Mitchell Laithes STW
digester roof refurbishment

by Michael Montgomery CEng, MIMechE

The sewage treatment works at Mitchell Laithes serves the catchment area of Dewsbury and is one of Yorkshire Water's (YW) sludge treatment centres. All the sludges, both indigenous and imported, are digested and then composted with domestic 'green' waste. The two sludge digesters at Mitchell Laithes are 23m in diameter and each has a 5000m^3 capacity; they are the largest in YW and have been in use since 1972. The base of the digesters is of concrete construction, but they are fitted with steel floating roofs, which rise and fall according to the volume of methane gas generated and being stored. An inspection of the roofs showed that the steel plates on top were at the end of their life and liable to fail at any time.

Mitchell Laithes: Fitting petal plates to digester roof *Photo: courtesy Earth Tech Engineering Ltd*

The weight of the roof has a direct correlation on the gas pressure generated. The gas pressure inside the bell is further regulated by Whessoe valves, which protect against over pressurisation or vacuum conditions.

Gas from the digesters is used to drive four Combined Heat and Power engines (CHPs) these generate electricity for use on the site and the waste heat is used to heat the digesters. The gas can also be used in the boilers for heating the digesters, and if there is an excess it can be burnt off in a flare stack.

In addition to the top roof plates being at the end of their life, it was assumed that as the digesters had not been cleaned for more than ten years, there would be a large build-up of grit.

Yorkshire Water asked Earth Tech Morrison (ETM) to refurbish the roofs, remove the grit and replace or refurbish ancillary equipment.

At an early stage it was recognised that if sludge was taken off site by tankers it would add a large cost to the scheme.

It was, therefore, decided to take one digester out of service at a time, divert all sludge imports to other sludge sites and feed the live digester with the total sludge output on site.

Before the first digester could be drained, the feed rate to the second (live) digester was gradually increased over a period of 4 weeks. The first digester was then drained and contractors employed to dig out and remove the build up of grit in the bottom of the digester. The total quantity of grit was 1400m^3 in one digester and 2000m^3 in the other, which is equivalent to 40% of the digester volume.

Initial intention was to replace the sheet steel plates on the top of the roof whilst retaining the steel and roof trusses inside. However, on opening up the top it became clear that the roof trusses were also in a poor condition. The sidewalls of the bell were sound and just required cleaning and repainting. In order to retain the shape of the bell, the roof trusses were replaced with universal beams, one at a time.

Mitchell Laithes: Roof trusses had to be renewed *Photo: courtesy Earth Tech Engineering Ltd*

Birdcage scaffolding was set up inside the digester to allow safe access for the welders working inside the roof. Each truss was welded from the sidewall to the existing king post. The king post was then modified to support the new beams. Once the structural frame was in place the roof petals could be welded on top with continuous welds inside and out. After welding, the roof was painted inside and outside.

Repairs were carried out to the mixing system and the heat exchangers. In addition SS lances were manufactured and one was fitted to each digester by bolting it to the access door at low level so that steam could be injected to assist the reheating process.

Upon completion of each digester it was filled using overflow sludge from the live digester. This had the advantage of being slightly warm and provided seed sludge to get the digestion process going again.

Once the digester was full to the level of the seal (on the roof skirt) a steam generation plant was hired and steam was injected through the lance that had been installed through the access hatch. The use of steam to supplement the heat from the CHPs reduced the time for reheating each digester from 28 days down to 3 days with very significant savings in site establishment costs as well as time.

Once the cleaned digester was up to temperature, the feed rate of the sludge was gradually increased until all the sludge was being fed into the cleaned digester and the process could be repeated on the second digester.

The total saving to the scheme of using steam to heat the digesters and avoiding the need to tanker sludge off site has been calculated at £100k. The total construction period was 10 months and the second digester was returned to service in September 2005.■

Note:*The author of this article Michael Montgomery, is Principal Mechanical Engineer with Earth Tech Engineering Ltd.*