Stirring Enhances Removal of Oil by Kapok Fiber

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Introduction

• Kapok fiber, high oil absorption capacity owing to high hollowness and natural hydrophobic property
• inexpensive and is readily available
• low water pickup, very lightweight, excellent buoyancy facilitates retrieval
• Reusability of material up to 15 cycles, environmental-friendly
• sustainable approach to control water pollution
Objectives of Paper

• highlight efficiency of kapok in removing oil greatly enhanced by mechanism of stirring
• suggest reasons for such enhancement
Materials and methods

• **Materials.** Kapok purchased from “Farmers’ Market” in Larkin, Johor Bahru, and palm oil “Labour” brand from local supermarket, “Giant”, in Taman Suria, Johor Bahru.

• **Preparation of kapok fiber.** Raw kapok fiber cut, as best as possible, into uniform shape of cube measuring 0.5 cm x 0.5 cm x 0.5 cm.
Measurements of oil absorption capacity

- Palm oil mixed with 500 mL of distilled water in 1000 mL beaker for 15 min at 100 rpm using 5 cm magnetic stirrer
- Palm oil used varied from 20 to 200 g
- Then, 0.50 g kapok fiber (absorbent) added to oil/water mixture, left with stirring at 300 rpm for 30 min at room temperature, about 30 °C.
• After that, sample removed from beaker using small flat spatula and weighed.
• Sample left in oven overnight at 105 °C
• Water and oil content determined next day by weighing and using following equations
Equations

• \( W_w = W_t - W \). \hspace{1cm} (1)

where \( W_w \) is weight of water absorbed in absorbent (g), \( W_t \) is weight of wet absorbent with oil (g) and \( W \) is weight of dry absorbent with oil (g).

• Amount of oil absorbed determined thus:

\[ W_o = W - W_i. \hspace{1cm} (2) \]

where \( W_o \) is amount of oil absorbed (g) and \( W_i \) is initial weight of absorbent (g).
Oil absorption capacity of absorbent determined and calculated by equation:

\[ Q = \frac{W_o}{W_i} \]  \hspace{1cm} (3)

where \( Q \) is oil absorption capacity of absorbent calculated as grams of oil per gram of absorbent.
Results and discussion

Fig. 1: Oil absorption capacities of the absorbent relative to the amount of oil used.
• Absorption dramatic when mechanism of stirring involved
• far surpasses even performance of various modified kapok fibers with no stirring
• oil absorption capacity in study exceeded 200 g per g of absorbent (Fig. 1)
• Thus, stirring mechanism very valuable method to ensure full potential of raw kapok being utilized
Reasons for Dramatic Performance

• Enhanced penetration of oil into lumen of kapok fiber and interstices within fibrils of kapok fiber as stirring increases number of collisions between oil molecules and kapok fiber.

• Stirring exposes the finer and coarser fibrils which in turn, creates much larger surface area for contact with oil molecules.
• Enhanced penetration and much larger surface area provide improved saturation of oil within the fiber leading to dramatic performance
• But performance dropped when more than 120 g of oil used due to disintegration of kapok fiber and occurrence of “coagulation” made it impossible to recover all oil-filled kapok fiber.
• Therefore, results obtained when amount of oil used greater than 120 g definitely not accurate
• For 20 to 120 g, graph is linear and if extrapolated, straight line will pass through origin indicates these results are very accurate.
Absorption of Water

Fig. 2: Amount of water absorbed relative to the amount of oil used.
• Amount of water being absorbed miniscule proved raw kapok fiber preferentially absorbed oil

• up to 100 g oil used, graph considerably linear and if extrapolated, straight line will pass through origin. As mentioned earlier and from Fig. 1, results obtained up to 120 g would be accurate
• Sharp decline in amount of water absorbed when 120 g of oil used
• this point doesn’t follow preceding trend
• reason is that the 0.50 g of kapok fiber reached maximum saturation of oil when 120 g of oil was used
• where almost all available space in lumen and interstices within fibrils, and surface area accessible were used for the absorption of oil
• Thus, very little space available for absorption of water which explains for sharp decline
• indicator that absorbent reached maximum saturation point for oil absorption
• Knowing maximum oil absorption capacity of absorbent will help us determine amount of absorbent to be used when amount of oil contaminant is known
• hence, avoiding wastage and facilitating transportation
• very little amount of water absorbed makes method a very viable one.
Conclusion

• kapok fiber performed to its fullest potential when mechanism of stirring involved
• oil absorption capacity more than 200 g/(g of absorbent)
• abundant, environmental-friendly, its application would be a sustainable approach
• also be highly effective to control water pollution