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Deinking- an Effective Process for Removable of Toxic Metal from Recycled Paper

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Abstract

This work is mainly focused on recycling of the waste paper and recovering the ink from those papers in simple and easy environmental friendly way. Deinking is a term describing a process for detaching and removing printing inks from recycled fibers to improve optical characteristics of pulp and paper using recovered printed material. It is the most important process stage in processing of recovered paper as a raw material for the production of deinked pulp primarily used for manufacturing different papers. The FTIR analysis of all paper shows similar functional group. However the percentage transmittance value shows deinked paper are more likely to transmit light. The EDX result shows that amount of lead present are nearly 0.012%, 0%, 019% and 0% in repulped photocopy paper, deinked photocopy paper, repulped newspaper and deinked newspaper respectively. All this data shows that almost all ink have been removed during deinking process along with inks heavy metals were also removed during recycling process.

Keywords: *deinking, repulp, recycle, FTIR, EDX.*

1. Introduction

World production of paper and paperboard is around 390 million tons and is expected to reach 490 million tons by 2020. Consumption of paper and paperboard per person varies significantly from country to country. One person uses about 60 kg of paper a year on average; the extremes are 265 kg for each US resident and some 7 kg for each African. In the heavily populated areas of Asia, only around 40 kg of paper per person is used [1].

According to Conservatree Paper Company statistics: recycling a ton of wastepaper can save approximately 17 trees, 7,000 gallons of water, 4,100 kWh energy; avoid 60 of air pollution effluents; and reduce three cubic yard

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of landfill materials. Therefore, it has become an important environmental issue to recover and reuse secondary fibers as raw materials for paper production [2].

Nowadays wastepaper is used in large quantities for the manufacture of newsprint and sanitary papers. Brightness and color are some of the quality features, which have to be met for these applications. To this end, the printing ink must be removed from the printed wastepaper [3]. Deinking is a term describing a process for detaching and removing printing inks from recycled fibers to improve optical characteristics of pulp and paper using recovered printed material. It is the most important process stage in processing of recovered paper as a raw material for the production of deinked pulp primarily used for manufacturing different papers [4].

The printing and the writing ink have some toxic effect to human and the environment. Food packaging papers and dyes used to colour food are some of the direct source of ink contamination. Therefore, before discharging these waste paper it is better to remove ink from the paper which seems to be eco-friendly. Some of the effects of ink are as follows:

- The carbon black content of the ink may cause headache, eye irritation, chronic itchiness and small growths on the tongue.
- Solvents used in the ink like ink dyes, some alcohols, glycol or ether can have negative effect on fertility and unborn foetus, as well as other organ system including, skin, liver, blood and kidneys.
- Inks may contain heavy metals Pb, Cd, Cr, Hg, etc. and heavy metals are toxic to human health [5].

Recycling of waste paper requires the removal of printing ink from the paper by a process called deinking. Deinking which involves the removal of printing ink mainly consists of two steps i.e. the detachment of ink particles from the fiber surface followed by the removal of detached ink from the pulp slurry by washing or floatation. Heavy metals are attached to ink particles so before discharging the deinked solution into environment, ink should be separated out. This helps to prevent direct contamination of heavy metals to the environments.

As we are talking about paper, the main source of paper pulp is wood. 90% of paper pulp is made of wood. Wood is the hard, fibrous substance found beneath bark in the stems and branches of trees and shrubs. It is plentiful and replaceable. Since a new tree can be grown where one has been cut, wood has been called world's only renewable natural resources. Almost 90% of virgin fibers come from woody plants that are being used in paper industry. However, in more and more region of world, recycled fiber is becoming major source of papermaking fibers. Paper production accounts for about 35% of felled trees and represents 1.2% of the world’s total economic output. Recycling one ton of newsprint saves about one ton of wood while recycling one ton of printing or copier paper saves more than two tons of wood. Therefore, paper recycling has been the area of interest nowadays.

Current deinking processes depend upon the use of large amount of environment damaging chemicals such as NaOH, Na2SiO3, Na2CO3, H2O2, chelating agent and surfactants. Use of these chemical based deinking methods produce toxic effluents, which increase the COD values of water and hence resulting in costly wastewater treatment. Deinking using enzymes is less polluting, energy saving and results in lower disposal problems. Enzymes that are being used in deinking are pectinases, hemicellulases, cellulases and lignolytic enzymes. These enzymes alter the fiber surface or bonds near the ink particle and remove the ink from fiber surface. The released ink is then removed by washing or floatation .Use of enzymes in deinking resulted in lower COD values thus reducing the cost of wastewater treatment in an environment friendly manner [6]. Block co-polymer composed of polyethene oxide and poly propylene oxide known as pluronics can also be used.

