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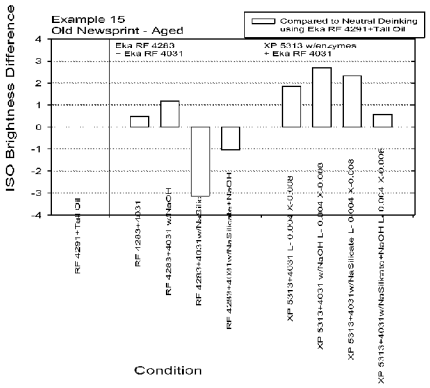
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(54) Title: METHOD FOR REMOVING INK FROM PAPER

FIGURE 44



(57) Abstract: A method for removing ink from printed paper comprising: (a) pulping printed paper at least 25 wt% of which is old newsprint at a consistency of at least about 3% to obtain a pulp slurry; (b) treating the pulp slurry with an ink removing system, which system comprises: (i) a combination of lipase and at least one second enzyme chosen from amylase, xylanase or cellulase, and (ii) a non-ionic surfactant, in amounts effective to release ink from said pulp slurry, wherein the lipase is present in an amount of at least about 0.001 wt% based on the dry content of the pulp slurry and the ratio of the at least one second enzyme:lipase is at least about 1.2:1; and (c) separating the released ink from the pulp slurry, wherein the treating step is carried out prior to a deinking flotation stage.

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METHOD FOR REMOVING INK FROM PAPER

FIELD OF THE INVENTION

The field of the invention relates to methods for deinking and decolorizing printed paper. More particularly, it relates to methods for removing ink from a paper pulp containing old newsprint.

BACKGROUND OF THE INVENTION

The paper industry has been practicing wastepaper recycling to regenerate usable cellulosic fiber for paper making for many decades. In these processes, ink is removed from the wastepaper pulp using a suitable deinking composition. The deinking process produces a new paper or paperboard product out of materials that might otherwise have ended up in a landfill.

Because of increasing public demand, the use of recycled paper has steadily increased. To recover the fibers used for papermaking from wastepaper, a waste paper deinking operation must generally be carried out to remove the inks used in printing, and thus create suitable characteristics for re-use. Increasing amounts of wastepaper, e.g. old newspapers (ONP) and waste magazines (WM), are becoming available with increased participation of end consumers in recycling.

In the course of conventional paper reclamation, deinking procedures include steps for converting the wastepaper to pulp and contacting the pulp with an alkaline aqueous deinking medium containing a chemical deinking agent. The mechanical action and the alkalinity of the aqueous medium cause the partial removal of ink from the pulp fiber. The deinking agent completes this removal and produces an aqueous suspension and/or dispersion of the ink particles. The resulting mixture is subsequently treated to separate the suspended/dispersed ink from the pulp. This separation may be by flotation and/or washing techniques known in the art.

Conventional deinking chemicals comprise a complex mixture of chemicals, e.g. sodium hydroxide, sodium silicate, chelating agents, hydrogen peroxide, surfactants, dispersants, collector chemicals and agglomeration chemicals. In general, it is standard in deinking to include a significant amount of alkaline material, since it is believed that the alkaline material is needed for sufficient saponification

and hydrolysis of the ink resins. In addition, mention is made of the fiber swelling by the caustic being partially responsible for the detachment of ink particles from the fiber surface. Typically, the pH during such a deinking process is from about 9.5 to about 11. Exposing the cellulosic and lignocellulosic fibers to this degree of alkalinity tends to cause yellowing of the fibers and, therefore, it is generally necessary to add an oxidative or reductive bleaching agent, such as peroxide or sodium hydrosulfite. The reductive bleaching step is commonly employed at the end of the deinking process while hydrogen peroxide is added at the pulper. In some deinking operations hydrogen peroxide will be added later in the process.

Furthermore, the alkaline method causes irreversible changes to the pulp fibers, and hence represents a cost to the facility in addition to just the cost of using the chemical. Using caustic will also solubilize papermaking additives and coatings that will lead to additional runnability problems due to deposits at the paper machine.

Thus, there is a need for a deinking process that avoids these shortcomings, which is safe and which is economically and environmentally desirable.

It has been found by the present inventors that treatment of a wastepaper containing pulp with an ink removing system in accordance with the present invention fulfills the above-mentioned requirements to such a deinking process.

SUMMARY OF THE INVENTION

The present invention is directed to a method for removing ink from printed paper. In one embodiment, the invention relates to removing ink from a pulp containing old news print (ONP) and maintaining or increasing brightness of the deinked pulp in a neutral deinking process.

In a first aspect, the invention is directed to a method for removing ink from printed paper, which comprises: (a) pulping printed paper at least 25 wt% of which is old newsprint at a consistency of at least about 3% to obtain a pulp slurry; (b) treating the pulp slurry with an ink removing system, which system comprises: (i) a combination of lipase and at least one second enzyme chosen from amylase, xylanase or cellulase, and (ii) a non-ionic surfactant, in amounts effective to release ink

from said pulp slurry, wherein the lipase is present in an amount of at least about 0.001 wt% based on the dry content of the pulp slurry and the ratio of the at least one second enzyme:lipase is at least about 1.2:1; and (c) separating the released ink from the pulp slurry in a deinking step (e.g., a deinking flotation stage) to provide a deinked pulp slurry, wherein the treating step is carried out prior to the deinking step.

In one embodiment of the invention, the enzyme combination is a combination of lipase and xylanase. The ratio of xylanase:lipase can be at least about 1.5:1. In embodiments of the invention, the ratio of xylanase:lipase can be chosen from a ratio in the range of about 1.5:1 to about 5:1; about 1.5:1 to about 4:1; about 1.5:1 to about 3:1; about 1.5:1 to about 2.5:1; about 2:1 to about 4:1; or about 2:1 to about 3:1. In additional embodiments the ratio of xylanase:lipase can be chosen from about 2:1, 2.5:1 or 3:1.

In an embodiment of the invention, the non-ionic surfactant can be chosen from fatty acid alkoxylates, fatty alcohol alkoxylates or mixtures thereof. The non-ionic surfactant can be chosen from fatty alcohol ethyoxylates (FAEO), propoxylates (FAPO) and combinations thereof (FAEPO).

In embodiments of the invention, the ratio of (i):(ii) present in the ink removing system can be chosen from a ratio in the range of about 1:1 to about 1:10; about 1:1 to about 1:5; or about 1:2 to about 1:4.

In another aspect of the invention, the above ink removing system can further comprise (iii) a soap. In another aspect, the ink removing system can further comprise (iv) an alkaline reagent. In yet another aspect, the ink removing system can further comprise (iii) a soap and (iv) an alkaline reagent.

In one embodiment, the consistency can be in the range of about 3 to about 30%. In additional embodiments, the consistency can be chosen from a value in the range of about 10% to about 17%, or about 18 to about 23%.

In an embodiment of the invention, the printed paper comprises at least about 40 wt% ONP. In another embodiment, the printed paper comprises at least about 50 wt% ONP. In other

embodiments, the printed paper comprises ONP in an amount chosen from within the range of from about 40 to about 95 wt%, about 45 to about 90 wt%, or about 50 to about 80 wt%. In yet another embodiment of the invention, the printed paper further comprises old magazine print (OMG).

In one embodiment, where the ink removing system comprises (iii) a soap and (iv) an alkaline reagent, the combination of enzymes (i) can be a combination of lipase and xylanase. In such an embodiment, the ratio of xylanase:lipase can be as discussed above.

In one embodiment of the invention, the soap can be fatty acid soap. In another embodiment, the fatty acid soap can be derived from tallow. In yet another embodiment, the fatty acid soap can be derived from plant oils.

In one embodiment of the invention, the alkaline reagent is sodium silicate. In one embodiment, the combination of enzymes (i) is a combination of lipase and xylanase; the non-ionic surfactant (ii) is chosen from fatty alcohol ethoxylates (FAEO), propoxylates (FAPO) and combinations thereof (FAEPO); the soap (iii) is a tallow fatty acid soap; and the alkaline reagent (iv) is sodium silicate. In such an embodiment, the ratio of xylanase:lipase and the ratio of (i):(ii) can be as discussed above.

In one aspect of the invention, components (i) and (ii) are premixed to form an enzyme composition (v) and then adding (v) to the pulp slurry as a component of the ink removing system. In one embodiment, the enzyme composition (v) is added to the pulp slurry in an amount in the range of about 0.04 to about 0.5 wt%, the soap (iii) is added to the pulp slurry in an amount in the range of about 0.1 to about 1 wt%, and the alkaline reagent (iv) is added to the pulp slurry in an amount in the range of about 0.5 to about 2 wt%, all based on the solid content of the slurry.

In one embodiment of the invention, the pH of the slurry is maintained in the range of about 6 to about 11. The preferred range is 6.7 to 9.5, the more preferred range is 7 to 9 and the most preferred range is 7.5 to 8.8.

In one embodiment of the invention, the slurry is substantially free of sodium sulfite. In another embodiment the slurry is substantially free of sodium hydroxide or, if added to the slurry, the sodium hydroxide is added in an amount less than about 0.15 wt%, based on the weight of the slurry. In yet

another embodiment, the slurry is substantially free of hydrogen peroxide. In yet another embodiment, two or all of these requirements (of being free of a specified material) are met.

Additional objects, advantages and novel features will be apparent to those skilled in the art upon examination of the description that follows.

BRIEF DESCRIPTIONS OF THE DRAWINGS

FIGURE 1 is a graph showing the effect of enzymes and sodium sulfite on brightness (pulper) for Example 1 deinking systems.

FIGURE 2 is a graph showing the effect of enzymes and sodium sulfite on brightness (Flot and Hyper) for Example 1 deinking systems.

FIGURE 3 is a graph showing the effect of enzymes and sodium sulfite on brightness difference (vs. conventional) for Example 1 deinking systems.

FIGURE 4 is a graph showing the effect of enzymes and sodium sulfite on brightness (pulper) for Example 2 deinking systems.

FIGURE 5 is a graph showing the effect of enzymes and sodium sulfite on brightness (Flot and Hyper) for Example 2 deinking systems.

FIGURE 6 is a graph showing the effect of enzymes and sodium sulfite on brightness difference (vs. conventional) for Example 2 deinking systems.

FIGURE 7 is a graph showing the effect of enzymes and sodium sulfite on brightness (pulper) for Example 3 deinking systems.

FIGURE 8 is a graph showing the effect of enzymes and sodium sulfite on brightness (Flot and Hyper) for Example 3 deinking systems.

FIGURE 9 is a graph showing the effect of enzymes and sodium sulfite on brightness difference (vs. conventional) for Example 3 deinking systems.

FIGURE 10 is a graph showing the effect of enzymes and sodium sulfite on brightness (pulper) for Example 4 deinking systems.

FIGURE 11 is a graph showing the effect of enzymes and sodium sulfite on brightness (Flot and Hyper) for Example 4 deinking systems.

FIGURE 12 is a graph showing the effect of enzymes and sodium sulfite on brightness difference (vs. conventional) for Example 4 deinking systems.

FIGURE 13 is a graph showing the effect of enzymes and sodium sulfite on brightness (pulper) for Example 5 deinking systems.

FIGURE 14 is a graph showing the effect of enzymes and sodium sulfite on brightness (Flot and Hyper) for Example 5 deinking systems.

FIGURE 15 is a graph showing the effect of enzymes and sodium sulfite on brightness difference (vs. conventional) for Example 5 deinking systems.

FIGURE 16 is a graph showing the effect of paper source, enzymes and sodium sulfite on brightness (pulper) for Example 6 deinking systems.

FIGURE 17 is a graph showing the effect of paper source, enzymes and sodium sulfite on brightness (Flot and Hyper) for Example 6 deinking systems.

FIGURE 18 is a graph showing the effect of paper source, enzymes and sodium sulfite on brightness difference (vs. conventional) for Example 6 deinking systems.

FIGURE 19 is a graph showing the effect of paper source, enzymes and sodium sulfite on brightness (pulper) for Example 7 deinking systems.

FIGURE 20 is a graph showing the effect of paper source, enzymes and sodium sulfite on brightness (Flot and Hyper) for Example 7 deinking systems.

FIGURE 21 is a graph showing the effect of paper source, enzymes and sodium sulfite on brightness difference (vs. conventional) for Example 7 deinking systems.

FIGURE 22 is a graph showing the effect of enzymes and sodium sulfite on brightness (pulper) for Example 8 deinking systems.

FIGURE 23 is a graph showing the effect of enzymes and sodium sulfite on brightness (Flot and Hyper) for Example 8 deinking systems.

FIGURE 24 is a graph showing the effect of enzymes and sodium sulfite on brightness difference (vs. conventional) for Example 8 deinking systems.

FIGURE 25 is a graph showing the effect of enzymes and sodium sulfite on brightness (pulper) for Example 9 deinking systems.

FIGURE 26 is a graph showing the effect of enzymes and sodium sulfite on brightness (Flot and Hyper) for Example 9 deinking systems.

FIGURE 27 is a graph showing the effect of paper source, enzymes and sodium sulfite on brightness (pulper) for Example 10 deinking systems.

FIGURE 28 is a graph showing the effect of paper source, enzymes and sodium sulfite on brightness (Flot and Hyper) for Example 10 deinking systems.

FIGURE 29 is a graph showing the effect of paper source, enzymes and sodium sulfite on brightness difference (vs. conventional) for Example 10 deinking systems.

FIGURE 30 is a graph showing the effect of paper source, enzymes and sodium sulfite on brightness (pulper) for Example 11 deinking systems.

FIGURE 31 is a graph showing the effect of paper source, enzymes and sodium sulfite on brightness (Flot and Hyper) for Example 11 deinking systems.

FIGURE 32 is a graph showing the effect of paper source, enzymes and sodium sulfite on brightness difference (vs. conventional) for Example 11 deinking systems.

FIGURE 33 is a graph showing the effect of enzymes and sodium sulfite on brightness (pulper) for Example 12 deinking systems.

FIGURE 34 is a graph showing the effect of enzymes and sodium sulfite on brightness (Flot and Hyper) for Example 12 deinking systems.

FIGURE 35 is a graph showing the effect of enzymes and sodium sulfite on brightness difference (vs. conventional) for Example 12 deinking systems.

FIGURE 36 is a graph showing the effect of enzymes, sodium hydroxide and sodium sulfite on brightness (pulper) for Example 13 deinking systems.

FIGURE 37 is a graph showing the effect of enzymes, sodium hydroxide and sodium sulfite on brightness (Flot and Hyper) for Example 13 deinking systems.

FIGURE 38 is a graph showing the effect of enzymes, sodium hydroxide and sodium sulfite on brightness difference (vs. conventional) for Example 13 deinking systems.

FIGURE 39 is a graph showing the effect of enzymes and sodium sulfite on brightness (pulper) for Example 14 deinking systems.

FIGURE 40 is a graph showing the effect of enzymes and sodium sulfite on brightness (Flot and Hyper) for Example 14 deinking systems.

FIGURE 41 is a graph showing the effect of enzymes and sodium sulfite on brightness difference (vs. conventional) for Example 14 deinking systems.

FIGURE 42 is a graph showing the effect of enzymes, sodium hydroxide and sodium sulfite on brightness (pulper) for Example 15 deinking systems.

FIGURE 43 is a graph showing the effect of enzymes, sodium hydroxide and sodium sulfite on brightness (Flot and Hyper) for Example 15 deinking systems.

FIGURE 44 is a graph showing the effect of enzymes, sodium hydroxide and sodium sulfite on brightness difference (vs. conventional) for Example 15 deinking systems.

DETAILED DESCRIPTION OF THE INVENTION

The present invention is directed to a method for removing ink from printed paper. In one embodiment, the invention relates to removing ink from a pulp containing old news print (ONP) and maintaining or increasing brightness of the deinked pulp in a neutral deinking process.

In one aspect the invention is directed to an ink removing system, which system comprises: (i) a combination of lipase and at least one second enzyme chosen from amylase, xylanase or cellulase, and (ii) a non-ionic surfactant, in amounts effective to release ink from said pulp slurry, wherein the lipase is present in an amount of at least about 0.001 wt% based on the dry content of the pulp slurry and the ratio of the at least one second enzyme:lipase is at least about 1.2:1.

In one embodiment of the invention, the enzyme combination is a combination of lipase and xylanase. The ratio of xylanase:lipase can be at least about 1.5:1. In embodiments of the invention, the ratio of xylanase:lipase can be chosen from a ratio in the range of about 1.5:1 to about 5:1; about 1.5:1 to about 4:1; about 1.5:1 to about 3:1; about 1.5:1 to about 2.5:1; about 2:1 to about 4:1; or about 2:1 to about 3:1. In additional embodiments the ratio of xylanase:lipase can be chosen from about 2:1, 2.5:1 or 3:1.

In embodiments of the method for removing ink, the total amount of enzyme added to the pulp slurry in the ink removal system is less than 0.5 lbs (0.23 kg), or 0.45 lbs (0.2 kg), or 0.4 lbs (0.18 kg), or 0.3 lbs (0.14 kg) per ton (2000 lbs) of dry pulp.

In embodiments of the method for removing ink, the components of the ink removing system are present in an amount to achieve an ink removal efficiency of at least about 50%, or at least about 60%, or at least about 70%, or at least about 80% in the subsequent deinking flotation stage. Ink removal efficiency means the percentage of ink removed based on the original amount of ink contained in the printed paper pulp prior to treating with the ink removal system and subjecting it to a deinking step to provide a deinked pulp. For example, 50% ink removal efficiency means the deinked pulp has 50% less ink than the starting printed paper pulp. In embodiments of the invention, the pulp slurry after the deinking step (e.g., deinking flotation stage) has a substantially

reduced amount of ink, including the printing ink resins or oils of the type typically contained in printing ink systems.

In embodiments of the invention, the deinked pulp contains less than 0.2 wt% or is substantially free of vegetable oils and mineral oils found in printing inks. In an embodiment of the method for removing ink, no vegetable or mineral oil is added to the pulp slurry.

Examples of nonionic surfactants include a higher aliphatic alcohol alkoxylate, aliphatic acid alkoxylate, higher aromatic alcohol alkoxylate, fatty acid amide of alkanolamine, fatty acid amide alkoxylate, propylene glycol alkoxylate, block or random copolymer of ethylene and propylene oxide, or higher alcohol polyethylene polypropylene block or random adducts.

In an embodiment of the invention, the non-ionic surfactant can be chosen from fatty acid alkoxylates, fatty alcohol alkoxylates or mixtures thereof. The non-ionic surfactant can be chosen from fatty alcohol ethyoxylates (FAEO), propoxylates (FAPO) and combinations thereof (FAEPO). In an embodiment of the invention, the non-ionic surfactant is chosen or incorporated in a system to provide a low foaming deinking system. The non-ionic surfactant itself, or composition containing the surfactant, can be low foaming. Examples of commercially available surfactant products that are useful in the present invention include Eka RF 4000 and 4200 series deinking products available from Eka Chemicals, and in particular Eka RF 4031 and Eka RF 4291. In one embodiment, the Eka RF 4291 deinking product is preferred to be included.

In one aspect of the invention, the ink removing system can further comprise (iii) a soap. In another aspect, the ink removing system can further comprise (iv) an alkaline reagent. In yet another aspect, the ink removing system can further comprise (iii) a soap and (iv) an alkaline reagent.

The soap can be fatty acid soap. The fatty acid soap can be derived from tallow or can be derived from plant oils.

In one embodiment of the invention, the alkaline reagent is sodium silicate.

Examples

The following examples were conducted to evaluate the performance of deinking systems in a neutral deinking process:

1. Flot studies using a ratio of 70% old newsprint (ONP) and 30% Old Magazine (OMG) were conducted using a mixture of the Wall Street Journal and the Los Angles Times. The example represents an average of tests that have similar amounts of rejects and hyperwash ERIC values. The test conditions were selected based on the assumption that the character of the ink changes with age so having similar hyperwash ERIC values means that the results are for paper with comparable aging effects.

2. Flot studies using just the Wall Street Journal were conducted based on preliminary tests showing that the different newspapers were impacting the amount of rejects.

3. Flot studies using just the Globe and Mail from Canada were conducted.

4. The results for a mill scale trial conducted in Canada.

Typical equipment, furnish and conditions used for examples 1-15 were as follows:

Equipment and Furnish

Pulper	Kitchen Aid Mixer
Flot Cell	Stainless Steel FRED Cell (Flotation with Radial Ejection Deinking Cell)
Furnish Mix ONP/OMG	70/30
Amount	50 g air weight dry
Old Newsprint	
Wall Street Journal (WSJ)	17.5 g
LA Times (LAT)	17.5 g
Old Magazine	
People Shape Bazaar	5 g 5 g 5 g
Old Newsprint Canada	
Globe & Mail	32 g

Table 1: Pulper Components used in Examples.

Conditions:

Pulping Time	10 min
Pulping Temperature	45°C (Water baths were run 5 °C higher)
Pulping % Consistency Kitchen Aid	12%
Pre-pulping soak	0 min
Pulping Hardness	Use tap water
Hold Time after pulping	10 min
Flotation Time	5-8 min
Flotation % Consistency	1%
Weight of Stock Added	3750 - 4200 g
Hardness (added at flot) Target hardness around 180 ppm	9 ml of 10% $CaCl_2$ If flot feed hardness is not at desired level after addition of the 9 ml – additional CaCl2 added until desired ppm
Samples	Pulper, Flot Accepts, Hyperwash Flot Accept
Rejects	Volume, Weight, Ash
Pump Speed	60
Air	15-20 SCHF

Table 2: Pulping Conditions for Examples.

Pulper Chemistry and Deinking Dosage:

Conventional Chemistry:		% on Fiber
	NaOH (10%)	1%
	Na Silicate (NaSil)	1.5%
	H2O2	1%
Deinking Agents		
	Eka RF 4031	0.5%
	Eka RF 4291	0.06%
Neutral Chemistry		
	Sodium Sulfite (NaSul)	1.5%
	NaSil	1.5%
Deinking Agents		
	Eka RF 4031	0.5%
	Eka RF 4291	0.06%
Neutral Chemistry + Enzymes with No Sulfite		
	NaSil	1.5%
Deinking Agents		

	Eka RF 4031	0.5%
	Eka RF 4291	0.06%
	Eka RF 4031-E6634: 95.7% RF 4031, 2.9% Xylanase, 1.4% Lipase	0.5225%
	Eka RF 4291-E6634: 72.7% RF 4291, 18.2% Xylanase, 9.1% Lipase	0.0825%
Enzymes	(treated as 100% active) Xylanase Lipase E6634: 66% xylanase, 34% lipase E5050: 50% xylanase, 50% lipase	 Varied Varied Varied Varied

Table 3: Pulper and deinking chemistry for Examples.

In each of the Examples, the tests were run in random order to prevent run order errors, but are listed in the tables out of sequence to group the tests according to the conditions used, e.g., cell level and enzymes used, to make analysis easier. In some Examples, test numbers have been omitted from the tables where duplicate tests were run or where a unique chemistry was used, e.g., another component was added, that makes the tests not relevant or not comparable to the present invention. In the case of duplicate tests, the results listed in the tables are an average of the results for the duplicate tests.

