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Recent Development on Treatment of Crude Oil Contaminated Water Using Agricultural Waste – A Review

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ABSTRACT

Crude oil recovery processes generate large volumes of crude oil-contaminated water. Crude oil-contaminated water was noted to contain hydrocarbons (including saturates and aromatics) as well as non-hydrocarbons. Some hydrocarbons in the contaminated water are found to be carcinogenic, neurotoxic, and genotoxic to humans and other organisms. Thus, the exposure of human being and other organism like fishes in the marine environment to these hydrocarbons through skin contact to such contaminated water or consumption of contaminated food and water may be very dangerous. The remediation of such oil contaminated water has become a crucial problem in oil producing countries and requires more drastic attention. Several technologies have been deployed at solving this problem. Utilization of agricultural wastes as adsorbents has however, been found to be more attractive to researches due to its environmental friendly tendencies and economic viability. This paper reviewed the attempt of researchers at addressing this problem by using agricultural wastes like banana peel, rice husk, etc as sorbent for removal of the oil from the crude oil-contaminated water. It was observed that agricultural wastes compete favourably with synthetic adsorbents in oil removal from crude oil contaminated water. Though many agricultural products have been investigated, there are some like plantain peel, papaya peel and water melon rind that need to be considered for this treatment.

***Keywords*--** Crude Oil, Contaminated Water, Agricultural Wastes

I. INTRODUCTION

Crude oil recovery processes generate large volumes of crude oil-contaminated water (Coelho *et al.*, 2006; Stubinger *et al.*, 2015). Although the global generation of oil contaminated water was recently estimated to be 33.6 million barrels per day (Diya'uddeen *et al.*, 2011), this may have increased as the demands for crude oil continue to rise year by year. Crude oil-contaminated water was noted to contain hydrocarbons (including saturates and aromatics) as well as other substances such as chloride (Cl), Sulphates (SO_4^{2-}), Nitrogen (N_2), Phosphorous (P), Sodium (Na^+), Potassium (K^+), Cadmium (Cd), Chromium (Cr), Copper (Cu), Iron (Fe), Nickel (Ni), Lead (Pb) (Afzal *et al.*, 2019; Kkiu *et al.*, 2019). Previous researchers have found that some of the hydrocarbons in the crude oil contaminated water are carcinogenic, neurotoxic, and genotoxic to living organisms (Dave *et al.*, 2014).The contaminated water need to be well treated before it is released into the environment. Various methods are available for the treatment of the contaminated water before it is released into the environment. Adsorption method is, however, considered to be most preferred technique due to its ease of carrying out, low cost and environmentally-friendly capability (Aaa El-Din *et al.*, 2017). This involves the use of adsorbent (sorbent) to remove the unwanted components of the water. The properties that determine the efficiency of an absorbent are oleophilicity, hydrophobicity, high rate of uptake, high uptake capacity, oil recovery, oil reusability, biodegradability and retention over time. Activated carbon has been used severally as adsorbent over the years. The cost involved with the initial establishment and the regeneration system regarding activated carbon is relatively high (Aktas and Cecen, 2007), as a results researchers have been engaging in search for more economically affordable and environmentally friendly alternatives. Agricultural waste materials have been found to be better alternative that fit into these desires. Hence, various agricultural wastes like rice, banana peel, etc. have been investigated as adsorbents for the treatment of crude oil-contaminated water. Apart from hydrocarbons which will be the largest constituent, crude oil-contaminated water may contain chloride, sulphates, lead, etc (Afzal *et al.*, 2019). Thus an appropriate adsorbent should be able to effectively remove these other impurities apart from removing the hydrocarbons in the water.

II. INVESTIGATED AGRICULTURAL WASTES

It was noted that many agricultural wastes have been tested for removal of heavy metals from contaminated water generally. Examples of agricultural wastes investigated as adsorbent for removal of heavy metals from contaminated water are banana peel, grape stalk, sugar cane baggase, potato peel, tamarind hull, papaya wood, etc. (Kkiu *et al*, 2019). It was however observed that not all of

