IMPROVEMENT OF THE PHYSICAL STRENGTH PROPERTIES OF RECYCLED PAPER: IN A NEW WAY

[1]S.N.PANDA,[1]S.K.BISWAL*& [2]U.P.TRIPATHY
[1]Research scholar,[1]Dean School of applied science and [2]Scientist B
Correspondence author id dr.skbiswal@cutm.ac.in.
[1]Centurion University of Technology and Management, Ramachandrapur, Jatani, Khurda,Bhubaneswar, Odisha, PIN-752050
[2]Pulp and Paper Research Institute, Jaykaypur, Rayagada, Odisha, PIN-765017

Abstract:

Due to increase in paper product requirement and decreasing the availability of fibrous raw materials now-a-days, recycling of paper is carried out. About 80% of all waste paper obtained from three sources: Corrugated box, Newspaper & Office waste papers. De-inking is an important step for recycling of old waste writing, printing and newsprint papers. The efficiency of ink separation in the process of waste paper recycling depends on the ink properties, kind of the substrates, age of waste papers, the printing techniques and printing conditions. In general deinking process a much more amount of different chemicals are required which makes expensive, pollution intensive and also not obtained a perfect quality. In the present research work we are trying for a better cost effective de-inking process by optimizing the chemical doses, maintaining the pH and applying different percentage of Na_2CO_3 as an additive. The physical strength properties of the paper after de-inking are studied briefly. The chemical doses at which better strength properties of paper is obtained can identified.

***Index terms:*Deinking, Flocculants, Recycled fibre, Coagulant, Ink, Office waste, Newsprint**

I.INTRODUCTION

In every academic year papers stained with fountain and ball ended pen inks as well as newsprint, printed papers & office waste papers being thrown out, so recycling of these papers is very much essential.Waste papers have an important source of fibers for paper making throughout the world.The de-inking process in which removal of printing ink and reuse of fibre can be done & is the best technology for solid waste management. Direct and indirect employment in Indian pulp and paper industry is 20 lakh persons and turn over annually INR 50000 crores. Current demand of wood for paper production is about 11 million TPA where as domestic available is 9 million TPA and is projected to rise to 15 million TPA by 2024-25. Wood price have gone up steeply, more than doubling in the last three-four years, making the Indian pulp and paper industry non competitive.Tandon et. al. explained that India needs a well designed sustainable model for collection of waste paper like setting up of public private partnership model to improve waste paper collection[1-3]. Trumic et.al reported that in the flotation process, air is bubbled through the low consistency pulp stock. Hydrophobic particles such as ink, attach to the bubbles and are lifted away from the stock. A foaming agent is added to create foam & it is scraped away as a reject stream, producing cleaner fibers in an accept stream[4]. Heimin.J et. al reported that in the flotation sub process in the deinking process is a combination of machinery technology, flow dynamics and surface chemistry[5]. Carre B. et. al reported that developing improved flotation technology requires understanding and mastering all these practices & released surface active substances.The ink used in news print is usually water based with a hydrophilic character, which makes them very difficult to remove from the pulp slurry[6]. Tutak D reported that water based flexography and inkjets prints are typical inks that are difficult to remove via flotation deinking. For an effective deinking, it is very important to prevent the re-deposition of ink particles on the fibers prior to removal. Ink removal process

follows two steps. Initially the interaction of the ink particles with air bubbles occur .Secondly the bubble/ink hetero structures flow in the froth, where the efficient upward flow of ink particles is closely correlated to the stability of the froth phase and the adhesion energy of ink particles to air bubbles[7]. Pathak et.al. explained that most of the enzymes work within 40 to 65^{0}C soaking after pulping, but before floatation adversely affected de-inking. Again they reported different units are required to separate inks from fibers and this mainly includes washing, flotation, cleaning and screening[8]. Gao et. alreported that the de-inking agents used for laser printed paper are different from those used in conventional de-inking due to distinct characteristics of commonly used inks and laser printed inks[9]. Jain et.al. used enzyme as a deinking agent towards recycle pulp procured from recycle based paper mill. The enzymes were added at the beginning of pulping stage followed by flotation and screening. Combining enzyme with chemicals significantly enhances deinking efficiency. By using enzymes and bio surfactants in recycling of waste paper the tear factor decreased by 3 to 2.5 units compared to chemical and only bio surfactants[10].Reddy et. al. explained de-inking of waste paper is normally carried out at alkaline pH value in the presence of alkali metal hydroxide, silicate and oxidative/reductive bleaching agents and surfactants at temperature 30 to 40^{0}C and pH 10 to 11[11].