Regarding pulp liquor pH, while it is not always possible or easy to measure the pH of the combined pulping chemicals and dilution water in a particular mill setting in real time, it can be measured in a lab setting. Accordingly, in the following examples the measured pH of the combined chemicals and the dilution water is referred to as the "Pulp Liquor pH", which is helpful in seeing how changes in alkaline reagents addition impact of pH.

Example 1:

The pulping recipes used in Example 1 (Tests 1-16) are listed below in Table 4. The specific pulping components and conditions were: 17.5 grams each of WSJ and LAT, flotation time of 8 min, and air rate of 20 SCHF. The pH operating ranges used for Example 1 are listed below in Table 5.

Test	Cell	Pulper	Deinking	Sulfite	Xylanase%	Lipase%	Ratio		FF pH

#	Level, grams		Agents					Pulp Liquor pH	
1	4200	Conventional	Eka RF 4291+ Eka RF 4031				NA	10.9	8.8
2	4200	Sodium Sulfite	Eka RF 4291+ Eka RF 4031	Yes			NA	9.4	7.5
5	4200	NaSul+Xylanase	Eka RF 4291+ Eka RF 4031	Yes	0.03	0	NA		7.5
4	4200	NaSul+Xylanase	Eka RF 4291+ Eka RF 4031	Yes	0.06	0	NA	9.5	7.4
6	3750	NaSul+Xylanase	Eka RF 4291+ Eka RF 4031	Yes	0.03	0	NA	9.6	7.5
3	3750	NaSul+Xylanase	Eka RF 4291+ Eka RF 4031	Yes	0.06	0	NA	9.4	7.4
7	3750	NaSul+Blend	Eka RF 4291+ Eka RF 4031	Yes	0.03	0.03	50/50	9.6	7.5
8	3750	NaSul+Blend	Eka RF 4291+ Eka RF 4031	Yes	0.015	0.03	34/66	9.6	7.4
10	3750	Lipase	Eka RF 4291+ Eka RF 4031	No	0	0.015	NA	9.4	7.4
9	3750	Lipase	Eka RF 4291+ Eka RF 4031	No	0	0.03	NA	9.4	7.5
14	3750	NaSul+Lipase	Eka RF 4291+ Eka RF 4031	Yes	0	0.015	NA	9.6	7.4
13	3750	NaSul+Lipase	Eka RF 4291+ Eka RF 4031	Yes	0	0.03	NA	9.6	7.5
12	4200	Lipase	Eka RF 4291+ Eka RF 4031	No	0	0.003	NA	9.4	7.3
11	4200	Lipase	Eka RF 4291+ Eka RF 4031	No	0	0.0075	NA	9.5	7.5
16	4200	NaSul+Lipase	Eka RF 4291+ Eka RF 4031	Yes	0	0.003	NA	9.6	7.6
15	4200	NaSul+Lipase	Eka RF 4291+ Eka RF 4031	Yes	0	0.0075	NA	9.6	7.6

Table 4: Pulping recipes for tests 1-16 (Example 1).

	Pulping Liquor	Pulping Flot Feed
Max pH	9.6	7.6
Min pH	9.4	7.3

Table 5: pH ranges for Example 1 for neutral deinking.

The deinking performance of the various test recipes were evaluated and the results are shown below in Table 6.

Test #	Wet Reject Wt.	ERIC Pulper	ERIC Flot	ERIC Hyper	Brightness Pulper	Brightness Flot	Brightness Hyper	Brightness Difference vs. Conv	Brightness Difference vs. Sulfite	Removal Efficiency at Flot

1	297	992	261	171	42.98	54.72	57.34		-1.5	74
2	283	1011	254	112	43.13	56.25	57.76	1.5		75
5	35	1026	221	143	43.65	57.00	56.26	2.3	0.7	78
4	452	1040	224	125	43.20	56.82	57.23	2.1	0.6	78
6	92	1037	287	114	43.35	55.44	57.08	0.7	-0.8	72
3	87	988	233	126	43.70	56.92	56.38	2.2	0.7	76
7	325	1006	155	175	44.50	59.20	56.55	4.5	2.9	85
8	341	1020	154	164	44.70	59.10	56.94	4.4	2.8	85
10	147	955	210	136	44.81	56.91	56.56	2.2	0.7	78
9	192	993	198	119	44.31	57.31	56.36	2.6	1.1	80
14	217	1112	221	151	43.22	56.89	56.75	2.2	0.6	80
13	447	1154	161	143	43.29	58.99	56.69	4.3	2.7	86
12	474	979	233	128	44.33	56.49	56.52	1.8	0.2	76
11	541	1032	222	130	43.13	56.55	56.38	1.8	0.3	78
16	593	1098	191	141	43.04	57.59	56.50	2.9	1.3	83
15	632	1066	183	127	43.38	57.66	56.89	2.9	1.4	83

Table 6: Deinking Results for tests 1-16 (Example 1).

In addition to the results in Table 6, the following was observed: tests 3, 5 and 6 had less foam with less rejects generated; tests 7 and 8 (with enzyme blends) gave the best ink removal; tests 11, 12, 15 and 16 had too much wet rejects; and test 13 showed good ink removal but too much rejects. For this Example a reject amount over about 350g was considered too high a yield loss.

The results of the deinking tests for Example 1 are shown graphically in Figures 1-3. A review of these figures shows that blending the lipase and xylanase at ratios of 50/50 or 66/34 gave the best deinking performance with a reasonable level of rejects. Lipase and xylanase added with a recipe that included sodium sulfite also performed better than conventional or sulfite based neutral deinking.

Example 2:

The pulping recipes used in Example 2 (Tests 1-16) are listed below in Table 7. The specific pulping components and conditions were: 17.5 grams each of WSJ and LAT, flotation time of 8 min, and air rate of 20 SCHF. The pH operating ranges for Example 2 are listed below in Table 7.

Test #	Cell Level, grams	Pulper	Deinking Agents	Sulfite	Xylanase%	Lipase%	Ratio	Pulp Liquor pH	FF pH
1	4200	Conventional	Eka RF4291, Eka RF4031	No	0	0	NA	11.25	8.95
2	4200	Sodium Sulfite	Eka RF4291, Eka RF 4031	Yes	0	0	NA	9.56	7.71

4	3750	NaSul+Blend	Eka RF4291, Eka RF4031	Yes	0.0015	0.03	5/95	9.60	7.56
3	3750	NaSul+Blend	Eka RF4291, Eka RF4031	Yes	0.03	0.03	50/50	9.61	7.55
7	4200	NaSul+Blend	Eka RF4291, Eka RF4031	Yes	0.015	0.015	50/50	9.60	7.62
8	4200	NaSul+Blend	Eka RF4291, Eka RF4031	Yes	0.03	0.015	66/34	9.63	7.57
6	4200	NaSul+Blend	Eka RF4291, Eka RF4031	Yes	0.0015	0.03	5/95	9.60	7.55
5	4200	NaSul+Blend	Eka RF4291, Eka RF4031	Yes	0.03	0.03	50/50	9.57	7.53
13	4200	Blend	Eka RF4291, Eka RF4031	No	0.015	0.015	50/50	9.51	7.26
14	4200	Blend	Eka RF4291, Eka RF4031	No	0.03	0.015	66/34	9.48	7.25
16	4200	Blend	Eka RF4291, Eka RF4031	No	0.075	0.015	80/20	9.47	7.38
12	4200	Blend	Eka RF4291, Eka RF4031	No	0.0015	0.03	5/95	9.45	7.44
11	4200	Blend	Eka RF4291, Eka RF4031	No	0.003	0.03	50/50	9.44	7.52
15	4200	Blend	Eka RF4291, Eka RF4031	No	0.015	0.075	20/80	9.34	7.43

Table 7: Pulping recipes for tests 1-16 (Example 2).

	Pulping Liquor	Pulping Flot Feed
Max pH	9.6	7.7
Min pH	9.3	7.3

Table 8: pH ranges for Example 2 for neutral deinking.

The deinking performance of the various test recipes were evaluated and the results are shown below in Table 9.

Test #	Wet Reject Wt.	ERIC Pulper	ERIC Flot	ERIC Hyper	Brightness Pulper	Brightness Flot	Brightness Hyper	Brightness Difference vs. Conv	Brightness Difference vs. Sulfite	Removal Efficiency at Flot
1	318	997	339	133	45.5	53.7	56.8	NA	0.42	66.0
2	325	1054	409	152	44.6	53.3	53.8	-0.42	NA	61.2
4	349	1030	191	150	45.8	56.9	54.9	3.20	3.61	81.5
3	404	973	177	147	46.4	57.4	54.4	3.71	4.13	81.8
7	679	1005	176	164	46.5	57.8	52.9	4.06	4.47	82.5
8	602	1089	186	135	45.7	58.0	53.7	4.31	4.73	82.9
6	680	1030	196	175	46.0	57.7	54.3	3.94	4.35	81.0
5	715	1079	177	169	45.9	57.9	52.7	4.12	4.53	83.6
13	598	934	194	114	46.2	56.7	52.1	2.95	3.36	79.2
14	634	1010	166	130	46.7	57.7	53.5	4.01	4.42	83.6
16	550	962	204	115	46.6	56.5	53.6	2.79	3.20	78.8
12	521	956	206	126	46.0	56.5	54.9	2.75	3.16	78.5

11	566	962	203	125	46.3	56.5	53.8	2.74	3.15	78.9
15	890	967	166	115	45.9	56.9	52.0	3.16	3.57	82.8

Table 9: Deinking Results for tests 1-16 (Example 2).

In addition to the results in Table 9, the following was observed: tests 5-8 and 11-16 had too much rejects. For this Example a reject amount over about 400g was considered too high a yield loss.

The results of the deinking tests for Example 2 are shown graphically in Figure 3-6. A review of these figures shows that a blend of lipase and xylanase at either a ratio of 95/5 or 50/50 and a cell level of 3750 g performed better than conventional or sulfite based neutral deinking. Much of the study was conducted at a level of 4200 g which rejected too much material. Removing sodium sulfite but keeping the enzymes reduced reject volume and improved ink detachment. Dosages of lipase of 0.15% and 0.03% gave about the same level of rejects.

Example 3:

The pulping recipes used in Example 3 (Tests 1-17) are listed below in Table 10. The specific pulping components and conditions were: 17.5 grams each of WSJ and LAT, flotation time of 8 min, and air rate of 20 SCHF. The pH operating ranges for Example 3 are listed below in Table 11.

Test #	Cell Level, grams	Pulper	Deinking Agents	Sulfite	Xylanase%	Lipase%	Ratio	Pulp Liquor pH	FF pH
1	4200	Conventional	Eka RF4291, Eka RF4031					11.22	9.17
2	4200	Sodium Sulfite	Eka RF4291, Eka RF 4031	Yes				9.58	7.79
4	3750	NaSul+Blend	Eka RF4291, Eka RF4031	Yes	0.015	0.015	50/50	9.61	7.76
3	3750	NaSul+Blend	Eka RF4291, Eka RF4031	Yes	0.015	0.03	34/66	9.61	7.80
17	4200	Blend	Eka RF4291, Eka RF4031		0.015	0.0075	66/34	9.43	7.45
15	4200	NaSul+Blend	Eka RF4291, Eka RF4031	Yes	0.0075	0.0075	50/50	9.44	6.84
10	4200	NaSul+Blend	Eka RF4291, Eka RF4031	Yes	0.015	0.015	50/50	9.60	7.50
11	4200	NaSul+Blend	Eka RF4291, Eka RF4031	Yes	0.03	0.03	50/50	9.58	7.51
16	4200	Blend	Eka RF4291, Eka RF4031		0.0075	0.0075	50/50	9.58	7.63
14	4200	Blend	Eka RF4291, Eka RF4031		0.015	0.0075	66/34	9.42	7.00
13	4200	Blend	Eka RF4291, Eka RF4031		0.0075	0.015	34/66	9.38	7.20

12	4200	Blend	Eka RF4291, Eka RF4031		0.015	0.015	50/50	9.41	6.98
5	4200	NaSul w H2O2	Eka RF4291, Eka RF4031	Yes				9.48	7.74
6	4200	NaSul w H2O2	Eka RF4291, Eka RF4031	Yes				9.50	7.68
7	4200	H2O2	Eka RF4291, Eka RF4031					9.23	7.10
8	4200	H2O2	Eka RF4291, Eka RF 4031					9.29	6.94

Table 10: Pulping recipes for tests 1-17 (Example 3).

	Pulping Liquor	Pulping Flot Feed
Max pH	9.6	7.8
Min pH	9.2	6.8

Table 11: pH ranges for Example 3 for neutral deinking.

The deinking performance of the various test recipes were evaluated and the results are shown below in Table 12.

Test #	Wet Reject Wt.	ERIC Pulper	ERIC Flot	ERIC Hyper	Brightness Pulper	Brightness Flot	Brightness Hyper	Brightness Difference vs. Conv	Brightness Difference vs. Sulfite	Removal Efficiency at Flot
1	470	1057	298	113	43.4	54.0	57.3		-2.6	71.9
2	542	1155	244	132	43.5	56.6	57.3	2.6		78.9
4	499	1097	168	128	44.4	59.0	56.6	5.0	2.4	84.7
3	566	1136	161	121	43.0	57.6	54.2	3.6	1.0	85.8
17	603	1048	217	125	45.0	57.7	57.2	3.7	1.1	79.3
15	639	1139	221	110	43.6	57.1	56.9	3.1	0.5	80.6
10	850	1164	186	113	44.1	59.0	58.2	5.0	2.4	84.0
11	841	1120	172	121	44.0	59.3	57.9	5.3	2.6	84.6
16	786	1089	193	125	44.7	58.4	57.6	4.4	1.8	82.3
14	618	1111	218	115	43.8	57.4	57.8	3.3	0.7	80.4
13	621	1091	209	115	44.0	57.3	57.8	3.3	0.7	80.8
12	755	1094	191	112	44.0	58.1	56.8	4.1	1.5	82.5
5	656	1175	223	110	42.7	57.5	56.4	3.5	0.9	81.0
6	618	1156	209	153	43.3	57.7	55.2	3.6	1.0	81.9
7	574	1140	319	122	42.7	54.6	56.9	0.6	-2.0	72.1
8	454	1115	322	115	44.6	55.5	57.1	1.4	-1.2	71.1

Table 12: Deinking Results for tests 1-17 (Example 3).

In addition to the results in Table 12, the following was observed: tests 6 and 10-16 had too much rejects. For this Example a reject amount over about 570-600g was considered too high a yield loss.

The results of the deinking tests for Example 3 are shown graphically in Figure 7-9. A review of these figures shows that a blend of lipase and xylanase at either a ratio of 67/33 or 50/50 and a cell level of 3750 g performed better than conventional or sulfite based neutral deinking. Much of the study was conducted at a level of 4200 g which rejected too much material even with reduced enzyme dosage level. Reducing the lipase dosage to 0.0075% with 0.015% Xylanase almost gave acceptable rejects level at a cell level of 4200 g of stock. Adding hydrogen peroxide with sodium sulfite gave higher flot accept brightness but lower hyperwash brightness (less bleaching). Hydrogen peroxide without sodium sulfite gave lower flot accept brightness and higher hyperwash brightness.

Examples 4 and 5:

The pulping recipes used in Examples 4 and 5 (Tests 1-30) are listed below in Table 13. The specific pulping components and conditions were: 17.5 grams each of WSJ and LAT (Example 4) and 35 grams of Globe and Mail mixed (Example 5), flotation time of 8 min, and air rate of 20 SCHF. The pH operating ranges for Examples 4 and 5 are listed below in Table 14.

Test #	Cell Level, grams	Pulper	Deinking Agents	Sulfite	Xylanase %	Lipase%	Ratio	Pulp Liquor pH	FF pH
1	4200	Conventional LAT-WSJ	Eka RF 4291+ Eka RF 4031				NA	11.0	9.1
3	4200	Neutral w/Sodium Sulfite LAT-WSJ	Eka RF 4291+ Eka RF 4031	Yes			NA	9.57	7.54
9	4200	Conventional+Blend LAT-WSJ	Eka RF 4291+ Eka RF 4031		0.0150	0.0750	66/34	11.22	9.09
22	4200	NaSul+Blend LAT-WSJ	Eka RF 4291+ Eka RF 4031	Yes	0.0100	0.0050	66/34	9.65	7.68
17	4200	NaSul+E6634 LAT-WSJ	Eka RF 4291+ Eka RF 4031	Yes	0.0100	0.0050	66/34	9.56	7.70
21	4200	NaSul+Blend LAT-WSJ	Eka RF 4291+ Eka RF 4031	Yes	0.0140	0.0070	66/34	9.62	7.63
19	4200	NaSul+E6634 LAT-WSJ	Eka RF 4291+ Eka RF 4031	Yes	0.0140	0.0070	66/34	9.56	8.18
13	4200	NaSul+Blend LAT-WSJ	Eka RF 4291+ Eka RF 4031	Yes	0.0075	0.0075	50/50	9.62	7.53
14	4200	NaSul+E5050 LAT-WSJ	Eka RF 4291+ Eka RF 4031	Yes	0.0075	0.0075	50/50	9.62	7.53
6	4200	NaSul+Blend LAT-WSJ	Eka RF 4291+ Eka RF 4031	Yes	0.0140	0.0075	65/35	9.55	7.57
15	4200	NaSul+E6634 LAT-WSJ	Eka RF 4291+ Eka RF 4031	Yes	0.0200	0.0100	66/34	9.59	7.64

5	4200	NaSul+Blend LAT-WSJ	Eka RF 4291+ Eka RF 4031	Yes	0.0140	0.0750	65/35	9.45	7.50
12	4200	NaSul+Blend LAT-WSJ	Eka RF 4291+ Eka RF 4031	Yes	0.0150	0.0150	50/50	9.54	7.46
25	4200	NaSul+E6634 in 4291 LAT-WSJ	0.0825% RF4291-E6634	Yes	0.0150	0.0075	66/34	9.60	7.63
26	4200	NaSul+E6634 in 4031 LAT-WSJ	0.5225% RF4031-E6634	Yes	0.0150	0.0075	66/34	9.54	7.69
11	4200	NaSul+E5050 LAT-WSJ	Eka RF 4291+ Eka RF 4031	Yes	0.1500	0.1500	50/50	9.58	7.61
29	4200	Blend LAT-WSJ	Eka RF 4291+ Eka RF 4031		0.0140	0.0050	74/26	9.48	6.98
27	4200	Blend LAT-WSJ	Eka RF 4291+ Eka RF 4031		0.0140	0.0070	66/34	9.47	7.16
23	4200	E6634 LAT-WSJ	Eka RF 4291+ Eka RF 4031		0.0140	0.0070	66/34	9.44	7.42
10	4200	Conventional GLOBE	Eka RF 4291+ Eka RF 4031				NA	10.96	9.05
4	4200	Neutral w/Sodium Sulfite GLOBE	Eka RF 4291+ Eka RF 4031	Yes			NA	9.35	7.62
20	4200	NaSul+E6634 GLOBE	Eka RF 4291+ Eka RF 4031	Yes	0.0200	0.0100	66/34	9.56	7.58
7	4200	NaSul+H2O2 GLOBE	Eka RF 4291+ Eka RF 4031	Yes			NA	9.44	7.21
8	4200	H2O2 GLOBE	Eka RF 4291+ Eka RF 4031				NA	9.26	6.85
28	4200	Blend GLOBE	Eka RF 4291+ Eka RF 4031		0.0140	0.0070	66/34	9.31	7.59
30	4200	NaSul+E6634 GLOBE	Eka RF 4291+ Eka RF 4031	Yes	0.1400	0.0070	66/34	9.56	8.04

Table 13: Pulping recipes for tests 1-30 (Examples 4 and 5).

	Pulping Liquor	Pulping Flot Feed
Max pH	9.7	8.2
Min pH	9.3	6.9

Table 14: pH ranges for Examples 4 and 5 for neutral deinking.

The deinking performance of the various test recipes were evaluated and the results are shown below in Table 15.

Test #	Wet Reject Wt.	ERIC Pulper	ERIC Flot	ERIC Hyper	Brightness Pulper	Brightness Flot	Brightness Hyper	Brightness Difference vs. Conv	Brightness Difference vs. Sulfite	Removal Efficiency at Flot
1	635	948	211	115	45.0	56.6	59.1	NA	-1.4	77.7
3	686	981	199	131	45.0	58.0	57.6	1.4	NA	79.7
9	1196	950	150	123	46.1	58.6	57.8	2.0	0.7	84.3

22	895	920	176	134	46.0	58.8	56.7	2.2	0.8	80.9
17	929	925	181	136	45.4	58.8	55.8	2.2	0.8	80.5
21	1019	917	163	134	45.3	58.8	57.1	2.2	0.9	82.3
19	722	1161	165	106	43.3	54.6	54.0	-2.0	-3.3	85.8
13	1035	901	153	125	45.2	58.9	57.8	2.3	0.9	83.0
14	949	950	178	126	45.2	58.6	56.8	2.0	0.6	81.3
6	817	1000	194	127	44.7	58.4	57.1	1.8	0.4	80.6
15	959	935	178	122	45.5	58.7	57.6	2.1	0.7	80.9
5	1104	1007	158	115	44.5	59.1	57.3	2.5	1.1	84.3
12	1092	969	168	121	45.9	59.2	57.7	2.6	1.2	82.6
25	912	894	168	111	45.6	58.5	56.9	1.9	0.6	81.2
26	684	916	187	137	45.0	57.8	56.2	1.3	-0.1	79.6
11	1168	979	150	120	45.0	59.0	56.8	2.4	1.0	84.7
29	1095	863	190	124	45.8	57.5	56.7	0.9	-0.5	77.9
27	848	903	201	134	45.8	57.3	56.2	0.7	-0.7	77.8
23	844	884	181	141	45.7	57.8	56.0	1.2	-0.2	79.6
10	656	1145	200	83	44.1	55.4	57.6	NA	1.0	82.5
4	797	1220	193	94	42.2	54.4	52.6	-1.0	NA	84.2
20	1058	939	160	127	46.0	59.0	57.1	3.6	4.6	82.9
7	798	1135	171	103	42.5	54.8	54.9	-0.6	0.4	85.0
8	772	1119	177	120	43.3	55.3	54.9	-0.1	0.9	84.2
28	698	1007	180	104	43.4	53.9	54.0	-1.5	-0.5	82.1
30	1141	1126	153	105	44.4	55.8	55.1	0.5	1.4	86.4

Table 15: Deinking Results for tests 1-30 (Examples 4 and 5).

In addition to the results in Table 15, the following was observed: tests 5, 9, 11-15, 17, 20-22, 25, 29 and 30 had too much wet rejects. For this Example a reject amount over about 850g was considered too high a yield loss.

The results of the deinking tests for Examples 4 and 5 are shown graphically in Figure 10-15. A review of these figures shows that a mixture of lipase and xylanase at either a ratio of 66/34 or 50/50 was compared to enzymes added separately and blended in pulper. The results were found to be the same or better when enzymes were mixed. Addition of enzymes to non-ionic surfactant gave better ink detachment and is best option if reject level is controlled. Removing the sodium sulfite lowered the amount of rejects in most cases. The Globe and Mail furnish saw no benefit adding peroxide with the sulfite chemistry and a slight benefit with sodium sulfite. Higher dosages of enzymes did not increase deinking performance.

