# CHAPTER II

# LITERATURE REVIEW

## Historical Reuse of Reclaimed Wastewater

Wastewater reclamation and reuse has recieved considerable attention during the last two decades as an alternative source of water. Intentional direct reuse is common within the industrial sector but is less widely recognized within the municipality which may use reclaimed wastewater for recreation, street cleaning lawn and garden watering or even drinking purposes. In the industrial sector, reclaimed wastewater has been used mostly as cooling and process water. In case of the United States in 1965, the total water demand of 90,000 mgd by the manufacturing industry were met mostly (i. e., 50,000 mgd) by reclaimed wastewater (U.S. WATER RESOURCES COUNCIL, 1968).

Reuse of reclaimed wastewater, while not yet fully accepted for municipal purposes in ordinary situations, does have historical precedent in unusual situations. This is the case with CHANUTE, KANSAS, in 1956. During two months of a serious drought there, the domestic sewage effluent, diluted as much as possible by the low river supply, was used after a well - controlled water purification process had made the water potable throughout the whole period with no ill effects noted, even though there were enteric viruses present in the treated wastewater (STEPHAN and WEINBERGE, 1968).

In case of the metropolis of WINDHOEK in SOUTH - WEST AFRICA, its population of 84,000 have been supplied about one - third of their water demand by treated wastewater effluent being returned directly into the city's supply system since 1968 with complete public acceptance while new sources of water supply are virtually unattainable. Similar plans are being considered for PRETORIA and JOHANNESBURG (STANDER and VAN VUUREN, 1969).

Experiments on Filtration Using Local Materials

SEVILLA (1971) Studied water filtration using local materials like pea gravel, coconut husk fiber, burnt rice husk, raw rice husk and sand as filter media. In preliminary test runs, two filtration rates were studied: semi rapid rate of 2.5 and 1.25 $m^3/m^2/hr$. Two levels of turbidity were investigated : 300 JTU and lower and 1,000 JTU and higher. The tests were aimed to determine the maximum filtration rates for different media to achieve an effluent turbidity of 5 JTU or lower at the highest turbidity loading of 1,000 JTU. The results were as follows :

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| Pea gravel | : | less than 2.5 $m^3/m^2/hr$ |
| Coconut husk fiber | : | 1.25 $m^3/m^2/hr$ |
| Burnt rice husk | : | 1.25 $m^3/m^2/hr$ |
| Raw rice husk | : | less than 1.25 $m^3/m^2/hr$ |

Moreover, he noticed that in all the runs except for burnt rice husk, breakthrough occurrence was highly dependent on the filtration rates and porosity of media more than the influent turbidity. Burnt rice husk removed most turbidity so efficiently even in the upper 2 - 3 cm of the medium. However, it is apparent that all the media investigated have two limitations : (1) good effluent quality but relatively short filter runs; and (2) relatively long filter runs with lower effluent quality.

He finally concluded that the most effective medium to remove turbidity was burnt rice husk, followed by sand, coconut husk fiber and pea gravel. Colour removal from raw water was effectively done by burnt rice husk, not by coconut husk fiber. However, no media seemed to be superior than the other if they were considered not only removal efficiency but also length of run.

His work was supported by JAKSIRINONT (JAKSIRINONT, 1972) who later on reported of her study on the same matters that with burnt rice husk as medium, the filtration rate of 1.25 $m^3/m^2/hr$ gave the most effective turbidity removal and for coconut husk fiber the length of run at 1.25 $m^3/m^2/hr$ was nearly twice the length of run at 2.5 $m^3/m^2/hr$ rate with influent turbidity range of 180 - 350 JTU. She also showed that, if dual media were used, the filtration rate of 1.25 $m^3/m^2/hr$ would give the maximum COD and turbidity removal. She finally suggested that burnt rice husk alone could be used satisfactorily in a filter for ground water or surface water of low turbidity (less than 40 JTU), and a thickness of 80 cm was optimal if coliform removal efficiency of over 99 per cent was to be had.

The first field study on burnt rice husk as filter medium was done by LOW in 1973 (LOW, 1973). Two filters were installed in a rural village, one using coconut husk fiber and the other burnt rice husk as filter medium. He could draw several interesting conclusions, from his study. He stated that the two - stage filters using coconut husk fiber of 40 to 80 cm in depth as primary filter medium and burnt rice husk of 40 to 60 cm in depth as secondary filter medium could produce effluent quality meeting WHO (1971)'s drinking water standards in terms of turbidity, color, taste and odor, but not coliform organisms if the raw surface water contained coliform organism level higher than 100 MPN/100 ml. Anyway, he concluded that two - stage filters gave better effluent quality in terms of turbidity and coliform organisms than that of dual-media filter with same water source.

A subsequent field study performed by FAN (FAN, 1974) further supported LOW's work by showing that two - stage filters possessed economy of scale characteristics, i. e., the unit cost could be reduced by expanding the scale of operation or plant capacity. Their investment costs and operating costs were also less than those of conventional water treatment plants.