II.MATERIAL AND METHODS

In this study six month old news print papers are made pieces having size 3 x 4cm^2. These pieces are soaked in water half an hour in a cleaned container. Then converted into pulp in a disintegrator at 10% consistency which is shown in figure-1 to 3. In pulping Sodium silicate, Sodium carbonate and EDTA are used while in flotation Sodium stearate in presence of potassium hydroxide is used as surfactants. Surfactants play three roles in flotation deinking (1) as a dispersant to separate the ink particles from the fiber surface and prevent the re deposition of separated particles on fiber during flotation, (2)as a collector to agglomerate small ink particles to large ones and change the surface of the particles from hydrophilic to hydrophobic and(3) as a frother to generate foam layer at the top of a flotation cell for ink removal. In oxidative bleaching H_2O_2 and NaOH and in reductive bleaching $NaHSO_3$ are used. In flotation method sodium stearate ($C_{18}H_{35}NaO_2$) is used in presence of KOH at 9 pH.The main reason of addition of hydrogen peroxide is to prevent the yellowing of paper that occurs with the addition of sodium hydroxide. The hydrogen peroxide generates perhydroxyl anion (HOO^-) which attacks the phenolic & chromophoric groups. The reason for addition of sodium silicate is to stabilize the hydrogen peroxide by deactivating the metal ions. Bleaching was conducted in two stages, first is oxidative bleaching by using 1% H_2O_2 and 1.5%NaOH at a temperature of 80^{0}C at pH 9 having consistency 10% for 60 minutes and secondly in reductive bleaching with $NaHSO_3$ 1.5% at temperature 60^{0}C for 1 hr at pH 6.5 having consistency 10%..The brightness pads are made for brightness, and hand sheets of 60 GSM are made to find the dirt area, number of ink particles & physical strength propertics.The physical strength properties & dirt area are measured according to standard TAPPI procedure by using the instruments like Tensile tester, Tearing tester, Mullen model Bursting strength tester, Micrometer, Schopper and folding endurance tester.

Fig.-1:Waste papers cut in small size

Fig.-2:Soaking of small size papers

Fig.- 3:Disintegrator used for pulping purpose

The brightness was measured by using ISO Brightness tester in accordance ISO standard 457nm, at light source. SEM analysis has done by using the instrument Scanning Electron Microscope JEOL model No- JSM-651OLV.

III.RESULTS AND DISCUSSION

Keeping EDTA and sodium silicate concentration constant, Na_2CO_3 concentration changed in the puling stage. In the de-inking process, physical & optical strength properties were studied. In pulping stage the brightness is 43.5% ISO, at 4% concentration of additive. By adding 3% of Na_2CO_3 concentration in the pulping stage the brightness is 42.3% ISO. The brightness increases suddenly at 3%. It shows that higher % of addition of Na_2CO_3 concentration has a little effect of brightness development in the pulping stage. After flotation, washing and oxidative stages the brightness development is maximum at 5% of additive and at the final reductive bleaching the brightness development is maximum at 5% addition of Na_2CO_3 additive. So for maximum brightness development it is preferable to addition of 5% Na_2CO_3 concentration in the pulping stage which is shown in the figure-4.

