Effect of Surfactant Application on Pulping Characteristics of Mill Chips and Reduction in Pollution Load

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Mill chips comprising of 55% bamboo and 45% mixed hard woods were treated with DCA-100 (AQ + non-ionic surfactant), IGSURF-1206 (blend of non-ionic surfactant) and R-DCA-1000 (non-ionic surfactant) separately along with optimum dosage of alkali as Na_2O under normal cooking conditions. There was reduction in D.C.M. extractives, pulp kappa, reject% and improvement in unbleached pulp brightness by applying DCA-100 and IGSURF-1206 surfactants compared to blank experiment. It was observed that improvement in unbleached and bleached pulp yield and physical strength properties were maximum with IGSURF-1206 non-ionic surfactant followed by DCA-100 (AQ + nonionic surfactant) while RDCA-1000 has not given encouraging results compared to blank experiment. Moreover considerable reduction was observed in COD mg/l, suspended solids mg/l, dissolved solids mg/l and chloride mg/l when DCA-100 and IGSURF-1206 applied unbleached pulps were bleached under C-Ep-H-D bleaching sequence compared to blank experiment. Here also RDCA-1000 has not observed to have reduced pollution load to the extent as compared to other non-ionic surfactants as compared with blank experiment.

INTRODUCTION

Improvement in productivity is the key to reduce cost of production. Very little improvement in productivity can be achieved by altering the pulping parameters such as alkali charge, cooking time, cooking temperature since most of them are being maintained at optimum level in plant operations. As of now no new methods / technology has arisen commercially to seriously challenge the Kraft pulping process itself and most productivity improvement efforts have focused on improving Kraft pulp yield through protection of polysaccharides against progressive degradation.

By way of intensive research in the development of suitable additive for improving Kraft pulping.

In this connection the use of anthraquinone with soda or Kraft process has been studied extensively in the laboratory and in the field [1,2] that results in higher production rate and more environmentally friendly operations[3]. It was observed that poor solubility of anthraquinone resulted in deposition in Recovery Evaporator with prolonged use of anthraquinone along with alkali. Attention was therefore diverted to new series of digester cooking additives based on surface-active reagents.

The use of surfactants as cooking additive minimize the surface tension between the liquor and chips, resulting in the wetting of chips surfaces. This gives rise to more uniform cooking with lower kappa No., lower screen rejects, lower resin content and improved black liquor residual active alkali[4-6]. The products of thermal degradation of extractives are strongly coloured and contribute to dark colour of unbleached pulps[7,8]. These results suggest another possibility of surfactant action, which is to avoid the deposition of extractive degradation products on to the surface of fibres. In the conventional cooking the presence of different surfactants minimize the deposition of thermally degraded substances on the fibre surface, thus preventing dark colouration[9,10]. The removal of extractives also contributes to decrease in Kappa No., because these are the compounds that are oxidizable by the permanganate solution in Kappa determination[11].

The aim of utilizing different surfactants as cooking additive on lab scale studies was to establish their efficacy in improvement of pulp yield, reduction in rejects percentage, reduction in bleach consumption, improvement in pulp quality and effluent characteristics.

EXPERIMENTAL :

Screened bamboo mix (from M.P, U.P and Assam) and screened hard wood mix (Sal, Eucalyptus, Acacia & Subabool) were taken in 55:45 proportion & treated with alkali along with various digester additive under normal cooking conditions as follows (i) DCA-100 (light yellow to grey crystal powder comprising of anthraquinone and surfactants) (ii) IGSURF-1206 (in liquid form a blend of non ionic surfactants) (iii) R-DCA-1000 (pale yellow liquid, non-ionic surfactant that is biodegradable in nature).

Fiber classification and physical strength properties evaluation of all the unbleached pulps (with and without addition of surfactants) was carried out. Subsequently all the unbleached pulps (with and without surfactant addition) were bleached under C-Ep-H-D bleaching sequence for pulp brightness to 87-88% P.V.

Effluent samples in each stage of bleaching of all the above six pulp samples was analysed for different parameters.

