KENAF AS A BODY-FEED FILTER AID

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ABSTRACT

The potential of kenaf (a natural fiber) as a body-feed filter aid was investigated by performing batch filtrations of a 1% kaolin slurry. Performance of kenaf fibers: kenaf 200 (<200 μm) and kenaf 500 (< 500 μm), was compared with that of the commercial filter aids: Diatomite Speedflow, Perlite 4106, and Solkafloc BW100. The maximum filtration rate for Diatomite, Perlite, Solkafloc, kenaf 200, and kenaf 500 were obtained at filter aid concentrations of 2.6, 2.0, 2.0, 1.0, and 1.6% respectively. Cycle analyses, for a downtime of 30 min. and a cake thickness of 1.0 cm, showed the maximum cycle rates of 6.3, 7.8, 8.6, and 8.7 ml/min. for kenaf, Diatomite, Perlite, and Solkafloc respectively, all at 1% filter aid concentration. The lower cycle rate for kenaf means more filter area requirement for kenaf. These results mean that the low price of kenaf combined with the possible savings on solid-waste disposal would be the key to the use of kenaf as a filter aid.

INTRODUCTION

Kenaf (Hibiscus Cannabinus) is an annual plant cultivated in Mississippi, Texas, Arizona, Louisiana, and widely cultivated in Africa. Kenaf stalk has a bast (bark) of long fibers and a core. Kenaf core has commercial applications as an absorbent, drilling mud additive, raw material for paper, and filler for plastics in the automotive industry. Kenaf bast is used in textile industry.

Kenaf is preferentially wetted by organic solvents like acetone and alcohol, and by oils. Kenaf can absorb and hold four to fifteen times its weight of oil, depending on the kenaf fiber size and the nature of the oil. These properties make kenaf a potential absorbent in the cleaning up of oil spills. Borazjani and Diehl (1994) demonstrated that the use of kenaf enhanced bioremediation of oil contaminated soils. Kenaf is combustible with a calorific value of about 7,000 btu/lb and an ash content of about 1.6%. Like most fine particles, kenaf particles exhibit a negative surface charge.

Filter aids are materials used to increase the permeability of filter cake in cake filtration so that a higher rate of filtration and a longer cycle time can be achieved. Use of filter aids reduces the overall filtration cost. Filter aids are also used in cases where a sparkling clarity is required for the product, like in beer and wine filtration (Cain, 1984). In most filter aid filtrations, the filtrate is recovered and the solids are disposed. Thermal and biological degradation are not possible with the mineral based commercial filter aids, diatomaceous earth and perlite. Preliminary studies at the University of Houston showed that kenaf had the potential to be used as a body feed filter aid (Tiller, et al., 1993).

This paper describes details and results of proof-of-principle experiments using kenaf as a body-feed filter aid.

MATERIALS AND METHODS

Materials

Kenaf: The whole Kenaf ground to 5-20 mm particles from Kenaf International, Louisiana was further ground to smaller particles using a laboratory grinding mill from Glen Mills, Inc. The size ranges used in the experiments were the following:(1) particles passing through a 200 μm sieve (Kenaf 200), and (2) particles passing through a 500 μm sieve (Kenaf 500).

Commercial Filter Aids: Diatomite Speedflow, and Perlite 4106, mineral based; and Solkafloc BW100, cellulose based.

Kaolin: Was used for the preparation of the slurry used in the filter aid experiments.

Methods

Filter Aid Filtration: Constant pressure, batch filtrations were carried out in a simple filter shown in Figure 1. Samples were prepared by mixing the filter aid (kenaf 200 or kenaf 500) with a slurry of 2 g of kaolin in 200 mL of tap water. Filtrate was collected in two batches: (1) upto 30 seconds, and (2) after 30 seconds; and analyzed for solids content. Filtrations were done in triplicates for all samples.

Analytical Methods: Solids content in the filtrate for filter aid filtration experiments were done using a turbidity meter. Particle size analyses were done using a Malvern Mastersizer with a size range of 0.5 μm to 900 μm. Microscopic analysis was used as confirmatory test.

Rate of filtration, cake thickness, and cycle analysis

Overall rate filtration for the various filter aids at various concentrations are plotted in Figure 3. The plots in the figure indicate that the rate of filtration is low for the kenaf samples compared to the commercial ones. This result does not necessarily mean that kenaf is not competitive as a filter aid. In practical applications, the thickness of the cake formed is very important because of the limitation to the possible thickness in any filter design. The formation of a thick cake in a short filtration time would mean that the filter unit has to be stopped for the cake removal and put back to service again completing the filtration cycle. The rate achieved over a cycle time (total time including filtration and clean up) is the important criterion in assessing the feasibility of a material as a filter aid. Therefore, cycle analysis was done for all the filter aids based on a cake thickness of 1 cm.

Time required to form a 1 cm thick cake was calculated for all the cases. For the cases where the actual thickness (Table 2) was equal to or more than 1 cm, time to form a 1 cm cake was directly obtained. For the cases where the actual thickness was less than 1 cm, time to form a 1cm thick cake was calculated from the filtrate volume, extrapolated from the filtrate volume-filtration time data, and the actual cake thickness measured. See, for example, Figure 4.

