ONP 탈묵 공정의 수율개선 방안 검증을 위한 Pilot Test

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The 2ndstage flotation was performed on Voith lab cell for 2 retention times: 3.5 and 7 min that correspond respectively to 100% and 200% air ratio. Note that in any case, the foaming was very high as the main part of surfactant is concentrated in 1ststage reject. The corresponding losses are then very high.

Comparison between conventional alkaline situation (0.5% NaOH +Silicate) & near neutral situation (silicate)

According to the last trials performed, it was recommended to run thepulping in close to neutral condition in terms of optical properties (reducction in ink binder resolubility of flexo inks), mainly due to the presence of flexo inks in the raw materials you sent us. Note that the present trials were performed without flexo prints (only conventional offset newspaper). According to the present trials, the following comments can be brought to the fore:

Flotation inlet characteristics (1st stage):

- Brightness at flotation inlet is about the same (43.5%) as well as ERIC (1560 vs 1510 ppm).
- Ink detachment is about the same (370 to 400 ppm on ERIC hyperwashed pulp)
- Brightness of fibre fraction is better than alkaline pulping as

yellowing occurs due to the presence of soda (and no peroxide is added): 56% vs 54% for respectively neutral and alkaline pulping. The yellowing is clearly illustrated by the b* values on hyperwashed pulp (5.9 vs 7.4)

- Speck contamination is higher for neutral pulping (920 vs 750 mm/m)

Flotation accept characteristics (1st stage):

- Brightness after flotation is the same for the 2 pulping conditions: 54.2% as well as the residual ink content (400 vs 370 ppm)
- An increase in brightness of fibre fraction is observed between the inlet and outlet of flotation stage (2% ISO brightness gain whatever the initial pulping condition) that can be linked to a decrease in ink content on fibres (decrease about 70 ppm in terms of ERIC hyperwashed). It can be supposed that the inked fibres are preferentially removed during flotation.
- Residual speck content after flotation is higher for neutral pulping condition (260 vs 220 mm/m).
- neutral pulping induces an increase in flotation losses (from 25.6 to 27% for 1st stage of flotation)

Flotation reject characteristics (1st stage):

- The entire pulp is characterised by about the sameERIC and the same brightness (3000 ppm and 38%)
- The speck contamination of 1st stage reject is about the same (7800 vs 8000 mm/m)

The potential of fibre fraction is greater for the reject corresponding to neutral pulping (51% - 540 ppm vs 46% - 600ppm)

2nd stage of flotation (100% air ratio):

- For neutral pulping condition, the 2nd stage flotation yield is lower 58.2% (vs 59.6%) and the total losses is 11.3% (vs 10.3%) if we consider as reject only the froth from 2nd stage (100% air ratio corresponding in our case to 3.5 min flotation).

Brightness, ink content and spepcks are the same between the two pulping conditions after the 2nd stage of flotation: 41% – 2350 ppm 2800 mm/m

If the flotation time is increased (air ratio from 100 to 200%), the totallosses increase to 17 and 16.1% for respectively the neutral and alkaline pulping conditions In that case, the quality of the pulp is improved to 45.6% brightness (and lower residual ERIC 1400 ppm). For this higher air ratio, the speck removal is also improved but the effect is more pronounced for the alkaline pulping condition (1500 mm/m vs 2700 mm/m). Besides, an increase in flotation time is also responsible for an improvement of fibre fraction (ERIC on hyperwashed pulp decrease to about 350 ppm (in comparison to 460 ppm for 100% air ratio)

Several comments:

- For low air ratio, no difference in pulp quality is observed. The main disadvantage of neutral pulping is then an increase in flotation losses.
- For high air ratio, the total losses increase andthe pulp quality of 2ndstage is improved. The advantage of alkaline pulping is then a reduction in losses associated with lower speck content.
- Neutral pulping can be a efficient alternative to alkaline pulping in terms of pulp quality (note that relativefresh ONP was

used: 4-5 week old, a pulp degradation could have been observed in the case of more difficult ink such as heat-offset or summer effect). The main drawback is then an increase in losses. To reduce this disadvantage, enzymatic treatment were proposed.

_Additionofenzymatictreatmentdirectlyinthedrum

If enzymatic treatment is directly performed in the drum pulper, the corresponding pulp at the end of this stage is equivalent to the neutral or alkaline pulping conditions for the entire pulp (brightness about 44% with corresponding ERIC of 1500 ppm), the fibre fraction corresponds to what have been obtained with neutral pulping (55.5% - 260ppm) that is better than alkaline pulping in terms of brightness (54%). The speck contamination is equivalent to neutral pulping (990 mm/m) and still higher than alkaline pulping (750 mm/m).

The enzymatic treatment induces also a different behaviour of the 1ststage of flotation: the flotation yield of this stage decreases to 68.2% in comparison to neutral condition (73%) or alkaline condition (74.4%). However, the flotation efficiency in terms of ink removal is improved: ERIC after flotation is 315 ppm that corresponds to an improvement of brightness (56%) that should be compared to 54.2% for both neutral or alkaline pulping conditions. The residual speck contamination is comparable to what have been obtained with neutral pulping (280 mm/m) and still higher than alkaline pulping (220 mm/m).

The rejects from 1st stage of flotation are similar to the two other pulping conditions excepted the speck content that is lower for the enzymatic treatment 6200 vs 7800 mm/m).

Regarding the 2ndstage of flotation with 100% air ratio, the flotation yield

increases from 58.2 to 63.8% (neutral to neutral+enzymaticpulping) with an intermediate 59.6% for alkaline pulping. However, this increase is not sufficient to compensate the higher amount of losses in the primary stage: total losses is 11.7% (vs 11.3% for neutral pulping condition and 10.3 for alkaline pulpingconditions) if we consider as reject only the froth from 2nd stage (100% air ratio corresponding in our case to 3.5 min flotation). The quality of the accepted pulp from secondary flotation stage is improved for the neutral + enzymatic treatment: 44% brightness (1800 ppm ERIC) in comparison to 41% (2400 ppm) for the two other conditions. On the other hand, the speck contamination is higher (4100 mm/m) in comparison to 2800 mm/m. It seems that the speck are more difficult to remove when enzymatic treatment is applied in the drum.

If the air ratio is increased to 200%, as for the other conditions, the losses increase and represent 21.1% if only the reject from secondary stage as the source of losse. On the other hand, the pulp properties are improved to 49.2% brightness and 2000 mm/m in terms of speck contamination.

Main conclusion:

By adding an enzymatic treatment directly in the drum pulper, the pulp quality is improved after flotation with 2 main drawbacks:

- specks seem to be more difficult to remove
- the losses are increased

_Additionofenzymatictreatmentbeforethesecondarystageof flotation

This solution has the main advantage to reduce the amount of enzyme to be added to treat the pulp (only small flow in comparison to the introduction in the pulper).

As there is no change with the neutral pulping condition and as we have done the trials in open loop, the same characteristics of the pulp around the first stage of flotation are observed.

Regarding the second stage of flotation with 100%of air ratio, the enzymatic treatment allows to improve the flotation yield of this stage (from 58.2 to 65%) so that this increase is able to compensate the higher amount of losses in the primary stage: total losses is 9.5% (vs 11.3% for neutral pulping condition and 10.3 for alkaline pulping conditions) if we consider as reject only the froth from 2nd stage. The brightness of 2nd stage of flotation is comparable to what have been obtained when enzymatic treatment was performed in the drum: 45% brightness(1800 ppm) that is better than what have been observed for the traditional neutral or alkaline pulping conditions (41% brightness 2300 ppm). However, the speck contamination is more pronounced: :3700 mm/m vs 2700 mm/m.

If the air ratio increases to200%, as previously, the losses increase. In that case, the enzymatic treatment induces equivalent total losses than alkaline pulping conditions (16.4 vs 16.1%). The pulp properties are improved to 49% brightness (1070 ppm) and 2000 mm/m for speck contamination.

Main conclusion:

The enzymatic treatment performed on the reject from the primary stage of flotation appears as a promising solution as the total losses are comparable or lower than conventional alkaline pulping and the accepted pulp from secondary flotation corresponds to a better quality. The main drawback is then a decrease in speck removal efficiency.

_Othercomments

It has been observed than an increase in air ratio during flotation

(equivalent to an increase in flotation time during the present trial) is responsible for a decrease in advantages of using the enzymatic treatment (too high losses). For this purpose, it can be suggested to reduce the air ratio in the secondary flotation cells or to decrease the retention time.

As soon as enzymatic treatment is applied, the brightness of accepted pulp from secondary flotation stage is reached after only 100% air ratio that correspond to a total loss of 9.5 to 11.5 % (depending where the enzyme is applied) whereas it requires 200% air ratio for non-enzymatic treatment that corresponds to a total loss between 16.1 and 17% (depending in neutral of alkaline pulping condition). Similar trend can be brought to the fore regarding the ERIC values. The main drawback is then the speck content in the pulp (4000 mm/m for enzymatic treatment and 1500 for alkaline pulping and 2500 for neutral pulping with the corresponding air ratio mentioned previously).

If higher brightness (or lower ERIC) is required, the only solution is then to apply 200% air ratio (withcorresponding losses between 16.4 and 21%) where brightness of accepted pulp from secondary stage is between 49.2 and 50.9%. Note that the accepted pulp from primary stage is around 54%.