Fiber classification of bleached pulps carried out in a Baur Mcnett classifier is

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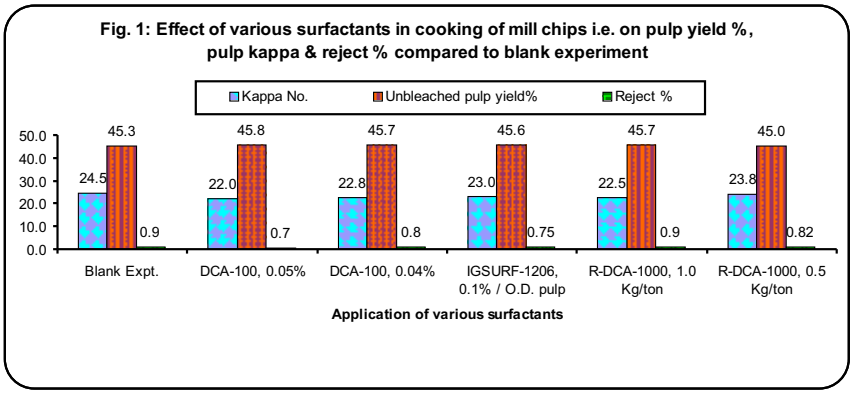


Fig. 1: Effect of various surfactants in cooking of mill chips i.e. on pulp yield %, pulp kappa & reject % compared to blank experiment

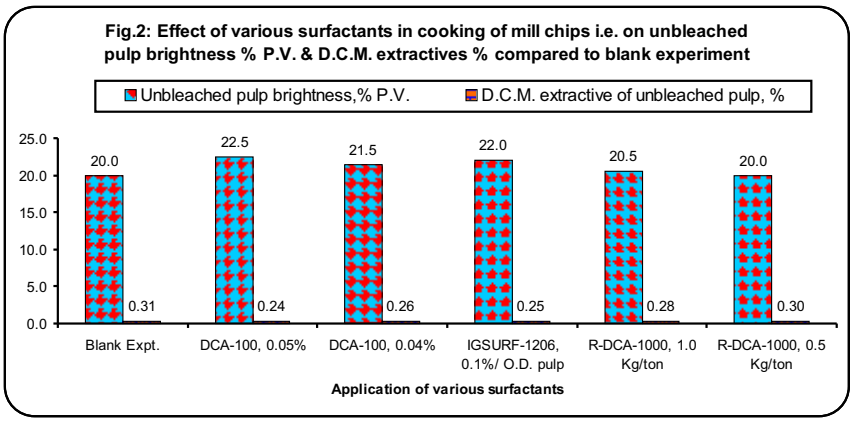


Fig.2: Effect of various surfactants in cooking of mill chips i.e. on unbleached pulp brightness % P.V. & D.C.M. extractives % compared to blank experiment

reported in Table-6. Above bleached pulps were beaten to 30°SR freeness and standard sheets were prepared and tested for physical strength properties.

DISCUSSIONS:

As may be seen from Fig. 1. composite-screened mill chips (bamboo+ hard wood: 55:45) digested with 17.0% alkali as Na_2O under normal cooking condition gave unbleached pulp of kappa 24.5, unbleached pulp yield 45.3% and rejects 0.9%. While application of DCA-100 digester additive (containing anthraquinone and non - ionic surfactant in powder form) with dosages 0.05% and 0.04 % on O.D. chips resulted in improvement in unbleached pulp yield to 45.8% and 45.7% respectively compared to blank experiment. Rejects percentage was also observed to reduce from 0.9% to 0.7% and 0.8% respectively. This is because the addition of surfactants based additives reduce the surface tension between liquor and chips, allowing for pronounced wetting of chips surface and facilitating rapid penetration of liquor into inner matrix of chip[12]. Better penetration of cooking liquor into wood chips helps in faster defibering of chips, improved deresina--tion, reduction in Kappa No. rejects resulting in over all improvement in pulp quality.

