

# Skipsea WwTW — MBR Plant

## Yorkshire Water's solution to sudden population changes

**S**kipsea Wastewater Treatment Works, located on Yorkshire's East coast serves a resident domestic population of 1,400 and a seasonal population of 6,000. The works is required to meet the Urban Waste Water Treatment Directive (UWWTD) and River Quality Objectives (RQO) and needs a process that has the ability to quickly react to sudden changes of population.



Skipsea WwTW MBR Plant (courtesy Eastern CaST)

The original works was a conventional filter works consisting of:

- \* screening
- \* three Dortmund type primary tanks;
- \* three mineral media biological filters with recirculation;
- \* three Dortmund type humus tanks;
- \* sludge storage.

### Problem

The overall consent standard of  $BOD_5$  — 31mg/l, SS — 60 mg/l,  $NH_3$  — 16 mg/l is not particularly stringent but the sudden rise in population, due primarily to an influx of campers and caravans creates a significant increase in biological load on the works over a relatively short period of time during the holiday season. As a result the works was at risk of failing its consent due to high ammonia levels.

Most wastewater treatment processes rely on biological treatment and perform at their best when presented with reasonably constant load. The sudden loads that appear at Skipsea cannot be accommodated by conventional biological treatment process and alternative processes needed to be considered. Temporary SAF

plants with chemical dosing were tried during construction and the experience has shown them to be insufficiently robust for this application.

### Options

To ensure the most cost effective solution to the problem an early decision was made to fully utilise the existing works. To supplement these works all other conventional biological options were considered.

The MBR was preferred over fixed film technologies (extra trickling filters, SAFFs) because of its expected speed of response to change in biological load. It was preferred over other variants of the activated sludge process because it was recognised that no biomass would be lost into the final effluent. This would retain a population of nitrifiers built up over a weekend from washing out during weekdays when the population was expected to drop back.

### Solution

To meet the demanding requirements it was decided to provide Yorkshire Water's first Membrane Bio-Reactor (MBR) for the Skipsea works. The MBR is one of the latest developments in wastewater treatment technology and can treat the sudden and



Typical arrangement of MBR membranes Skipsea WwTW MBR Plant  
(courtesy Eastern CaST)

seasonal variation in load. The plant is operated in parallel to the existing works. The high quality effluent from the MBR is blended with the effluent from the existing plant to meet the consent.

#### New works

The MBR plant is designed on the following basis:

Average Daily Flow	Summer	648 m <sup>3</sup> /d
	Winter	168 m <sup>3</sup> /d
Maximum Daily Flow		1300 m <sup>3</sup> /d
Peak Flow		1650 m <sup>3</sup> /d
Average BODs	Summer	271 kg/d
	Winter	33kg/d
Maximum Ammoniacal		36kg/d

Nitrogen Performance	BOD <sub>5</sub>	5mg/l
	SS	5mg/l
	NH <sub>3</sub> -	5mg/l

To incorporate the MBR plant within the existing works the flow is split between the filter works and the MBR plant. During the period of high population in summer, 75% of the load is passed to the MBR and in winter 40% of the loads. The MBR flow is pumped to 3mm screens prior to being delivered to the MBR.

#### MBR plant

The MBR plant comprises:

- \* two membrane tanks each containing 1000 membrane panels;
- \* anoxic zone;
- \* supplementary aeration (FBDA);
- \* aeration and air scour blowers;
- \* mixers and sludge transfer/recycle pumps;

3mm screened flows arrive in an anoxic zone and from there pass to either one or both membrane tanks depending on flow needs. During periods of high population, flow is routed through a common Fine Bubble Diffused Air (FBDA) section to ensure BOD removal and nitrification. Under gravity flat plate membranes separate solids from the mixed liquors. The resulting high quality clean permeate passes via a washwater reservoir to be blended in the main works common discharge. Air is introduced into the membrane base units to aerate and circulate the mixed liquors retained within the system.

The mixed liquors are recycled from the MBR sections to the anoxic zone for alkalinity recovery. Residual sludge nominally 1.5% within the system is periodically drawn off and delivered to the works sludge holding tank.

Daily automatic membrane relaxation and air diffuser flushing maintain the membrane units in their optimum condition. A chemical cleaning make-up and gravity delivery system are incorporated in the plant for a routine internal six monthly membrane clean. Cleaning is carried out with membranes in place without the need to drain or access the tank.

#### Procurement & construction

The £2m works was designed by *Charles Haswell & Partners Ltd* and constructed by *Costain Ltd* under Yorkshire Water's Capital Solution Partnership (CaSP). Under this innovative framework arrangement all of Yorkshire Water wastewater schemes in the Eastern region of Yorkshire (up to £2m) during AMP3 are carried out by the *Costain Haswell Partnership*. *Aquator Group Ltd* provided the MBR mechanical, and electrical package plant.

#### Key elements of the plant are:

- \* high level; of MLSS (12,000 – 18,000 mg/l) in the process enables the plant to respond to sudden increases in load;
- \* high MLSS results in less than half the sludge make of a conventional process;
- \* although not required currently at Skipsea the membranes produce an effluent that meets EC Bathing Water guideline standards;
- \* wide range of MLSS so not sensitive to loads;
- \* SAS produced is >1.5% DS;
- \* filament bulking or rising sludge on settlement tanks that cause other plant failures does not compromise plant.

#### Next steps

Future development of the works may be to provide flow balancing and reduce reliance on the existing filter works. ■

**Note:** The Editor & Publishers thank Yorkshire Water's Eastern CaST for producing the above article for publication.



#### Water and Wastewater Treatment Process Contractors

Naston Ltd were pleased to act as the Main Mechanical and Electrical Contractor for the:  
**Skipsea Wastewater Treatment Works**

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