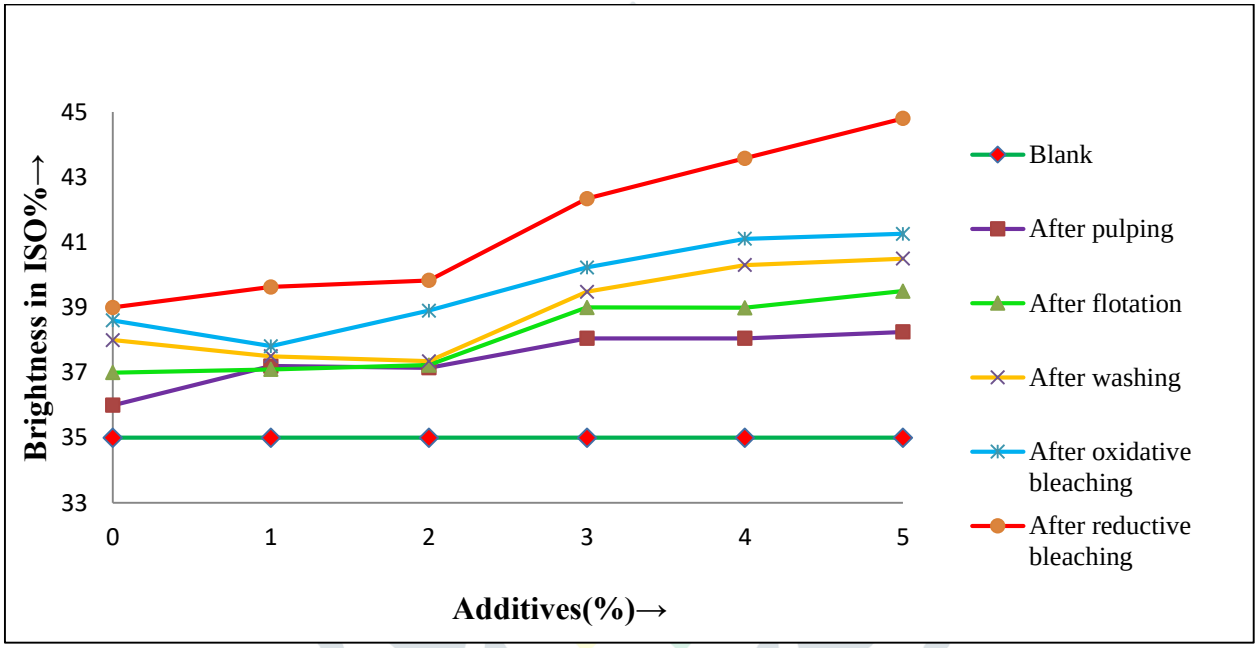

Fig-4: Variation of brightness with different concentrations of Na_2CO_3 as the additive

The cleanness in terms of dirt area and number of ink particles was studied. The result is a value hike at 3% concentration of additives but more prominent at 4-5 % of additives. At the pulping stage ink particles detached from their fibre attachment but the ink particles together covered as a coating of surface shown in fig-5 & 6. The result is prominent and effective flotation onwards.

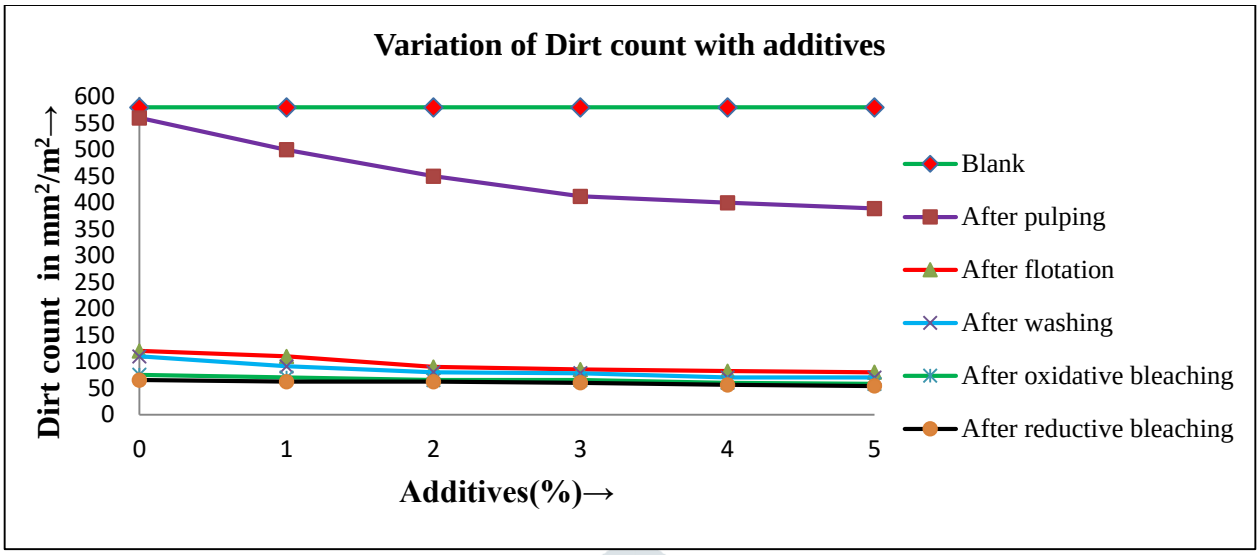

Fig-5: Variation of dirt area with different concentration of Na_2CO_3 as the additive