It was observed that unbleached pulp brightness also improved by 12.5% and 7.5% respectively where as D.C.M. extractive reduced to 22.5% and 16.1% compared to blank experiment. Synergistic effects are obtained when surfactant and anthraquinone are applied together. Anthraquinone acts as a catalyst to accelerate delignification and preserves hemicelluloses by reducing peeling off reaction of hemicelluloses, while the surfactant improve the selectivity of anthraquino--ne and enhances the rate of white liquor penetration[13]. Also there was noticed improvement in residual alkali in black liquor with addition of digester additive compared to blank experiment.

Application of IGSURF-1206 digester additive (Combination of non ionic surfactant in liquid form) 0.1 % on O.D. pulp under similar cooking conditions as in blank experiment, resulted in improvement of unbleached pulp yield 45.6 % and reduction in rejects (0.75%) compared to blank experiment. Unbleached pulp brightness improved by 10.0% and reduction in D.C.M. extractive (19.35%) was observed compared to blank experiment. There was also improvement in residual alkali in black liquor compared to blank experiment.

In another set of experiments R-DCA-1000 digester additive (Non-ionic surfactant in liquid form) with dosages of 1.0 and 0.5 Kg/ton of chips were applied. Improvement in unbleached pulp yield (45.7%) was observed with 1.0% surfactant but there was no reduction in reject %. Also there was no significant improvement in pulp brightness of unbleached pulp and reduction in D.C.M. extractives compared to blank experiment. Improvements in unbleached pulp yield% and reduction in rejects% with surfactant addition compared to blank experiment is projected in Fig.1. Unbl--eached pulp brightness improvement by addition of surfactants and reduction in D.C.M extractives is depicted in Fig.2.

As may be seen from above addition of surfactant DCA-100 (doses, 0.4%) and RDCA-1000 (dosage, 0.5 kg/Ton of chips) has not given encouraging results hence these pulps were not

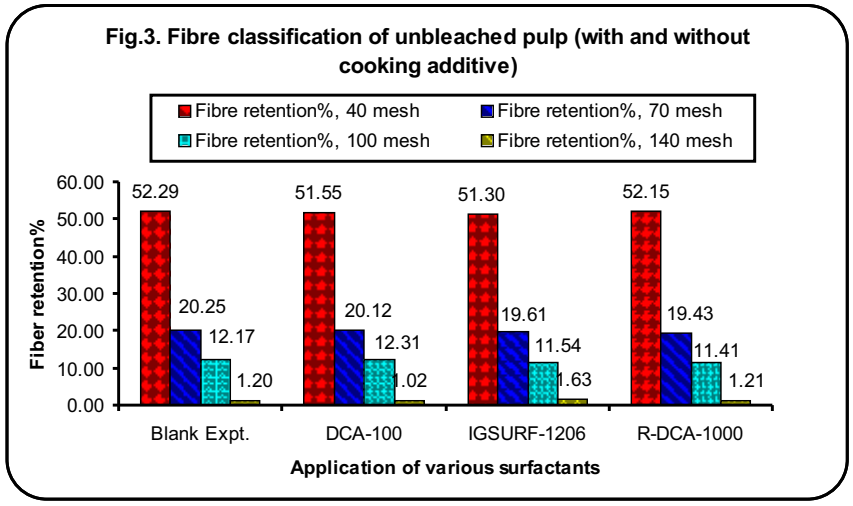


Fig.3. Fibre classification of unbleached pulp (with and without cooking additive)

