ISO	84.8	85.8	87.1	87.7	85.5	86.2
Scattering coefficient, m^2/kg	52.1	55.0	55.6	59.3	55.0	56.3
CIE whiteness	76.8	76.9	78.4	78.8	78.7	78.4

CS = Cationic strength additive; AS Amphoteric strength additive; PS = Polymeric strength additive

Direct loading of GCC with MHW pulp

Particular	Ref. (CS, 5 kg/t)	CS, 10 kg/t	AS, 10 kg/t
Filler addition, %	30	38	38
Retained ash, %	15.6	18.3	18.6
FPAR, %	67.8	68.0	73.2
Charge demand, µeq/l	6.3	8.2	6.4
Zeta potential, mV	-14.3	-15.2	-11.2
Bulk, cc/g	1.25	1.17	1.22
Breaking length, m	4222	4353	4373
Burst index, kN/g	2.71	2.86	2.96
Tear index, mNm^2/g	6.66	6.47	6.28
Bending stiffness, mNm	0.159	0.156	0.154
Double fold, no.	17	18	17
ZD tensile strength, kPa	724	737	733
Air permeance, Gurley s	19.2	25.3	24.0
Bendtsen roughness, ml/min	107	73	68
Brightness, %ISO	83.9	84.1	84.5
Opacity, %ISO	83.6	84.1	83.9
Scattering coefficient, m^2/kg	39.8	42.8	43.6
CIE whiteness	73.5	73.1	74.6

CS = Cationic strength additive; AS Amphoteric strength additive

Preflocculated PCC filler loading with MHW pulp

Particular	Ref. (CS, 5 kg/t)	APAM, 22 g/t	CS, 2.8 kg/t	CS, 6.9 kg/t	Ref. (AS, 10 kg/t)	AS, 2.8 kg/t
PCC addition, kg/t pulp	360	360	360	360	360	360
CS in wet-end, kg/t pulp	5	5	4	2.5	0	0
AS in wet-end, kg/t pulp	0	0	0	0	10	9
APAM in wet end, g/t	80	72	80	80	80	80
Retained ash, %	17.6	19.5	21.2	21.5	18.7	21.9
FPAR, %	66.5	73.5	81.2	80.1	70.6	82.7
Charge demand, µeq/l	6.9	5.3	6.0	6.8	4.4	5.4
Zeta potential, mV	-17.2	-16.0	-19.5	-19.7	-3.2	-5.2
Bulk, cc/g	1.49	1.45	1.51	1.52	1.47	1.47
Breaking length, m	3316	3235	2859	2764	3695	3583
Burst index, kN/g	1.83	1.87	1.68	1.62	2.40	2.39
Tear index, mNm^2/g	4.89	4.32	4.88	4.98	5.38	5.04
Bending stiffness, mNm	0.174	0.180	0.205	0.203	0.209	0.178
Double fold, no.	7	6	7	5	11	8
ZD tensile strength, kPa	715	650	627.7	624.6	775	649
Air permeance, Gurley s	8.8	5.68	6.3	6.2	6.92	5.46
Bendtsen roughness, ml/min	133	137	157	135	165	169
Brightness, %ISO	86.9	87.5	88.1	87.8	86.8	86.6
Opacity, %ISO	85.1	88.0	87.9	88.3	87.0	87.7
Scattering coefficient, m^2/kg	55.1	62.9	64.2	65.0	62.3	64.1
CIE whiteness	77.1	77.6	79.8	78.8	76.7	76.1

CS = Cationic strength additive; AS Amphoteric strength additive; APAM = Anionic polyacrylamide

Preflocculated GCC filler loading with MHB pulp

Particular	Ref. (CS, 0 kg/t)	CPAM, 26.3 g/t	Ref. (AS, 5 kg/t)	AS, 2.6 kg/t	Ref. (CS, 5 kg/t)	CS, 6.6 kg/t
PCC addition, kg/t pulp	380	380	380	380	380	380
CS in wet-end, kg/t pulp	0	0	0	0	5	2.5
AS in wet-end, kg/t pulp	0	0	5	4	0	0
APAM in wet end, g/t	200	190	200	200	200	200
Retained ash, %	18.3	20.4	18.6	24.3	17.9	22.4
FPAR, %	66.5	74.2	72.3	88.3	65.0	81.4
Charge demand, μeq/l	9.1	11.3	7.8	7.4	8.8	7.4
Zeta potential, mV	-19.3	-18.8	-17.2	-16.2	-16.1	-18.1
Bulk, cc/g	1.27	1.26	1.27	1.24	1.24	1.25
Breaking length, m	3792	3613	3775	3846	4001	3723
Burst index, kN/g	1.81	2.45	2.43	2.54	2.40	2.39
Tear index, mNm^2/g	5.97	5.78	6.12	5.87	6.25	5.61
Bending stiffness, mNm	0.170	0.138	0.145	0.141	0.144	0.133
Double fold, no.	11	13	16	21	12	15
ZD tensile strength, kPa	682	511	702	737	712	707
Air permeance, Gurley s	21.0	21.9	18.3	17.9	18.0	18.6
Bendtsen roughness, ml/min	88	95	95	95	105	91
Brightness, %ISO	85.2	84.8	84.1	84.3	84.9	84.6
Opacity, %ISO	86.8	85.0	84.3	85.9	84.0	85.2
Scattering coefficient, m^2/kg	50.6	48.3	43.9	47.2	43.0	47.7
CIE whiteness	75.2	73.8	74.2	73.5	74.2	73.7

CS = Cationic strength additive; AS Amphoteric strength additive; CPAM = Cationic polyacrylamide