Effect of Recycling Process on Paper Properties

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Abstract— Continued improvement of paper of paper qualities is essential to meet development needs. Therefore, one way in dealing with the problem is to recycle or just decrease the use of paper made entirely from primary components, mainly wood fibers. Analysis of mechanical properties of waste samples with and without deinking agent was carried out to explore the prospect of paper recycling. Experiments were performed on four samples, two A4, two booklets with and without deinking agent. Results, obtained from measurements, confirm that the A4 and booklets strength are improved when deinking agent was added. Shrinkage rate of less than 20 was obtained.

Index Terms— Deinking, Mechanical properties, Recycled Paper

1 Introduction

THE success of waste paper recycling is highly dependent on securing a satisfactory level of public participation. Wenger and Nakamura stated that countries measure effectiveness of their waste reduction programs mainly upon two general approaches. First, on the basis of recycling rates and second, on the disposal reduction rates [1],[2].
Sustainable consumption and production is in the most challenging aspect of the waste paper and it requires changes to the way products and services are designed, produced, used and in the end, disposed [3]. The investigation possibilities to replace conventional A_4 office paper and used booklets with recycled ones can assist the sustainable production of paper.
For sustainable paper recycling, specifications shall satisfy the end use characteristics such as paper grammage , thickness, strength ..ect. Paper strength is mainly influenced by the type of fiber and the alignment of the fibres in the microstructure of the paper. An important paper strength characteristic is the burst strength which is used extensively in pulp and packaging papers evaluation, [4].

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Recycling faces many challenges, one of which is the deinking. The deinking process increase the degree of whiteness and cleanliness. The chemical materials used are hydrogen peroxide , special types of soap or detergents . Alank ,[5] , found that d inking chemicals could have a beneficial effect on fibers inter- bonding which removed oleophilic materials from fiber surfaces. Another challenge is paper shrinkage .Weise and Paulaouro observed that at relatively drying stage of up to70%, solids caused uneven fibers shrinkage and became visibly wrinkled,[6].

The present study used waste A_4 office papers and booklets from University of Khartoum ,Sudan, to establish the effect of recycling on paper properties in order to examine the technical possibility of utilizing waste paper .The effect of deinking on the waste papers properties were conducted. Also the shrinkage extent was determined so as to verify the expected product loss.

2 Experiment Work

2.1 Experimental Materials

Two types of waste paper , A_4 high quality office paper (sample A) ,low quality booklets (sample B), were collected from University of Khartoum to be recycled and reused. A detergent was used as a deinking material.

2.2 Pulp Preparation and Moisture Content Experiment

Samples A and B were shredded and 500 gm of each was prepared. Three percent NaOH was added to each sample for 1 hour. For the pulping step, samples A and B were put in a Turbo pulper for 6 min to turn it into pulp. Each sample was divided into two parts (A_1,A_2) and (B_1,B_2) of 250g each. Five percent of the detergent was added to A_1,B_1 for 1 hour, while A_2,B_2 where processed without detergent . The 4 samples (A_1,A_2,B_1,B_2) were put in a strainer to ensure separation of fiber .The samples were placed in cloth bags for drying , then the average moisture content (MC), and the average moisture content factor (MCF) were calculated

for each sample so as to determine the equivalent paper dry weight.

2.3 Pulp to Paper Manufacture

For each sample the wet pulp equivalent of15.6 g dry weight was prepared and placed in desintegrator for 5 minutes to ensure fiber distribution. After distribution the pulp was placed in a measuring cylinder and filled to 5200 m l of water. For one paper manufacture, 400 ml was taken to the hand sheet forming machine, then the yield and the shrinkage percentage for each paper sample was calculated.

3 Results and Discussion

The properties of the four recovered papers (A_1,B_1 ,A_2.B_2) were tested according to the Technical Association of the Pulp and Paper Industry (TAPPI) standards, Table 1 .Grammage , density, tensile strength , burst strength and paper shrinkage as shown in Fig 1 to 5 .

Table 1: Technical Association of the Pulp and Paper Industry,[6]

Property	Standards Method
Grammage	TAPPI T 410
Density	TAPPI T 500
Tensile Strength	TAPPI T 494
Burst Strength	TAPPI T 403