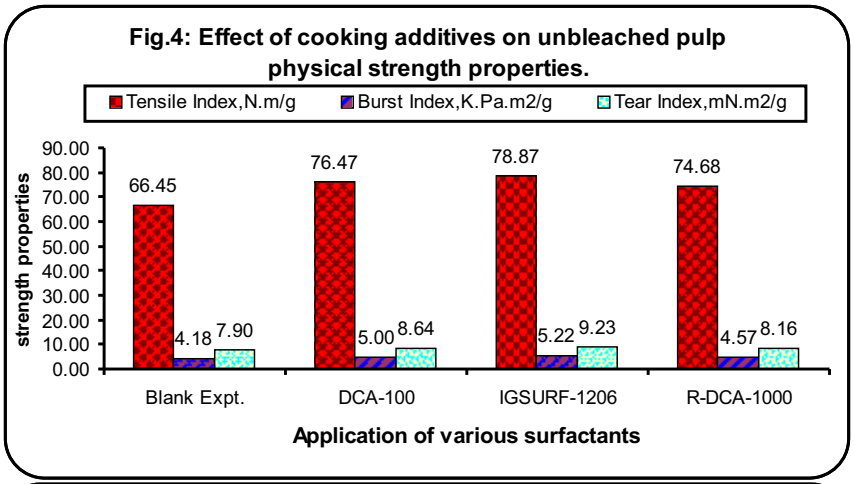


Fig.4: Effect of cooking additives on unbleached pulp physical strength properties.

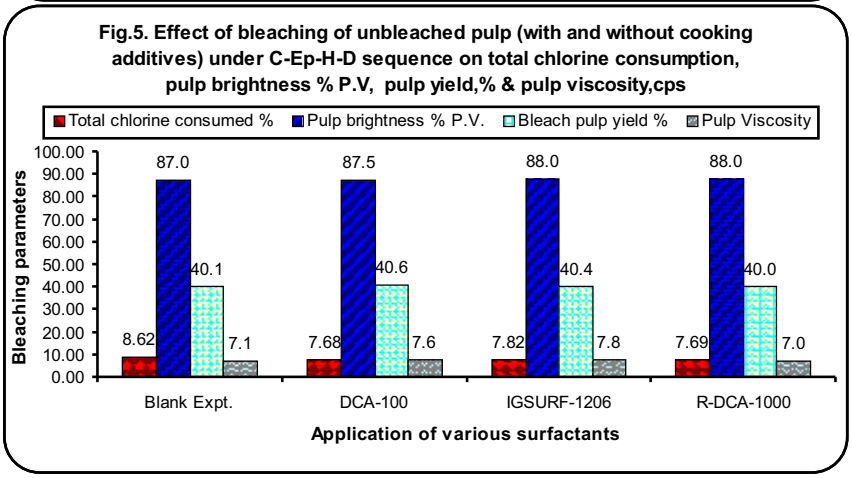


Fig.5. Effect of bleaching of unbleached pulp (with and without cooking additives) under C-Ep-H-D sequence on total chlorine consumption, pulp brightness % P.V, pulp yield,% & pulp viscosity,cps

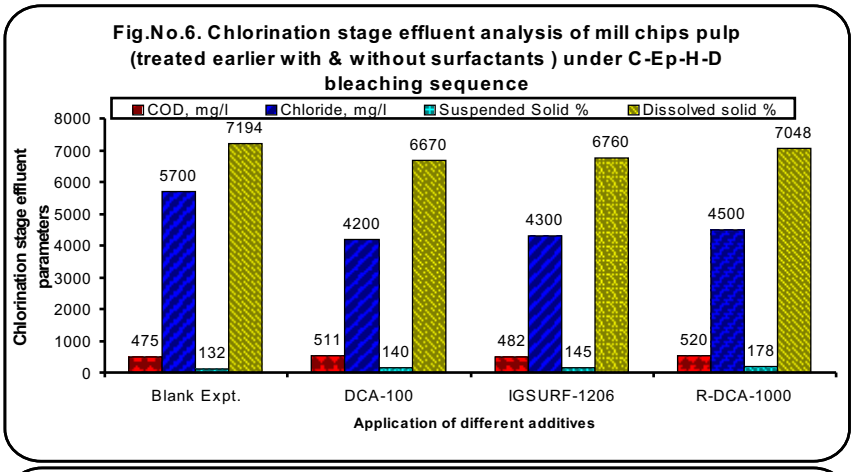


Fig.No.6. Chlorination stage effluent analysis of mill chips pulp (treated earlier with & without surfactants) under C-Ep-H-D bleaching sequence

