

# Paper Waste Recycle and Its Sludge Reduction - Towards Waste and Cost Minimization

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## ABSTRACT

Various biological treatments produce solid sludge, which needs to be treated further or disposed. The sludge can be incinerated, landfilled or can be used for various construction purposes. The domestic waste can be used for production of ethanol like products. Also various options like vermicomposting and anaerobic treatments are very useful. The methanol synthesis is added advantage of the anaerobic treatment. Aerobic treatments are also very common because of ease and acceptability. Paper waste is generally recycled. It can be recycled for limited number of cycles. Paper waste sludge can be used in concrete with better results. Also biofuel synthesis from the waste papers is reported. Production of ceiling boards, bioelectricity production, and fuel gas generation are some of the cost effective applications of waste papers.

**Key words:** Reuse, recycle, hypo sludge, strength, enzymatic deinking, bioelectricity.

## INTRODUCTION

Waste minimization and recycling are widely used terms in recovery and solid waste treatments. Various biological treatments produce solid sludge, which needs to be treated further or disposed. [1-4] The sludge can be incinerated, landfilled or can be used for various construction purposes. [5-7] The domestic waste can be used for production of ethanol like products. [8-12] Also various options like vermicomposting and anaerobic treatments are very useful. The methanol synthesis is added advantage of the anaerobic treatment. Aerobic treatments are also very common because of ease and acceptability. [13-16] Use of plastic waste for road construction is very widely investigated research area. [17-20] Vermicomposting of domestic sludge is becoming acceptable alternative. [21-24] Paper waste is generally recycled. It can be recycled for limited number of cycles. After that the waste becomes useless and needs to be disposed. Various options are being

explored for this paper waste and its sludge. The current review summarizes research and studies on use of paper waste.

## PAPER WASTE RECYCLE AND ITS SLUDGE REDUCTION - TOWARDS WASTE AND COST MINIMIZATION

Lenin used waste paper sludge ash for blending with concrete. [25] They used hypo sludge for production of concrete. To prepare good quality paper, only limited number of recycles can be done for waste papers. This produces huge amount of paper waste. The treatment of this waste hypo sludge is a problem. They tested use of hypo sludge in concrete formulations as a supplementary cementitious material. Their studies indicated that for upto 30 percent addition of the waste material, the cement quality went on increasing, but further addition decreased the strength.

Prema et. al. carried out investigations on production of biofuel using waste papers. [26] They used

*Pseudomonas aeruginosa*. They enlightened on various feed stock viz. waste papers, sugar beets, sugar cane, corn, wheat, barley etc. for biofuel synthesis. They used the microbial process for converting the waste paper substrate (basically made up of starch) into simple fermentable sugar.

Mathuriya and Sharma investigated bioelectricity production from paper industry waste.<sup>[27]</sup> They used microbial fuel cell by *Clostridium* species in their work. They monitored microbial fuel cells during the experiment. They observed that all the samples shown same current generation pattern. The current decreased after 22 hours. They also replaced 50 percent part of bacterial medium with a syringe through the anode by 10% glucose. They observed that there was no remarkable fouling at anode. Khongkrapan et. al. investigated thermo chemical conversion of waste papers to fuel gas.<sup>[28]</sup> They used a microwave plasma reactor for conversion of waste papers to generate fuel gas. They also performed test run for the microwave plasma system. This was done in order to confirm that the generated plasma can be achieved with their reactor. An investigation was carried out by Okeyinka et.al. on suitability of paper waste as an engineering material.<sup>[29]</sup> In their work, they investigated the potential applicability of waste paper in the production of ceiling boards. Their focus during investigation was mainly on environmental sustainability, safe disposal of waste paper and more cost effective production of materials. They used calcium carbonate as an additive. They also conducted laboratory experiments to determine the properties and suitability of the produced boards. Their investigation indicated that the boards with 1:1 mix ratio displayed the best results of the test properties. Allahvakil et.al. carried out investigation on deinking of mixed office waste papers.<sup>[30]</sup> They characterized two types of enzymatically deinked waste paper, including laser printed paper and photocopy paper. This aspect of their work provided further insight into the effects of enzymatic activity on waste papers. Their investigation

