

Kirkwall WwTW

novel SBR system for Orkney Island plant

by
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Kirkwall WwTW, is situated on a finger of land known as Head of Work, on Mainland, Orkney and is designed to serve the main town of Kirkwall and surrounding areas. Design full flow to treatment is up to 100 l/sec and a raw sewage BOD load of 1.36 tonnes per day – broadly a population equivalent of 25,000. In addition to sewered flows, there are significant imports of septic tank sludges from some of the more remote outlying areas. Consent is for a 25:35 BOD:SS treated effluent. Initially, the works was designed for Primary Treatment only but before the system came on stream, the regulator changed the discharge standard in response to objections from a salmon farm in the vicinity of the relatively short outfall, discharging to sea. This change of standard required the addition of Secondary Treatment



Kirkwall WwTW (photo courtesy of Hitech Bioreactors Ltd)

Over the preceding several years *Hitech International*, designers of the original scheme had been developing an interest in SBRs, following involvement in the process design of a large SBR system for Hull (known at the time as the Hull 2000 scheme). Learning from that scheme and from many operating SBRs in the UK in which the firm was involved in commissioning and trouble shooting roles, a novel SBR was developed and seen to be appropriate and suitable for the Kirkwall scheme.

A new company *Hitech BioReactors Ltd* was set up to undertake this project which was now under the control; of *Pierse Contracting Ltd*.

Priority in the system design was to provide a stable control platform, with the ability to accept a very large and rapid flow and load variation. The control of filaments was also of great importance over a wide range of operating conditions.

Primary treatment

The primary treatment system consists of a Storm Tank (2 hours capacity) and two duty Primary Tanks. The discharge from these tanks was diverted to a new interstage pumping chamber in which duty/standby pumps deliver to three reactors. The system is a true batch process, with only one tank filling at any one time, and only one tank decanting at any one time. The SBRs de-sludge on a time sequence back to the splitter chamber feeding the Primary Tanks. This results in a single source of co-settled sludge which provides a consistent feed to the subsequent sludge treatment system.

Commissioning of the Primary and Secondary treatment systems commenced late in 2001 on intermittent (daytime) flows from the forwarding pumping station. Early in January 2002, the works accepted continuous flows and the testing of treated effluent was undertaken by an independent laboratory acceptable to the client

(NOSWA). The treated effluent standard is compliance with 35mg/l SS and 25mg/l BOD. The system is designed to nitrify and de-nitrify, with variable anoxic periods during the fill cycle. However, there is no nitrogen or ammonia standard set by the regulator.

Sludge treatment

In the initial intermittent and continuous operation of the works, the sludge treatment system was under modification to enable the additional load of biological solids to be treated. The system, already in place under Phase 1, includes thickening, balancing, de-watering and lime/heat treatment for disposal to agricultural land. The original dewaterer was inadequate for the revised load and was taken out of service until a larger unit was delivered. For several months no sludge was removed from the system and all primary sludges, together with a large proportion of septic tank sludge was discharged direct to the SBRs. This sludge load, included a considerable volume of imported septic tank sludge.

Very high levels of solids and BOD were pumped to the system, without apparent ill effect.

This situation continued for three months, until the SBR SSVs measured externally (500 ml cyclinder) were in excess of 75%. Under these extreme circumstances, the treated effluent was maintained at a very high standard. During a large variation of mixed liquor solids, from a few hundred mg/l to several thousand mg/l, there has been no tendency for sludge bulking or the

formation of filamentous organisms. At its optimum, the system operates at a SSV (TWL) of about 10%, producing a settlement rate of around 3m/hour from very large flocs.

SBRs

The SBRs are 20m diameter x 5m operating depth. Each reactor has a submersible mixer to maintain floc suspension during the anoxic fill period. The aeration system is based on *Envicon* tubular diffusers, which are the most efficient we have tested. Each SBR has a dedicated blower, with a single common standby, which is brought into service automatically if a duty unit fails. The decanter is a stainless steel floating device which draws from 400mm below the surface. In the operating period, there has been no accumulation of floating matter on the surface of the SBRs. A sludge concentrator

is built into each reactor which allows withdrawal of a lower volume of excess activated sludge and also prevents accidental over desludging;

The process has proved to be extremely robust, and due to the inability of the downstream facilities to accept sludge, has been tested to extreme limits. The average effluent quality over the monitored period has bettered 10mg/l BOD; 10mg/l SS,w with a large number of results very much lower than these. ■

Note: *The author of this article, Peter Carnes is Director, Hitech BioReactors Ltd.*