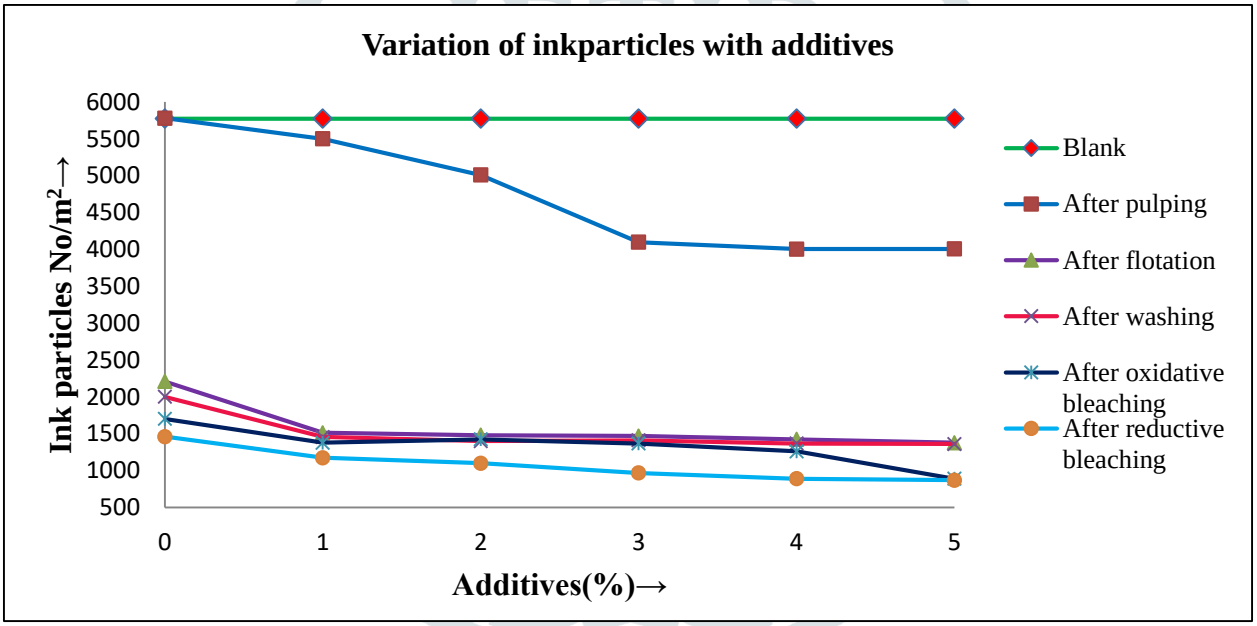

Fig-6:Variation of ink particles with different concentrations of Na_2CO_3 as the additive

Physical strength properties increase by the addition of Na_2CO_3 as additive. The tear factor increases up to addition of 2% addition of Na_2CO_3, then it remains constant & at higher dose the tear factor decreases due to fiber degradation which is shown in the figure-7. The breaking length & burst factor increases up to 4% addition of Na_2CO_3 then decreases which is shown in the figure-8 & figure-9.The below figures expressed the improvement of physical properties of hand sheets after de inking. As the ink removal efficiency increases the physical properties also increases because the ink content caused weakening of inter fibre bond formation. The high concentration of additives may cause increase in brightness but decrease in physical properties. So giving importance in physical strength properties the additive concentration is 4% is the best.

