

# Grape wine distillery waste in UASB systems - Feasibility, alkalinity requirements and pH control

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## Abstract

Grape wine distillery waste developed a pelletised sludge bed in a UASB system. Product formation along the line of flow in the pelletised bed was similar to that when treating a pure carbohydrate apple juice waste. Pelletised sludge production was about 0,14 mg VSS/mg COD removed as against 0,42 mg VSS/mg COD removed for apple juice waste, indicating a low influent COD carbohydrate fraction. The pellets were not as compact as with apple juice waste and were smaller (< 2 mm). The grape wine distillery waste COD concentration ranged from 20 000 to 30 000 mg/l. An appreciable amount of H<sub>2</sub>CO<sub>3</sub>\* alkalinity was generated internally due to deamination of proteins and removal of organic salts. Provided the system was operated with a recycle from the effluent to influent at a recycle ratio sufficiently high to dilute the base influent COD concentration to an effective influent COD (COD<sub>e</sub>) of < 2 000 mg/l, sufficient of the H<sub>2</sub>CO<sub>3</sub>\* alkalinity generated internally was recycled to maintain a sludge bed pH > 6,6. Recycle ratios as high as 33:1, reducing the base influent COD concentration of 27 000 mg/l to a COD<sub>e</sub> of 790 mg/l, did not adversely affect COD removal. No nitrogen, phosphate or trace element supplementation was required. COD removal was greater than 94 per cent for COD loading rates up to the maximum of 19 kg/(m<sup>3</sup> sludge bed-d, the maximum COD loading rate was determined by gas lifting pellets in to the settling section, not by process failure.

## Introduction

Grape wine distillery waste is the residue left after ethyl alcohol has been distilled from fermented grape juice. It contains organic acids and their salts, soluble proteins and carbohydrates, as well as various inorganic compounds which are normal constituents of wine. In the literature successful treatment of rice wine distillery waste in full-scale UASB plants has been reported (Cheng et al., 1990). It was of interest, therefore, to investigate the potential of grape wine distillery waste for treatment in a UASB system. The study was divided into two major parts:

- Feasibility of the treatment of grape wine distillery waste in a flow-through UASB system, to ascertain formation of a pelletised sludge bed and to study the product formation pattern along the line of flow of the reactor.
- Investigation into the effects of recycling on process performance and mass of H<sub>2</sub>CO<sub>3</sub>\* alkalinity required to maintain a near neutral minimum pH in the lower part of the sludge bed.

## Assessment of grape wine distillery waste for treatment in a UASB system

From available information, the grape wine distillery waste was theoretically assessed for suitability as a substrate for the UASB system against the prerequisites for pelletisation set out by Sam-Soon et al. (1987), i.e. (1) development of a high pH<sub>2</sub> environment; (2) cysteine deficiency; (3) excess supply of nitrogen; and (4) a near neutral pH.

With regard to (1), the presence of carbohydrates and proteins would be desirable as they give rise to a high pH<sub>2</sub> during the acidogenic phase (Sam-Soon et al., 1987 and Moosbrugger et al., 1990). A number of analyses of grape wine distillery waste were obtained from the distilleries. However, these analyses tended to focus either on the potential for recovery of some compounds

such as tartaric acid, or on compounds that may cause problems in distillation, for example sugars that may caramelize onto the distillation apparatus. Reported waste COD values ranged from 20 000 to 30 000 mg/l, carbohydrates COD from about 2 000 to 3 000 mg/l; organic nitrogen content ca. 300 mg N/l. Clearly the protein fraction made up a relatively small portion of the waste COD. Other data on organic acids are listed in Table 1. From the analysis provided in Table 1, an appreciable fraction of COD is in the form of organic acids which probably would not induce a high hydrogen partial pressure (pH<sub>2</sub>) to the same extent as the carbohydrates contained in the apple juice waste used by Sam-Soon et al. (1987) in their investigation.

With regard to (2), cysteine deficiency, no analysis was available and it was not known whether cysteine was deficient or not.

With regard to (3), excess ammonium supply, Sam-Soon et al. (1990) suggested a minimum of 0,02 mg N/mg influent COD for unimpeded pellet production. Data on grape wine distillery waste (Table 2) indicated a TKN/COD ratio of 0,015, considerably lower than the value recommended for a carbohydrate type substrate (Sam-Soon et al., 1990). Also, there was uncertainty as to whether the organic nitrogen would be deaminated sufficiently rapidly to be available for pelletisation in the lower part of the reactor.

With regard to (4), a near neutral pH, initially it was not known how much alkalinity the substrate would generate internally and how much would need to be added from an external source.

From the theoretical assessment, no explicit conclusion was possible as to whether the waste would be suitable for treatment in a UASB system or not; that is, whether the waste would generate a pelletised sludge bed or not - the only option was an experimental feasibility study.

## Feasibility study

Influent feed stock of grape wine distillery waste was collected from the KVV distillery at Paarl and stored at 4°C. The waste batches contained different low concentrations of particulate material; to eliminate this variable the waste was settled and the supernatant only used as feed to the UASB reactor. The average characteristics of the supernatant are shown in Table 2.

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