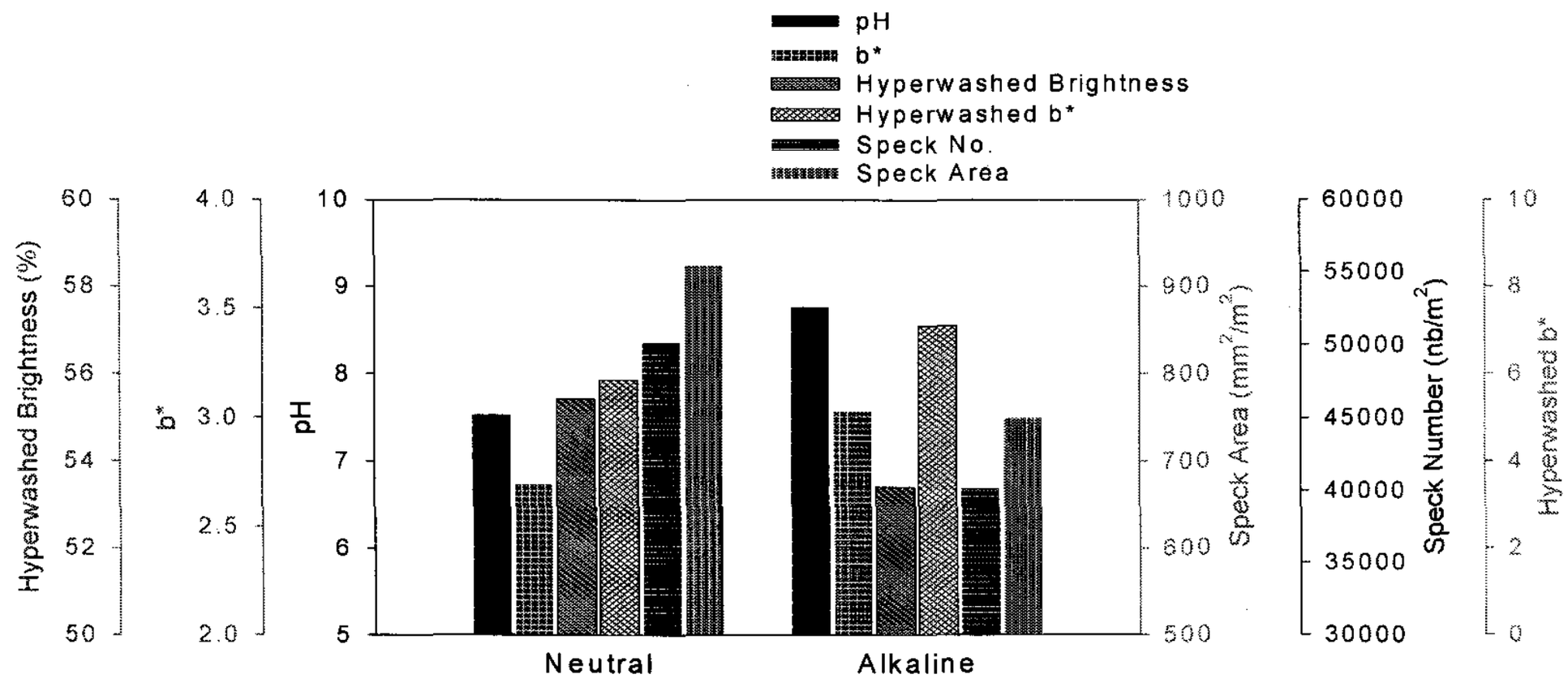
Note that the incidence of the various treatment has been investigated in open loop, and differences can occur when recirculating the accept pulp from secondary flotation stage (mainly at the inlet of the primary stage).

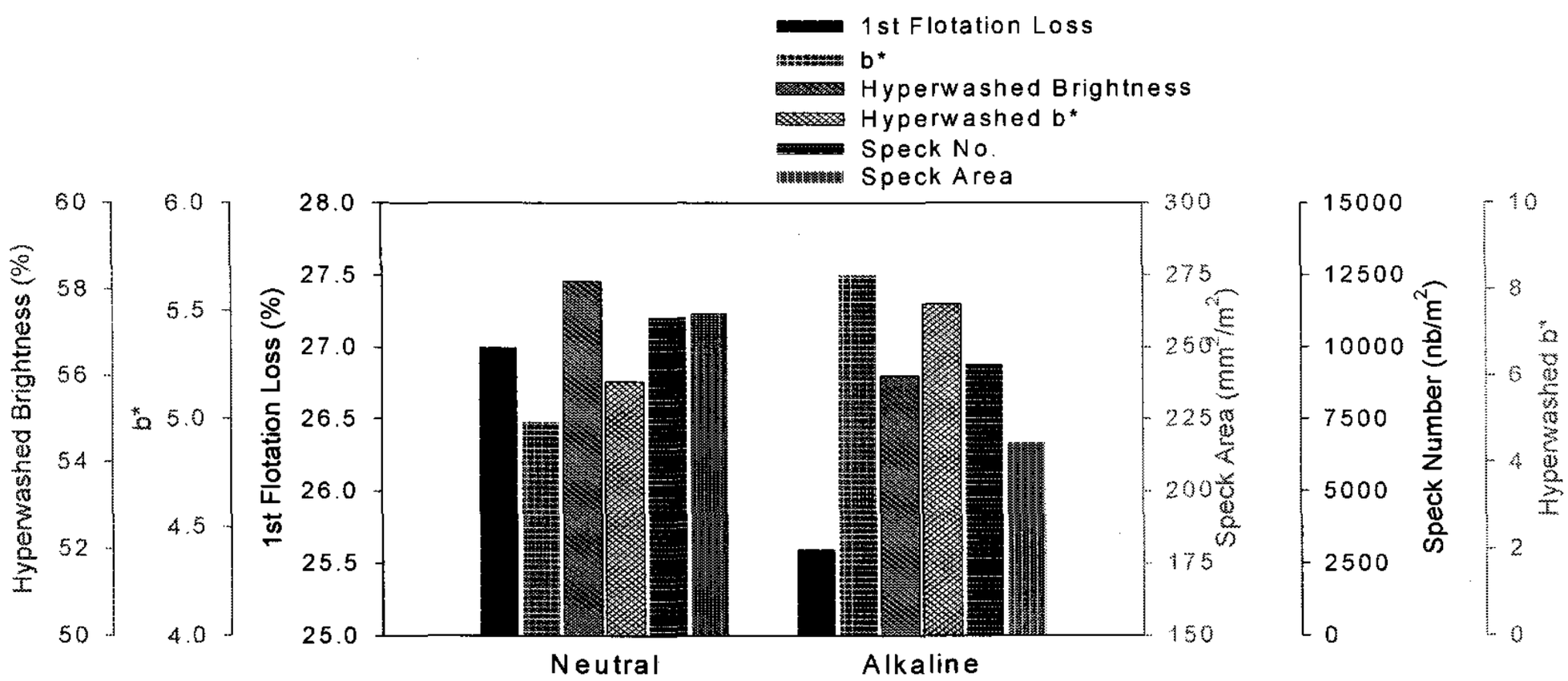
Enzymatic treatment has also the advantage to reduce the ERIC values after secondary flotation (it seems that enzymatic treatment facilitate the ink detachment from the fine elements or from the filler). On the other hand, the speck contamination is higher (more difficulty to remove them?).

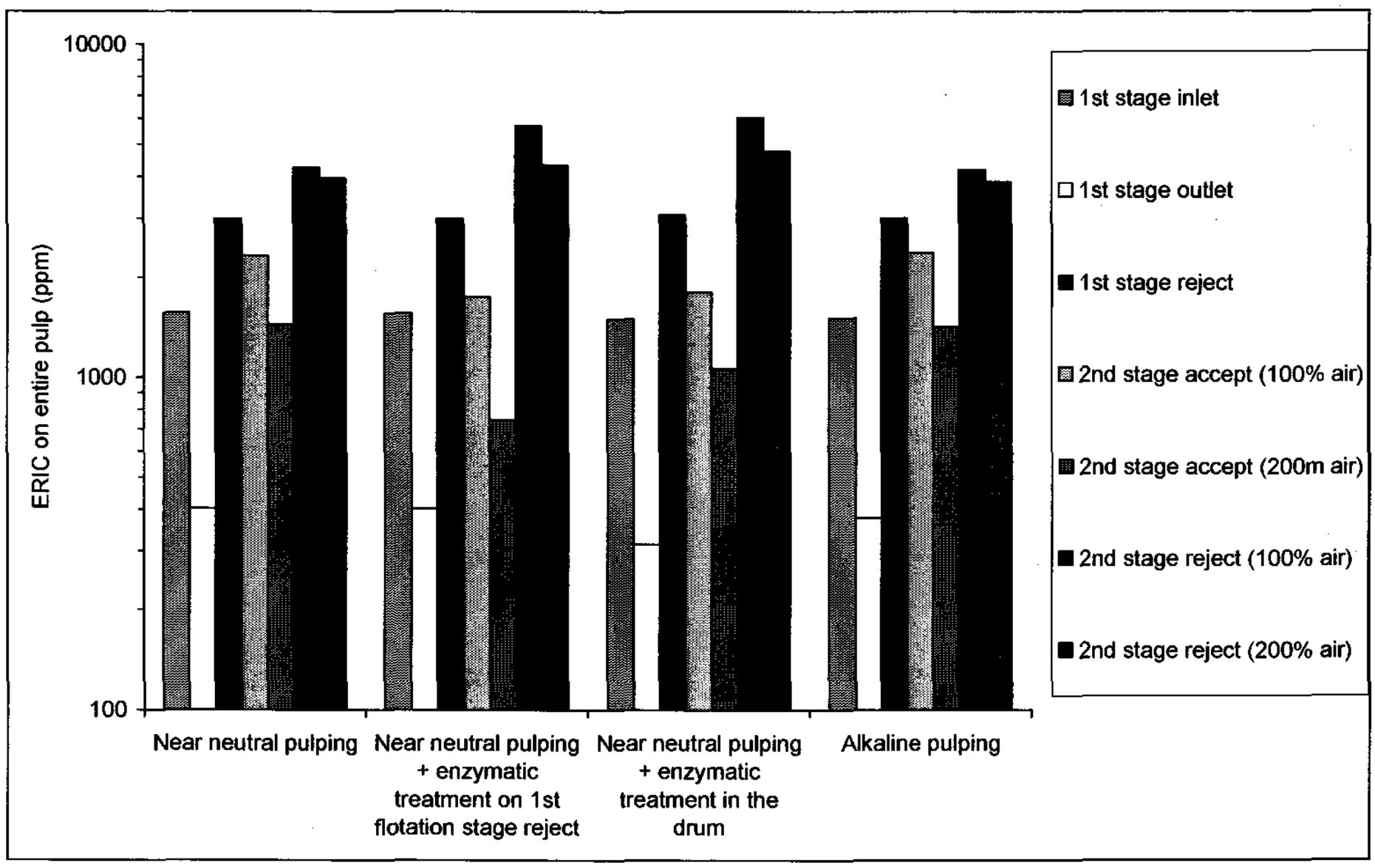
The comparison of the various conditions are reported in the following table.