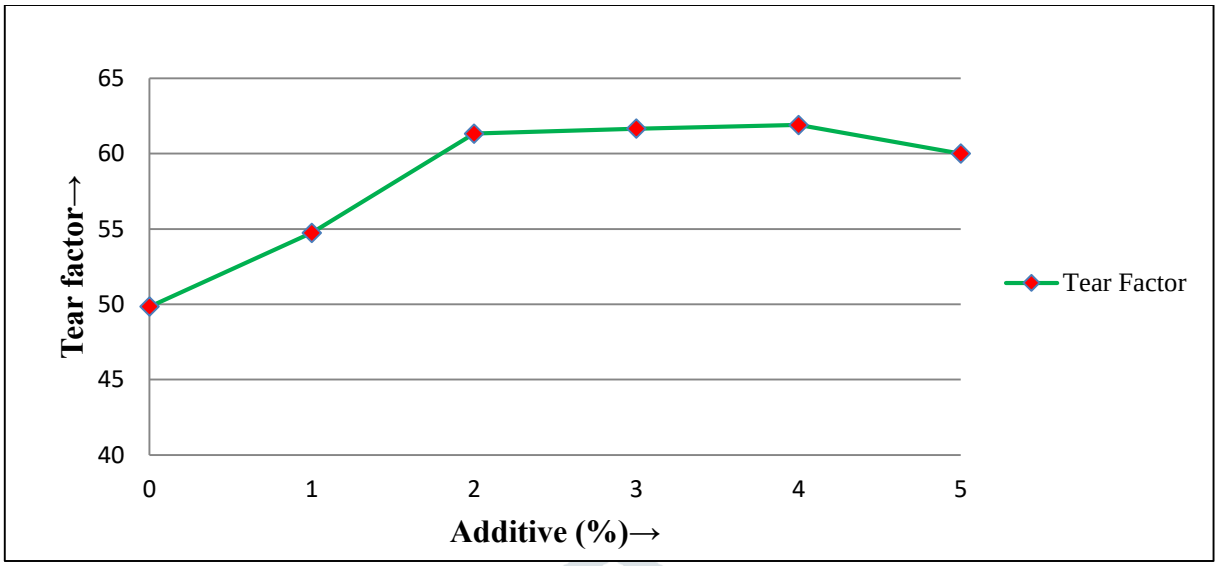

Fig-7: Variation of Tear factor at different concentration of Na_2CO_3 as the additive.

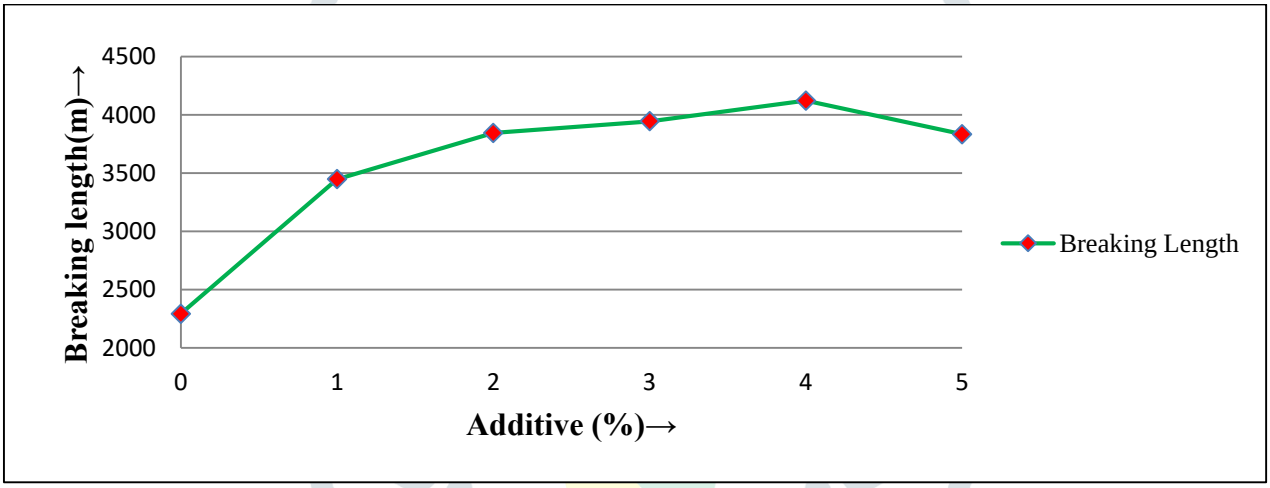

Fig-8: Variation of Breaking Length at different concentration of Na_2CO_3 as the additive.