Example 6 and 7:

The pulping recipes used in Examples 6 and 7 (Tests 1 to 17) are listed below in Table 16. The specific pulping components and conditions were: 17.5 grams each of WSJ and LAT (Example 6)

and 35 grams of Globe and Mail mixed (Example 7), flotation time of 8 min, and air rate of 20 SCHF. The pH operating ranges for Examples 6 and 7 are listed below in Table 17.

Test #	Cell Level, grams	Pulper	Deinking Agents	Sulfite	Xylanase%	Lipase%	Ratio	Pulp Liquor pH	FF pH
1	4200	Conventional 70 LAT-WSJ	Eka RF 4291+ Eka RF 4031				NA	11.2	9.1
9	4200	Neutral w/Sodium Sulfite 70 LAT-WSJ	Eka RF 4291+ Eka RF 4031	Yes			NA	9.6	8.4
12	4200	NaSul+E6634 70 LAT-WSJ	Eka RF 4291+ Eka RF 4031	Yes	0.013	0.007	66/34	9.6	8.4
3	4200	Conventional 90 LAT-WSJ	Eka RF 4291+ Eka RF 4031				NA	11.2	9.5
11	4200	Neutral w/Sodium Sulfite 90 LAT-WSJ	Eka RF 4291+ Eka RF 4031	Yes			NA	9.5	8.4
14	4200	NaSul+E6634 90 LAT-WSJ	Eka RF 4291+ Eka RF 4031	Yes	0.013	0.007	66/34	9.6	8.2
4	4200	Conventional 100 LAT-WSJ	Eka RF 4291+ Eka RF 4031				NA	11.1	9.0
16	4200	NaSul+E6634 100 LAT-WSJ	Eka RF 4291+ Eka RF 4031	Yes	0.013	0.007	66/34	9.5	8.4
5	4200	Conventional 70 Globe	Eka RF 4291+ Eka RF 4031				NA	11.1	9.0
10	4200	Neutral w/Sodium Sulfite 70 Globe	Eka RF 4291+ Eka RF 4031	Yes			NA	9.6	8.1
13	4200	NaSul+E6634 70 Globe	Eka RF 4291+ Eka RF 4031	Yes	0.013	0.007	66/34	9.5	8.2
7	4200	Conventional 90 Globe	Eka RF 4291+ Eka RF 4031				NA	11.1	9.0
15	4200	NaSul+E6634 90 Globe	Eka RF 4291+ Eka RF 4031	Yes	0.013	0.007	66/34	9.6	8.1
8	4200	Conventional 100 Globe	Eka RF 4291+ Eka RF 4031				NA	11.1	8.9
17	4200	NaSul+E6634 100 Globe	Eka RF 4291+ Eka RF 4031	Yes	0.013	0.007	66/34	9.6	7.8

Table 16: Pulping recipes for tests 1-17 (Examples 6 and 7).

	Pulping Liquor pH	FF pH
Max pH	9.6	8.4
Min pH	9.5	7.8

Table 17: pH ranges for Examples 6 and 7 for neutral deinking.

The deinking performance of the various test recipes were evaluated and the results are shown below in Table 18.

Test #	Wet Reject Wt.	ERIC Pulper	ERIC Flot	ERIC Hyper	Brightness Pulper	Brightness Flot	Brightness Hyper	Brightness Difference vs. Conv	Brightness Difference vs Sulfite	Removal Efficiency at Flot
1	510	1275	475	132	46.2	56.3	61.3	NA	1.0	72.2
9	681	1384	442	149	44.6	55.3	57.0	-1.0	NA	66.2
12	644	1448	337	133	44.1	57.2	58.3	0.9	1.9	60.4
3	340	1281	510	157	45.7	53.8	59.1	NA	1.2	69.3
11	543	1268	505	166	44.7	52.6	56.3	-1.2	NA	67.3
14	729	1308	399	180	44.6	54.4	56.0	0.7	1.8	54.9
4	370	1304	525	170	43.6	51.4	57.5	NA	-2.0	67.7
16	491	1236	413	201.2	45.2	53.4	54.2	2.0	NA	51.3
5	450	1137	350	83	44.9	53.7	57.5	NA	1.5	76.4
10	496	1218	347	87	43.1	52.2	53.9	-1.5	NA	74.8
13	510	1249	318	81.85	43.2	53.2	54.2	-0.5	1.0	74.2
7	269	1328	644	98	40.1	46.6	54.8	NA	NA	84.8
15	279	1569	635	117.3	38.8	46.3	51.5	-0.3	NA	81.5
8	249	1603	1480	147	37.2	37.9	52.9	NA	NA	90.1
17	205	1557	1339	176.6	38.5	39.8	50.4	1.9	NA	86.8

Table 18: Deinking Results for tests 1-30 (Examples 6 and 7).

For this Example a reject amount over about 700g was considered too high a yield loss. In addition to the results in Table 18, the following was observed: tests 14 had too much wet rejects.

The results of the deinking tests for Examples 6 and 7 are shown graphically in Figures 16-21. As expected increasing ONP content dropped the amount of rejects and lowered brightness. The addition of the mixture of enzymes with sulfite based neutral deinking gave higher flot accept brightness than conventional of 1 (70%), 0.5 (90%) and 2 (100%) points for the LAT/WSJ combination in Example 6. For Example 7, Globe and Mail it was -0.5 (70%), -0.3 (90%) and 2 (100%) points. The foaming nature helped when using 100% ONP for both examples. The ink type

for the Globe and Mail showed a significant drop in brightness and ability to be deinked when going to 100% ONP due to low levels of rejects. The use of this enzyme mixture will allow mills to use a higher ONP content while maintaining deinking performance.

Example 8:

The pulping recipes used in Example 8 (Tests 1 to 7) are listed below in Table 19. The specific pulping components and conditions were: 17.5 grams each of WSJ and LAT, flotation time of 8 min, and air rate of 20 SCHF. The pH operating ranges for Example 8 is listed below in Table 20.

Test #	Cell Level, grams	Pulper	Deinking Agents	Sulfite	Xylanase%	Lipase%	Ratio	Pulp Liquor pH	FF pH
1	4200	Conventional	Eka RF 4291+ Eka RF 4031				NA	11.3	8.9
3	4200	Neutral with Sodium Sulfite LAT	Eka RF 4291+ Eka RF 4031	Yes			NA	9.6	7.2
4	4200	E5050	Eka RF 4291+ Eka RF 4031		0.01	0.01	50/50	9.3	6.9
5	4200	E6634	Eka RF 4291+ Eka RF 4031		0.013	0.007	66/34	9.3	7.2
6	4200	E7525	Eka RF 4291+ Eka RF 4031		0.015	0.005	75/25	9.4	7.2
7	4200	Blend	Eka RF 4291+ Eka RF 4031		0.015	0.005	75/25	9.7	7.2

Table 19: Pulping recipes for tests 1-7 (Example 8).

	Pulping Liquor pH	FF pH
Max pH	9.7	7.2
Min pH	9.3	6.9

Table 20: pH ranges for Example 8 for neutral deinking.

The deinking performance of the various test recipes were evaluated and the results are shown below in Table 21.

Test #	Wet Reject Wt.	ERIC Pulper	ERIC Flot	ERIC Hyper	Brightness Pulper	Brightness Flot	Brightness Hyper	Brightness Difference vs. Conv	Brightness Difference vs Sulfite	Removal Efficiency at Flot

1	932	759	206	110	45.6	56.3	58.1	NA	1.2	72.9
3	897	729	225	126	45.5	56.1	55.7	0.9	NA	69.1
4	1367	681	202	143	45.4	55.4	54.4	0.3	0.4	70.4
5	1229	714	207	145	45.2	55.1	55.2	0.0	0.1	71.0
6	1166	727	223	139	45.2	55.0	55.0	-0.1	0.0	69.4
7	1009	677	243	140	45.7	54.7	54.1	-0.5	-0.4	64.2

Table 21: Deinking Results for tests 1-7 (Example 8).

For this Example a reject amount over about 1130g was considered too high a yield loss. In addition to the results in Table 21, the following was observed: tests 4 to 6 had too much wet rejects.

The results of the deinking tests for Example 8 are shown graphically in Figures 22-24. This study looked at removing sodium sulfite and at ratios of xylanase/lipase of 50/50, 66/34 and 75/25 with a dosage of 0.02%. Going to a ratio of 75/25 dropped the reject level to an acceptable level. Mixing the two together gave about 0.5 points better brightness than adding the two enzymes separately and a lower rejects level. Flot Accept brightness was lower than conventional for this study but within the two point criteria and a difference of about 1.2 points. The study also showed further adjustments needed to control the amount of wet rejects when the sodium sulfite was removed.

Example 9:

The pulping recipes used in Example 9 (Tests 1 to 14) are listed below in Table 22. The specific pulping components and conditions were: 17.5 grams each of WSJ and LAT, flotation time of 8 min, and air rate of 20 SCHF. The pH operating ranges for Example 8 is listed below in Table 23.

Test #	Cell Level, grams	Pulper	Deinking Agents	Sulfite	Xylanase%	Lipase%	Ratio	Pulp Liquor pH	FF pH
1	4200	conv	Eka RF 4291+ Eka RF 4031				NA	11.7	9.3

3	4200	S-Quad	Eka RF 4291+ Eka RF 4031	Yes			NA	9.5	9.4
8	4200	no sulfite P0.5-NI 0.03-Si 0.5	Eka RF 4291+ Eka RF 4031				NA	8.8	7.2
9	4200	no sulfite P1.5-NI 0.03-Si 1.5	Eka RF 4291+ Eka RF 4031				NA	9.1	7.2
13	4200	no sulfite P 0.5-NI 0.06-Si 1.0	Eka RF 4291+ Eka RF 4031				NA	9.0	7.2
11	4200	no sulfite P0.5-NI 0.09-Si 1.5	Eka RF 4291+ Eka RF 4031				NA	9.1	7.2
5	4200	no sulfite P1.0-NI 0.06-Si 1.0	Eka RF 4291+ Eka RF 4031				NA	9.2	7.1
14	4200	no sulfite P51 1.0-NI 0.06-Si 1.5	Eka RF 4291+ Eka RF 4031				NA	9.3	7.2
4	4200	no sulfite P1.5-NI 0.03-Si 0.5	Eka RF 4291+ Eka RF 4031				NA	8.9	7.3
7	4200	no sulfite P1.5-NI 0.09-Si 0.5	Eka RF 4291+ Eka RF 4031				NA	9.1	7.1
12	4200	no sulfite P1.5-NI 0.09-Si 0.5	Eka RF 4291+ Eka RF 4031				NA	9.2	7.2

Table 22: Pulping recipes for tests 1-14 (Example 9).

Neutral Deinking pH range	Pulping Liquor pH	FF pH
Max pH	9.5	9.4
Min pH	8.8	7.1

Table 23: pH ranges for Example 9 for neutral deinking

The deinking performance of the various test recipes were evaluated and the results are shown below in Table 24.

Test #	Wet Reject Wt.	ERIC Pulper	ERIC Flot	ERIC Hyper	Brightness Pulper	Brightness Flot	Brightness Hyper	Brightness Difference vs. Conv	Brightness Difference vs Sulfite	Removal Efficiency at Flot
1	721	1157	403	155	41.1	48.0	50.5	NA	-3.0	61.5
3	735	1203	380	181	43.6	53.2	53.6	1.9	NA	52.4

8	683	1260	456	231	42.8	51.8	52.7	0.5	0.9	49.3
9	593	1272	511	236	42.8	51.3	52.0	0.0	0.4	53.7
13	633	1141	517	215	43.8	50.9	49.8	-0.4	0.0	58.5
11	444	1342	611	249	42.5	50.5	51.4	-0.8	-0.4	59.3
5	601	1260	463	233	42.7	52.0	52.5	0.7	1.0	49.6
14	563	1204	562	232	43.7	51.0	52.1	-0.3	0.1	58.8
4	782	1289	423	208	42.8	52.6	53.3	1.3	1.7	50.9
7	726	1175	408	229	42.4	51.5	51.4	0.2	0.6	43.9
12	656	1311	437	248	42.2	52.3	51.7	1.0	1.4	43.3

Table 24: Deinking Results for tests 1-14 (Example 9).

For this Example a reject amount over about 920g was considered too high a yield loss. In addition to the results in Table 24, the following was observed: no tests had too much wet rejects.

The results of the deinking tests for Example 9 are shown graphically in Figures 25-26. This study looked at adding hydrogen peroxide without adding caustic and without adding sodium sulfite. A testing error resulted in no hydrogen peroxide being added to the conventional pulper chemistry which produced darker paper due to bleach removal and caustic yellowing. The removal of sodium sulfite and the enzymes resulted in a large increase in ink redeposition as seen with ERIC hyperwash averaging 226 for neutral deinking. Dropping the sodium silicate dosage to 0.5% gave better ink removal and higher brightness but was due to a higher amount of rejects. The sodium silicate is helping to reduce reject volume during neutral deinking.

Example 10:

The pulping recipes used in Example 10 (Tests 1 to 14) are listed below in Table 25. The specific pulping components and conditions were: 35 grams each of WSJ, LAT or Globe and Mail, flotation time of 5 min, and air rate of 15 SCHF. The pH operating ranges for Example 10 is listed below in Table 26.

Test #	Cell Level, grams	Pulper	Deinking Agents	Sulfite	Xylanase%	Lipase%	Ratio	Pulp Liquor	FF pH

								pH	
1	4200	Conventional - LAT	Eka RF 4291+ Eka RF 4031				NA	11.02	9.24
13	4200	Neutral with Sodium Sulfite LAT	Eka RF 4291+ Eka RF 4031	Yes			NA	9.63	8.50
14	4100	E6634 LAT-4100	Eka RF 4291+ Eka RF 4031		0.013	0.07	66/34	9.54	8.13
3	4200	Conventional - WSJ	Eka RF 4291+ Eka RF 4031				NA	11.02	9.58
4	4200	Neutral with Sodium Sulfite-WSJ	Eka RF 4291+ Eka RF 4031	Yes			NA	9.52	8.34
5	4100	E6634 -WSJ-4100	Eka RF 4291+ Eka RF 4031		0.013	0.07	66/34	9.34	8.45
2	4200	Conventional - GLOBE	Eka RF 4291+ Eka RF 4031				NA	11.03	9.02
8	4200	Neutral with Sodium Sulfite - GLOBE	Eka RF 4291+ Eka RF 4031	Yes			NA	9.64	8.01
7	4100	E6634 - GLOBE-4100	Eka RF 4291+ Eka RF 4031		0.013	0.07	66/34	9.32	7.86

Table 25: Pulping recipes for tests 1-14 (Example 10).

Neutral Deinking pH range	Pulping Liquor pH	FF pH
Max pH	9.6	8.5
Min pH	9.3	7.9

Table 26: pH ranges for Example 10 for neutral deinking

The deinking performance of the various test recipes were evaluated and the results are shown below in Table 27.

Test #	Wet Reject Wt.	ERIC Pulper	ERIC Flot	ERIC Hyper	Brightness Pulper	Brightness Flot	Brightness Hyper	Brightness Difference vs. Conv	Brightness Difference vs Sulfite	Removal Efficiency at Flot
1	180	937	461	201	42.02	48.03	53.94	NA	-1.4	56.4

13	242	1202	382	243	38.62	49.45	50.15	1.4	NA	36.3
14	87	958	421	177	41.26	48.39	48.16	0.4	-1.1	57.9
3	388	932	310	107	48.30	57.39	59.84	NA	-0.2	65.6
4	388	976	343	141	47.75	57.58	58.14	0.2	NA	59.0
5	308	889	338	212	49.10	57.22	57.59	-0.2	-0.4	37.1
2	491	1005	345	141	45.62	53.83	56.96	NA	-0.1	59.0
8	582	1284	298	190	42.33	53.96	54.20	0.1	NA	36.4
7	649	944	308	141	44.95	52.95	53.97	-0.9	-1.0	54.2

Table 27: Deinking Results for tests 1-14 (Example 10).

For this Example a reject amount over about 380g (LA Times), 590 (WSJ) or 690 (Globe and Mail) was considered too high a yield loss. In addition to the results in Table 27, the following was observed: no tests had too much wet rejects.

The results of the deinking tests for Example 10 are shown graphically in Figures 27-29. Reject levels have been an issue in the development effort. In this study the amount of air injected was dropped from 20 to 15 scfm. Also the cell level was dropped to 4100 g from 4200 g when using the enzymes. This study looks at deinking performance of neutral deinking with no sodium sulfite but with enzymes and is compared to conventional deinking and sulfite based neutral deinking. This comparison in pulper chemistry was made using the Los Angles Times (LAT), the Wall Street Journal (WSJ) and the Globe and Mail (GLOBE). Dropping the air flow rate and a drop to 4100 g cell level for neutral deinking with enzymes without sodium sulfite gave similar reject losses to conventional and a sodium sulfite based pulper chemistry. This study showed the combination of xylanase and lipase at 66/34 at a dose of 0.2% gave equal deinking performance to conventional or sulfite neutral deinking. The worse performance was for the Globe and Mail after flotation and it was within 1 point of conventional.

Example 11:

The pulping recipes used in Example 11 (Tests 1 to 23) are listed below in Table 28. A portion of the tests were not related to this study and are not included. The specific pulping components and conditions were: 35 grams each of WSJ, LAT or Globe and Mail, flotation time of 5 min, and air rate of 15 SCHF. The pH operating ranges for Example 11 is listed below in Table 29.

Test #	Cell Level, grams	Pulper	Deinking Agents	Sulfite	Xylanase%	Lipase%	Ratio	Pulp Liquor pH	FF pH
1	4200	Conventional-LAT-4200	Eka RF 4291+ Eka RF 4031				NA	12.0	9.8
13	4200	Neutral w/Sodium Sulfite LAT-4200	Eka RF 4291+ Eka RF 4031	Yes			NA	9.6	8.3
14	4100	E6634 LAT-4100	Eka RF 4291+ Eka RF 4031		0.013	0.007	66/34	9.4	8.2
22	4100	XP 5313 LAT-4100	Eka RF 4291+ Eka RF 4031		0.013	0.007	66/34	9.4	7.8
3	4200	Conventional-WSJ-4200	Eka RF 4291+ Eka RF 4031				NA	12.2	10.0
4	4200	Neutral w/Sodium Sulfite WSJ-4200	Eka RF 4291+ Eka RF 4031	Yes			NA	10.2	8.3
5	4100	E6634 WSJ-4100	Eka RF 4291+ Eka RF 4031		0.013	0.007	66/34	9.6	8.1
2	4100	Conventional-GLOBE	Eka RF 4291+ Eka RF 4031				NA	12.1	8.7
8	4000	Neutral w/Sodium Sulfite GLOBE-4000	Eka RF 4291+ Eka RF 4031	Yes			NA	10.2	7.7
7	4000	E6634 GLOBE-4000	Eka RF 4291+ Eka RF 4031		0.013	0.007	66/34	9.5	7.7
23	4000	XP 5313 GLOBE-4000	Eka RF 4291+ Eka RF 4031		0.013	0.007	66/34	9.5	7.6

Table 28: Pulping recipes for tests 1-23 (Example 11).

Neutral Deinking pH range	Pulping Liquor pH	FF pH
Max pH	10.2	8.3
Min pH	9.4	7.6

Table 29: pH ranges for Example 10 for neutral deinking

The deinking performance of the various test recipes were evaluated and the results are shown below in Table 30.

Test #	Wet Reject Wt.	ERIC Pulper	ERIC Flot	ERIC Hyper	Brightness Pulper	Brightness Flot	Brightness Hyper	Brightness Difference vs. Conv	Brightness Difference vs Sulfite	Removal Efficiency at Flot
1	317	924	380	124	44.3	51.1	53.0	NA	2.5	58.9
13	373	1181	429	116	40.3	48.6	48.1	-2.5	NA	63.6
14	248	1147	447	180	40.5	48.1	46.6	-3.0	-0.5	61.1
22	359	1011	288	151	40.3	49.3	45.9	-1.8	0.7	71.5
3	450	957	292	156	47.5	58.8	58.2	NA	0.9	69.5
4	501	988	267	192	46.2	57.9	56.6	-0.9	NA	73.0
5	357	1037	367	176	45.5	55.0	55.2	-3.8	-2.9	64.6
2	490	1055	331	143	44.8	54.3	55.0	NA	0.3	68.6
8	662	1284	301	180	42.1	54.1	53.3	-0.3	NA	76.6
7	492	1127	353	140	42.6	51.6	52.0	-2.7	-2.5	68.7
23	703	1174	294	181	42.3	51.9	51.7	-2.5	-2.2	74.9

Table 30: Deinking Results for tests 1-23 (Example 11).

For this Example a reject amount over about 380g (LA Times), 590 (WSJ) or 690 (Globe and Mail) was considered too high a yield loss. In addition to the results in Table 30, the following was observed: test 23 was barely above having too much wet rejects.

The results of the deinking tests for Example 11 are shown graphically in Figures 30-32. The amount of ink redeposited also varied significantly indicating easy to very difficult to deink based on the ERIC hyperwash value as shown in Table 31. In general this example did not meet the within 2 point criteria and was mainly due to the more difficult nature of the ONP based on the aging effect as seen by an increase in the ERIC value of the hyperwashed pulp. This example included blending the mixture of enzymes with a non-ionic surfactant which preformed better than the other neutral

deinking pulper recipes for the LA Times and Globe and Mail. The blended mixture condition was not run for the Wall Street Journal.

Old Newsprint	Neutral	Conventional	Deinking	Conventional Rejects
LAT Average HW	210	201	very difficult	180
WSJ Average HW	177	107	easy	388
GLOBE Average HW	165	141	difficult	491

Table 31: Comparison of the amount of attached redeposited ink based on ONP used (Example 11).

Example 12:

The pulping recipes used in Example 12 are listed below in Table 32. A portion of the tests were not related to this study and are not included or were repeats averaged into the reported results. The specific pulping components and conditions were: 17.5 grams each of WSJ and LAT, flotation time of 5 min, and air rate of 15 SCHF. The pH operating ranges for Example 12 is listed below in Table 33.

Test #	Cell Level, grams	Pulper	Deinking Agents	Sulfite	Xylanase%	Lipase%	Ratio	Pulp Liquor pH	FF pH
	4200	Conventional	Eka RF 4291+ Eka RF 4031				NA	11.3	9.6
	4200	Conventional	Eka NA120 + Eka RF 4031				NA	11.4	9.6
5	4200	Neutral w/ NaSul - RF 4291	Eka RF 4291+ Eka RF 4031	Yes			NA	9.8	8.5
8	4200	Neutral w/NaSul- 120 NA	Eka NA120 + Eka RF 4031	Yes			NA	9.8	8.6
9	4100	Neutral/No NaSul - RF 4291	Eka RF 4291+ Eka RF 4031				NA	9.6	8.5
10	4100	Neutral/No NaSul - 120 NA	Eka NA120 + Eka RF 4031				NA	9.6	8.6
	4100	E6634 - RF 4291	Eka RF 4291+ Eka RF 4031		0.013	0.07	66/34	9.6	8.5
	4100	E6634 - NA 120	Eka NA120 + Eka RF 4031		0.013	0.07	66/34	9.6	8.6

Table 32: Pulping recipes (Example 12).

