A Novel Process for the Treatment of Palm Oil Refinery Wastewater

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INTRODUCTION

The amount and characteristics of the wastewater produced by a palm oil refinery depend very much on the type of process used in the refinery. The complexity of the wastewater is greater in the case of chemical refining with downstream processes than in the case of physical refining. Variation in the strength, composition and amount of the wastewater account for much of the difficulty and expense of the treatment system. In dry weather the amount of wastewater varies from 0.2 tonne per tonne of oil processed (with physical refining) to 1.22 tonnes per tonne of oil (with chemical refining and soapstock splitting). It is beyond the scope of this paper to detail the different processes from which wastewater is discharged. However it should be stressed here that to a large extent the refiners themselves can determine the total amount of wastewater and minimize it through good house-keeping.

This paper describes a novel process, using equipment known as a sequencing batch reactor (SBR) developed by PORIM together with the National University of Singapore for the treatment of wastewater from physical refining process. This process has undergone laboratory and pilot scale testings and has already been adopted by some refineries.

PRINCIPLES OF THE SBR PROCESS

As the name implies, SBR is a fill-and-draw activated sludge process. The system operates in time rather than space, *i.e.* all unit operations and processes take place one after another, in the same reactor tank, instead of material being moved to a second tank for the continuation of the treatment. There are generally five discrete operational periods or modes during one cycle of each reactor. They are identified as: fill, react, settle, decant and idle. The purpose of each period, with the exception of 'idle' is self-explanatory. In a multiple-tank configuration, one of the tanks could be in the 'wait' or 'idle' mode. A typical SBR operation cycle is shown in *Figure 1.* The control and operation of the SBR are made relatively simple by cheap and reliable microprocessor sequencing controller. It can be made to respond to changing wastewater characteristics or discharge quality by manipulating the programme controlling the sequence of events in the reactor.

The removal of organics, measured as biochemical oxygen demand (BOD), and nitrogenous compounds, occurs through various stages of operation. Bacteria found in the SBR system are mostly facultative in nature.

During the 'fill' phase, when oxygen is absent, the organics will be removed anaerobically. Aerobic removal of organics will take place during the 'react' phase when oxygen is abundant. The oxygen requirement is normally calculated on the basis of the aerobic removal of BOD. However if ammoniacal nitrogen is present, extra oxygen is required to meet the demand exerted by the nitrogen. The oxygen requirements for organics and ammoniacal nitrogen removal are 1.5 to 2.0 kg per kg of BOD and 4.6 kg per kg of ammoniacal nitrogen respectively. It is also imperative to ensure adequate mixing in the reactor tank. A good aeration system should be able to satisfy both the