Among all these methods one of the easy, fast and comparatively environment friendly method is using detergents as deinking agent. Detergents are easily available, easy to use and non-toxic agent.

2. Experiment

2.1. Preparation of the reagents

1. Detergent solution: 100g of ariel detergent solution was made in 1000ml of distilled water.
2. Bleaching powder solution: 7g of bleaching powder solution was prepared in 100ml water.
3. Ethanol solution, (laboratory grade).

2.2. Instruments used

Digital balance, Volumetric flask, Pipettes, Beakers, Burner, Grinder, Oven, Water bath, Porcelain basins, FTIR Spectrometer (Model: IRPrestige-21), EDX-8000.

2.3. Procedure

2.3.1 Recycling of waste paper

60g of used photocopy paper was weighed and soaked in distilled water for 2 days. After 2 days, the soaked papers were re-pulped by the help of grinder by adding some distilled water. Then all the pulp was collected in a beaker. The collected pulp was divided into two parts. One part of pulp was kept separately to make the re-pulped paper and next part of pulp was mixed with 100g ariel detergent used as deinking agent and left for 24 hours. Then the deinked pulp was washed to remove the ink particles separated out from the pulp. The filtrate solution was kept in the separate beaker. Only washing deinking was performed here. Again, the deinked pulp was mixed with 7g of bleaching powder to bleach the pulp. Then it was left for 24 hours. After being bleached, the pulp was again washed to remove the bleaching powder. This bleached solution was also stored in the previous beaker. The bleached pulp was used to make the paper. Similar process was carried out for waste newspaper to make two different recycled papers as above.

2.3.2. Recovery of the ink

The deinked solution obtained during deinking process was evaporated in the water bath to obtain concentrated ink along with other impurities like detergents, bleaching powder and other waste. It was then mixed with ethanol. Ethanol dissolved all the ink leaving behind other impurities as residue. After decantation, the solution was again kept in water bath to evaporate ethanol and ink was obtained in powder state.

3. Results

Large quantity of paper wastes are produced daily in home and offices. These waste papers can be recycled to get paper and ink. So, this research work is also based on paper production and ink recovery from the waste paper. In the FTIR pattern of figure 1(a), (b), (c), and (d), the peak intensity band at 3356 cm^{-1} is attributed to O–H stretching vibration. The bands at 2893 and 1357 cm^{-1} are characteristics of C–H stretching and $–CH_2$ bending, respectively. The peaks at 1635 and 972 cm^{-1} are attributed to the H–O–H stretching vibration of absorbed water in carbohydrate and the C_1–H deformation vibrations of cellulose, respectively. The peak at 1730 cm^{-1} represents the ester linkage of carboxylic group of ferulic and p-coumaric acids in hemicelluloses. Peak intensity at 1514 cm^{-1} is attributed to the C=C stretching vibration in the aromatic ring of lignin.

Comparisons of FTIR pattern of different recycled paper in figure 2 showed that the percentage transmittance value for deinked recycled paper is more than that of repulped recycled paper [7].

Lead analysis was carried out by EDX and lead in repulped photocopy paper was found to be 0.012% and 0.019% in repulped newspaper. Lead was not detected in deinked photocopy paper and deinked newspaper. This data shows

that heavy and toxic metals are removed during deinking process.