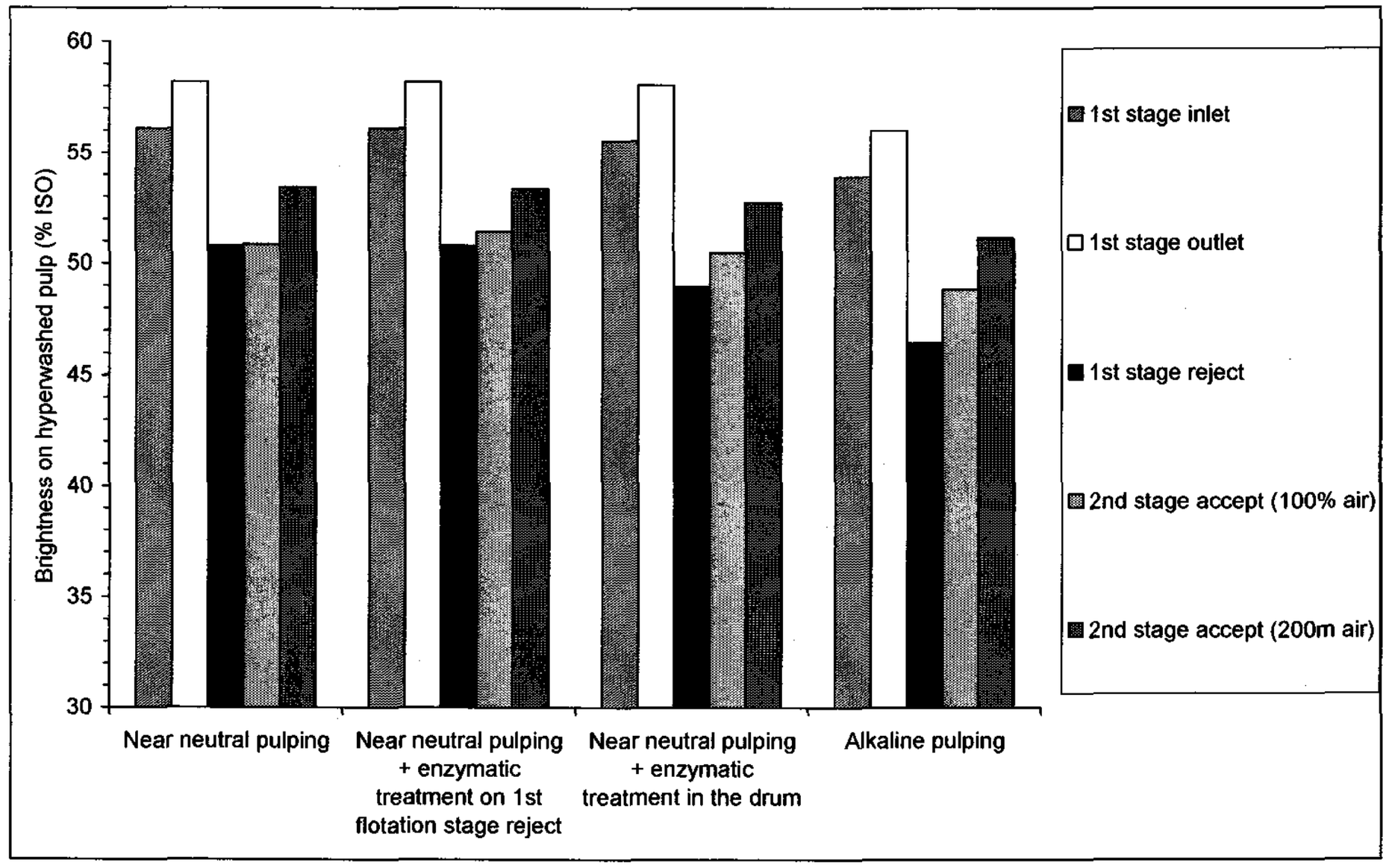
		Neutral pulping	Neutral+ enzyme pulping	Neutral pulping + enzyme on foam	Alkaline pulping
Primary flotation stage	Brightness inlet	44	44	44	44
	ERIC Inlet	1560	1500	1560	1510
	Specks inlet	920	990	920	750
	Brightness outlet	54	56	54	54
	ERIC outlet	400	320	400	380
	Speck outlet	260	280	260	220
Secondary flotation 100% air ratio	Total losses	11.3	11.7	9.5	10.3
	Brightness outlet	41	44	46	41
	ERIC outlet	2300	1810	1750	2400
	Speck outlet	2800	4100	3700	2900
Secondary flotation 200% air ratio	Total losses	17	21	16.4	16.1
	Brightness outlet	46	49	51	46
	ERIC outlet	1450	1070	750	1420
	Speck outlet	2700	2000	2600	1500

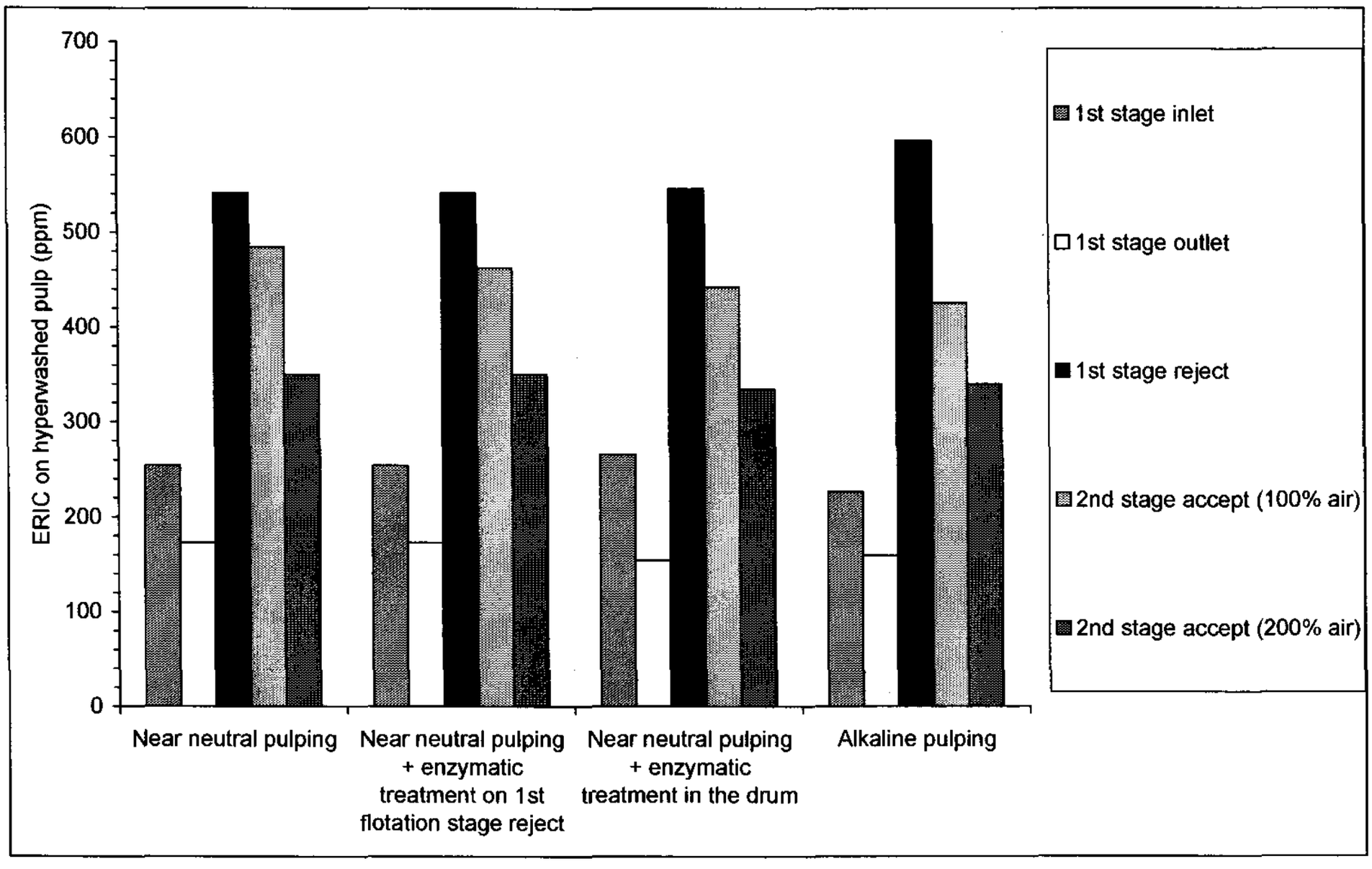
Well done for the enzyamtic treeatment: better ink removal associated with lower losses (if reduction in air ratio in secondary stage flotation). However, some difficulties to deal with specks.