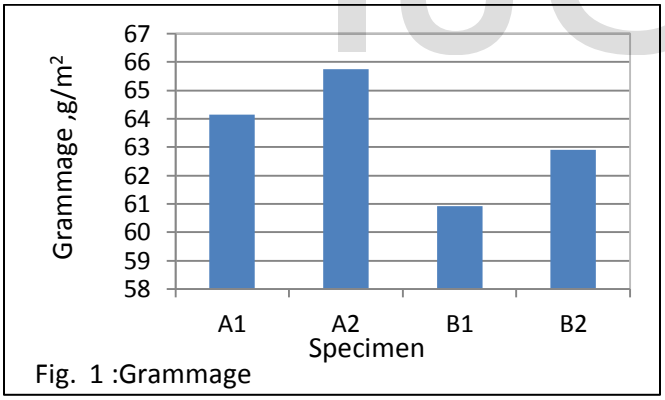

Fig. 1 :Grammage

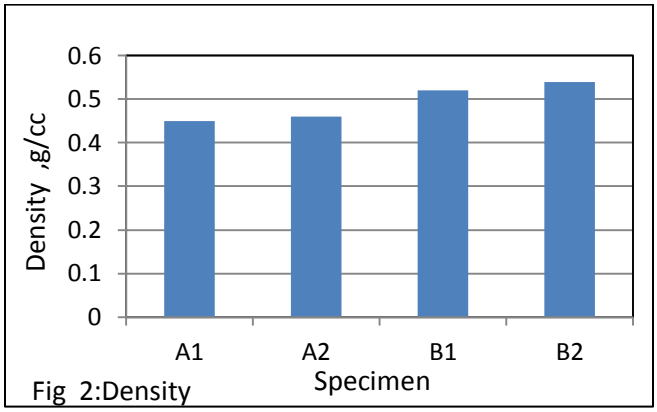

Fig 2:Density

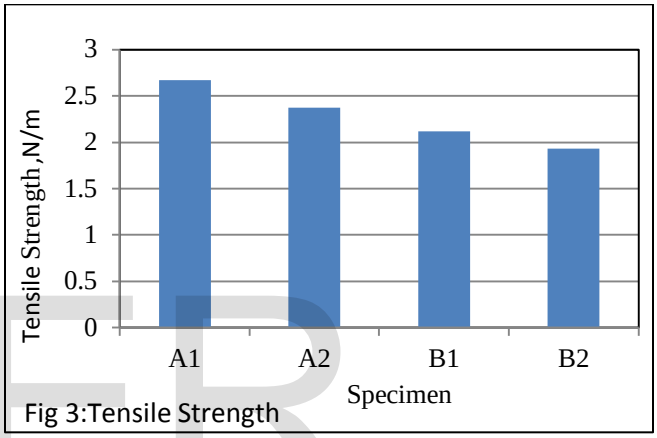

Fig 3:Tensile Strength

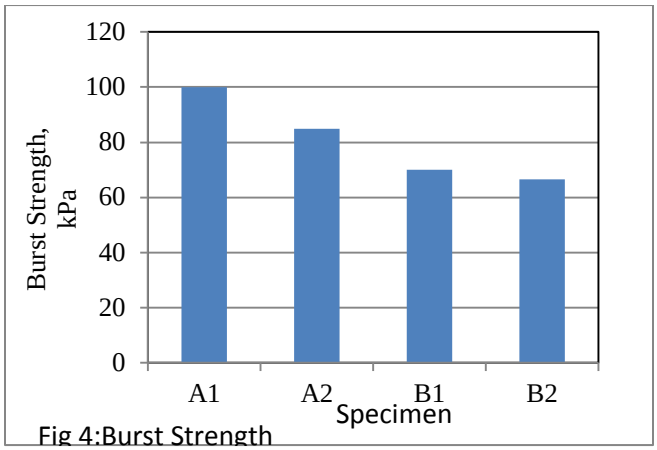

Fig 4:Burst Strength

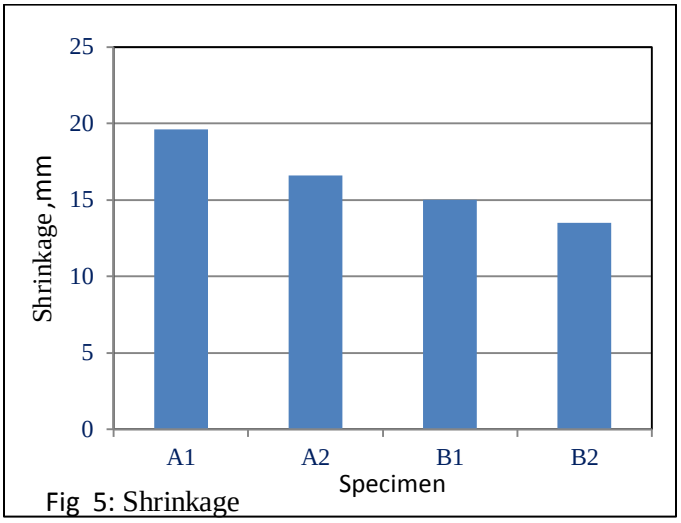

Fig 5: Shrinkage

The basis weight or grammage is the most fundamental property of paper and paperboard. The Basis weight of paper is the weight per unit area. For new paper the standards grammage for office paper is (60-90) g/m^2 .The samples (A_1,B_1 ,A_2.B_2) grammage range from 60 to 65which is within the range of office paper grammage . The deinked samples A_1,B_1 have lower grammage than A_2,B_2. Fig.1.

Bulk or density is another very important parameter of paper, particularly for printers. Bulk is a term used to indicate volume or thickness in relation to weight. It is the reciprocal of density . Decrease in bulk or in other words increase in density makes the sheet smoother, glossier, less opaque, darker, lower in strength etc. Samples A_1,B_1 with detergents ,Fig. 2 have lower densities than A_2,B_2 with mean higher strengths . This means that the deinking process lowers the density while improving the strength and quality of paper, Fig 3.
Bursting strength tells how much pressure paper can tolerate before rupture. Bursting strength is measured as the maximum hydrostatic pressure required rupturing the sample by constantly increasing the pressure. A_1,B_1 specimens showed high burst strength ,Fig 4. The shrinkage is high in samples A_1,B_1 ,the deinking increases the loss of fibers .Fig 5

4 CONCLUSION

The results showed that A_4 office paper and booklets kept most of their original properties, even after reuse. Recycled paper produced from secondary cellulose fibers, meets the required standards and expectations. In spite the shrinkage of fibers the presented work showed positive results of recycling A_4 and booklet papers .

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