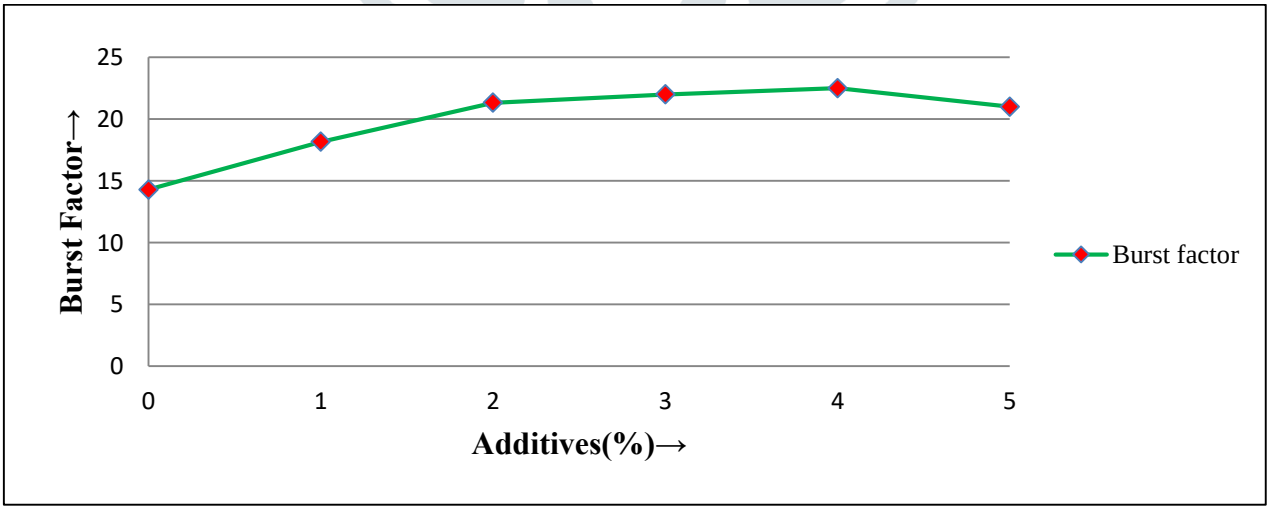

Fig-9: Variation of Burst factor at different concentration of Na_2CO_3 as the additive.

The SEM figures of the different deinking hand sheet samples are shown in figure 10 to 21. From the SEM figures it is cleared that the blank sample contains high percentage of ink particles given in fig-10 and fig-11.

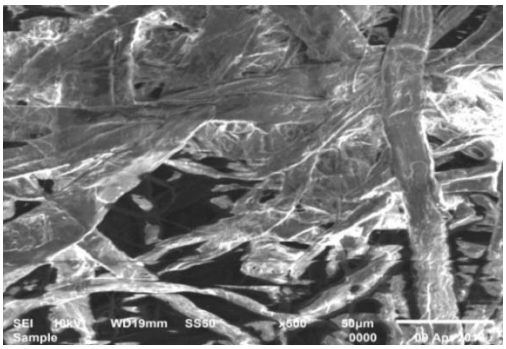

Fig-10: 10KV, 50µ (Blank)

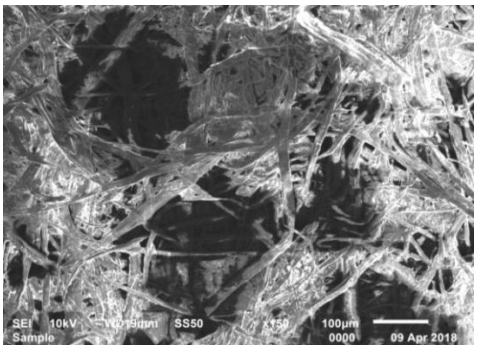

Fig-11: 10KV, 100µ (Blank)

The SEM figures 12 & 13 are not giving satisfactory observations in brightness but better than blank sheet.

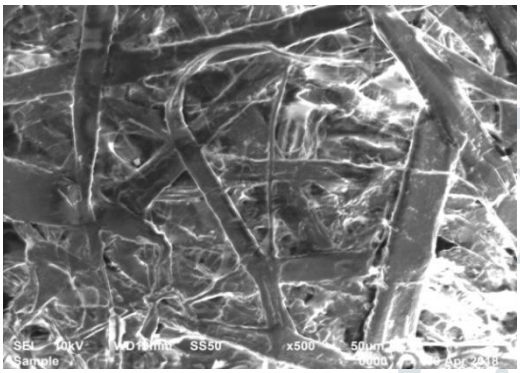

Fig-12: 10KV, 50µ (1% Additive)

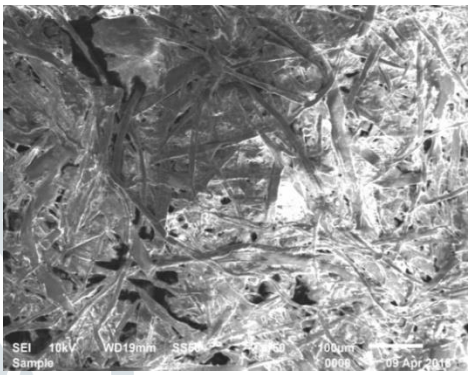

Fig-13: 10KV, 100µ (1%Additive)

The SEM figures 14 & 15 gave a better brighnness value, where 3% of Na_2CO_3 is used in deinking process.