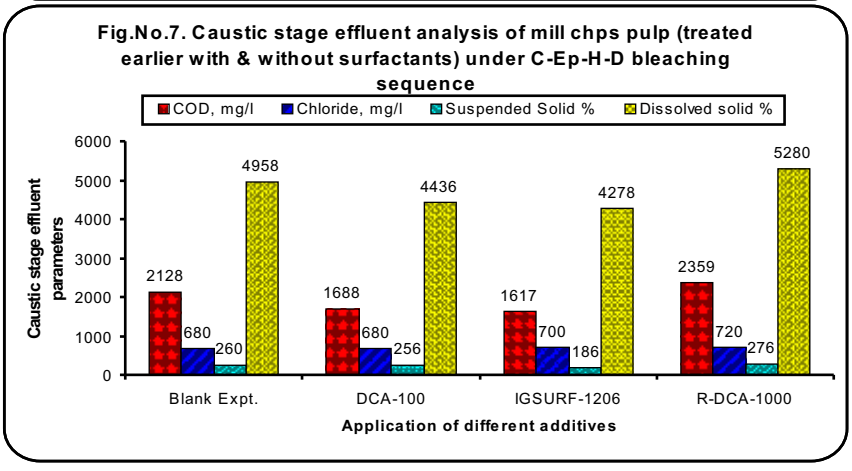


Fig.No.7. Caustic stage effluent analysis of mill chps pulp (treated earlier with & without surfactants) under C-Ep-H-D bleaching sequence

further considered for bleaching studies.

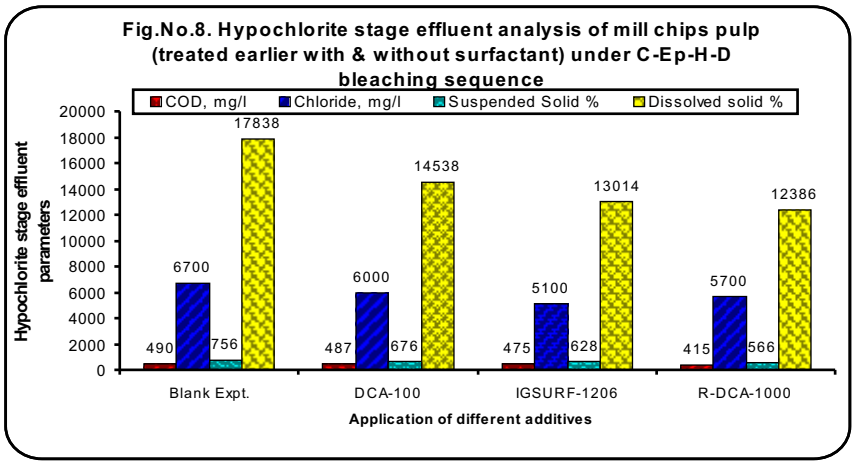
Fibre classification of unbleached pulps shows that fines percentage passing through 200 mesh was higher in R-DCA-1000 followed by IGSURF-1206 and DCA-100 compared to blank experiment. Fibre retention% on different mesh (with & without addition of surfactants) is projected in Fig.3.

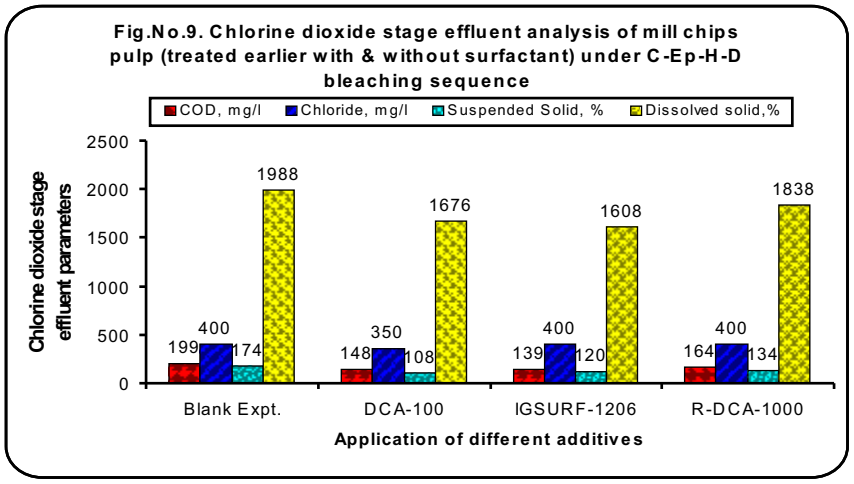
Unbleached pulps were beaten to 3^{o} S.R. in a PFI mill and standard sheets evaluated for physical strength properties which shows that tensile index, burst index and tear index of unbleached pulps were higher than blank experiment and are projected in Fig.4.