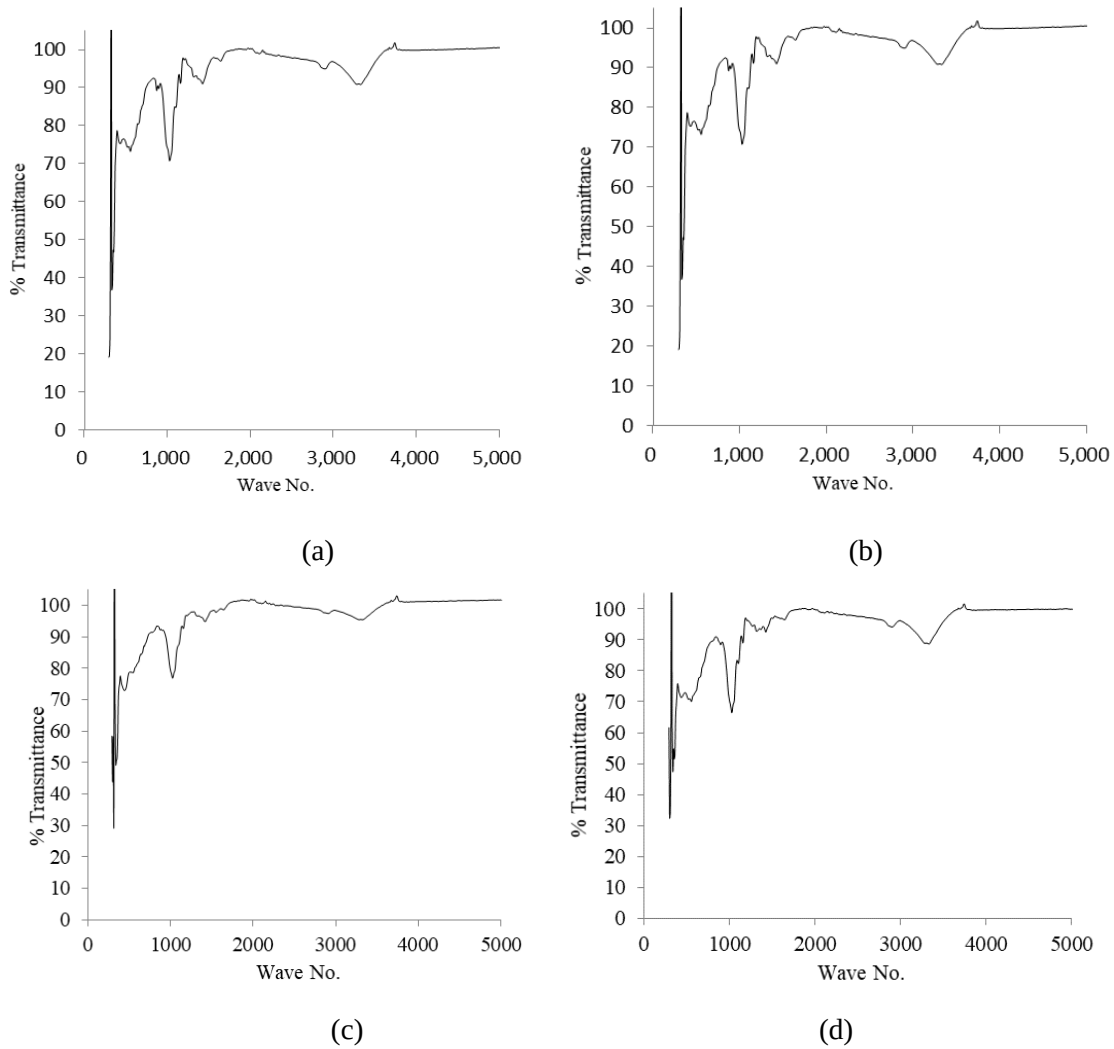


Figure 1. FTIR analysis (a) waste photography paper, (b) deinked photocopies paper, (c) waste newspaper and (d) deinked newspaper.

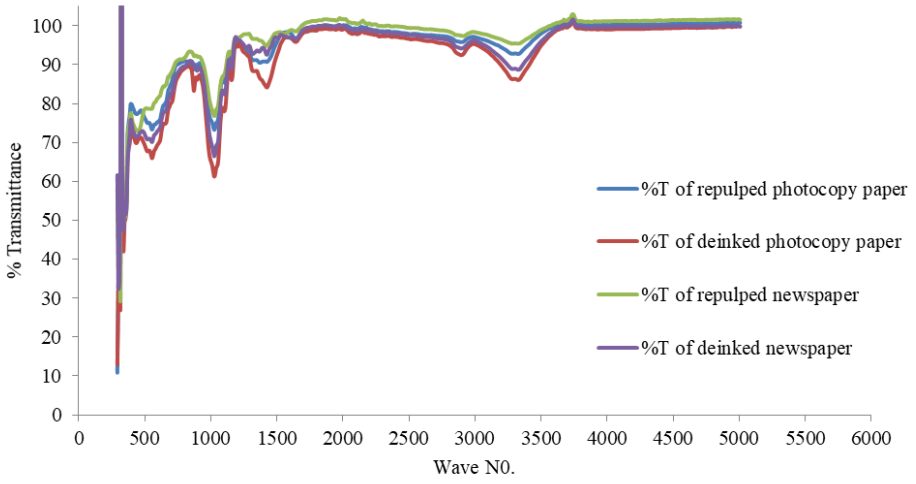


Figure 2. Comparison of FTIR spectra of papers.

3. Conclusion

In this work, FTIR pattern before and after deinking means no chemical changed occurred during deinking process. The presence of any heavy metals can cause decrease in intensity of FTIR spectrum. The main reason for this is that, heavy metals bind with the functional groups resulting the change in intensity of the spectrum. The percentage transmittance value for deinked recycled paper is more than that of repulped recycled paper. It indicates the removable of ink from the paper during deinking process. In the above spectrum the peak intensity of deinked paper is more than that of repulped paper. It signifies that heavy metals like lead are removed during deinking process. Similarly analysis of lead in the papers was carried out by EDX, which showed that heavy and toxic metals were removed by deinking process.

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