Neutral Deinking pH range	Pulping Liquor pH	FF pH
Max pH	9.8	8.6
Min pH	9.6	8.5

Table 33: pH ranges for Example 12 for neutral deinking

For this Example a reject amount over about 1030g (Eka RF 4291) or 920 (Eka NA120) was considered too high a yield loss. In addition to the results in Table 34, the following was observed: none of the tests had too much wet rejects.

The results of the deinking tests for Example 12 are shown graphically in Figures 33-35. The paper used in this study was very difficult to deink as denoted by having a hyperwash ERIC value of about 250 for conventional deinking due to the age of the paper. The study showed under these challenging conditions that the addition of the enzyme mixture of 66% xylanase and 33% lipase without sodium sulfite gave comparable deinking performance to conventional and to sodium sulfite based neutral deinking. The study also showed that a deinking agent beside Eka RF 4291 could be used for neutral deinking. The study also showed that in general Eka RF 4291 was a better deinking agent than the current formula used to make Eka NA 120.

Test #	Wet Reject Wt.	ERIC Pulper	ERIC Flot	ERIC Hyper	Brightness Pulper	Brightness Flot	Brightness Hyper	Brightness Difference vs. Conv	Brightness Difference vs Sulfite	Removal Efficiency at Flot
	826	1185	379	245	43.7	55.6	56.7	NA	0.2	68
	721	1202	458	261	43.1	54.8	55.9	NA	2.0	62
5	939	1299	365	279	41.7	55.3	54.9	-0.2	NA	71.9
8	808	1307	491	291	41.8	52.8	54.5	-2.0	NA	62.5
9	685	1352	439	274	41.5	53.5	54.6	-2.1	-1.8	67.5
10	707	1355	491	313	41.2	52.5	53.9	-2.3	-0.3	63.8
	858	1301	388	298	42.0	54.4	53.7	-1.2	-1.0	70
	878	1244	370	291	41.6	54.5	53.6	-0.3	1.7	70

Table 34: Deinking Results (Example 12).

Example 13:

The pulping recipes used in Example 13 (Tests 1-14) are listed below in Table 35. The specific pulping components and conditions were: 17.5 grams each of WSJ and LAT, flotation time of 5 min, and air rate of 15 SCHF. The pH operating ranges for Example 13 is listed below in Table 36.

Test #	Cell Level, grams	Pulper	Deinking Agents	Sulfite	Xylanase%	Lipase%	Ratio	Pulp Liquor pH	FF pH
1	4200	Conventional-NaOH 1%	Eka RF 4291+ Eka RF 4031				NA	11.5	9.5
3	4200	Conventional-NaOH 0.6%	Eka RF 4291+ Eka RF 4031				NA	11.1	9.2
4	4200	Conventional-NaOH 0.3%	Eka RF 4291+ Eka RF 4031				NA	10.6	8.9
5	4200	Conventional-NaOH 0.15%	Eka RF 4291+ Eka RF 4031				NA	10.2	8.6
6	4200	Conventional-NaOH 0.03%	Eka RF 4291+ Eka RF 4031				NA	9.5	8.5
2	4200	Neutral w/NaSulfite	Eka RF 4291+ Eka RF 4031	Yes			NA	9.5	8.6
8	4100	Neutral wo/NaSulfite	Eka RF 4291+ Eka RF 4031				NA	9.5	8.5
7	4100	E6634	Eka RF 4291+ Eka RF 4031		0.013	0.007	66/34	9.5	8.4
9	4100	E6634-NaOH 0.03%	Eka RF 4291+ Eka RF 4031		0.013	0.007	66/34	9.6	8.4
10	4100	E6634-NaOH 0.08%	Eka RF 4291+ Eka RF 4031		0.013	0.007	66/34	9.9	8.7
11	4100	E6634-NaOH 0.15%	Eka RF 4291+ Eka RF 4031		0.013	0.007	66/34	10.4	8.8
12	4100	E6634-NaOH 0.3%	Eka RF 4291+ Eka RF 4031		0.013	0.007	66/34	11.0	9.1
13	4100	E6634-NaOH 0.6%	Eka RF 4291+ Eka RF 4031		0.013	0.007	66/34	11.3	9.4

14	4100	E6634-NaOH 1%	Eka RF 4291+ Eka RF 4031		0.013	0.007	66/34	11.5	10.1

Table 35: Pulping recipes for tests 1-14 (Example 13).

Neutral Deinking pH range	Pulping Liquor pH	FF pH
Max pH	10.4	8.8
Min pH	9.5	8.4

Table 36: pH ranges for Example 13 for neutral deinking

For this Example a reject amount over about 1020 to 1070g was considered too high a yield loss. In addition to the results in Table 37, the following was observed: none of the tests had too much wet rejects.

The results of the deinking tests for Example 13 are shown graphically in Figures 36-38. The paper used in this study was very difficult to deink as denoted by having a hyperwash ERIC value of about 240 for conventional deinking due to the age of the paper. The study showed under these challenging conditions that the addition of the enzyme mixture of 66% xylanase and 33% lipase without sodium sulphite gave comparable deinking performance to conventional and to sodium sulphite based neutral deinking. The study also showed that above 0.15% of caustic addition the loss of enzyme performance in conjunction with yellowing of fiber give a brightness a point lower than conventional and going above 0.3% lowered brightness by 2 points. With regards to pH, a value above 10 in the pulping liquor would be beyond the range of enzyme performance or a pH of 9 after pulping.

Test #	Wet Reject Wt.	ERIC Pulper	ERIC Flot	ERIC Hyper	Brightness Pulper	Brightness Flot	Brightness Hyper	Brightness Difference vs. Conv	Brightness Difference vs Sulfite	Removal Efficiency at Flot
1	830	1318	433	239	43.3	54.7	55.9	NA	-1.4	67.1
3	860	1398	398	247	42.8	55.0	55.0	0.3	-1.1	71.6
4	853	1364	393	243	42.7	54.6	54.6	-0.1	-1.5	71.2
5	817	1430	421	258	41.9	55.2	54.9	0.5	-0.9	70.6
6	867	1420	416	299	42.5	55.3	54.9	0.5	-0.9	70.7
2	986	1420	344	248	42.3	56.1	54.7	1.4	NA	75.8

8	752	1417	431	261	42.6	54.6	53.7	-0.2	-1.6	69.6
7	744	1408	422	273	42.2	54.9	54.5	0.2	-1.2	70.0
9	788	1500	451	258	41.8	53.9	54.2	-0.8	-2.2	69.9
10	822	1426	409	262	42.4	54.9	54.4	0.2	-1.2	71.3
11	817	1463	438	264	41.7	54.4	53.6	-0.3	-1.7	70.1
12	808	1441	411	268	41.4	53.6	53.9	-1.1	-2.5	71.5
13	751	1381	422	250	41.5	52.9	53.2	-1.8	-3.2	69.4
14	820	1472	415	259	40.7	52.5	52.1	-2.2	-3.6	71.8

Table 37: Deinking Results for tests 1-14 (Example 13).

Example 14:

The pulping recipes used in Example 14 (Tests 1-14) are listed below in Table 38. The specific pulping components and conditions were: 17.5 grams each of WSJ and LAT, flotation time of 5 min, and air rate of 15 SCHF. The pH operating ranges for Example 14 is listed below in Table 39. This study used a pulping consistency of 20%.

Test #	Cell Level, grams	Pulper	Deinking Agents	Sulfite	Xylanase%	Lipase%	Ratio	Pulp Liquor pH	FF pH
1	4200	Conventional	Eka RF 4291+ Eka RF 4031				NA	11.45	9.16
2	4200	Neutral w/ NaSul - RF 4291	Eka RF 4291+ Eka RF 4031	Yes			NA	9.71	8.23
4	4100	XP 5313 0.045%	XP 5313 at 0.045%		0.0075	0.00375	66/34	9.68	8.32
6	4100	XP 5313 0.065%	XP 5313 at 0.065%		0.011	0.0055	66/34	9.78	8.38
3	4100	XP 5313 Tote 0.045%	XP 5313-Tote at 0.045%		0.0075	0.00375	66/34	9.59	8.06
5	4100	XP 5313 Tote 0.065%	XP 5313-Tote at 0.065%		0.011	0.0055	66/34	9.755	8.385

Table 38: Pulping recipes for tests 1-6 (Example 14).

Neutral Deinking pH range	Pulping Liquor pH	FF pH

Max pH	9.8	8.4
Min pH	9.6	8.1

Table 39: pH ranges for Example 14 for neutral deinking

For this Example a reject amount over about 790g was considered too high a yield loss. In addition to the results in Table 40, the following was observed: none of the tests had too much wet rejects.

The results of the deinking tests for Example 14 are shown graphically in Figures 39-41. The blend of xylanase and lipase with the non-ionic surfactant using either production grade product in a tote or from lab samples had a lower amount of residual ink and about 0.5 points brighter after flotation. The amount of attached/redeposited ink after hyperwashing was 150 for conventional and 196 with neutral deinking indicating difficult to deink old newsprint. The reject levels for neutral are equal to slightly lower indicating that increased solids loss was not the cause of better deinking performance.

Test #	Wet Reject Wt.	ERIC Pulper	ERIC Flot	ERIC Hyper	Brightness Pulper	Brightness Flot	Brightness Hyper	Brightness Difference vs. Conv	Brightness Difference vs Sulfite	Removal Efficiency at Flot
1	586	975	286	159	43.6	54.9	56.1	NA	-1.0	70.6
2	664	1076	239	215	42.4	55.9	53.3	1.0	NA	77.8
4	608	1021	258	202	42.8	55.3	54.3	0.4	-0.6	74.7
6	490	1117	263	178	43.2	55.5	55.3	0.6	-0.4	76.5
3	585	1025	264	202	43.1	55.5	54.7	0.6	-0.4	74.2
5	524	1070	268	185	43.4	55.7	54.1	0.8	-0.2	74.9

Table 40: Deinking Results for tests 1-6 (Example 14).

Example 15:

The pulping recipes used in Example 15 (Tests 1-14) are listed below in Table 41. The specific pulping components and conditions were: 50.0 grams mixture of old newspaper using flexographic ink and coated paper , flotation time of 5 min, and air rate of 15 SCHF. The pH operating ranges for Example 15 is listed below in Table 42. This study used a pulping consistency of 20%.

Test #	Cell Level, grams	Pulper	Deinking Agents	Sulfite	Xylanase%	Lipase%	Ratio	Pulp Liquor pH	FF pH

1	4200	RF 4291+Tall Oil	Eka RF 4291				NA	7.6	7.2
2	4200	RF 4283+4031	Eka RF 4283				NA	7.9	7.3
5	4200	RF 4283+4031 w/NaOH	Eka RF 4283+ Eka RF 4031				NA	9.9	7.4
4	4200	RF 4283+4031w/NaSilicate	Eka RF 4283+ Eka RF 4031				NA	8.9	7.2
8	4200	RF 4283+4031w/NaSilicate+NaOH	Eka RF 4283+ Eka RF 4031				NA	9.9	7.5
3	4200	XP 5313+4031	XP 5313 + Eka RF 4031		0.008	0.004	66/34	8.0	7.2
6	4200	XP 5313+4031 w/NaOH	XP 5313 + Eka RF 4031		0.008	0.004	66/34	10.0	7.4
7	4200	XP 5313+4031w/NaSilicate	XP 5313 + Eka RF 4031		0.008	0.004	66/34	9.0	7.4
9	4200	XP 5313+4031w/NaSilicate+NaOH	XP 5313 + Eka RF 4031		0.008	0.004	66/34	10.1	7.5

Table 41: Pulping recipes for tests 1-6 (Example 15).

Neutral Deinking pH range	Pulping Liquor pH	FF pH
Max pH	9.0	7.4
Min pH	7.6	7.2

Table 42: pH ranges for Example 15 for neutral deinking

Test #	Wet Reject Wt.	ERIC Pulper	ERIC Flot	ERIC Hyper	Brightness Pulper	Brightness Flot	Brightness Hyper	Brightness Difference vs. Conv	Brightness Difference vs Sulfite	Removal Efficiency at Flot
1	838	1010	331	217	40.6	48.9	48.8	NA	NA	67.3
2	644	931	330	154	41.2	49.4	51.3	0.5	NA	64.6
5	602	877	293	157	42.1	50.1	50.5	1.2	NA	66.6
4	453	1176	448	208	37.9	45.8	47.3	-3.1	NA	61.9

8	477	1062	381	167	40.3	47.9	49.1	-1.0	NA	64.2
3	907	825	258	135	43.3	50.8	52.1	1.9	NA	68.7
6	898	993	259	166	41.6	51.6	51.0	2.7	NA	73.9
7	762	962	265	154	41.8	51.3	49.9	2.3	NA	72.4
9	828	1023	310	179	41.3	49.5	49.3	0.6	NA	69.7

Table 43: Deinking Results for tests 1-6 (Example 15).

The ink fragmentation test conditions were within the range of conventional deinking except for the neutral deinking tests that included hydrogen peroxide. For ERIC values after flotation all of the neutral deinking conditions matched or out preformed conventional deinking. Except for cellulase all of the other neutral deinking conditions gave equal to better ink detachment.

All of the neutral deinking conditions were within 2 points of conventional deinking after flotation. Tests that included Xylanase, Xylanase/Lipase and peroxide had higher brightness than the sulfite based neutral deinking.

The hyperwash brightness after flotation was within two points of conventional deinking expect for tests that included sodium sulfite and lipase alone, cellulase alone, or amylase alone.

The tests that included lipase and hydrogen peroxide tended to have the highest levels of rejected material. However, the hydrogen peroxide tests were not been conducted at lower air injection rates.

What is Claimed is:

1. A method for removing ink from printed paper comprising:

(a) pulping printed paper at least 25 wt% of which is old newsprint at a consistency of at least about 3% to obtain a pulp slurry;

(b) treating the pulp slurry with an ink removing system, which system comprises: (i) a combination of lipase and at least one second enzyme chosen from amylase, xylanase or cellulase, and (ii) a non-ionic surfactant, in amounts effective to release ink from said pulp slurry, wherein the lipase is present in an amount of at least about 0.001 wt% based on the dry content of the pulp slurry and the ratio of the at least one second enzyme:lipase is at least about 1.2:1; and

(c) separating the released ink from the pulp slurry in a deinking step to provide a deinked pulp slurry, wherein the treating step is carried out prior to the deinking step.

2. A method according to claim 1, wherein the enzyme combination is a combination of lipase and xylanase.

3. A method according to claim 2, wherein the ratio of xylanase:lipase is at least about 1.5:1.

4. A method according to claim 3, wherein the ratio of xylanase:lipase is in the range of about 1.5:1 to about 5:1.

5. A method according to claim 4, wherein the ratio of xylanase:lipase is in the range of about 1.5:1 to about 2.5:1.

6. A method according to claim 5, wherein the ratio of xylanase:lipase is about 2:1.

7. A method according to claim 2, wherein the non-ionic surfactant is chosen from fatty acid alkoxylates, fatty alcohol alkoxylates or mixtures thereof.

8. A method according to claim 7, wherein the non-ionic surfactant is chosen from fatty alcohol ethyoxylates (FAEO), propoxylates (FAPO) and combinations thereof (FAEPO).

9. A method according to claim 8, wherein the ratio of (i):(ii) is in the range of about 1:1 to about 1:10.

10. A method according to claim 9, wherein the ratio of (i):(ii) is in the range of about 1:1 to about 1:5.

11. A method according to claim 10, wherein the ratio of (i):(ii) is in the range of about 1:2 to about 1:4.

12. A method according to claim 1, wherein the ink removing system further comprises (iii) a soap.

13. A method according to claim 1, wherein the ink removing system further comprises (iv) an alkaline reagent.

14. A method according to claim 1, wherein the ink removing system further comprises (iii) a soap and (iv) an alkaline reagent.

15. A method according to claim 14, wherein the consistency is in the range of about 3 to about 30%.

16. A method according to claim 14, wherein the printed paper comprises at least about 40 wt% ONP.

17. A method according to claim 16, wherein the printed paper comprises at least about 50 wt% ONP.

18. A method according to claim 16, wherein the printed paper comprises ONP in an amount in the range of from about 40 wt% to about 95 wt%.

19. A method according to claim 16, wherein the printed paper further comprises old magazine print (OMG).

20. A method according to claim 14, wherein the combination of enzymes (i) is a combination of lipase and xylanase.

21. A method according to claim 20, wherein the ratio of xylanase:lipase is at least about 1.5:1.

22. A method according to claim 21, wherein the ratio of xylanase:lipase is in the range of about 1.5:1 to about 5:1.

23. A method according to claim 22, wherein the ratio of xylanase:lipase is in the range of about 1.5:1 to about 2.5:1.

24. A method according to claim 23, wherein the ratio of xylanase:lipase is about 2:1.

25. A method according to claim 20, wherein the non-ionic surfactant is chosen from fatty alcohol ethoxylates (FAEO), propoxylates (FAPO) and combinations thereof (FAEPO).

26. A method according to claim 25, wherein the ratio of (i):(ii) is in the range of about 1:1 to about 1:10.

27. A method according to claim 26, wherein the ratio of (i):(ii) is in the range of about 1:1 to about 1:5.

28. A method according to claim 27, wherein the ratio of (i):(ii) is in the range of about 1:2 to about 1:4.

29. A method according to claim 14, wherein the soap is a fatty acid soap.

30. A method according to claim 29, wherein the soap is derived from tallow.

31. A method according to claim 29, wherein the soap is derived from plant oils.

32. A method according to claim 14, wherein the alkaline reagent is sodium silicate.

33. A method according to claim 14, wherein the combination of enzymes (i) is a combination of lipase and xylanase; the non-ionic surfactant (ii) is chosen from fatty alcohol ethoxylates (FAEO), propoxylates (FAPO) and combinations thereof (FAEPO); the soap (iii) is a tallow fatty acid soap; and the alkaline reagent (iv) is sodium silicate.

34. A method according to claim 33, wherein the ratio of xylanase:lipase is in the range of about 1.5:1 to about 5:1.

35. A method according to claim 34, wherein the ratio of (i):(ii) is in the range of about 1:2 to 1:4.

36. A method according to claim 35, wherein (i) and (ii) are premixed to form an enzyme composition (v) and then adding (v) to the pulp slurry as a component of the ink removing system.

37. A method according to claim 36, wherein the enzyme composition (v) is added to the pulp slurry in an amount in the range of about 0.04 to about 0.5 wt%, the soap (iii) is added to the pulp slurry in an amount in the range of about 0.1 to about 1 wt%, and the alkaline reagent (iv) is added to the pulp slurry in an amount in the range of about 0.5 to about 2 wt%, all based on the solid content of the slurry.

38. A method according to claim 36, wherein the pH of the slurry is maintained in the range of about 6 to about 11.

39. A method according to claim 36, wherein the slurry is substantially free of sodium sulfite.

40. A method according to claim 36, wherein the slurry is substantially free of sodium hydroxide or, if added to the slurry, the sodium hydroxide is added in an amount less than 0.15 wt%, based on the weight of the slurry.