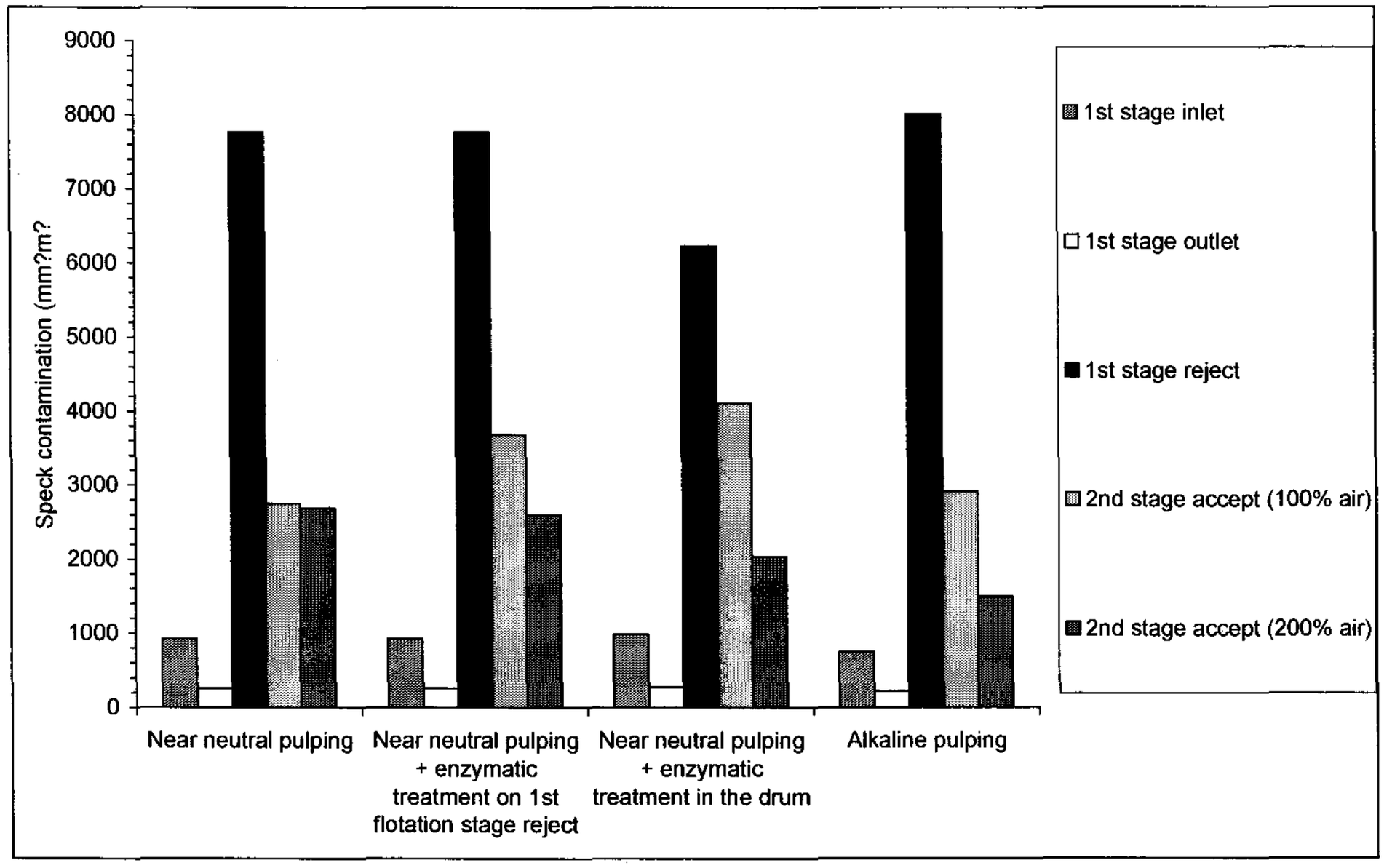

pH
b*
Hyperwashed Brightness
Hyperwashed b*
Speck No.
Speck Area
Hyperwashed Brightness (%)
b*
pH
Speck Area (mm²/m²)
Speck Number (nb/m²)
Hyperwashed b*
Neutral
Alkaline

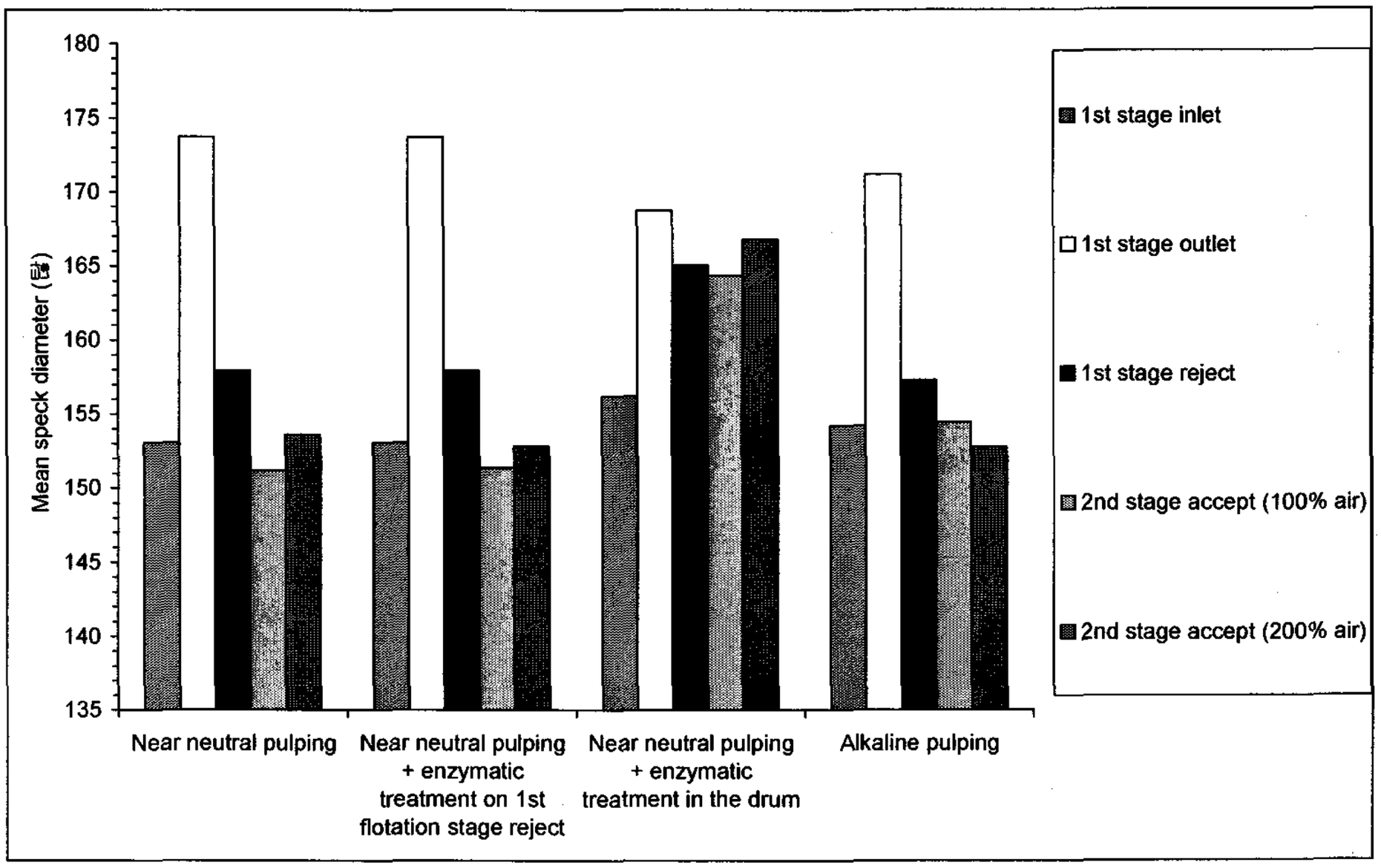

1st Flotation Loss
b*
Hyperwashed Brightness
Hyperwashed b*
Speck No.
Speck Area
Hyperwashed Brightness (%)
b*
1st Flotation Loss (%)
Speck Area (mm²/m²)
Speck Number (nb/m²)
Hyperwashed b*
Neutral
Alkaline