them have been tested specifically for treatment of crude oil contaminated water. The agricultural wastes that have been reportedly investigated as adsorbent in treatment of crude oil contaminated water are shown in Table 1. Sun *et al.* (2002) investigated Acetylation of rice straw for oil sorption; with or without catalysts. Kumagai *et al.* (2007) worked on oil adsorbent produced by the carbonization of rice husks, while Srinivasan & Viraraghavan (2008) investigated the removal of oil by walnut shell media. Husseien *et al.* (2009a) worked on a comprehensive characterization of corn stalk and study of carbonized corn stalk in dye and gas oil sorption. Husseien *et al.* (2009b) worked on availability of barley straw application on oil spill cleanup while Ibrahim *et al.* (2009) investigated the removal of emulsified food and mineral oils from wastewater using surfactant modified barley straw and Ibrahim *et al.* (2010) investigated the removal of emulsified oil from oily wastewater using agricultural waste barley straw. Furthermore, Sathasivam and Haris (2010) worked on adsorption kinetics and capacity of fatty acid-modified banana trunk fibers for oil in water and Husin *et al.* (2011) worked on sorption equilibrium and kinetics of oil from aqueous solution using banana pseudostem fibers. Also, El-Nafaty *et al.* (2013) carried out biosorption and kinetic Studies on oil removal from produced water using banana peel, Aliyu *et al.* (2015) investigated oil removal from crude oil polluted water using banana peel as sorbent in a packed column and Alaa El-Din *et al.* (2017) studied the use of banana peels for oil spill removal. Vlaev *et al.* (2011) investigated cleanup of water polluted with crude oil or diesel fuel using rice husks ash while Kudaybergenov *et al.* (2012) carried out study on the effectiveness of thermally treated rice husks for petroleum adsorption. Removal of oil from oil produced water using eggshell was studied by Muhammad *et al.* (2012) while Sidiras *et al.* (2014) worked on simulation of auto-hydrolysis effect on adsorptivity of wheat straw in the case of oil spill cleaning. Behnood *et al.* (2014) worked on Crude oil layer sorption from saline water surface by raw and acetylated sugarcane bagasse. Zou *et al.* (2014) investigated sorption of oil from simulated seawater by fatty acid modified pomelo peel, desalination and water treatment. Chai *et al*. (2015) investigated pomelo peel modified with acetic anhydride and styrene as new sorbents for removal of oil pollution. Olufemi and Otolorin (2017) worked on comparative adsorption of crude oil using mango (*Mangnifera indica*) shell and mango shell activated carbon.

Table 1. Reported agricultural products investigated as adsorbent for treating crude oil contaminated water

S/N	Agricultural products	Researcher (s)
1.	Rice straw	Sun *et al.* (2002)
2.	Carbonized rice husk	Kumagai *et al.* (2007)
3	Walnut shell	Srinivasan & Viraraghavan (2008)
4.	Corn stalk	Husseien *et al.*(2009a)
5.	Barley straw	Husseien *et al.*(2009b); Ibrahim, *et al.* (2009); Ibrahim, *et al.* (2010)
6.	Fatty acid modified banana trunk fibers	Sathasivam and Haris (2010)
7.	Banana pseudo-stem fibers	Husin, *et al.* (2011)
8.	Banana peel	El-Nafaty, *et al.* (2013), Aliyu *et al.* (2015) and Alaa El-Din *et al.*, (2017)
9.	Rice husk ash	Vlaev, *et al.* (2011)
10.	Rice husk	Kudaybergenov *et al* (2012)
11.	Raw eggshell	Muhammad *et al.* (2012)
12.	Wheat straw	Sidiras *et al.* (2014)
13.	Raw and acetylated sugarcane bagasse	Behnood *et al.* (2014)
14.	Pomelo peel	Zou *et al.* (2014); Chai *et al.* (2015)
15.	Mango shell	Olufemi and Otolorin (2017)

III. RESULTS OF INVESTIGATIONS

From the various investigations carried out on the agricultural wastes, it was observed that many of the crop residues are excellent adsorbents with good adsorption capacity better than activated carbons and commercial ion exchangers. It was observed that banana peel and rice husk are the most investigated of all the agricultural products for treatment of crude oil-contaminated water. However, some agricultural products that could also serve as adsorbent for treatment of crude oil-contaminated water have not yet been

investigated. Some of these products are plantain peels, watermelon rind, pawpaw peel, etc.

IV. CONCLUSION

The advent of utilization of agricultural wastes in treatment of crude oil-contaminated water is a very good development. This will provide very good alternatives to widely used expensive activated carbon and also create the opportunity of turning waste to wealth. Furthermore, this will remove environmental hazard that may result from utilization of activated carbon. Some other available plant materials like pawpaw peel, plantain peel and watermelon rind, which are yet to be investigated need to be considered too for the treatment of crude oil contaminated water. Their use could indeed be an environmentally friendly approach and even yield better results in removal of the oil.

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