41. A method according to claim 36, wherein the slurry is substantially free of hydrogen peroxide.

42. A method according to claim 36, wherein the ink removal efficiency is at least 50%.

43. A method according to claim 42, wherein the ink removal efficiency is at least 60%.

44. A method according to claim 43, wherein the ink removal efficiency is at least 70%.

45. A method according to claim 44, wherein the ink removal efficiency is at least 80%.

FIGURE 1

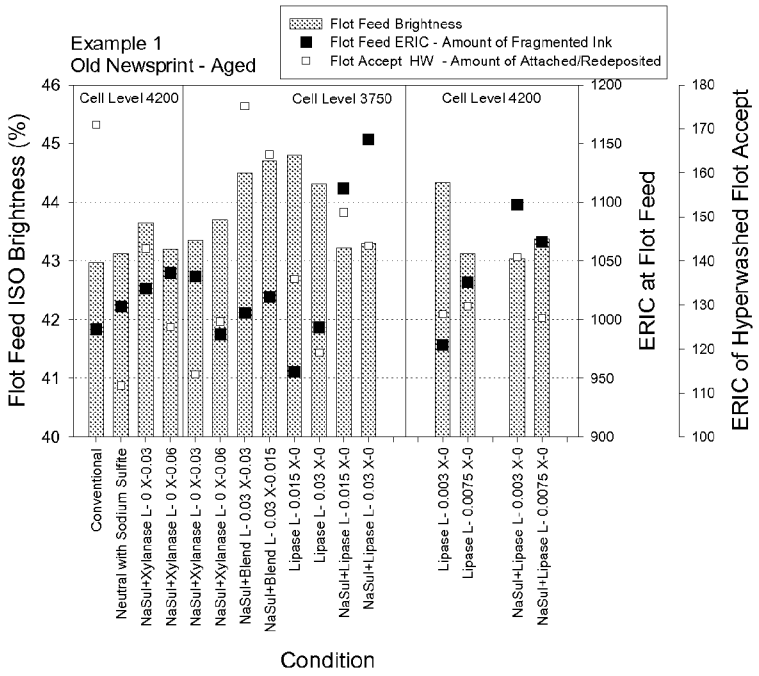


FIGURE 2

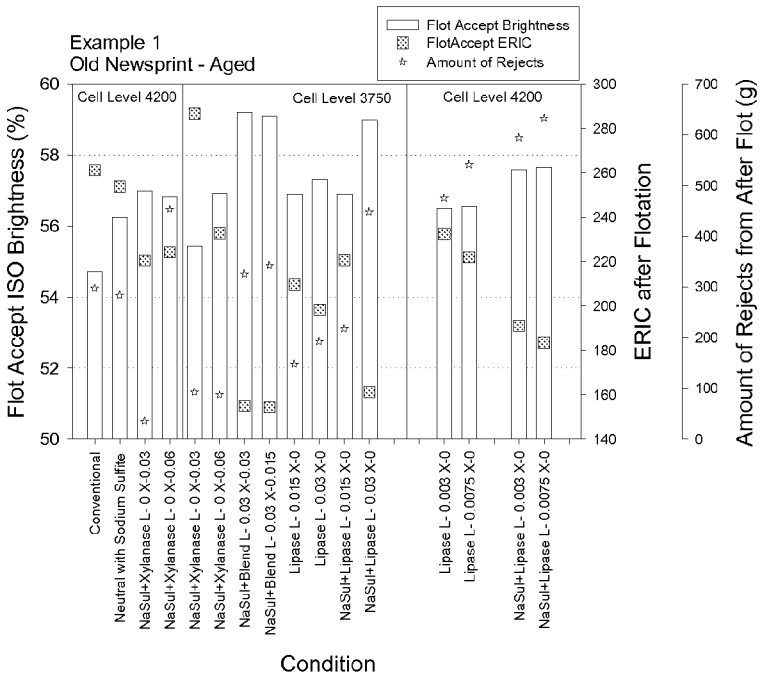


FIGURE 3

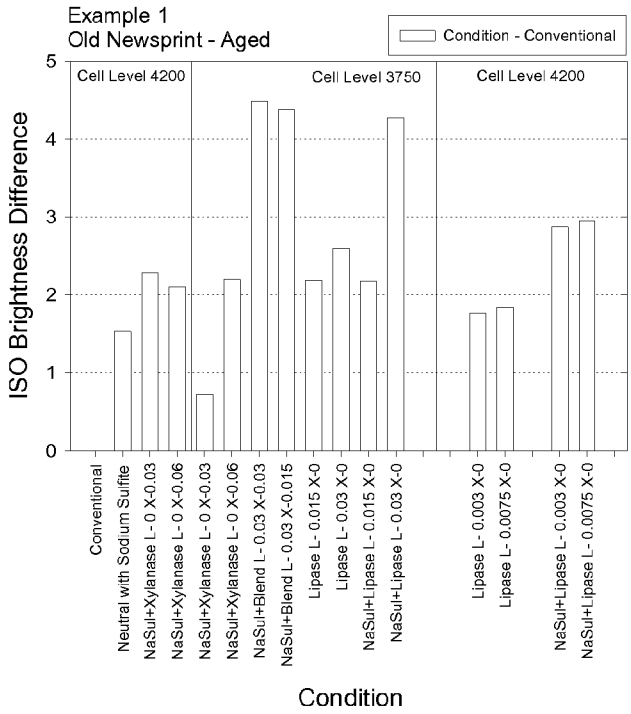


FIGURE 4

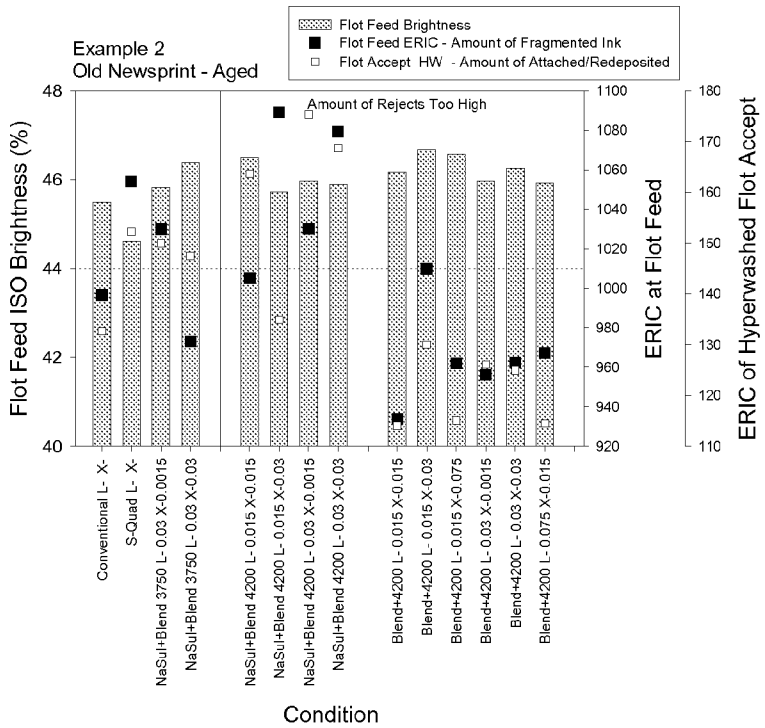


FIGURE 5

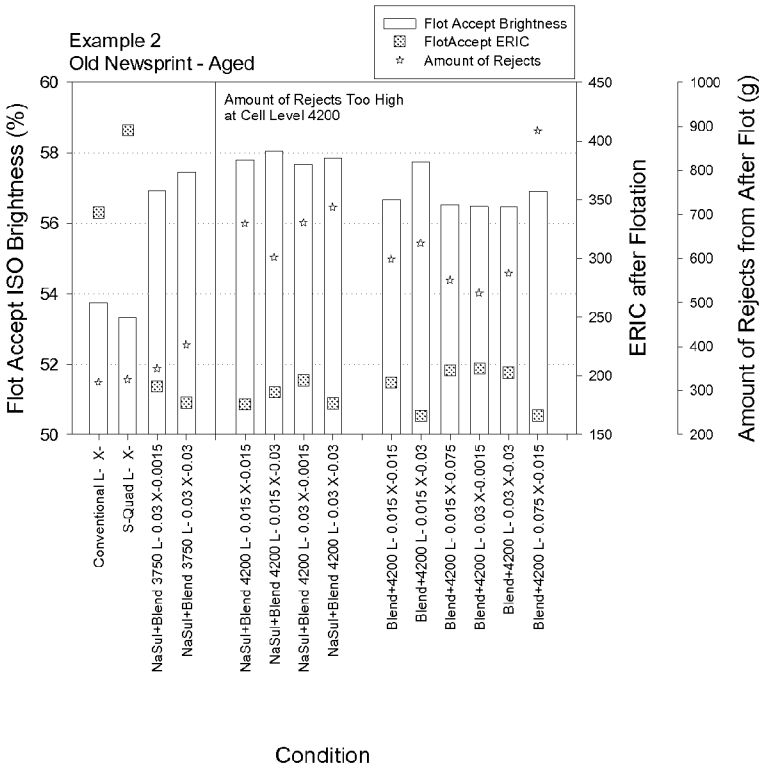

Example 2
Old Newsprint - Aged
Flot Accept Brightness
FlotAccept ERIC
Amount of Rejects
Amount of Rejects Too High
at Cell Level 4200
Flot Accept ISO Brightness (%)
ERIC after Flotation
Amount of Rejects from After Flot (g)
Conventional L- X-
S-Quad L- X-
NaSul+Blend 3750 L- 0.03 X-0.0015
NaSul+Blend 3750 L- 0.03 X-0.03
NaSul+Blend 4200 L- 0.015 X-0.015
NaSul+Blend 4200 L- 0.015 X-0.03
NaSul+Blend 4200 L- 0.03 X-0.0015
NaSul+Blend 4200 L- 0.03 X-0.03
Blend+4200 L- 0.015 X-0.015
Blend+4200 L- 0.015 X-0.03
Blend+4200 L- 0.015 X-0.075
Blend+4200 L- 0.03 X-0.0015
Blend+4200 L- 0.03 X-0.03
Blend+4200 L- 0.075 X-0.015
Condition

FIGURE 6

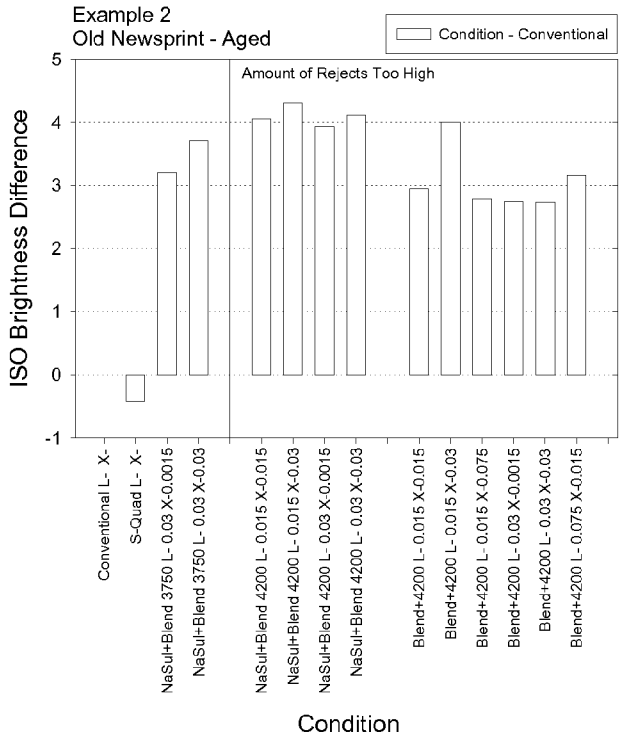

Example 2
Old Newsprint - Aged
Condition - Conventional
Amount of Rejects Too High
ISO Brightness Difference
5
4
3
2
1
0
-1
Conventional L- X-
S-Quad L- X-
NaSul+Blend 3750 L- 0.03 X-0.0015
NaSul+Blend 3750 L- 0.03 X-0.03
NaSul+Blend 4200 L- 0.015 X-0.015
NaSul+Blend 4200 L- 0.015 X-0.03
NaSul+Blend 4200 L- 0.03 X-0.0015
NaSul+Blend 4200 L- 0.03 X-0.03
Blend+4200 L- 0.015 X-0.015
Blend+4200 L- 0.015 X-0.03
Blend+4200 L- 0.015 X-0.075
Blend+4200 L- 0.03 X-0.0015
Blend+4200 L- 0.03 X-0.03
Blend+4200 L- 0.075 X-0.015
Condition

FIGURE 7

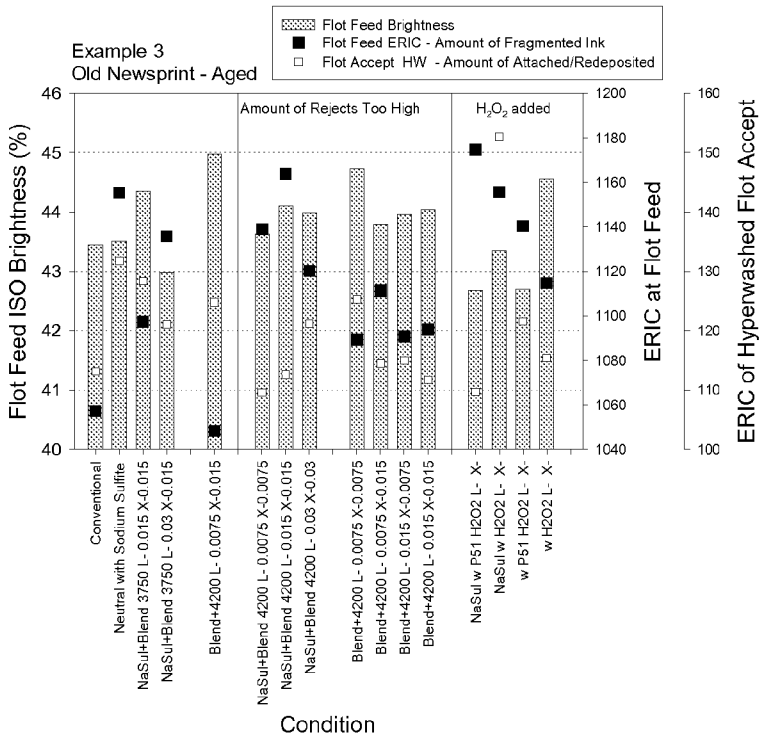


FIGURE 8

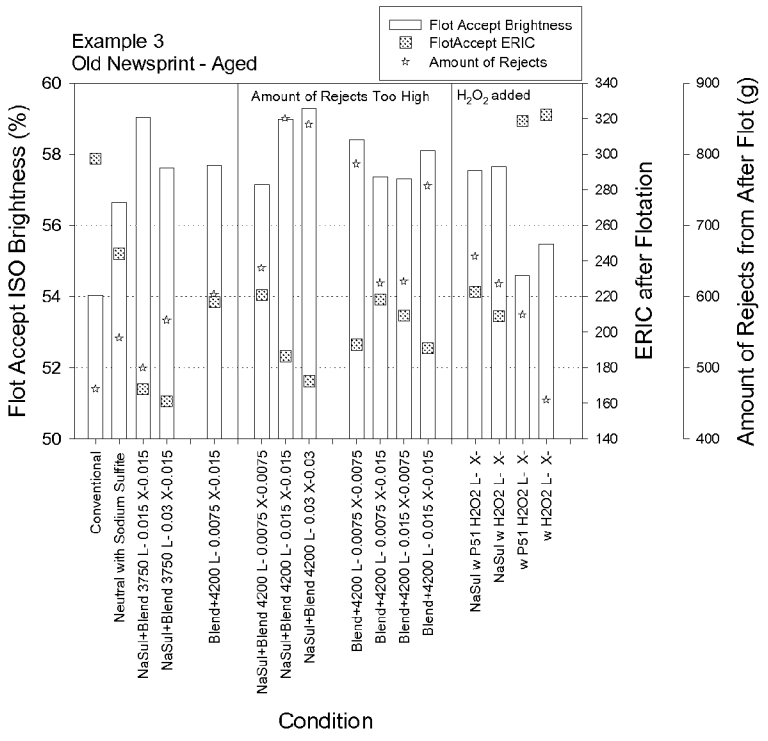


FIGURE 9

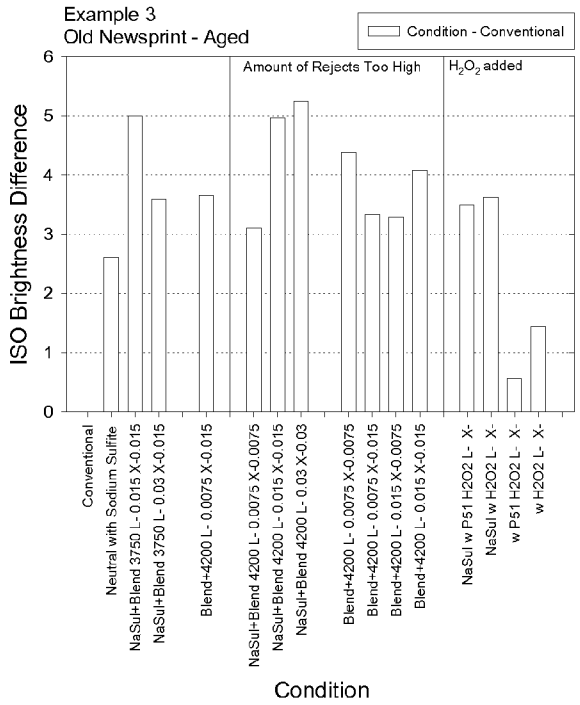


FIGURE 10

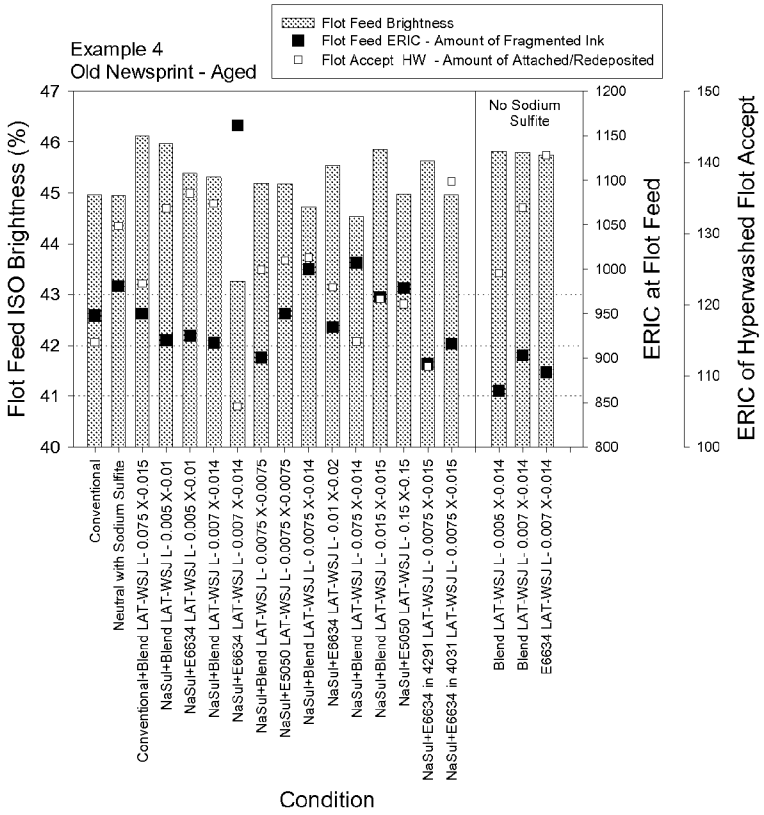


FIGURE 11

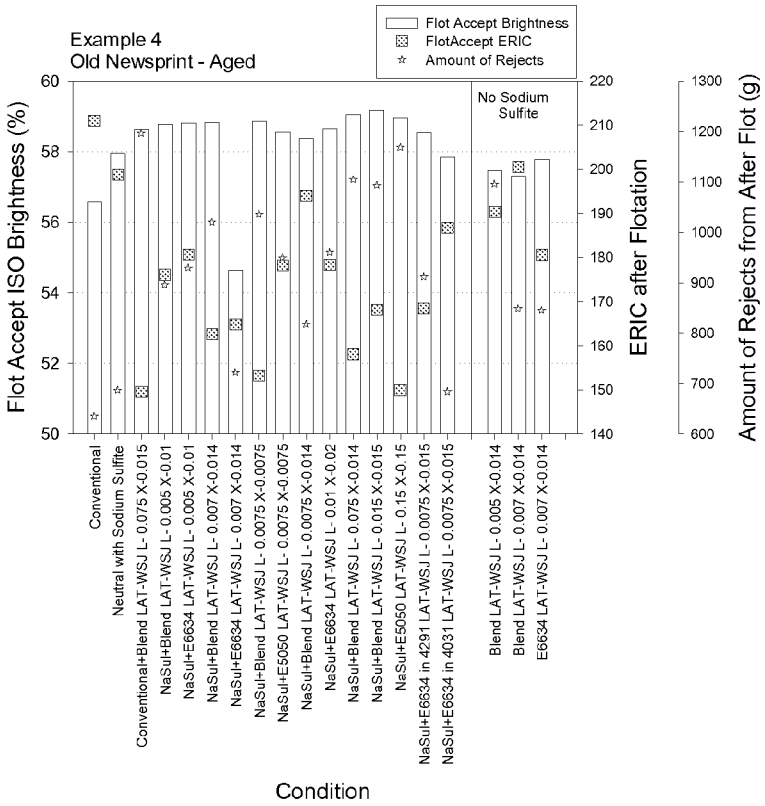

Example 4
Old Newsprint - Aged
Flot Accept Brightness
FlotAccept ERIC
Amount of Rejects
No Sodium Sulfite
Flot Accept ISO Brightness (%)
ERIC after Flotation
Amount of Rejects from After Flot (g)
Condition
Conventional
Neutral with Sodium Sulfite
Conventional+Blend LAT-WSJ L- 0.075 X-0.015
NaSul+Blend LAT-WSJ L- 0.005 X-0.01
NaSul+E6634 LAT-WSJ L- 0.005 X-0.01
NaSul+Blend LAT-WSJ L- 0.007 X-0.014
NaSul+E6634 LAT-WSJ L- 0.007 X-0.014
NaSul+Blend LAT-WSJ L- 0.0075 X-0.0075
NaSul+E5050 LAT-WSJ L- 0.0075 X-0.0075
NaSul+Blend LAT-WSJ L- 0.0075 X-0.014
NaSul+E6634 LAT-WSJ L- 0.01 X-0.02
NaSul+Blend LAT-WSJ L- 0.075 X-0.014
NaSul+Blend LAT-WSJ L- 0.015 X-0.015
NaSul+E5050 LAT-WSJ L- 0.15 X-0.15
NaSul+E6634 in 4291 LAT-WSJ L- 0.0075 X-0.015
NaSul+E6634 in 4031 LAT-WSJ L- 0.0075 X-0.015
Blend LAT-WSJ L- 0.005 X-0.014
Blend LAT-WSJ L- 0.007 X-0.014
E6634 LAT-WSJ L- 0.007 X-0.014

FIGURE 12

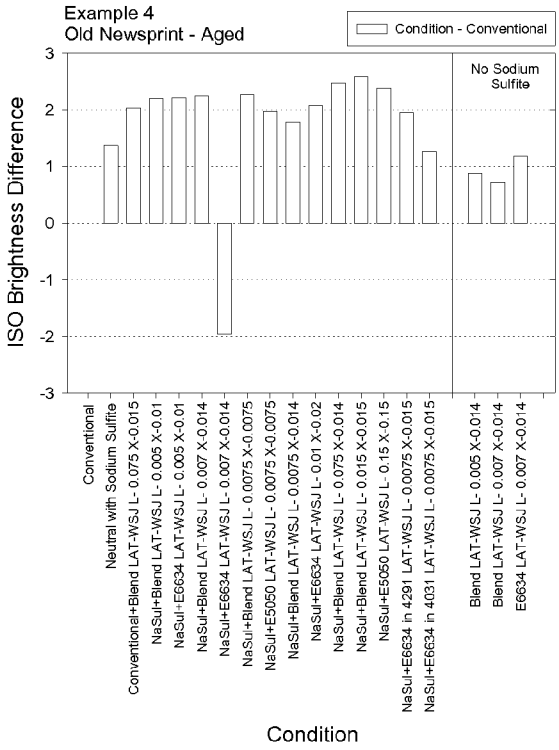

Example 4
Old Newsprint - Aged
Condition - Conventional
No Sodium Sulfite
ISO Brightness Difference
3
2
1
0
-1
-2
-3
Conventional
Neutral with Sodium Sulfite
Conventional+Blend LAT-WSJ L- 0.075 X-0.015
NaSul+Blend LAT-WSJ L- 0.005 X-0.01
NaSul+E6634 LAT-WSJ L- 0.005 X-0.01
NaSul+Blend LAT-WSJ L- 0.007 X-0.014
NaSul+E6634 LAT-WSJ L- 0.007 X-0.014
NaSul+Blend LAT-WSJ L- 0.0075 X-0.0075
NaSul+E5050 LAT-WSJ L- 0.0075 X-0.0075
NaSul+Blend LAT-WSJ L- 0.0075 X-0.014
NaSul+E6634 LAT-WSJ L- 0.01 X-0.02
NaSul+Blend LAT-WSJ L- 0.075 X-0.014
NaSul+Blend LAT-WSJ L- 0.015 X-0.015
NaSul+E5050 LAT-WSJ L- 0.15 X-0.15
NaSul+E6634 in 4291 LAT-WSJ L- 0.0075 X-0.015
NaSul+E6634 in 4031 LAT-WSJ L- 0.0075 X-0.015
Blend LAT-WSJ L- 0.005 X-0.014
Blend LAT-WSJ L- 0.007 X-0.014
E6634 LAT-WSJ L- 0.007 X-0.014
Condition

FIGURE 13

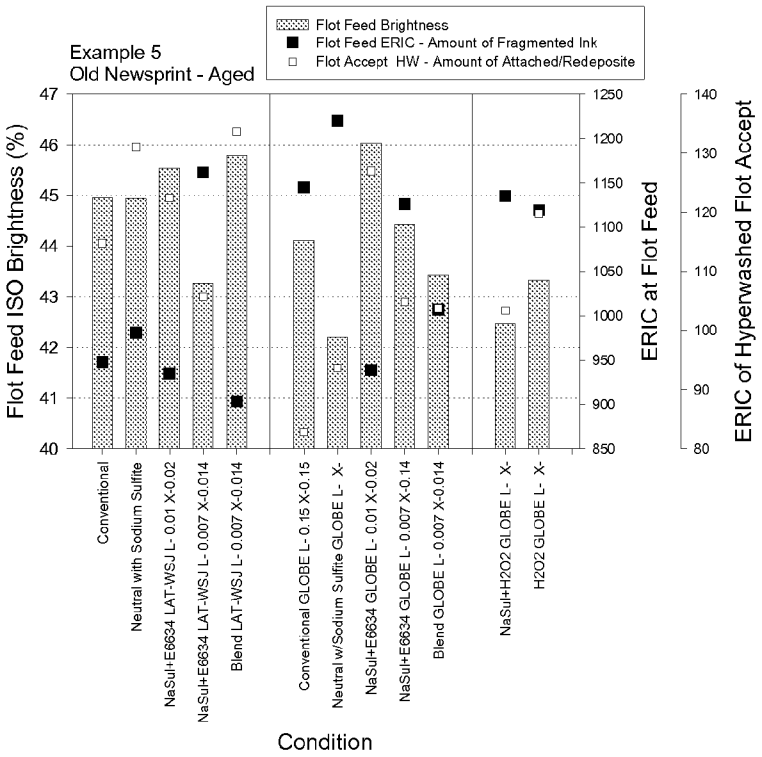

Flot Feed Brightness
Flot Feed ERIC - Amount of Fragmented Ink
Flot Accept HW - Amount of Attached/Redeposite
Example 5
Old Newsprint - Aged
Flot Feed ISO Brightness (%)
ERIC at Flot Feed
ERIC of Hyperwashed Flot Accept
Conventional
Neutral with Sodium Sulfite
NaSul+E6634 LAT-WSJ L- 0.01 X-0.02
NaSul+E6634 LAT-WSJ L- 0.007 X-0.014
Blend LAT-WSJ L- 0.007 X-0.014
Conventional GLOBE L- 0.15 X-0.15
Neutral w/Sodium Sulfite GLOBE L- X-
NaSul+E6634 GLOBE L- 0.01 X-0.02
NaSul+E6634 GLOBE L- 0.007 X-0.14
Blend GLOBE L- 0.007 X-0.014
NaSul+H2O2 GLOBE L- X-
H2O2 GLOBE L- X-
Condition