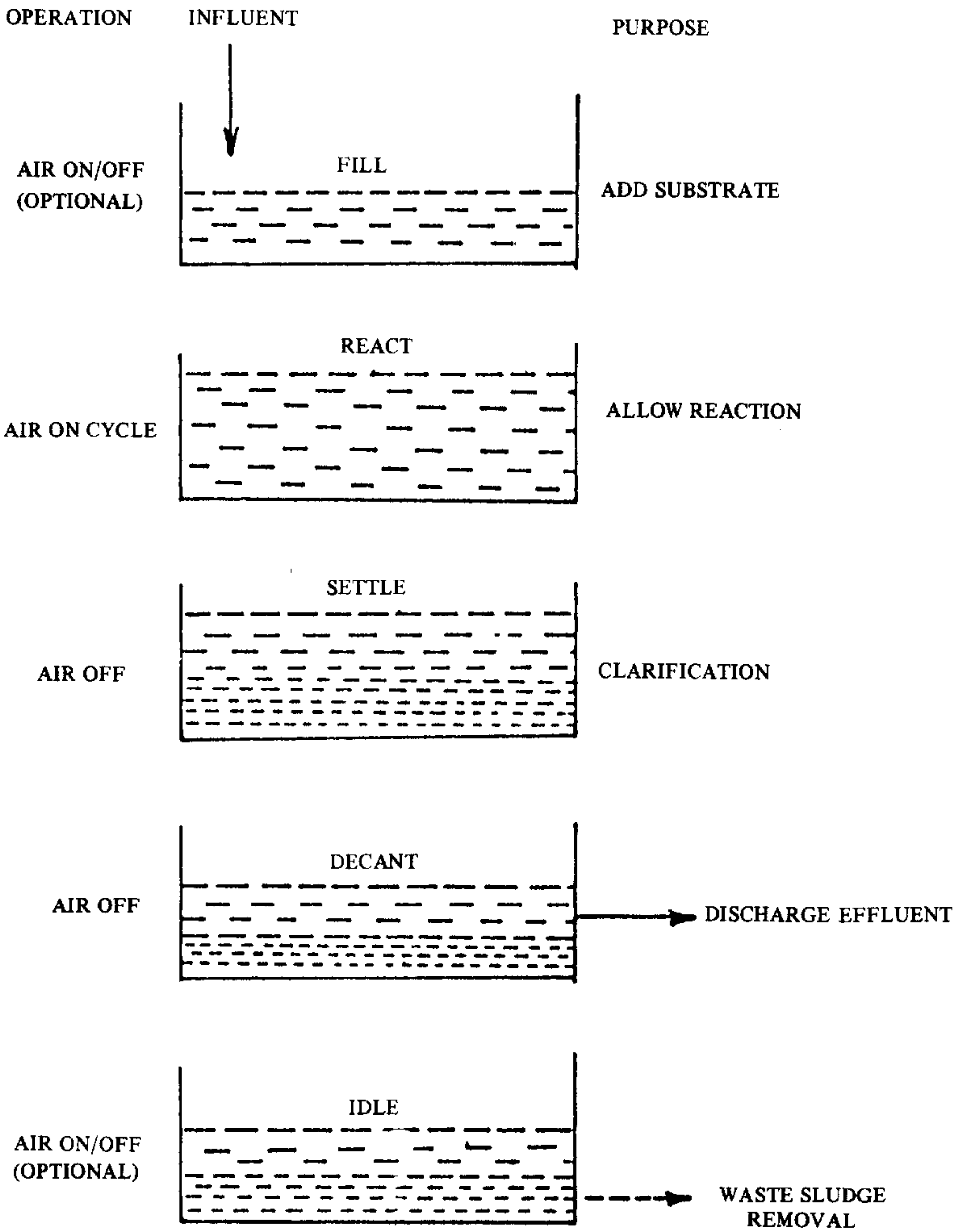

Figure 1. Typical SBR operation – one cycle

oxygen and mixing requirements. As with any other biological process, SBR requires supplementation of nutrients if they are insufficient in the wastewater. A BOD: N:P = 100:5:1 ratio is recommended for the treatment of palm oil refinery wastewater.

PERFORMANCE OF THE SBR SYSTEM

SBR has many advantages over the conventional activated sludge system. These include equalization, ideal settling, simple operation, compact layout and perhaps cost-saving (capital and running costs). It has been used successfully to treat many medium-strength wastes like municipal wastewater and milking parlour wastewater. As shown in *Figure 1*, during the 'settle' period the sludge settles to the bottom of the reactor under quiescent conditions. Only the supernatant is discharged during the 'decant' period. The active sludge is retained at the bottom. The SBR system does not require a separate settler or a pump to recycle the sludge to the reactor basin as does the activated sludge system.

The SBR system has been fully tested in the laboratory and in pilot plant studies and has been adopted by a number of refineries for treating wastewater from their physical refining processes. The performance has so far been very encouraging. Different water quality objectives (COD and suspended solids removal) are consistently achieved as shown in *Figure 2*. The COD and suspended solids of final discharge are consistently below the levels set in the standards of the Department of Environment, which are 250 and 100 mg/ℓ respectively.

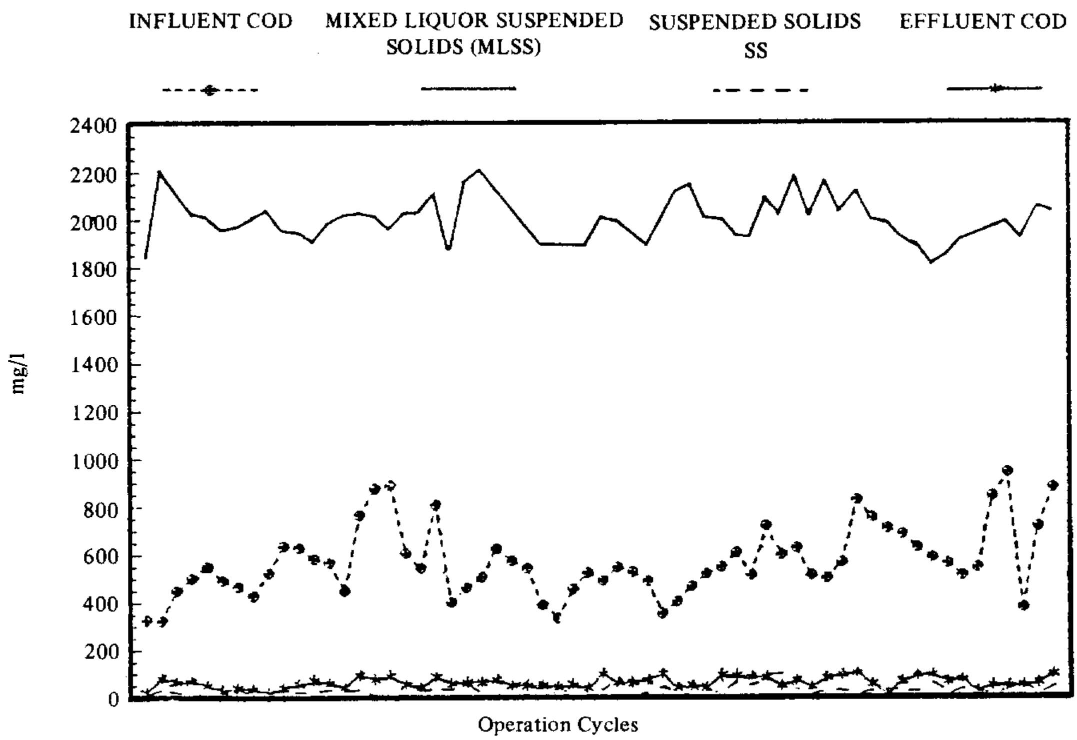

Figure 2. Performance of the SBR Process