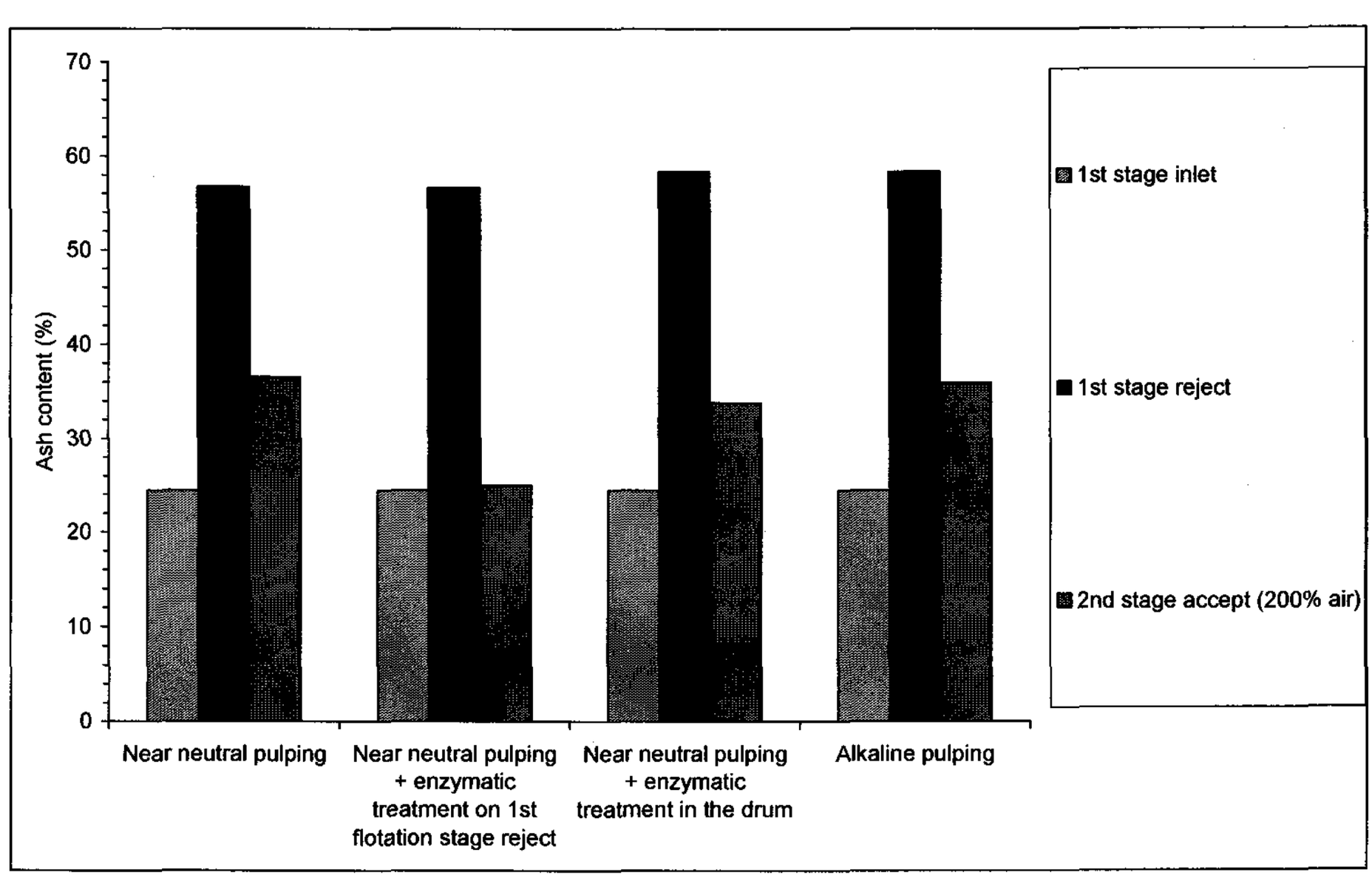

10000
1000
100
ERIC on entire pulp (ppm)
Near neutral pulping
Near neutral pulping + enzymatic treatment on 1st flotation stage reject
Near neutral pulping + enzymatic treatment in the drum
Alkaline pulping
1st stage inlet
1st stage outlet
1st stage reject
2nd stage accept (100% air)
2nd stage accept (200m air)
2nd stage reject (100% air)
2nd stage reject (200% air)

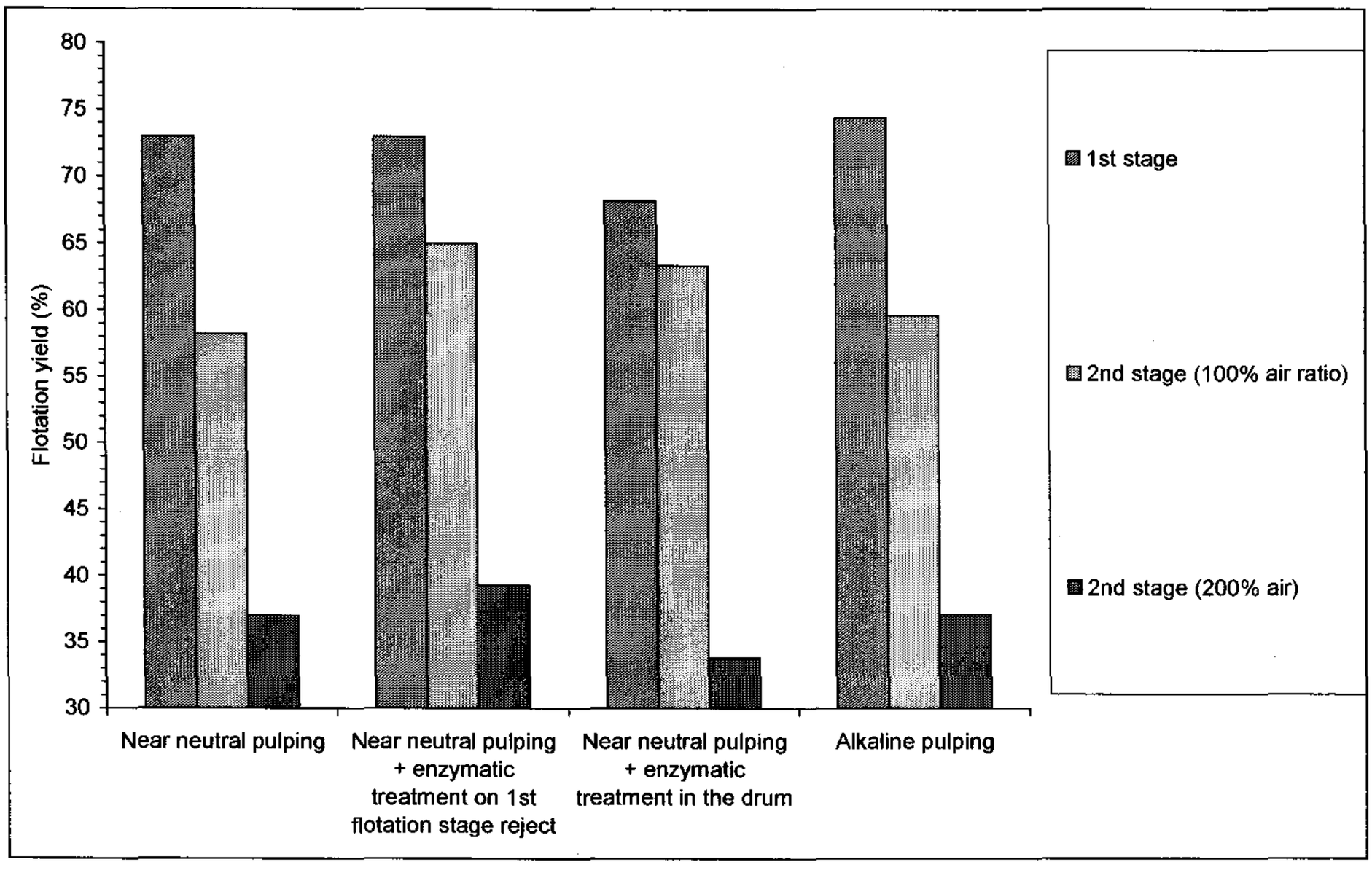

60
55
50
45
40
35
30
Brightness on hyperwashed pulp (% ISO)
Near neutral pulping
Near neutral pulping + enzymatic treatment on 1st flotation stage reject
Near neutral pulping + enzymatic treatment in the drum
Alkaline pulping
1st stage inlet
1st stage outlet
1st stage reject
2nd stage accept (100% air)
2nd stage accept (200m air)