FIGURE 14

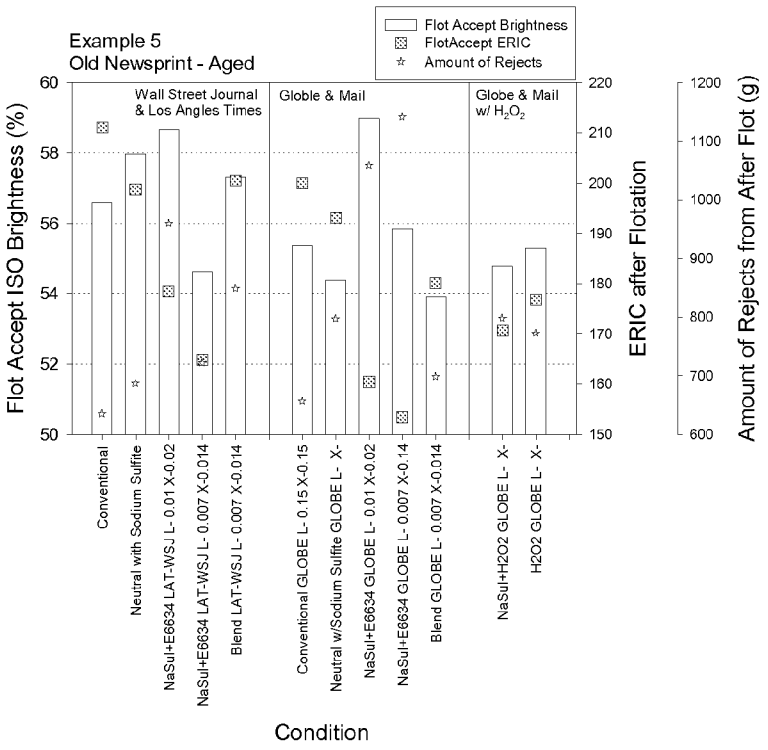

Example 5
Old Newsprint - Aged
Flot Accept Brightness
FlotAccept ERIC
Amount of Rejects
Wall Street Journal & Los Angles Times
Globle & Mail
Globe & Mail w/ H_2O_2
Flot Accept ISO Brightness (%)
ERIC after Flotation
Amount of Rejects from After Flot (g)
Conventional
Neutral with Sodium Sulfite
NaSul+E6634 LAT-WSJ L- 0.01 X-0.02
NaSul+E6634 LAT-WSJ L- 0.007 X-0.014
Blend LAT-WSJ L- 0.007 X-0.014
Conventional GLOBE L- 0.15 X-0.15
Neutral w/Sodium Sulfite GLOBE L- X-
NaSul+E6634 GLOBE L- 0.01 X-0.02
NaSul+E6634 GLOBE L- 0.007 X-0.14
Blend GLOBE L- 0.007 X-0.014
NaSul+H2O2 GLOBE L- X-
H2O2 GLOBE L- X-
Condition

FIGURE 15

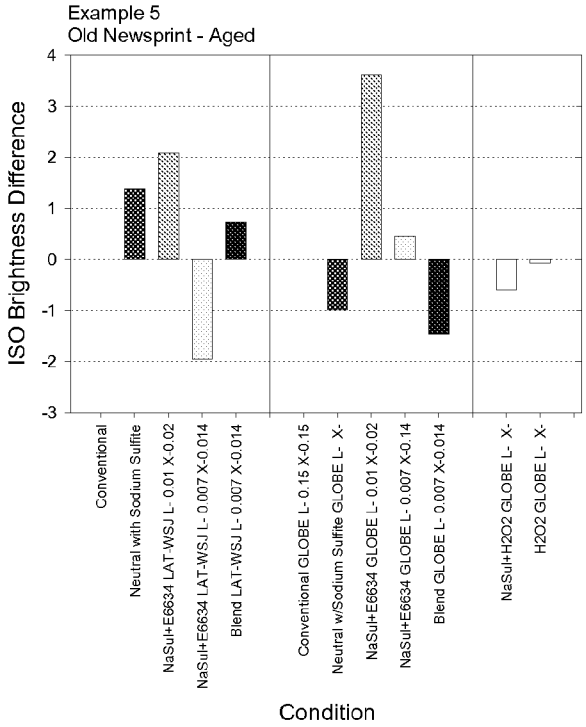

Example 5
Old Newsprint - Aged
ISO Brightness Difference
4
3
2
1
0
-1
-2
-3
Conventional
Neutral with Sodium Sulfite
NaSul+E6634 LAT-WSJ L- 0.01 X-0.02
NaSul+E6634 LAT-WSJ L- 0.007 X-0.014
Blend LAT-WSJ L- 0.007 X-0.014
Conventional GLOBE L- 0.15 X-0.15
Neutral w/Sodium Sulfite GLOBE L- X-
NaSul+E6634 GLOBE L- 0.01 X-0.02
NaSul+E6634 GLOBE L- 0.007 X-0.14
Blend GLOBE L- 0.007 X-0.014
NaSul+H2O2 GLOBE L- X-
H2O2 GLOBE L- X-
Condition

FIGURE 16

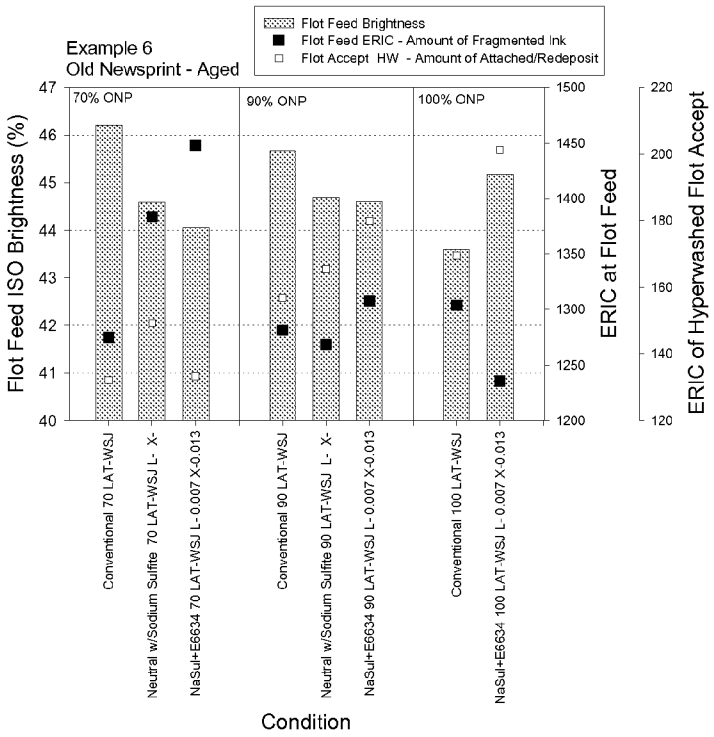

Flot Feed Brightness
Flot Feed ERIC - Amount of Fragmented Ink
Flot Accept HW - Amount of Attached/Redeposit
Example 6
Old Newsprint - Aged
70% ONP
90% ONP
100% ONP
Flot Feed ISO Brightness (%)
ERIC at Flot Feed
ERIC of Hyperwashed Flot Accept
Conventional 70 LAT-WSJ
Neutral w/Sodium Sulfite 70 LAT-WSJ L- X-
NaSul+E6634 70 LAT-WSJ L- 0.007 X-0.013
Conventional 90 LAT-WSJ
Neutral w/Sodium Sulfite 90 LAT-WSJ L- X-
NaSul+E6634 90 LAT-WSJ L- 0.007 X-0.013
Conventional 100 LAT-WSJ
NaSul+E6634 100 LAT-WSJ L- 0.007 X-0.013
Condition

FIGURE 17

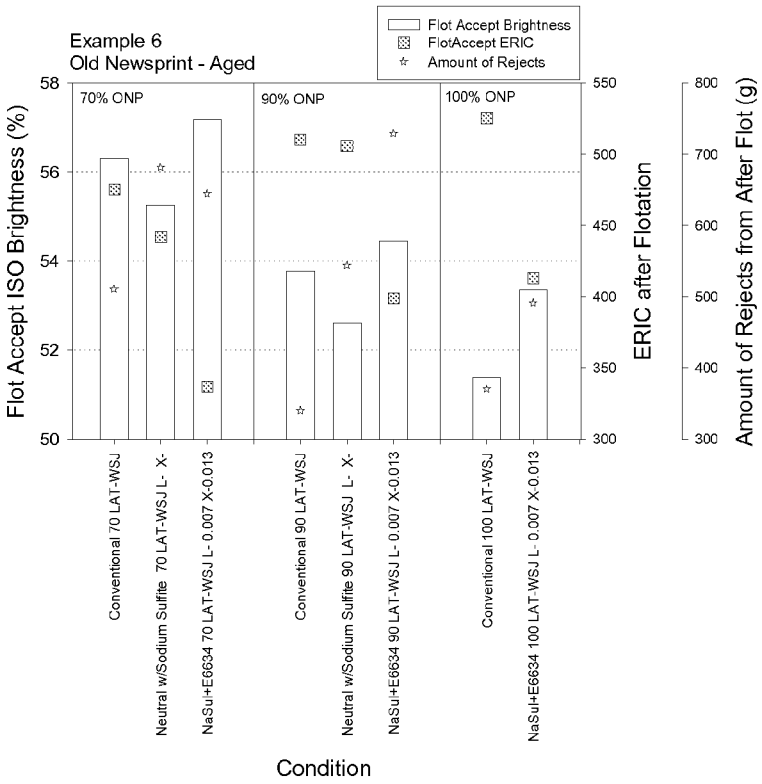

Example 6
Old Newsprint - Aged
Flot Accept Brightness
FlotAccept ERIC
Amount of Rejects
70% ONP
90% ONP
100% ONP
Flot Accept ISO Brightness (%)
ERIC after Flotation
Amount of Rejects from After Flot (g)
Conventional 70 LAT-WSJ
Neutral w/Sodium Sulfite 70 LAT-WSJ L- X-
NaSu+E6634 70 LAT-WSJ L- 0.007 X-0.013
Conventional 90 LAT-WSJ
Neutral w/Sodium Sulfite 90 LAT-WSJ L- X-
NaSu+E6634 90 LAT-WSJ L- 0.007 X-0.013
Conventional 100 LAT-WSJ
NaSu+E6634 100 LAT-WSJ L- 0.007 X-0.013
Condition

FIGURE 18

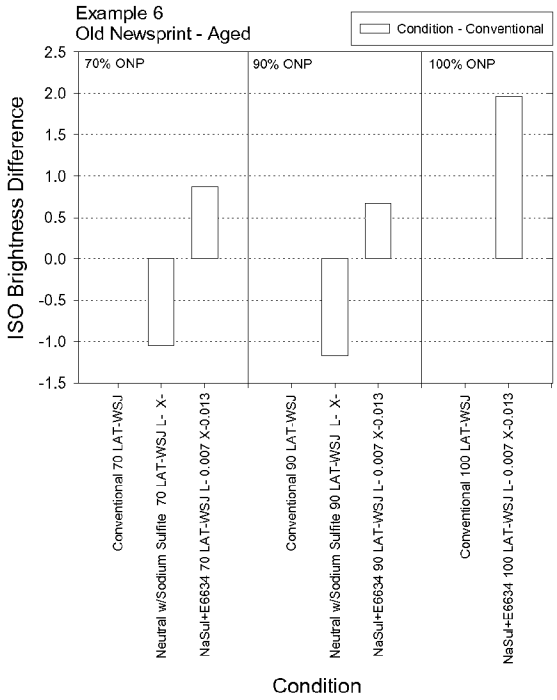


FIGURE 19

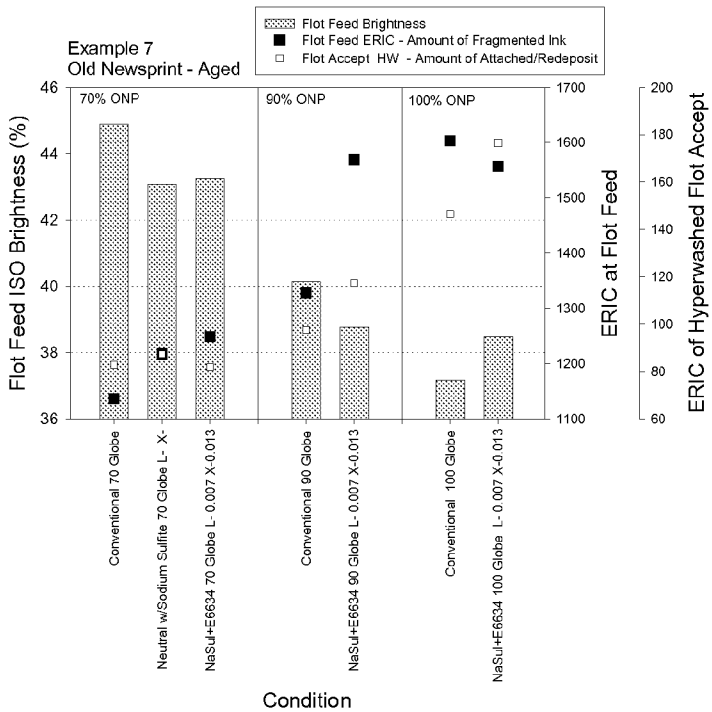


FIGURE 20

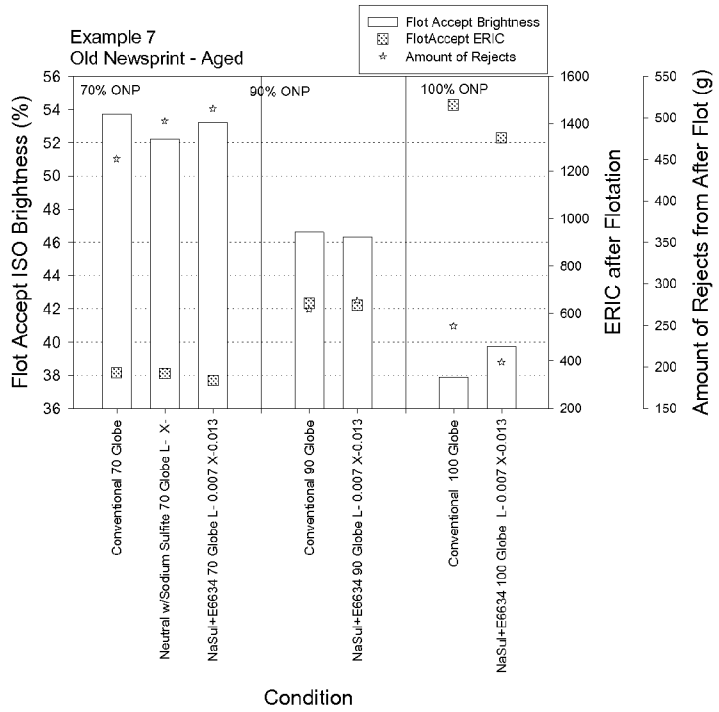


FIGURE 21

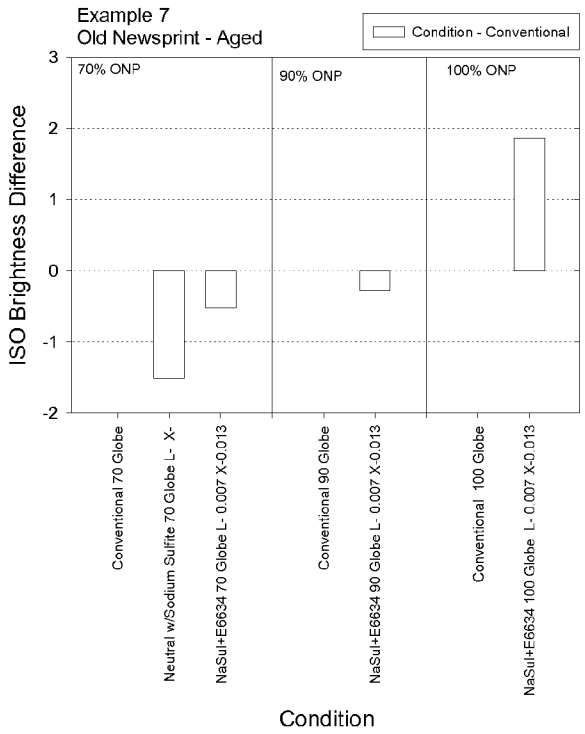


FIGURE 22

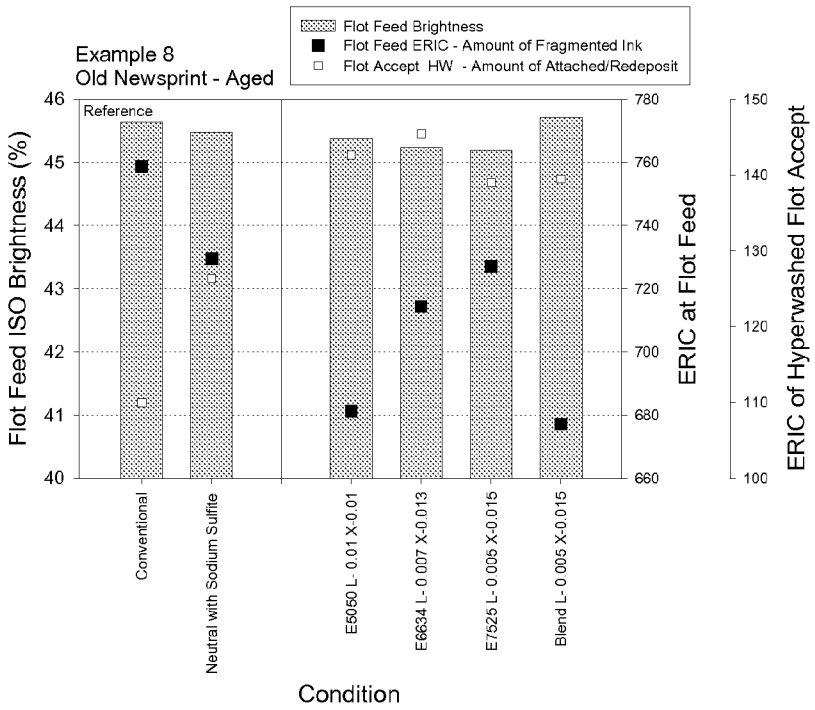


FIGURE 23

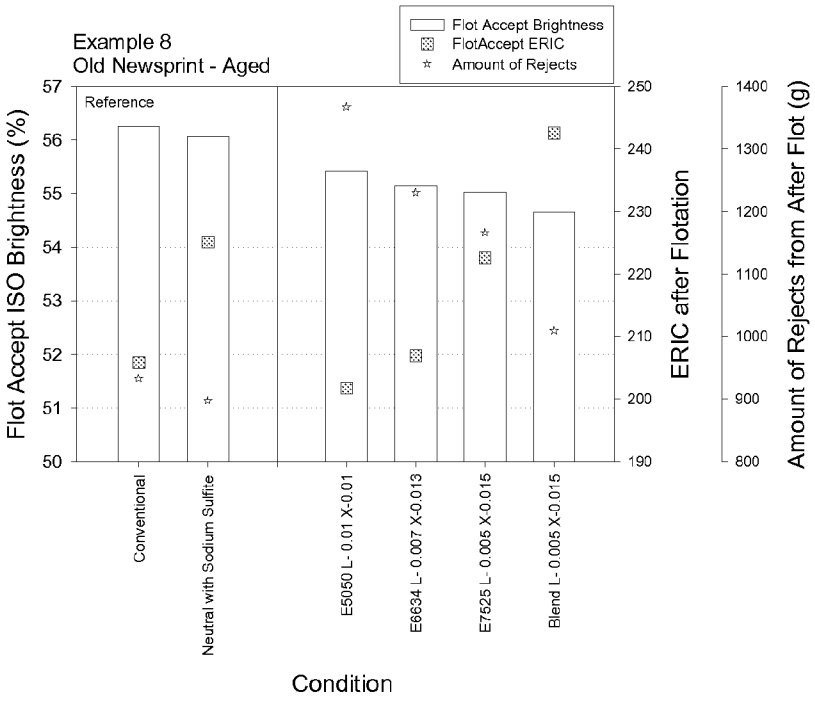


FIGURE 24

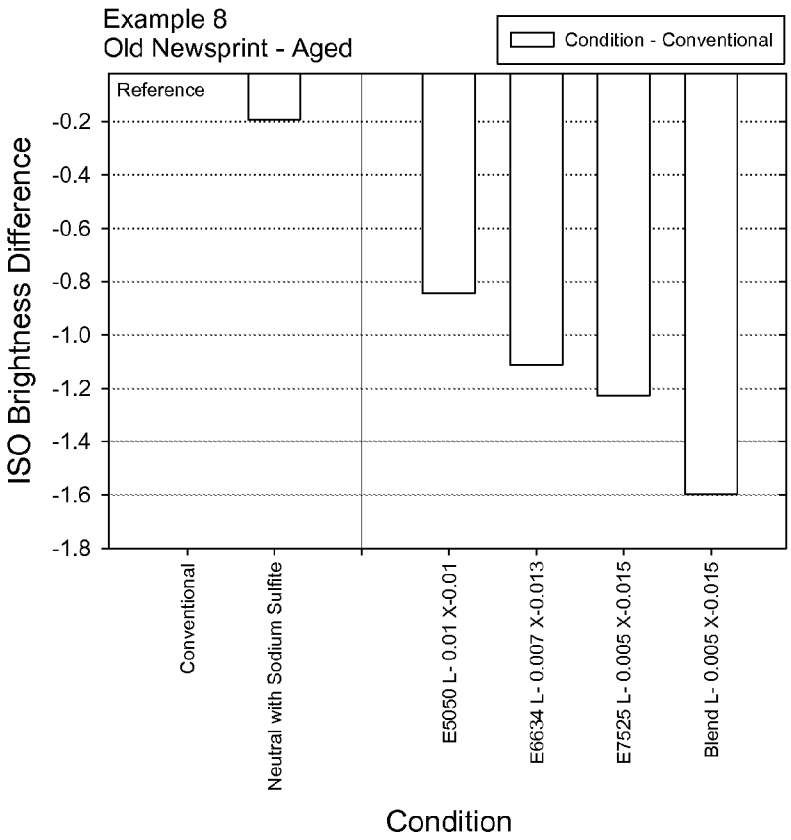

Example 8
Old Newsprint - Aged
Condition - Conventional
Reference
ISO Brightness Difference
-0.2
-0.4
-0.6
-0.8
-1.0
-1.2
-1.4
-1.6
-1.8
Conventional
Neutral with Sodium Sulfite
E5050 L- 0.01 X-0.01
E6634 L- 0.007 X-0.013
E7525 L- 0.005 X-0.015
Blend L- 0.005 X-0.015
Condition