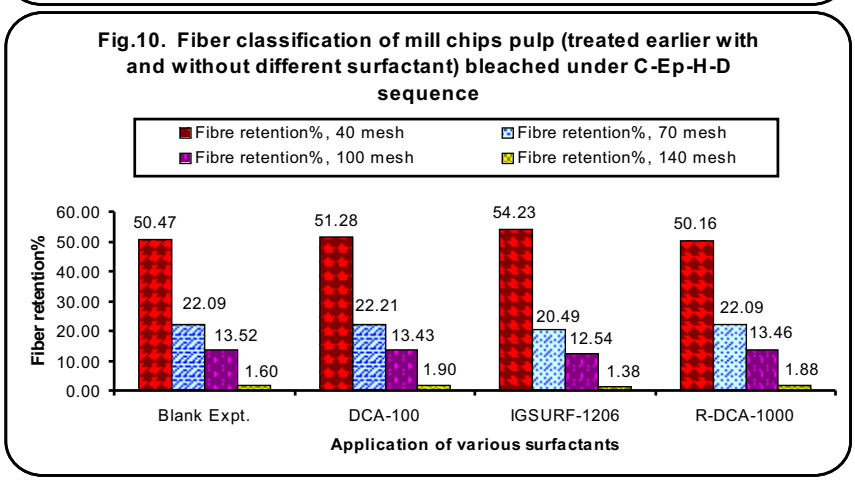
Above unbleached pulps were subsequently bleached under C-Ep-H-D sequence for 87-88 % P.V. brightness, which shows that total chlorine consumption reduced from 8.62% to 7.68% by using DCA-100 (AQ + Nonionic surfactant). Bleached pulp yield & viscosity was observed to increase from 40.1% to 40.6% and 7.1 to 7.6 cps respectively. Addition of IGSURF-1206 (mixture of nonionic surfactant) also improved bleached pulp yield from 40.1% to 40.4% and pulp viscosity 7.1 to 7.8 cps compared to blank experiment. It was further observed that surfactant R-DCA-1000 as cooking additive did not improve bleached pulp yield and pulp viscosity.

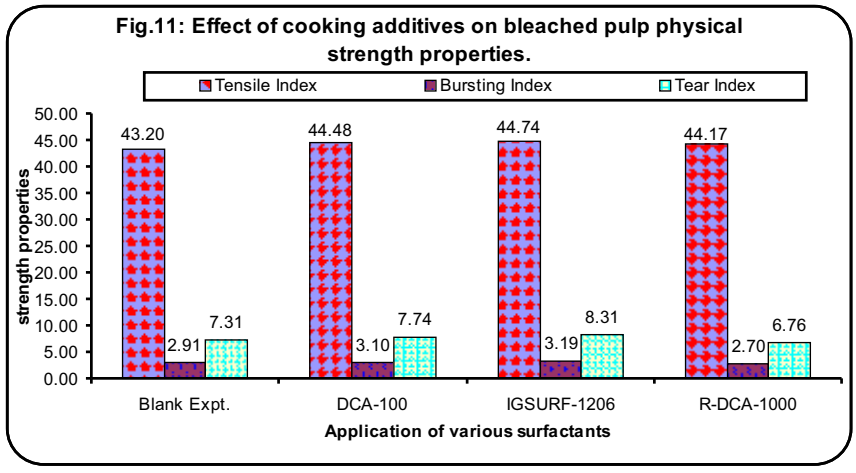
Total chlorine consumption%, pulp brightness% P.V, bleached pulp yield % and viscosity of bleached pulps (with and without surfactants) are projected in Fig.5.