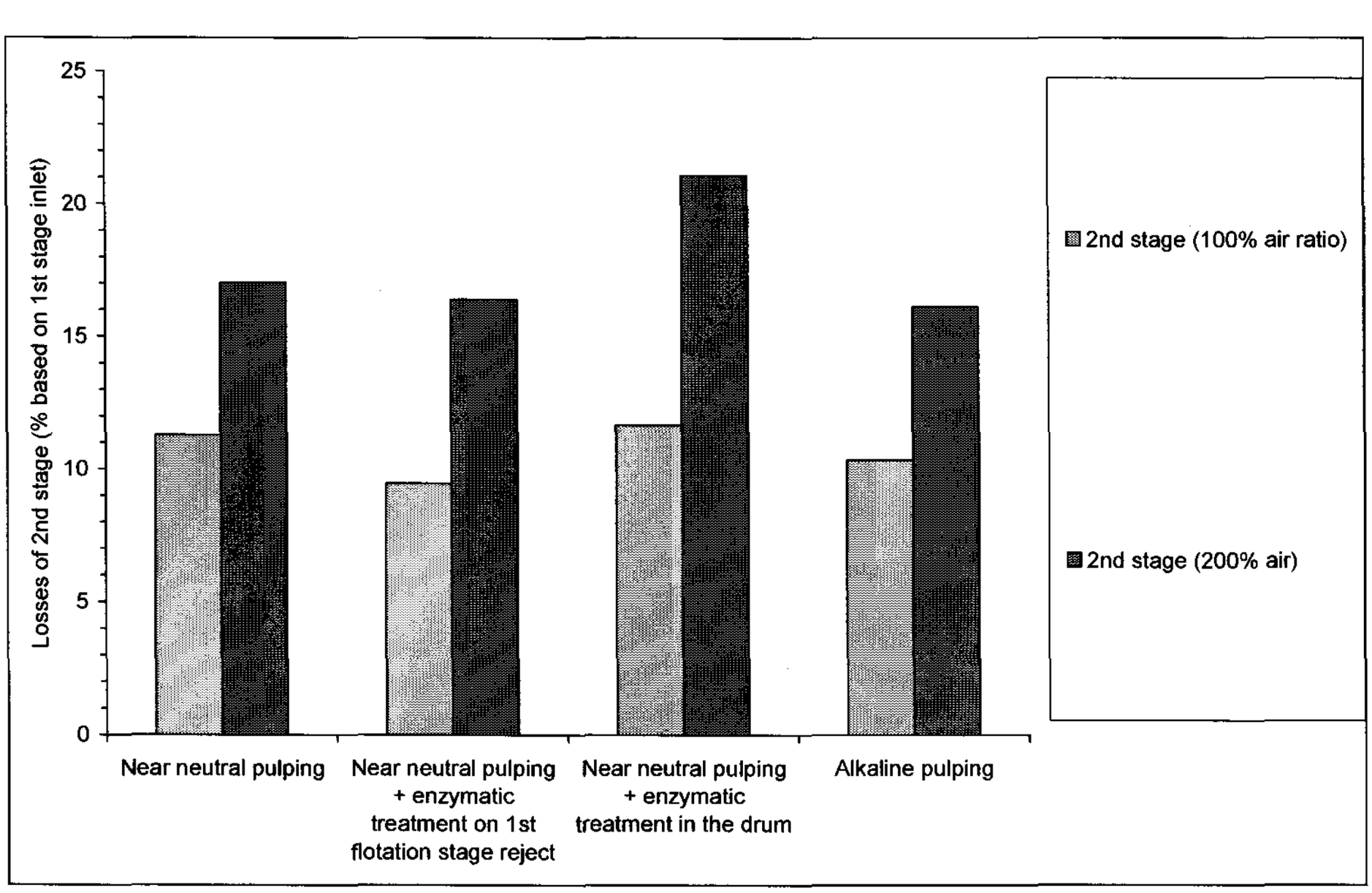

ERIC on hyperwashed pulp (ppm)
700
600
500
400
300
200
100
0
Near neutral pulping
Near neutral pulping + enzymatic treatment on 1st flotation stage reject
Near neutral pulping + enzymatic treatment in the drum
Alkaline pulping
1st stage inlet
1st stage outlet
1st stage reject
2nd stage accept (100% air)
2nd stage accept (200% air)

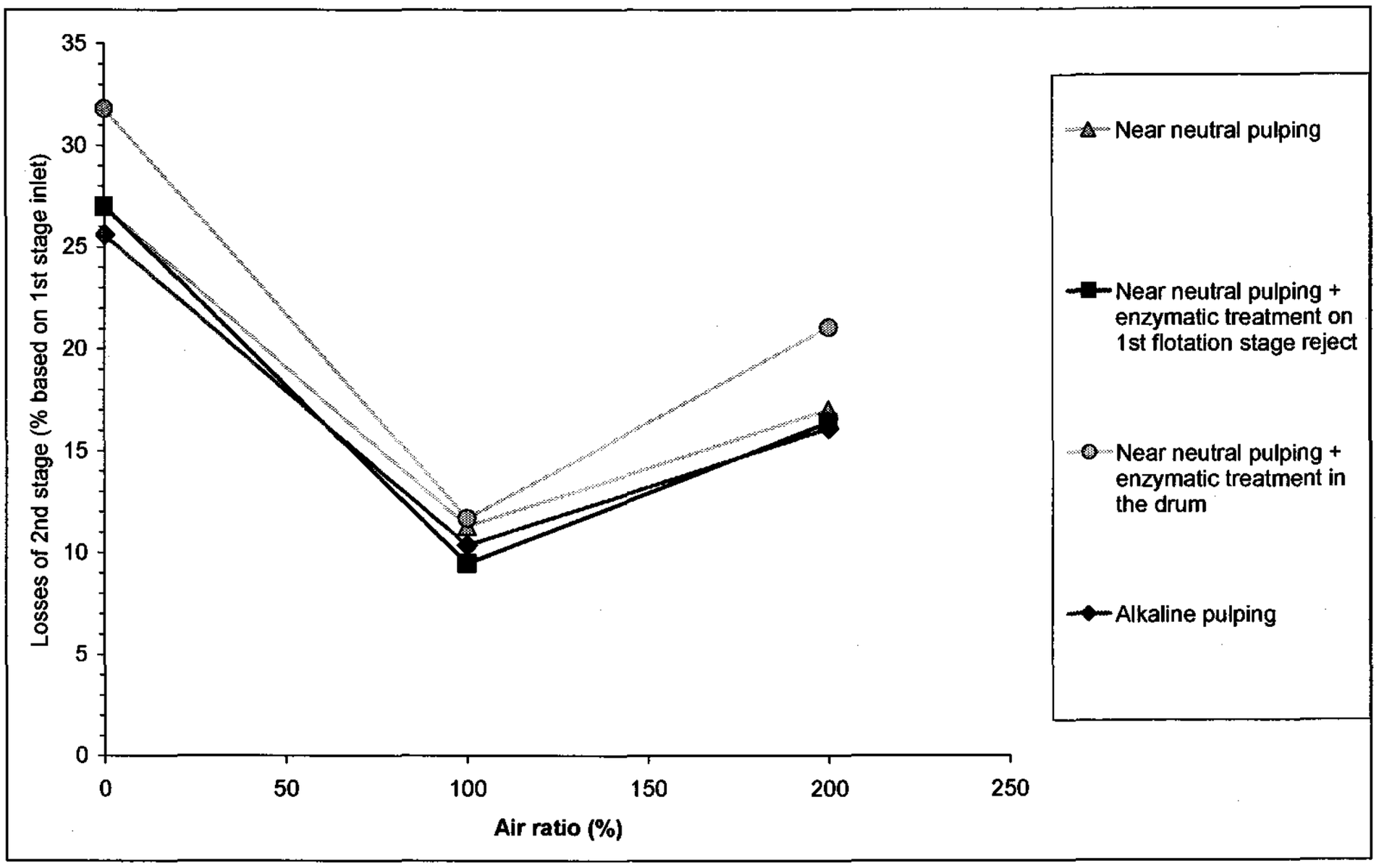

Speck contamination (mm?m?
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Near neutral pulping
Near neutral pulping + enzymatic treatment on 1st flotation stage reject
Near neutral pulping + enzymatic treatment in the drum
Alkaline pulping
1st stage inlet
1st stage outlet
1st stage reject
2nd stage accept (100% air)
2nd stage accept (200% air)

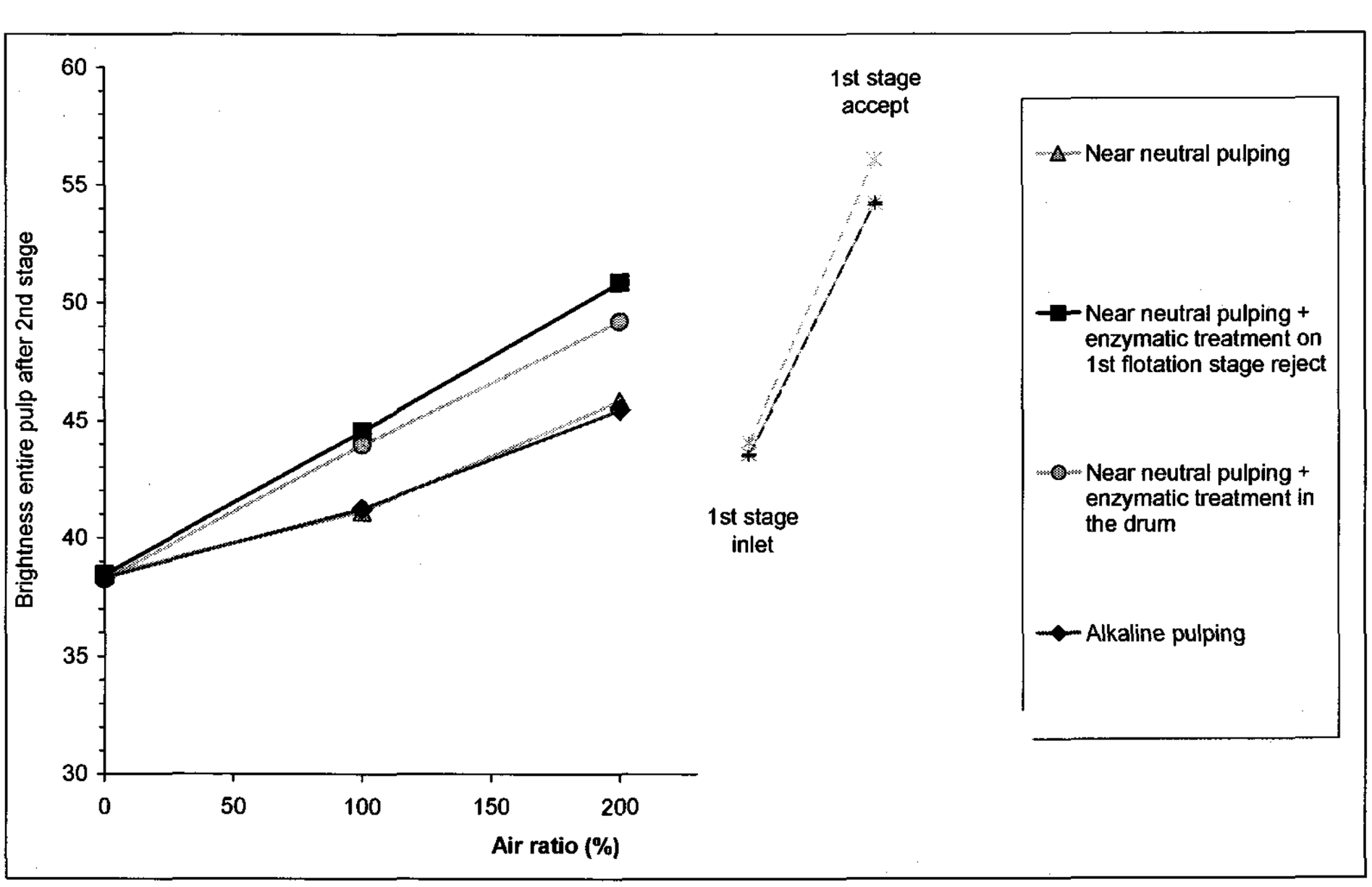

Mean speck diameter (µm)
180
175
170
165
160
155
150
145
140
135
Near neutral pulping
Near neutral pulping + enzymatic treatment on 1st flotation stage reject
Near neutral pulping + enzymatic treatment in the drum
Alkaline pulping
1st stage inlet
1st stage outlet
1st stage reject
2nd stage accept (100% air)
2nd stage accept (200% air)