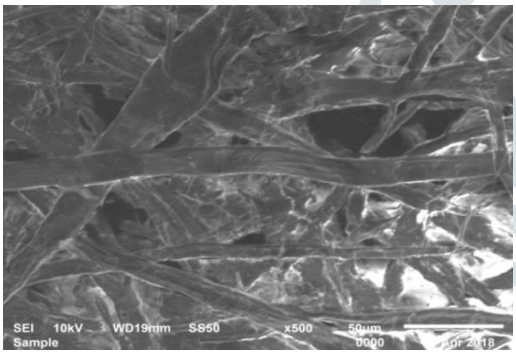

Fig-14: 10KV, 50µ (2% Additive)

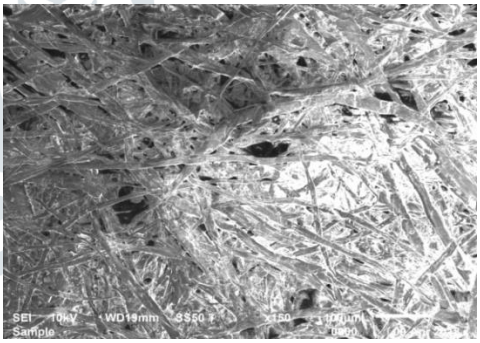

Fig-15:10KV, 100µ (2% Additive)

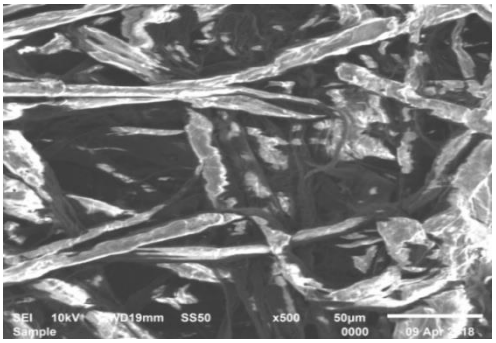

Fig-16:10KV, 50µ (3% Additive)

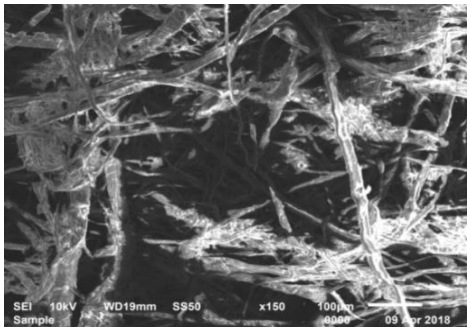

Fig-17:10KV, 100µ (3% Additive)

The physical properties of paper increases gradually by applying up to 4% additive because ink particle content is decreasing and increases the fibre-fibre bond strength. It also clearly identified in SEM figure-18 &19.

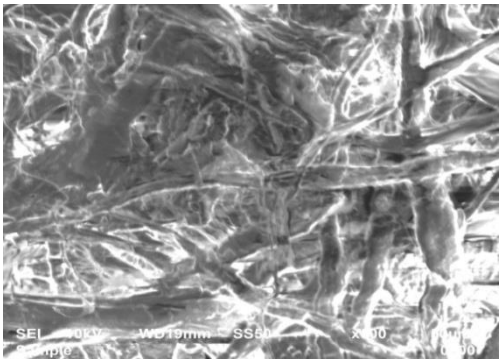

Fig-18:10KV, 50µ (4% Additive)

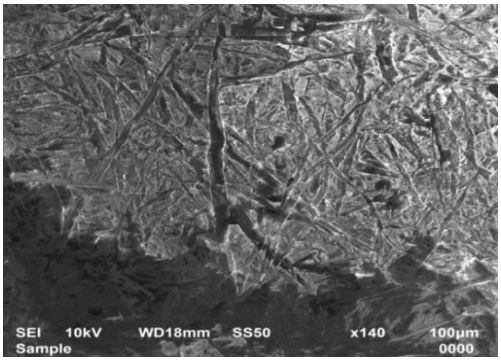

Fig-19:10KV, 100µ (4% Additive)

Application of 5% additive gives higher brightness than others but strength properties start decreased due to fibre degradation clearly identif.ied in SEM fig-20 &21.