Effluent samples at each stage of bleaching under C/Ep/H/D sequence were collected and analysed for pH, COD, colour, chloride, suspended solids and dissolved solids. In chlorination stage effluent COD and suspended solids were observed to be on higher side in R-DCA-1000 added pulp followed by DCA-100, IGSURF-1206 and blank experiments. Chloride and dissolved solids were observed to be higher in blank experiment followed by R-DCA-1000, IGSURF-1206 and DCA-100 added experiments. Parameters of chlorination stage effluent (with and without surfactants) are projected in Fig.6.









In caustic extraction stage COD, suspended solids and dissolved solids were found higher in R-DCA-1000 surfactant added experiment followed by blank experiment, DCA-100 and IGSURF-1206 added pulps. COD, chloride, dissolved solids, suspended solids, in effluent (with and without surfactant addition) are depicted in Fig.7.

In hypochlorite stage dissolved solids, COD, chloride, suspended solids are observed to be on higher side in blank experiment followed by DCA-100, IGSURF-1206 and R-DCA-1000 added pulps. Various effluent paramet - -ers in hypochlorite stage (with and without surfactant addition) are projected in Fig.8.

In the final stage of bleaching with chlorine dioxide COD, dissolved solids and suspended solids were observed to be higher in blank experiment followed by R-DCA-1000, DCA-100 and IGS - -URF-1206 added pulps. Various effluents Parameters in chlorine dioxide stage pulps (with and without surfactant addition) are highlighted in Fig.9.

Fiber classification of bleached pulps reported in Table.6 shows that fibre retention % on 40 mesh was higher in IGSURF-1206 followed by DCA-100 and was nearly same in R-DCA-1000 and blank experiment but fines retention percentage was lower in DCA-100, followed by IGSURF-1206 but was nearly same in R-DCA-1000 and blank experiments. Fiber retention% on different mesh (with & without surfactants application) is highlighted in Fig.10.

It is observed that IGSURF-1206 surfactant addition has improved physical strength properties (Table.7) viz, Tensile index, Burst index and Tear index followed by DCA-100 surfactant as compared to blank experiment. While R-DCA-1000 surfactant added bleached pulp has lower strength properties compared to blank experiment. Tensile index, Burst index & Tear index of bleached pulps (with and without surfactant addition) are depicted in Fig.11.

PLANT TRIAL OF DCA-100 SURFACTANT:

Out of the three surfactants DCA-100 was investigated at the Plant level,

was investigated at the Plant level, based on laboratory findings. The trial run was conducted for about 32 days using 400 grams of DCA-100 per ton of chips in cooking operation. Application of DCA-100 has helped to maintain K. No. around 15.0 by saving alkali 1.9% as Na_2O. It was observed that Knotter and screen rejects also reduced by around 0.8% and bleached pulp yield improved by 0.4%. The total chlorine consumption could be brought down by 0.7%. Physical strength properties of the bleached pulp were uniform during the plant trial that has helped in maintaining better machine run ability.

CONCLUSION:

Out of three surfactants used as cooking additive of mill chips DCA-100 (AQ + non ionic surfactant) and IGSURF-1206 (blend of non-ionic surfactant) improved unbleached yield and pulp brightness but reverse trend was observed with pulp kappa and DCM extractives. Pollution load in terms of COD, chloride, dissolved solids also reduced during bleaching of these two surfactant added pulps under C-Ep-H-D bleaching sequence compared to blank experiment. Bleached pulp yield and pulp quality with these two surfactants were found better than R-DCA-1000 surfactant and blank experiment.

Plant trial run of DCA-100 at the pulp mill confirmed reduction in alkali and chlorine consumption. Bleach pulp yield and pulp quality also improved that resulted in better machine run ability.

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