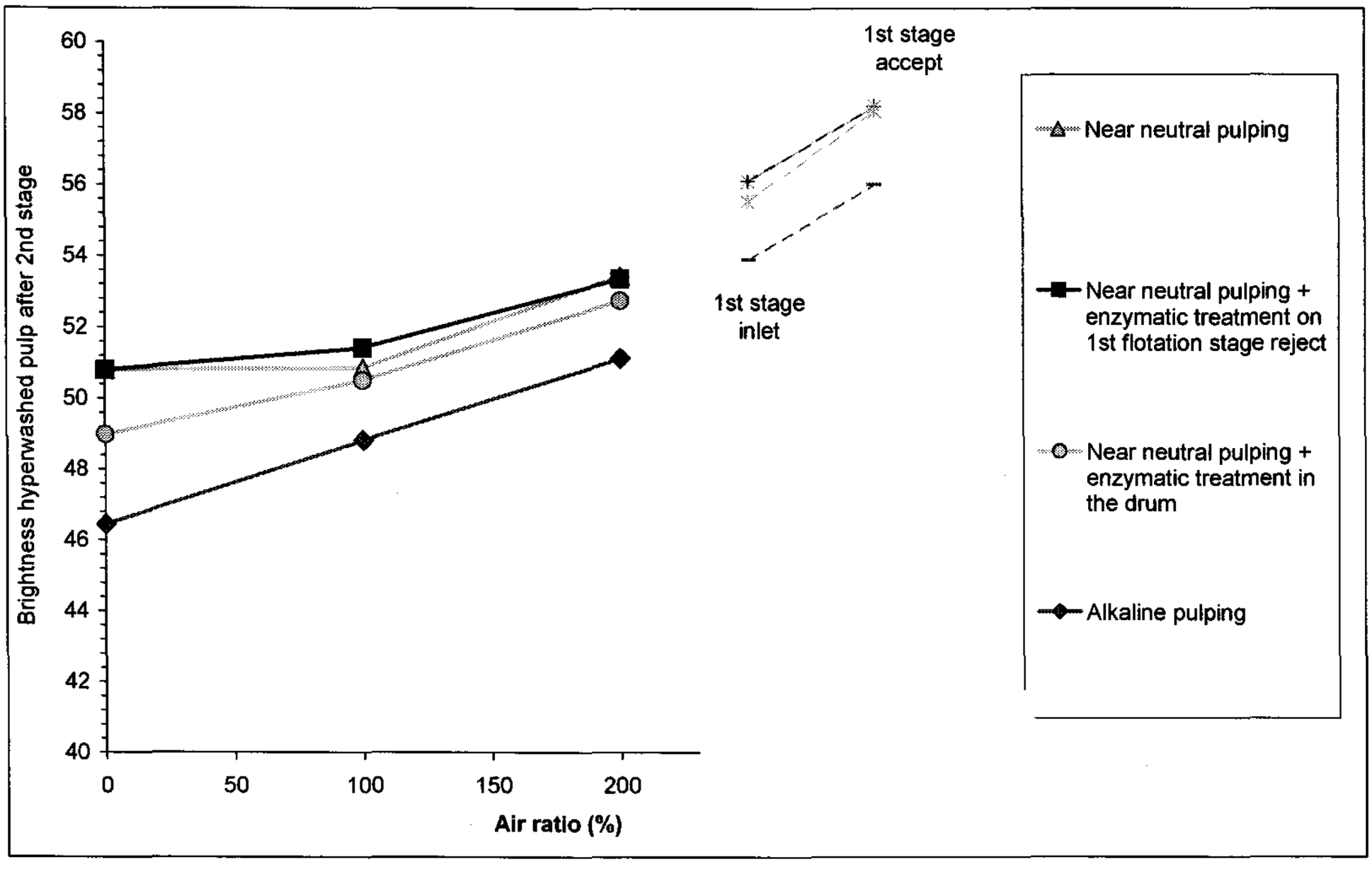

Ash content (%)
70
60
50
40
30
20
10
0
Near neutral pulping
Near neutral pulping + enzymatic treatment on 1st flotation stage reject
Near neutral pulping + enzymatic treatment in the drum
Alkaline pulping
1st stage inlet
1st stage reject
2nd stage accept (200% air)

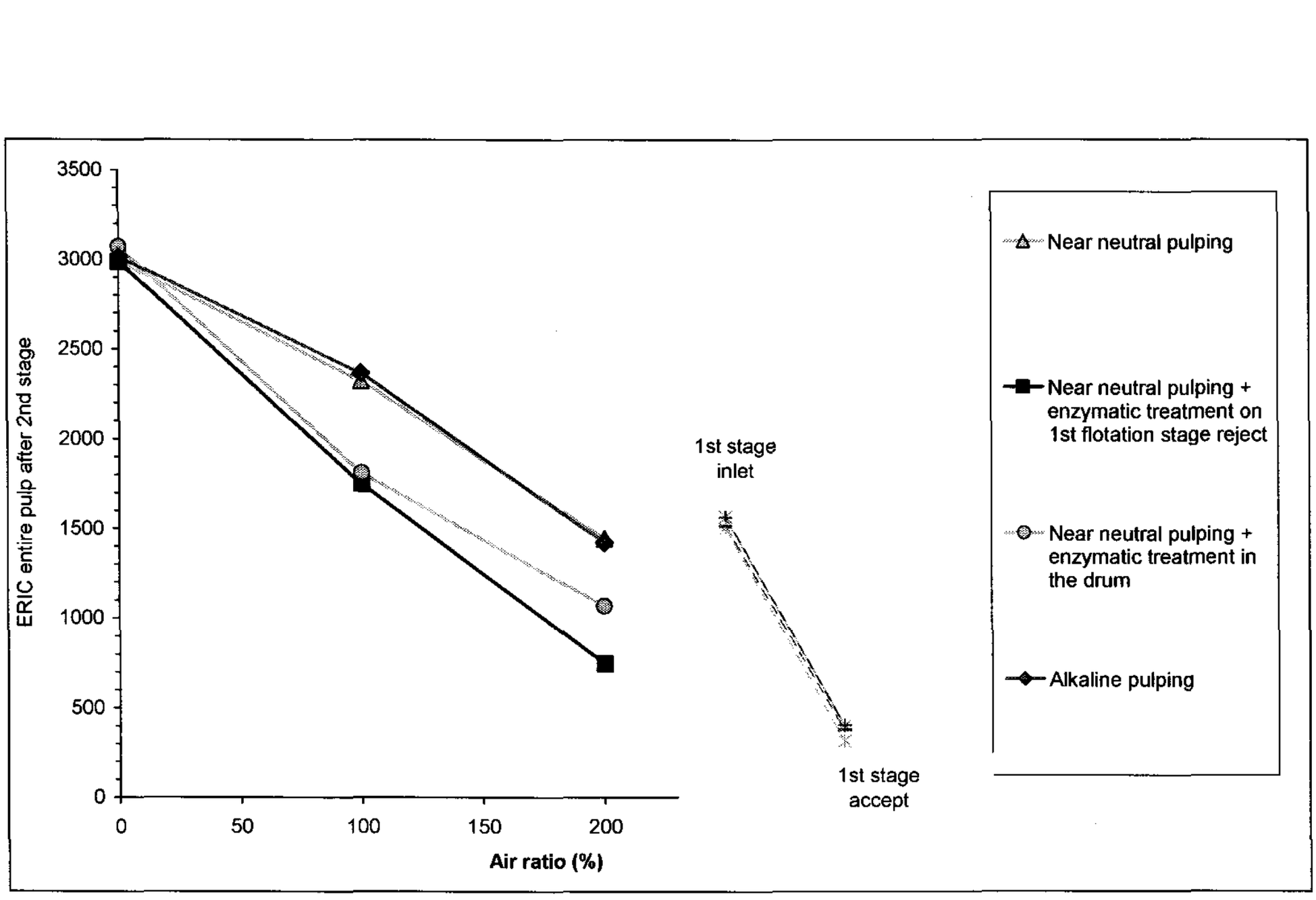

Flotation yield (%)
80
75
70
65
60
55
50
45
40
35
30
1st stage
2nd stage (100% air ratio)
2nd stage (200% air)
Near neutral pulping
Near neutral pulping + enzymatic treatment on 1st flotation stage reject
Near neutral pulping + enzymatic treatment in the drum
Alkaline pulping