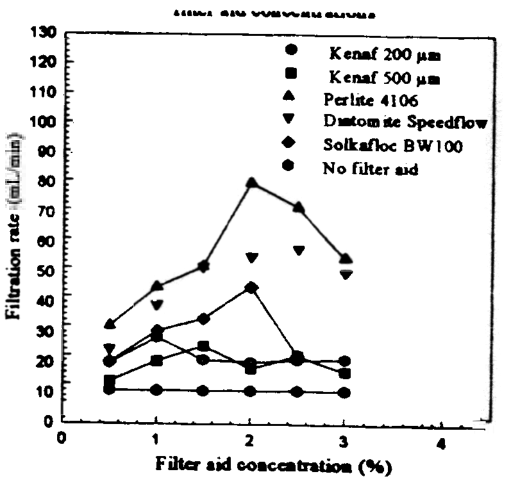

Figure 3 Variation in filtration rate with variation in filter aid concentration and type

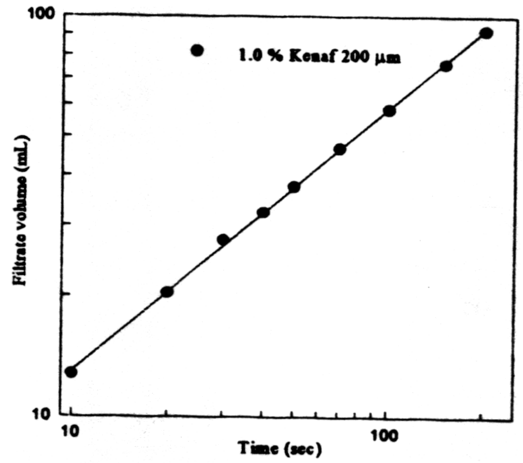

Figure 4 Log-log of filtrate volume to filtration time

Assuming a dead (time from the end of a filtration run to the beginning of the next one) time of 30 minutes and the calculated time for the formation of a 1 cm thick cake, cycle

Table 2 Actual, measured cake thickness

Filter Aid %	Diatomite cm	Perlite cm	Solkafloc cm	Kenaf 200 µm cm	Kenaf 500 µm cm
0.5	0.20	0.30	0.30	0.30	0.30
1.0	0.40	0.55	0.50	0.50	0.50
1.5	0.70	0.75	0.60	0.75	0.70
2.0	0.80	1.00	0.73	0.90	0.90
2.5	0.80	1.30	0.80	1.30	1.30
3.0	1.10	1.55	1.00	1.45	1.50

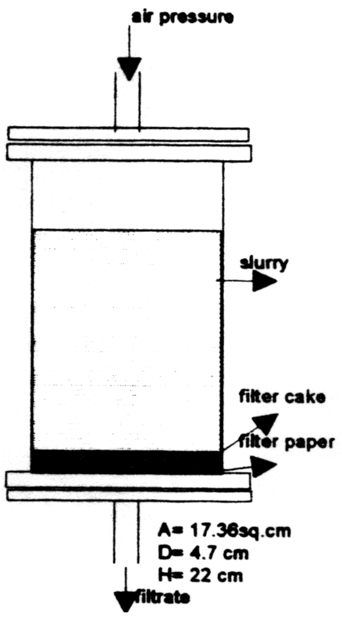

Figure 1 Set up used for filter aid filtrations

RESULTS AND DISCUSSION

Filtrations were carried out using kaolin slurry with different concentrations of the three commercial filter aids, the kenaf 200, and the kenaf 500.

Clarity of the filtrate

Turbidity measurements showed that clarity of the filtrate in the first 30 seconds was the best for diatomaceous earth and perlite. Clarity for solka floc, kenaf 200, and kenaf 500 were in the same range and much higher compared to the other two. The common practice in cake filtration is to recycle the initial filtrate until the required clarity is achieved. Therefore, the high solids content in the initial filtrate is not of much concern.

Table 1 shows the solids content in the filtrate for the various filtration runs. The values in the table show that they are in the same range, meaning that the kenaf filter aids can give the same filtrate clarity as the commercial ones.

Table 1 Turbidity readings for the filtrates collected after 30 seconds (10 ntu = 12.5 mg/L solids)

Filter Aid %	Diatomite ntu	Perlite ntu	Solkafloc ntu	Kenaf 200 μm ntu	Kenaf 500 μm ntu
0.5	3.70	2.00	4.90	5.20	5.70
1.0	2.00	1.50	1.80	7.50	4.50
1.5	4.30	2.60	12.20	5.60	4.90
2.0	4.60	4.10	2.45	7.90	14.00
2.5	1.90	3.60	9.00	3.60	5.10
3.0	2.50	3.40		5.50	6.60

time analyses were done for all the filter aids and all the concentrations studied. Results in Table 3 show that, for all the materials, cycle rate (rate over an entire cycle) is the highest when the filter aid concentration is 1%. The values in the table also show that the cycle rate for the kenaf samples were 75-80% of that of the commercial materials. This result would mean that in order to achieve a given rate of filtration using kenaf as a filter aid will require 25-30% more filter area compared to the other commercial filter aids.

Table 3 Cycle rates for the various filter aid materials and concentrations

Filter Aid %	Diatomite mL/min	Perlite mL/min	Solkafloc mL/min	Kenaf 200 μm mL/min	Kenaf 500 μm mL/min
0.5	2.63	7.52	3.29	4.87	4.33
1.0	7.84	8.55	8.77	6.36	6.30
1.5	7.29	7.10	7.50	4.75	5.43
2.0	6.56	5.42	6.88	4.47	4.33
2.5	6.42	4.09	5.19	3.46	3.64
3.0	4.79	3.37		3.25	3.05

CONCLUSIONS

Kenaf is an effective body feed filter aid. Filtrate clarity is in the same range as with the commercial filter aids. Compared to the commercial filter aids, kenaf has a 25 % lower cycle rate and would require about 25% more filter area, for the same application. The low cost of kenaf and the possible saving on the solid waste (filter cake) disposal could make kenaf a commercially competitive filter aid.

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