indicated that there was an increase in drain ability of recycled papers due to enzymatic deinking. According to these studies, enzymes such as pectinase, cellulase, hemicellulase and lignolytic modify the chemical or physical bonds and so help in detachment of ink from the paper. Cabalova et.al. carried out an investigation on paper recycling and its environmental impact.<sup>[31]</sup> According to them, repeatedly used fibers do not fully regenerate their properties. After certain number of recycles, when the paper cannot be recycled, it can be used for the paper utilization in the building industry, at the soil reclamation, in the agriculture, in the power industry. An investigation was carried out by Damisa et.al. on Cellulase production from waste paper.<sup>[32]</sup> In their investigation, they used *Trichoderma* species isolated from rhizospheric soil. They employed submerged fermentation technique. They proved that it was possible to convert waste paper into cellulase by *Trichoderma* isolated from the soil. Beukering et. al. discussed waste collection sector in Mumbai.<sup>[33]</sup> Their emphasis was on waste paper. They observed that throw-away consumer behaviour is more manifest in cities. According to them, traffic jams and high rise buildings can hamper the recovery and collection of waste. Their survey was useful in determining contribution of various sectors various entrepreneurs in the waste paper collection sector. Rathod et.al. carried out an investigation on manually operated portable paper recycling machine.<sup>[34]</sup> According to them, designing manually operated small-scaled paper recycling plant ensures a cheap and non-complex method of production of paper product. They discussed components of manually operated recycling machine such as pulp feeding system, pulp transferring system, calendaring system, driving mechanism. Ahmad et.al. carried out an investigation on use of waste paper sludge ash as partial replacement of cement.<sup>[35]</sup> Their work explored possibility of using waste paper sludge ash as partial replacement of cement for new concrete.

For various mix combinations, they tested compressive strength, tensile strength, water absorption and dry density up to 28 days of age. They found that 5 percent paper waste indicated 15 percent increase in compressive strength in 15 days. They also observed that with an increase in the waste paper content, ash content, the percentage water absorption increases. Also, it was seen that workability of concrete mix decreases with increase in waste paper. Teja et.al. used waste paper sludge for improvement of properties of highly swelling soil. [36] Presence of Montmorillonite is reason for swelling of mineral soil. This investigation indicated that with the increase in waste paper sludge percentage, there was an increase in the optimum moisture content. According to Ioelovich, waste paper is promising feed stock for biofuel. [37] They highlighted that the waste of office paper is distinguished by increased content of cellulose and negligible content of lignin. They proposed a technology including steps such as redispersion of the waste paper and then screening of the pulp, acidification and washing of the fibers, high-solids enzymatic hydrolysis of the demineralized paper and fermentation of the glucose into biofuel. They were able to synthesize 280 liters of bioethanol from 1 ton of waste office paper biomass. Varkey et.al. carried out an investigation on utilization of waste paper sludge by partial replacement of cement in concrete. [38] Their investigation was focused on using waste paper sludge to produce a low cost concrete by blending various ratios of cement with paper sludge. This in turn reduced disposal problems. Their investigation indicated that waste paper sludge can be used as cement replacement up to 5% by weight. An investigation was carried out by Azmi, in order to demonstrate the use of waste paper sludge ash (WPSA) and recycled aggregate concrete for production of controlled low strength material. [39] In 1:1,1:2 ratios with dosage levels of 20% and 30% of WPSA, they obtained optimum results. They also found that the workability

of concrete mix decreases with the increase in WPSA content. Singh et.al. explored use of paper waste in concrete. [40] Amidst serious challenge in disposing the waste in landfills throughout the country, use of waste papers can be a relief from waste minimization perspectives. They reported an investigation of utilization of paper waste as additional material in concrete mixes. Their investigation yielded promising results. Khalid et.al. carried out an investigation on use of waste paper sludge ash (WPSA) mixtures for stabilization of clay soil. [41] The combustion of wastepaper sludge in paper recycling factories is source of waste paper sludge ash (WPSA). They found that about 10% was optimum for stabilization. Better values of California Bearing Ratio (CBR) results were obtained. According to an investigation carried out by Arshad and Pawade, it is possible to reduce the quantity of clay with natural waste material. [42] They used Clay as a binding material for natural waste material and paper mill waste.

## CONCLUSION

Paper waste is generally recycled. It can be recycled for limited number of cycles. Paper waste sludge can be used in concrete with better results. Also biofuel synthesis from the waste papers is reported. Production of ceiling boards, bioelectricity production, and fuel gas generation are some of the cost effective applications of waste papers.

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