A review of characterisation requirements for in-line prefermenters Paper 1: Wastewater characterisation

WH Rössle* and WA Pretorius

ERWAT Chair in Wastewater Management, Water Utilisation Division, Department of Chemical Engineering, University of Pretoria, Pretoria 0001, South Africa

Abstract

The impact of wastewater prefermentation cannot be evaluated in isolation, based only on the local prefermenter biodegradable organic matter production rate, as represented by the volatile fatty acids concentration increase across the prefermenter. The nutrients ratio changes and solids removal variations from the raw to the settled sewage must be taken into account when considering the suitability of the prefermented wastewater for downstream biological nutrient removal processes. The raw and settled wastewater must, therefore, be characterised according to component nutrients and solids fractions. This paper reviews related wastewater characteristics required for in-line prefermenters, to establish simple strategies on which in-line prefermenter evaluations could be based.

Nomenclature

APT	=	activated primary tank
BCOD	=	biodegradable chemical oxygen demand
BEPR	=	biological excess phosphorus removal
BNRAS	=	biological nutrient removal activated sludge
C	=	carbon
COD	=	chemical oxygen demand
F-RBCOD	=	fermentable readily biodegradable chemical oxygen demand
GC	=	gas chromatography
HAB	=	heterotrophic active biomass
N	=	nitrogen
N/A	=	not available
NH_3	=	ammonia
NH_4	=	ammonium
NH_3+NH_4-N	=	total ammonia nitrogen
NO_3	=	nitrate
NO_2	=	nitrite
o-PO_4	=	orthophosphate
P	=	phosphorus
PCOD	=	particulate chemical oxygen demand
PST	=	primary settling tank
RBCOD	=	readily biodegradable chemical oxygen demand
SBCOD	=	slowly biodegradable chemical oxygen demand
SCOD	=	soluble chemical oxygen demand
SCVFA	=	short-chain volatile fatty acid
SetS	=	settleable solids
SS	=	suspended solids
TDS	=	total dissolved solids
TKN	=	total Kjeldahl nitrogen
TN	=	total nitrogen
TP	=	total phosphorus
TS	=	total solids
UCOD	=	unbiodegradable chemical oxygen demand
UPCOD	=	unbiodegradable particulate chemical oxygen demand
USCOD	=	unbiodegradable soluble chemical oxygen demand
VFA	=	volatile fatty acid
VFA-COD	=	equivalent COD for VFA
WCW	=	water care works

Introduction

The presence of appropriate proportions of the macro-nutrients C, N and P in municipal wastewater is important for the efficient performance of a BNRAS process employing BEPR. These constituents are characterised by the TKN and the TP to COD ratios respectively. The TKN/COD ratio principally determines which BNRAS process configuration is the most appropriate, with a process feed ratio smaller than 0.07 to 0.08 mg N/mg COD required for the frequently utilised 3-stage Phoredox process (Ekama et al., 1983). In a typical South African wastewater, the TKN/COD ratio range of 0.07 to 0.10 in the raw sewage changes towards 0.09 to 0.12 mg N/mg COD in the settled sewage. Concurrently, the TP/COD ratio range changes from 0.015 to 0.025 towards 0.02 to 0.03 mg P/mg COD (WRC, 1984). These ratio increases are due to the average 15 to 20% TKN and TP removals against the higher average 40% COD removal occurring in the primary settling process. Solids removal taking place simultaneously can result in SetS and SS removal of about 90% and 60% respectively.

The change towards a low-strength settled sewage (low COD concentration) BNRAS reactor feed, lacking sufficient available biodegradable matter, can be counteracted by changing the settled sewage composition to contain more soluble organic matter. This can be accomplished by the prefermentation of the settled solids in the primary treatment process, where anaerobic bacteria hydrolyse biodegradable solids in the sludge to soluble organic compounds. These compounds can then be elutriated (washed) from the sludge and transferred to the settled sewage, where they are available as suitable carbon and energy sources in the downstream BNRAS process.

The full-scale implementation of prefermentation occurred only in the past 10 to 20 years at several WCW worldwide

* To whom all correspondence should be addressed.
☎(011) 316-1304; fax (011) 316-1928; e-mail: wernerr@erwat.co.za
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