FIGURE 25

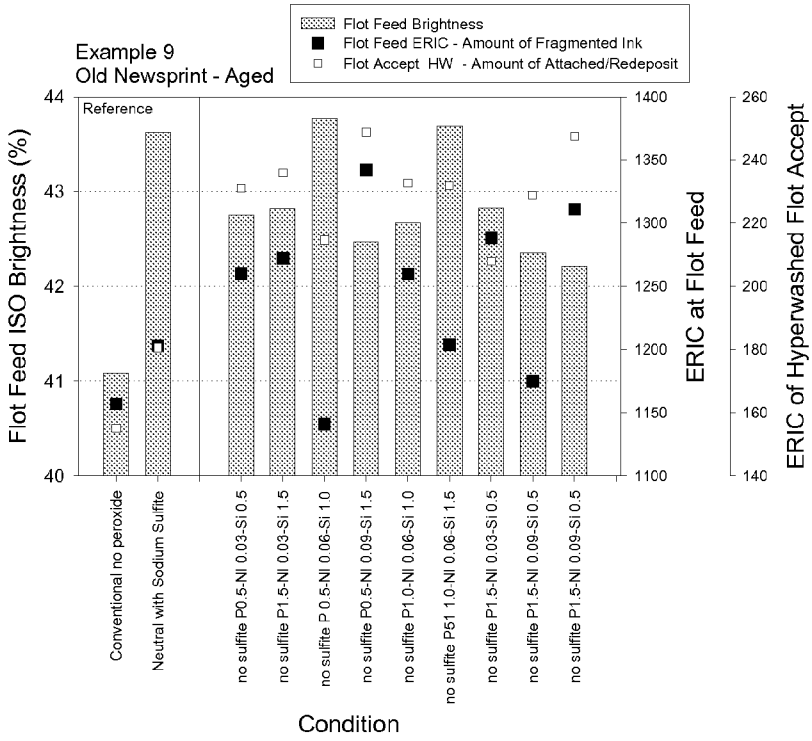

Flot Feed Brightness
Flot Feed ERIC - Amount of Fragmented Ink
Flot Accept HW - Amount of Attached/Redeposit
Example 9
Old Newsprint - Aged
Reference
Flot Feed ISO Brightness (%)
ERIC at Flot Feed
ERIC of Hyperwashed Flot Accept
Conventional no peroxide
Neutral with Sodium Suffite
no sulfite P0.5-NI 0.03-Si 0.5
no sulfite P1.5-NI 0.03-Si 1.5
no sulfite P 0.5-NI 0.06-Si 1.0
no sulfite P0.5-NI 0.09-Si 1.5
no sulfite P1.0-NI 0.06-Si 1.0
no suffite P51 1.0-NI 0.06-Si 1.5
no sulfite P1.5-NI 0.03-Si 0.5
no sulfite P1.5-NI 0.09-Si 0.5
no sulfite P1.5-NI 0.09-Si 0.5
Condition

FIGURE 26

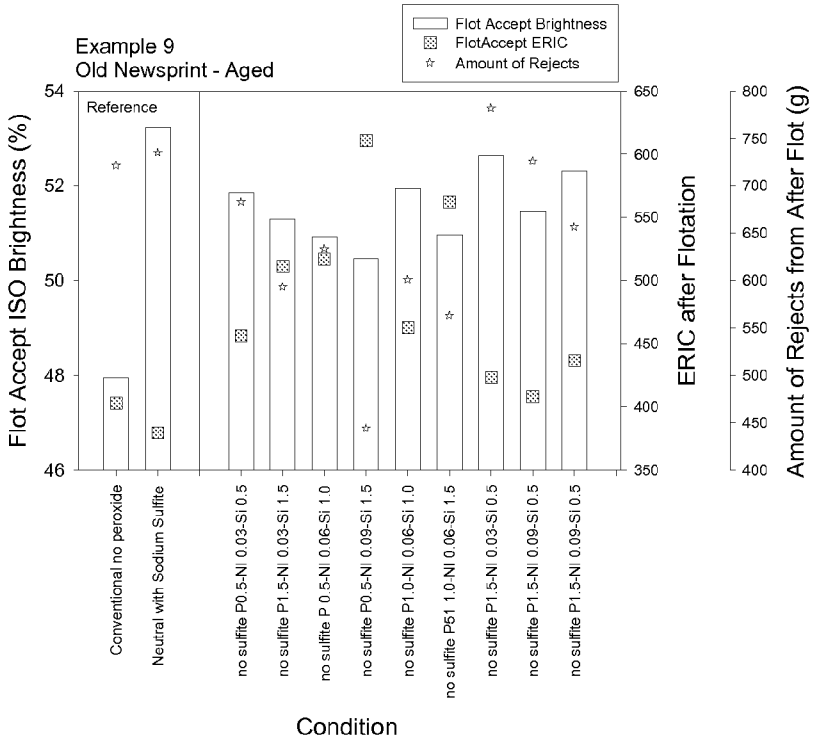


FIGURE 27

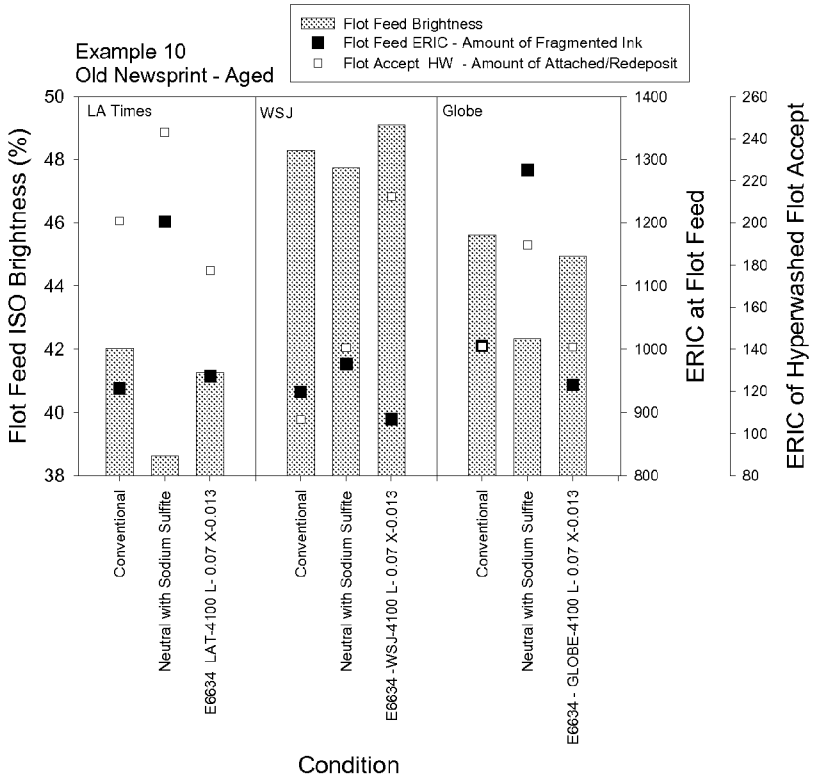


FIGURE 28

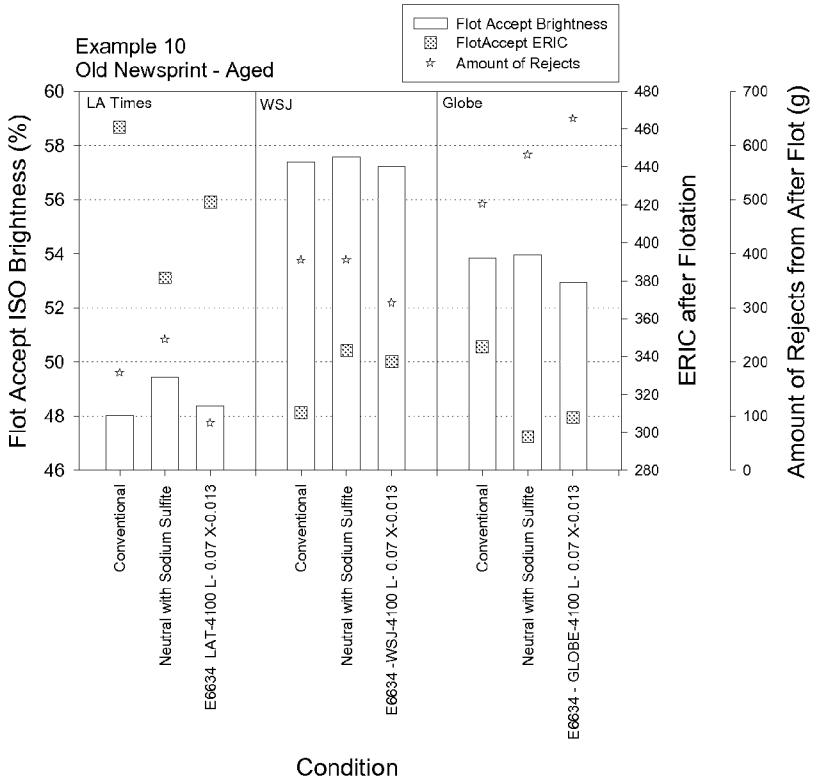


FIGURE 29

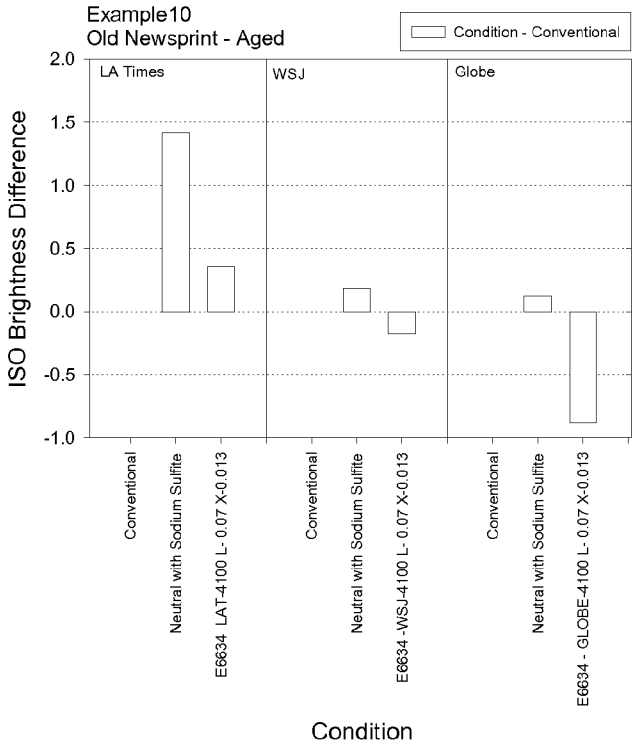


FIGURE 30

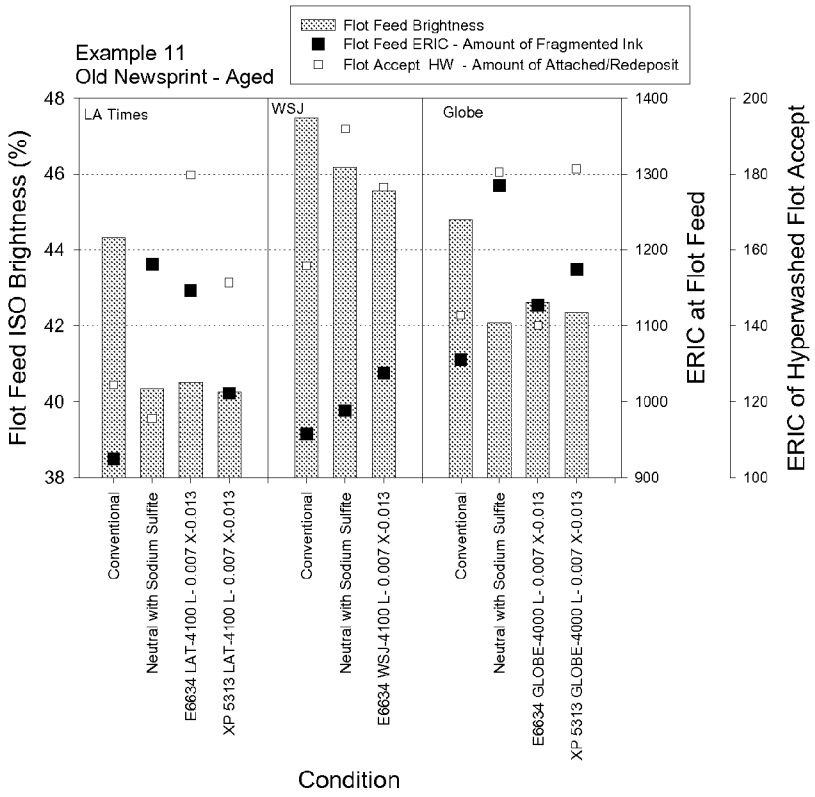

Example 11
Old Newsprint - Aged
Flot Feed Brightness
Flot Feed ERIC - Amount of Fragmented Ink
Flot Accept HW - Amount of Attached/Redeposit
LA Times
WSJ
Globe
Flot Feed ISO Brightness (%)
ERIC at Flot Feed
ERIC of Hyperwashed Flot Accept
48
46
44
42
40
38
1400
1300
1200
1100
1000
900
200
180
160
140
120
100
Conventional
Neutral with Sodium Sulfite
E6634 LAT-4100 L- 0.007 X-0.013
XP 5313 LAT-4100 L- 0.007 X-0.013
Conventional
Neutral with Sodium Sulfite
E6634 WSJ-4100 L- 0.007 X-0.013
Conventional
Neutral with Sodium Sulfite
E6634 GLOBE-4000 L- 0.007 X-0.013
XP 5313 GLOBE-4000 L- 0.007 X-0.013
Condition

FIGURE 31

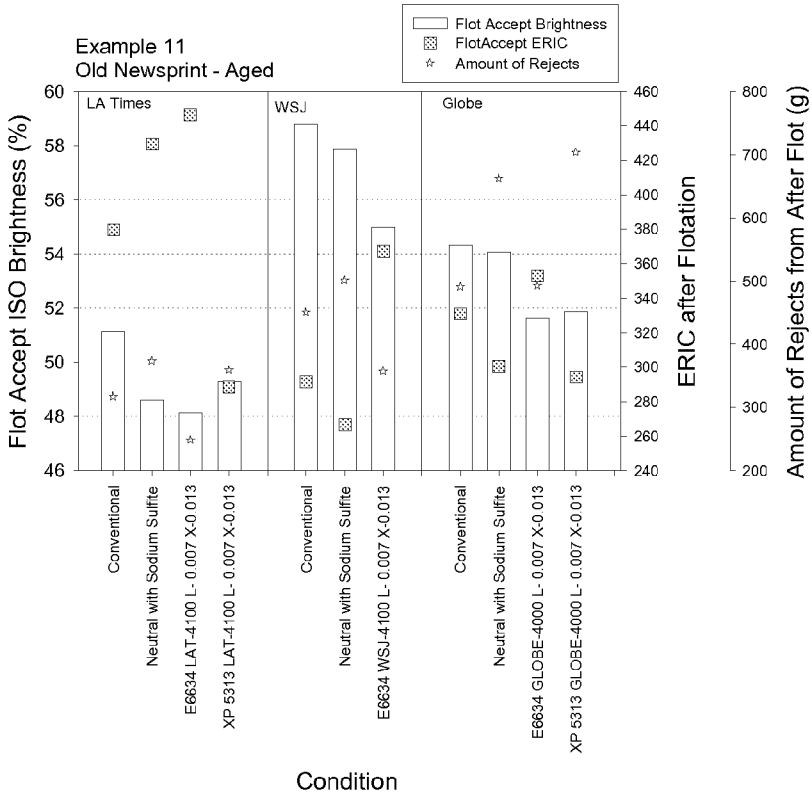

Example 11
Old Newsprint - Aged
Flot Accept Brightness
FlotAccept ERIC
Amount of Rejects
LA Times
WSJ
Globe
Flot Accept ISO Brightness (%)
ERIC after Flotation
Amount of Rejects from After Flot (g)
Conventional
Neutral with Sodium Sulfite
E6634 LAT-4100 L- 0.007 X-0.013
XP 5313 LAT-4100 L- 0.007 X-0.013
Conventional
Neutral with Sodium Sulfite
E6634 WSJ-4100 L- 0.007 X-0.013
Conventional
Neutral with Sodium Sulfite
E6634 GLOBE-4000 L- 0.007 X-0.013
XP 5313 GLOBE-4000 L- 0.007 X-0.013
Condition

FIGURE 32

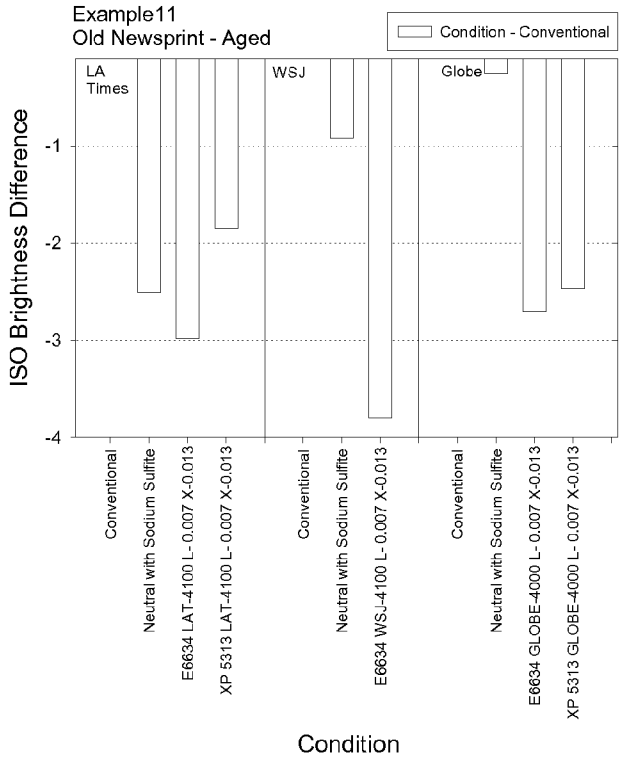

Example11
Old Newsprint - Aged
Condition - Conventional
LA Times
WSJ
Globe
ISO Brightness Difference
-1
-2
-3
-4
Conventional
Neutral with Sodium Sulfite
E6634 LAT-4100 L- 0.007 X-0.013
XP 5313 LAT-4100 L- 0.007 X-0.013
Conventional
Neutral with Sodium Sulfite
E6634 WSJ-4100 L- 0.007 X-0.013
Conventional
Neutral with Sodium Sulfite
E6634 GLOBE-4000 L- 0.007 X-0.013
XP 5313 GLOBE-4000 L- 0.007 X-0.013
Condition

FIGURE 33

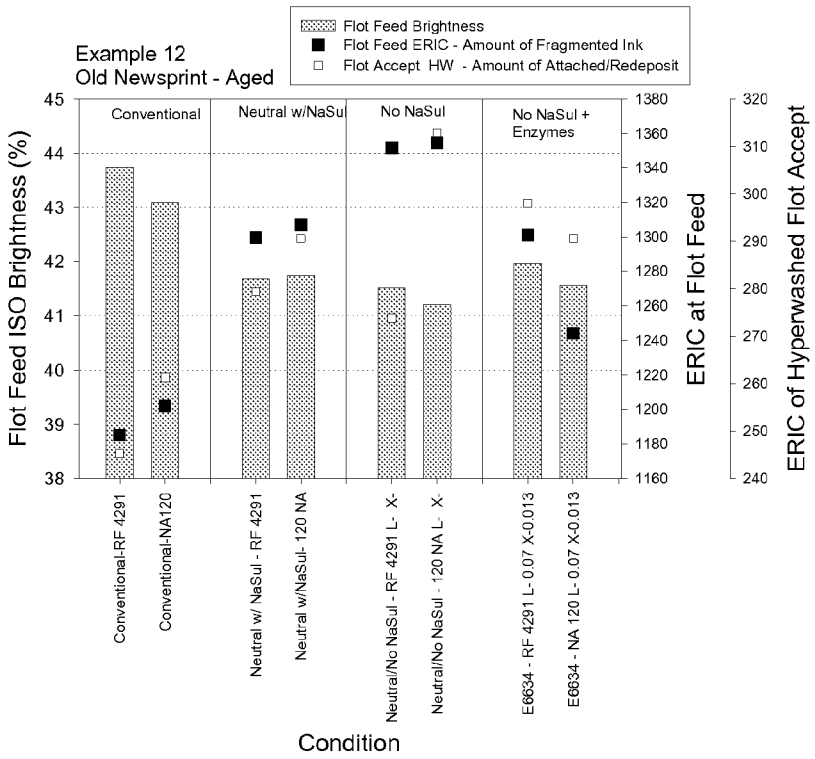

Example 12
Old Newsprint - Aged
Flot Feed Brightness
Flot Feed ERIC - Amount of Fragmented Ink
Flot Accept HW - Amount of Attached/Redeposit
Conventional
Neutral w/NaSul
No NaSul
No NaSul + Enzymes
Flot Feed ISO Brightness (%)
ERIC at Flot Feed
ERIC of Hyperwashed Flot Accept
Conventional-RF 4291
Conventional-NA120
Neutral w/ NaSul - RF 4291
Neutral w/NaSul- 120 NA
Neutral/No NaSul - RF 4291 L- X-
Neutral/No NaSul - 120 NA L- X-
E6634 - RF 4291 L- 0.07 X-0.013
E6634 - NA 120 L- 0.07 X-0.013
Condition