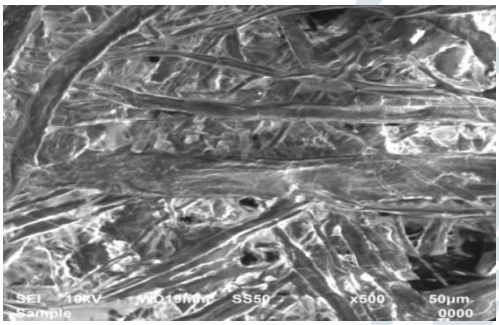

Fig-20:10KV, 50µ (5% Additive)

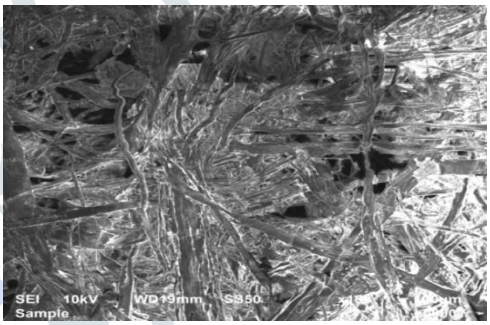

Fig-21,10KV, 100µ (5% Additive)

CONCLUSION:

The present research work gives a comperative study of different concentrations of Na_2CO_3 as an additive in deinking process with water based inkjet inks.The removal selectivity of ink in DAF(diffused air flotation) cell is very good. In this process removal of long and short fibres are less. Because of hydrophobic nature of ink in the froth ink particles get separated. Visual assessment of the hand sheet surface images revealed that at 2% Na_2CO_3 brightness in % ISO increased a higher value as compared to blank up to 5%. The ISO brightness values of bleaching samples are higher than that of samples deinked by other procedures, and its brightness value was much closer to that of the unprinted recycled paper. The physical properties like tear, tensile strength, burst factor, double folding increases by using 4% of Na_2CO_3 in puling than other percentages of additive. In India, to fulfill the demand of paper consumption per head, recycle of waste paper must be followed. To be environmentally healthy, eco friendly and waste management, recycle of waste paper is one step ahead for society.

REFERENCES:

[1] Indian paper industry pre-budget memorandum, IPMA (2017-18). www.capital market.com. Prebudget. Page 1-8.

[2] Bekiroglu S and Elmas G M (2017). Contribution to national economy of waste paper recycling. International journal of environmental science and natural resources. Vol-2-1,1-5.

[3] Tandon R, Negi S D and Mathur R M (2013): Waste paper collection mechanism in India current status and future requirement:IPPTA J:25-3: 37-40.

[4] Trumic M, Trumic. M, and Markovic. Z (2007).Separation of ink particles from waste news paper by deinking flotation. Journal of mining and metallurgy, 43a.33-41**.**

[5] Heimanen J, Koivuniemi P T, Jain N K and Goyal M. (2009) .Fundamental studies applied for latest development in deinking flotation technology.Paperex,57-63

[6] Carre B, Zeno E, Delagoutte T and Houber P(2016) Innovative solution to increase yield in deinking process: Research approach. Inpaper International.3, 22-23.

[7] Tutak D (2017) Modified deinking of digitally printed paper with water based ink jet ink, Cellulose chemistry.Technol,51.483-488.

[8] Pathak P, Bharadwaj N, Singh A K (2010): Enzymatic de-inking of office waste paper : an over view, IPPTA J 22-2:83-88.

[9] Gao Y, Xiaojiao, Gao L, and Li J. 2015. Study of neutral chemical de-inking of laser printed papers. TAAPI, 15-1, 49-57.

[10] Jain R.K, Gupta C, Pandey D, Kumar D and Dixit A.K (2015) Deinking of old newsprint (ONP) mixed with old magazine (OMG). Paper India, 18 (4) : 12-17.

[11] Reddy B H L, Swamy G P V, Prabha N P, Pai K V(2010) The chemical dispersion is a debate in deinking of ONP/ONB/OMG using displector. IPPTA J:22-3: 139-141.