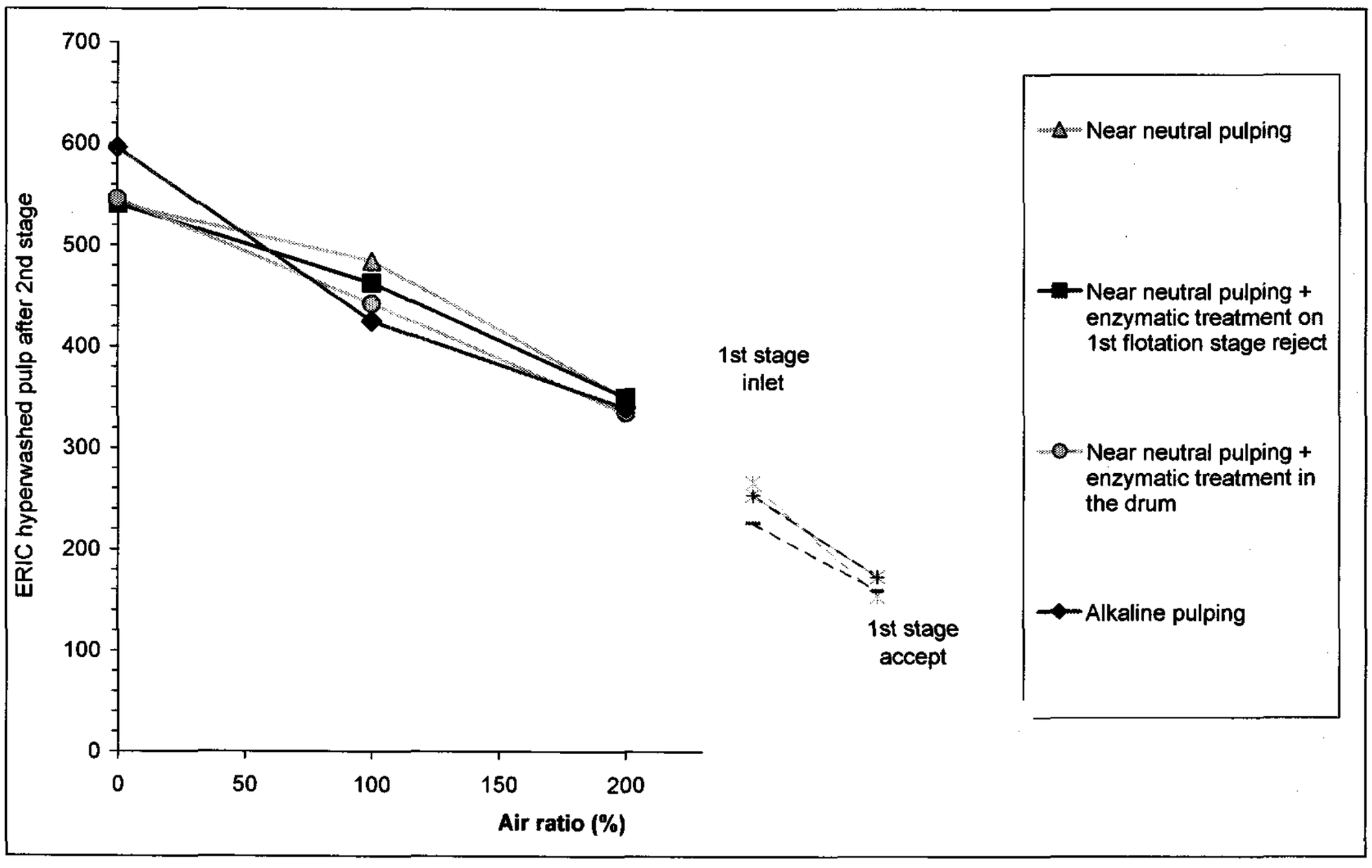

Losses of 2nd stage (% based on 1st stage inlet)
25
20
15
10
5
0
2nd stage (100% air ratio)
2nd stage (200% air)
Near neutral pulping
Near neutral pulping + enzymatic treatment on 1st flotation stage reject
Near neutral pulping + enzymatic treatment in the drum
Alkaline pulping

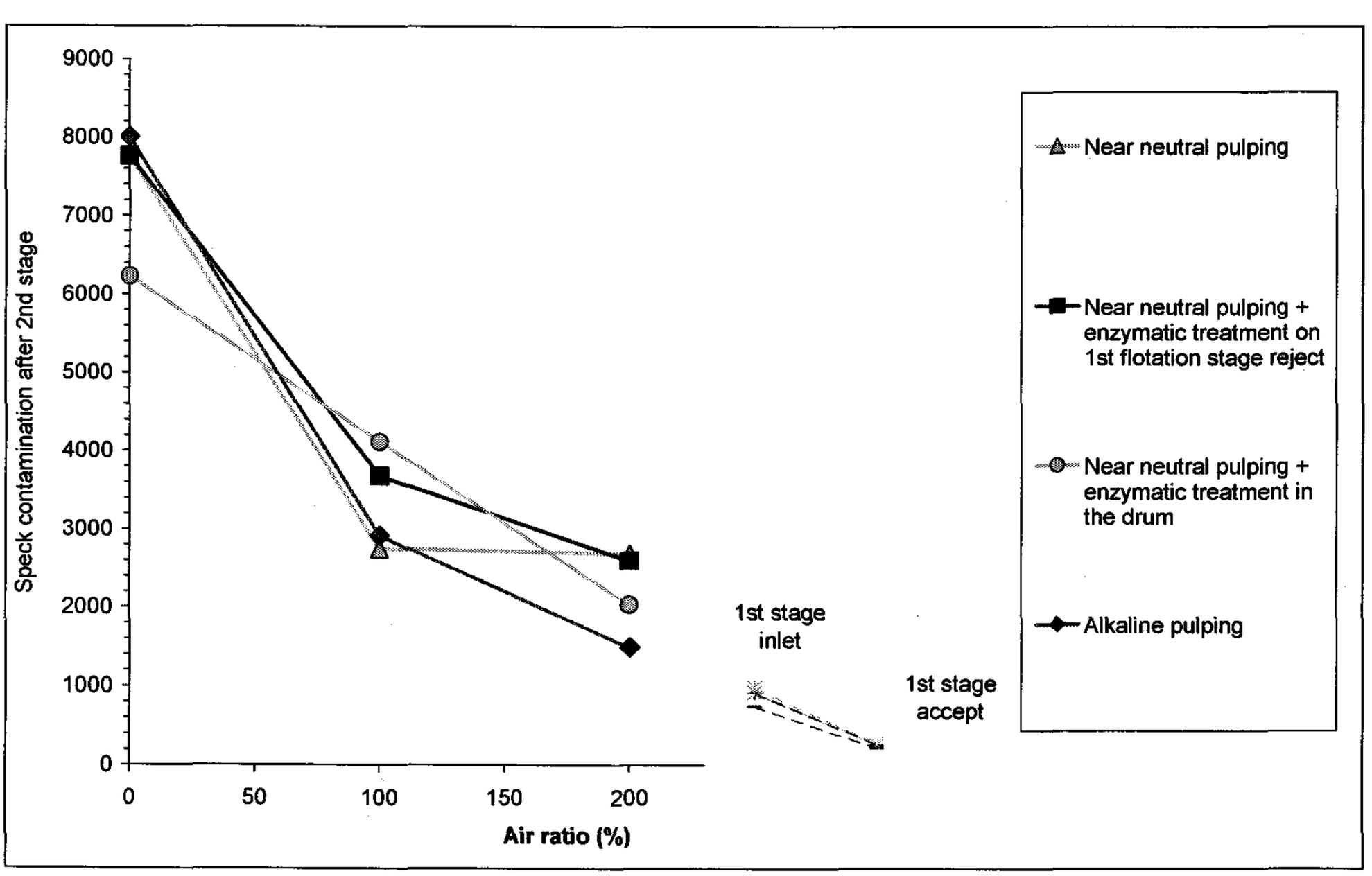

Losses of 2nd stage (% based on 1st stage inlet)
35
30
25
20
15
10
5
0
0
50
100
150
200
250
Air ratio (%)
Near neutral pulping
Near neutral pulping + enzymatic treatment on 1st flotation stage reject
Near neutral pulping + enzymatic treatment in the drum
Alkaline pulping


Brightness entire pulp after 2nd stage
60
55
50
45
40
35
30
0
50
100
150
200
Air ratio (%)
1st stage accept
1st stage inlet
Near neutral pulping
Near neutral pulping + enzymatic treatment on 1st flotation stage reject
Near neutral pulping + enzymatic treatment in the drum
Alkaline pulping


Brightness hyperwashed pulp after 2nd stage
60
58
56
54
52
50
48
46
44
42
40
0
50
100
150
200
Air ratio (%)
1st stage accept
1st stage inlet
Near neutral pulping
Near neutral pulping + enzymatic treatment on 1st flotation stage reject
Near neutral pulping + enzymatic treatment in the drum
Alkaline pulping


ERIC entire pulp after 2nd stage
3500
3000
2500
2000
1500
1000
500
0
0
50
100
150
200
Air ratio (%)
1st stage inlet
1st stage accept
Near neutral pulping
Near neutral pulping + enzymatic treatment on 1st flotation stage reject
Near neutral pulping + enzymatic treatment in the drum
Alkaline pulping


700
600
500
400
300
200
100
0
ERIC hyperwashed pulp after 2nd stage
0
50
100
150
200
Air ratio (%)
1st stage inlet
1st stage accept
Near neutral pulping
Near neutral pulping + enzymatic treatment on 1st flotation stage reject
Near neutral pulping + enzymatic treatment in the drum
Alkaline pulping


9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Speck contamination after 2nd stage
0
50
100
150
200
Air ratio (%)
1st stage inlet
1st stage accept
Near neutral pulping
Near neutral pulping + enzymatic treatment on 1st flotation stage reject
Near neutral pulping + enzymatic treatment in the drum
Alkaline pulping