FIGURE 34

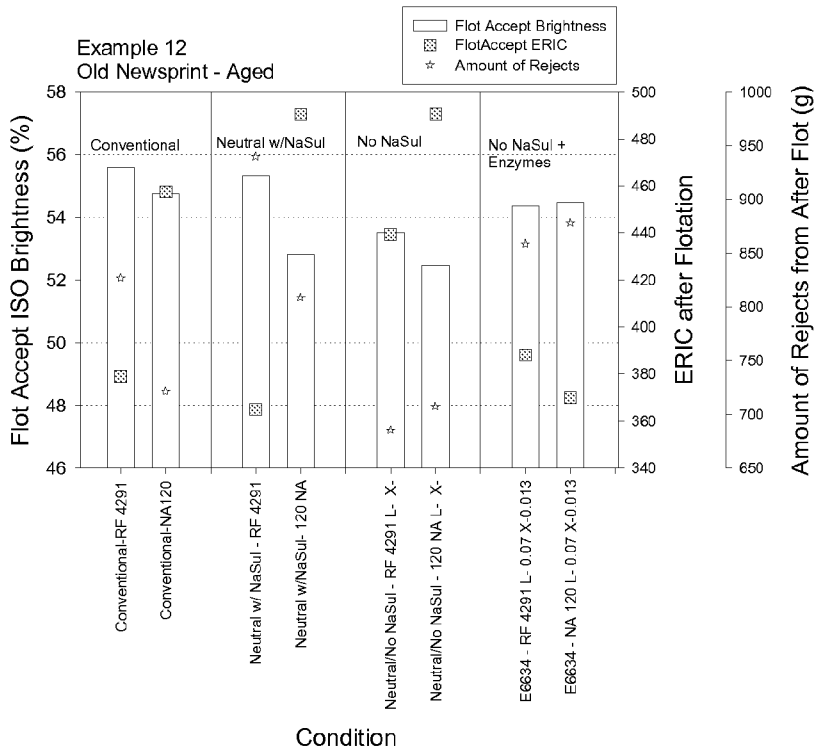


FIGURE 35

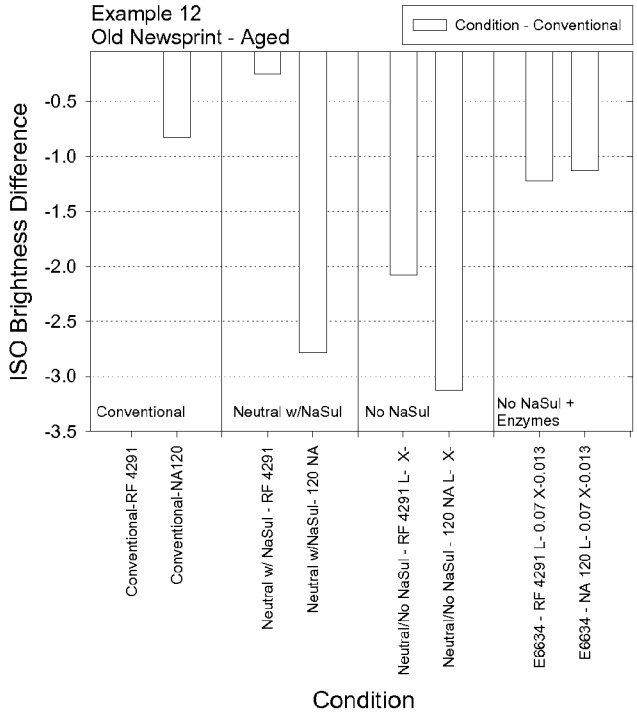


FIGURE 36

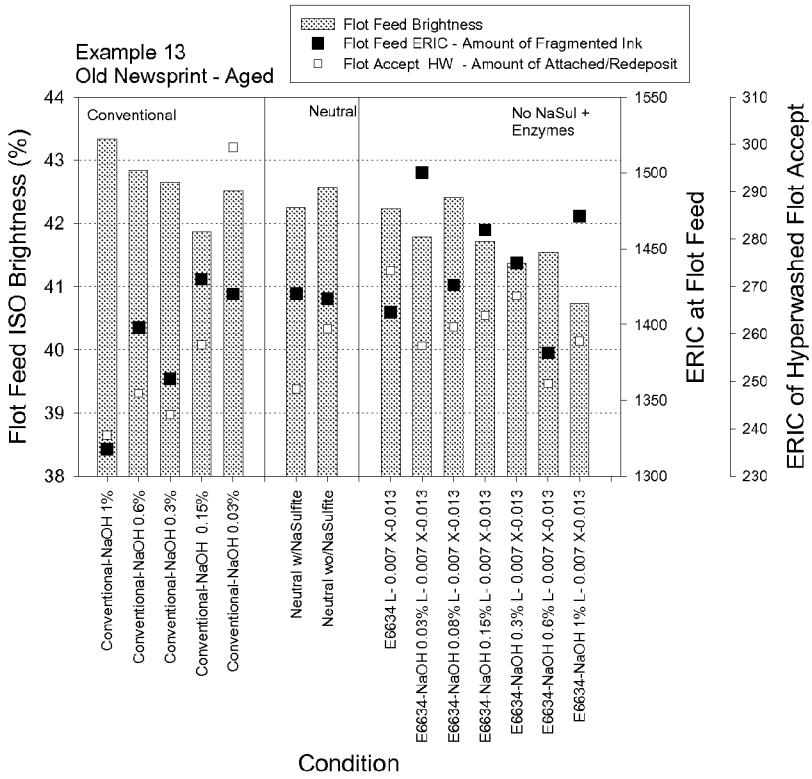

Flot Feed Brightness
Flot Feed ERIC - Amount of Fragmented Ink
Flot Accept HW - Amount of Attached/Redeposit
Example 13
Old Newsprint - Aged
Conventional
Neutral
No NaSul + Enzymes
Flot Feed ISO Brightness (%)
ERIC at Flot Feed
ERIC of Hyperwashed Flot Accept
Conventional-NaOH 1%
Conventional-NaOH 0.6%
Conventional-NaOH 0.3%
Conventional-NaOH 0.15%
Conventional-NaOH 0.03%
Neutral w/NaSulfite
Neutral wo/NaSulfite
E6634 L- 0.007 X-0.013
E6634-NaOH 0.03% L- 0.007 X-0.013
E6634-NaOH 0.08% L- 0.007 X-0.013
E6634-NaOH 0.15% L- 0.007 X-0.013
E6634-NaOH 0.3% L- 0.007 X-0.013
E6634-NaOH 0.6% L- 0.007 X-0.013
E6634-NaOH 1% L- 0.007 X-0.013
Condition

FIGURE 37

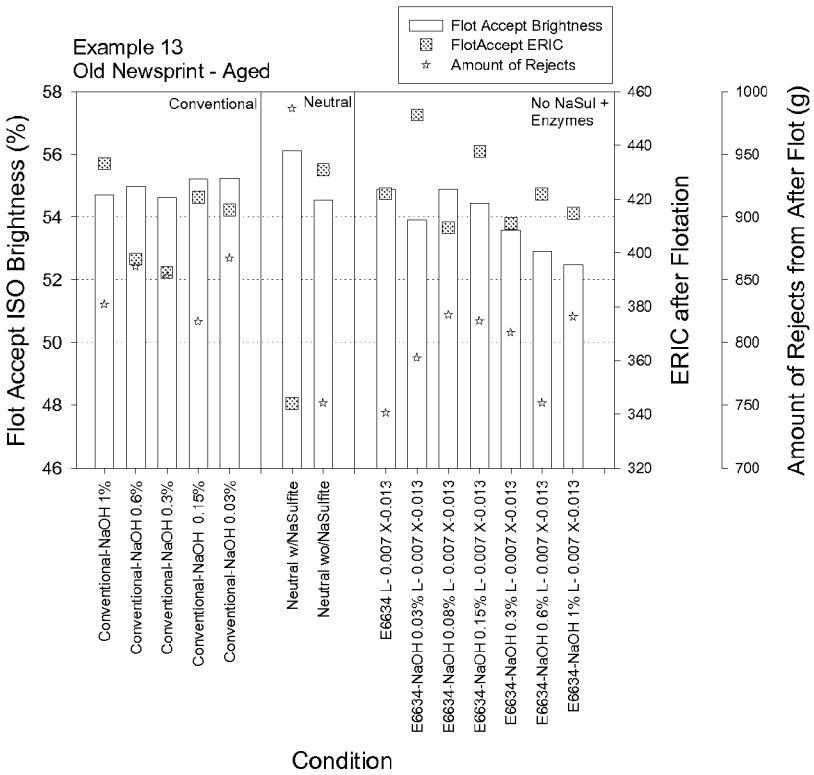

Example 13
Old Newsprint - Aged
Flot Accept Brightness
FlotAccept ERIC
Amount of Rejects
Conventional
Neutral
No NaSul + Enzymes
Flot Accept ISO Brightness (%)
ERIC after Flotation
Amount of Rejects from After Flot (g)
58
56
54
52
50
48
46
460
440
420
400
380
360
340
320
1000
950
900
850
800
750
700
Conventional-NaOH 1%
Conventional-NaOH 0.6%
Conventional-NaOH 0.3%
Conventional-NaOH 0.15%
Conventional-NaOH 0.03%
Neutral w/NaSulfite
Neutral wo/NaSulfite
E6634 L- 0.007 X-0.013
E6634-NaOH 0.03% L- 0.007 X-0.013
E6634-NaOH 0.08% L- 0.007 X-0.013
E6634-NaOH 0.15% L- 0.007 X-0.013
E6634-NaOH 0.3% L- 0.007 X-0.013
E6634-NaOH 0.6% L- 0.007 X-0.013
E8634-NaOH 1% L- 0.007 X-0.013
Condition

FIGURE 38

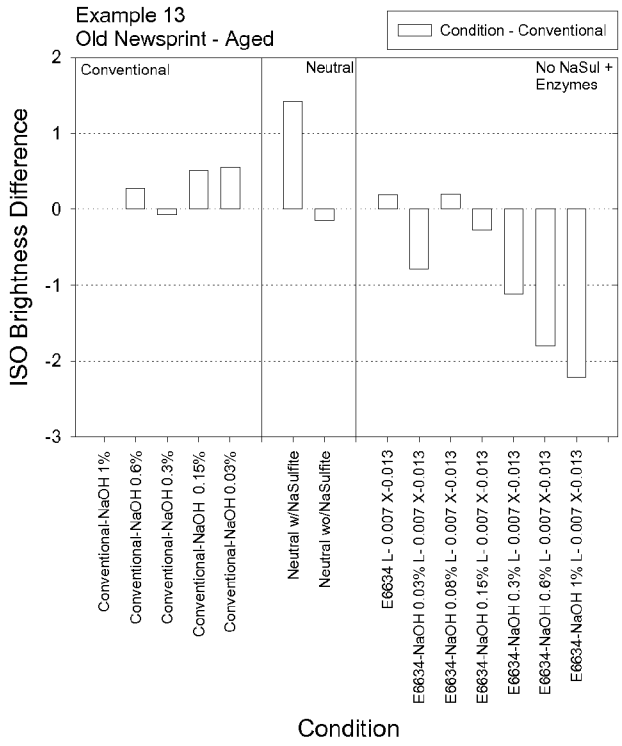


FIGURE 39

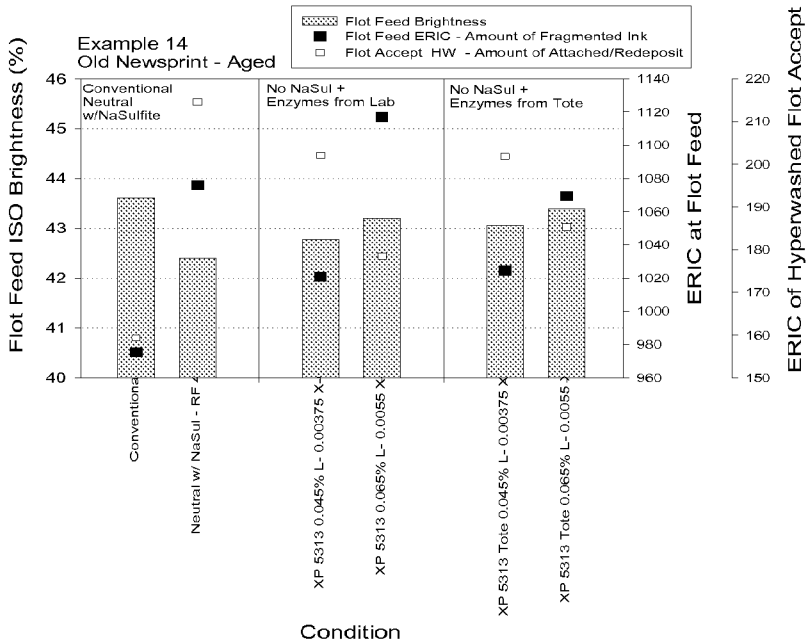


FIGURE 40

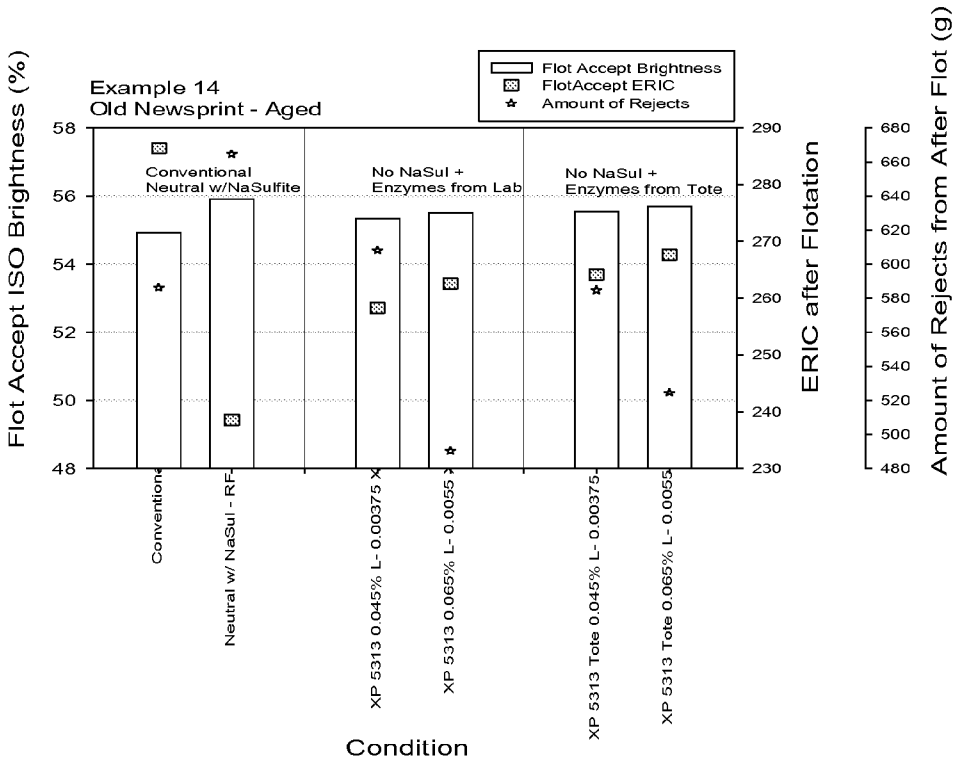


FIGURE 41

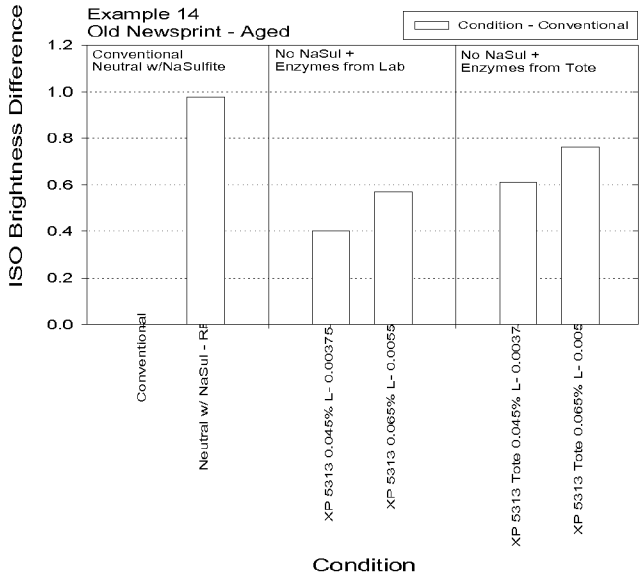


FIGURE 42

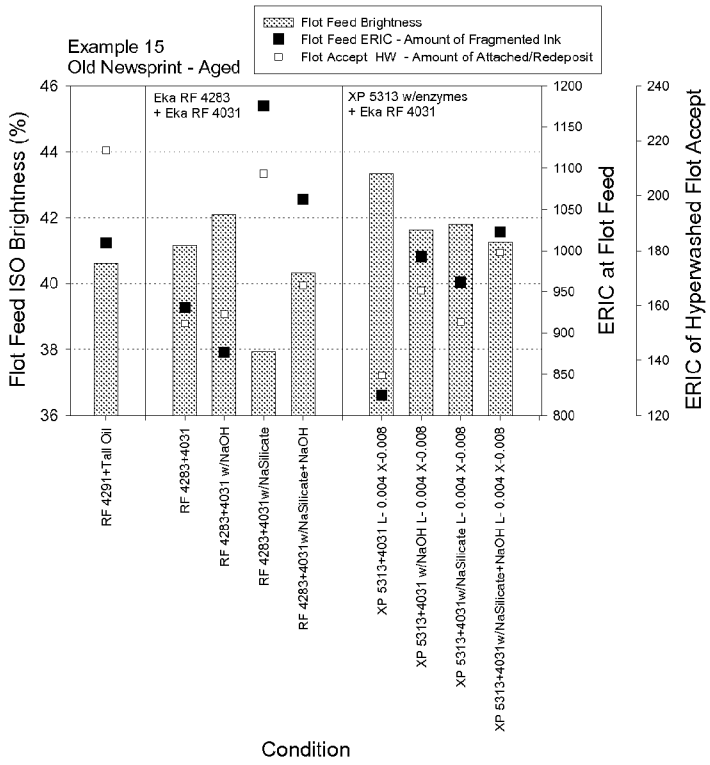


FIGURE 43

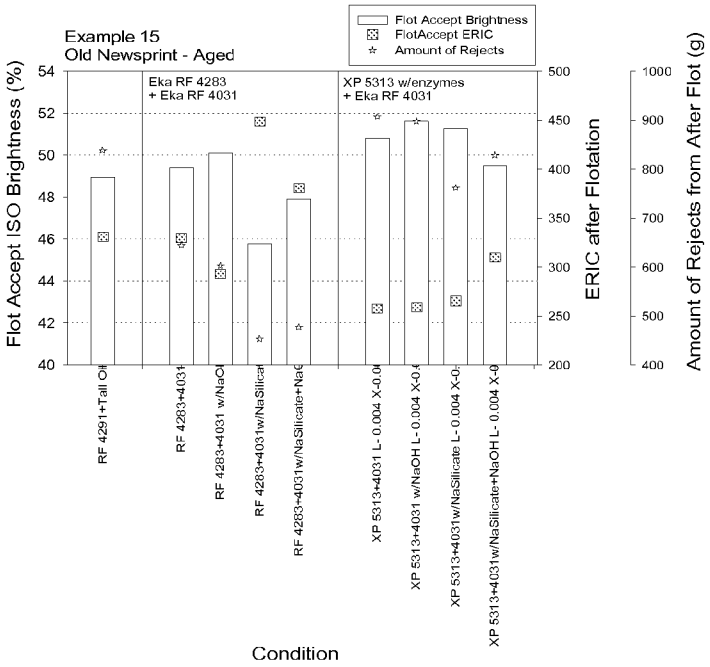
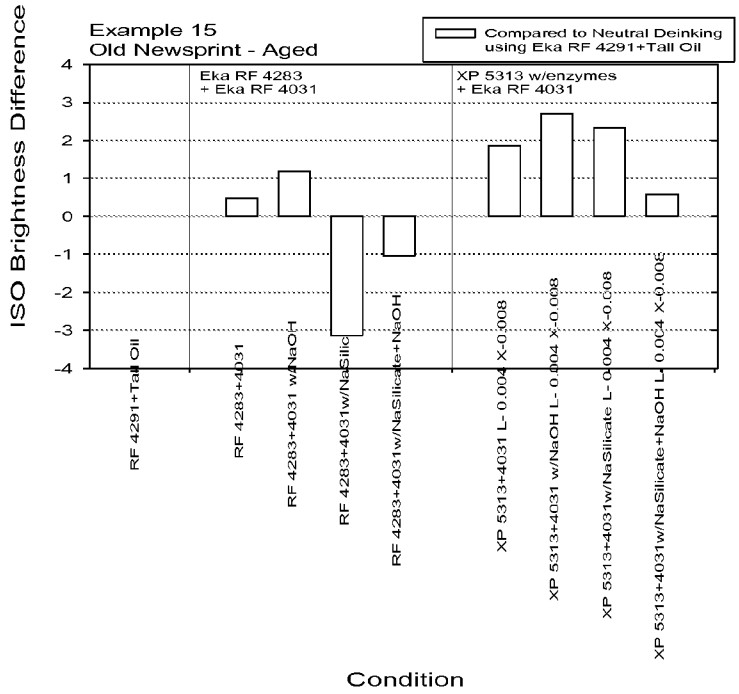


FIGURE 44


Example 15
Old Newsprint - Aged
Compared to Neutral Deinking using Eka RF 4291+Tall Oil
Eka RF 4283 + Eka RF 4031
XP 5313 w/enzymes + Eka RF 4031
ISO Brightness Difference
4
3
2
1
0
-1
-2
-3
-4
RF 4291+Tall Oil
RF 4283+4031
RF 4283+4031 w/NaOH
RF 4283+4031w/NaSilic
RF 4283+4031w/NaSilicate+NaOH
XP 5313+4031 L- 0.004 X-0.008
XP 5313+4031 w/NaOH L- 0.004 X-0.008
XP 5313+4031w/NaSilicate L- 0.004 X-0.008
XP 5313+4031w/NaSilicate+NaOH L- 0.004 X-0.008
Condition

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2011/024501

A. CLASSIFICATION OF SUBJECT MATTER
INV. D21C5/02
ADD. D21C5/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
D21C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 96/00811 A1 (SCOTT PAPER CO [US]) 11 January 1996 (1996-01-11) claims 1-53; example 2	1,2,8,13
A	US 2001/047852 A1 (FRANKS NEAL E [US]) 6 December 2001 (2001-12-06) claims 1-42	1-45
A	US 2002/142452 A1 (YANG JAN L [US] ET AL YANG JAN L [US] ET AL) 3 October 2002 (2002-10-03) claims 1-84	1-45
A	WO 2007/018368 A1 (KOREA RES INST CHEM TECH [KR]; RYU JEONG-YONG [KR]; KIM YONG HWAN [KR]) 15 February 2007 (2007-02-15) the whole document	1-45

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 March 2011	06/04/2011

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Karlsson, Lennart

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2011/024501

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2005/039869 A1 (FRANKS NEAL [US] ET AL) 24 February 2005 (2005-02-24) the whole document	1-45
A	US 5 503 709 A (BURTON STEVEN W [US]) 2 April 1996 (1996-04-02) claims 1-5; example 4	1-45
A	GB 2 231 595 A (KOREA RES INST CHEM TECH [KR]) 21 November 1990 (1990-11-21) claims 1-7	1-45
A	EP 0 967 320 A1 (KOREA RES INST CHEM TECH [KR]) 29 December 1999 (1999-12-29) the whole document	1-45
A	WO 91/14822 A1 (NOVO NORDISK AS [DK]) 3 October 1991 (1991-10-03) the whole document	1-45

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2011/024501

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9600811 A1	11-01-1996	AT 222307 T	15-08-2002
		AU 689919 B2	09-04-1998
		AU 2913295 A	25-01-1996
		BR 9508134 A	02-09-1997
		CA 2194188 A1	11-01-1996
		CN 1159841 A	17-09-1997
		CZ 9603832 A3	15-10-1997
		DE 69527794 D1	19-09-2002
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