£19m Effluent Plant At Pharmaceutical Works

protecting Severn Estuary environment

by
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A new £19m 4200 Kg/d COD capacity effluent treatment plant at a leading pharmaceutical manufacturer's works on the Severn Estuary is designed to meet current and possible future environmental legislation, meet the company's social responsibilities and, in doing so, safeguard the company's asset and protect the coastal waters of the estuary. The plant will provide full preliminary and secondary treatment arising from the works, together with sludge dewatering and handling facilities.

Avlon ETP: Overview of Avlon Works prior to commencement of construction courtesy: Purac Ltd

AstraZeneca is a leading manufacturer of pharmaceutical products with works at Avlon, Avonmouth, currently discharging aqueous effluent to the local coastal waters under consent from the Environment Agency. The manufacturing processes are regulated under the IPC regime and, as part of this, the Environment Agency is seeking improvements in pollution control. These improvements include the elimination of discharges of substances proscribed for release to water and a reduction in the chemical oxygen demand (COD) of the main site, together with reductions in the release of volatile substances.

Process selection

The Avlon works currently produces four effluent streams:

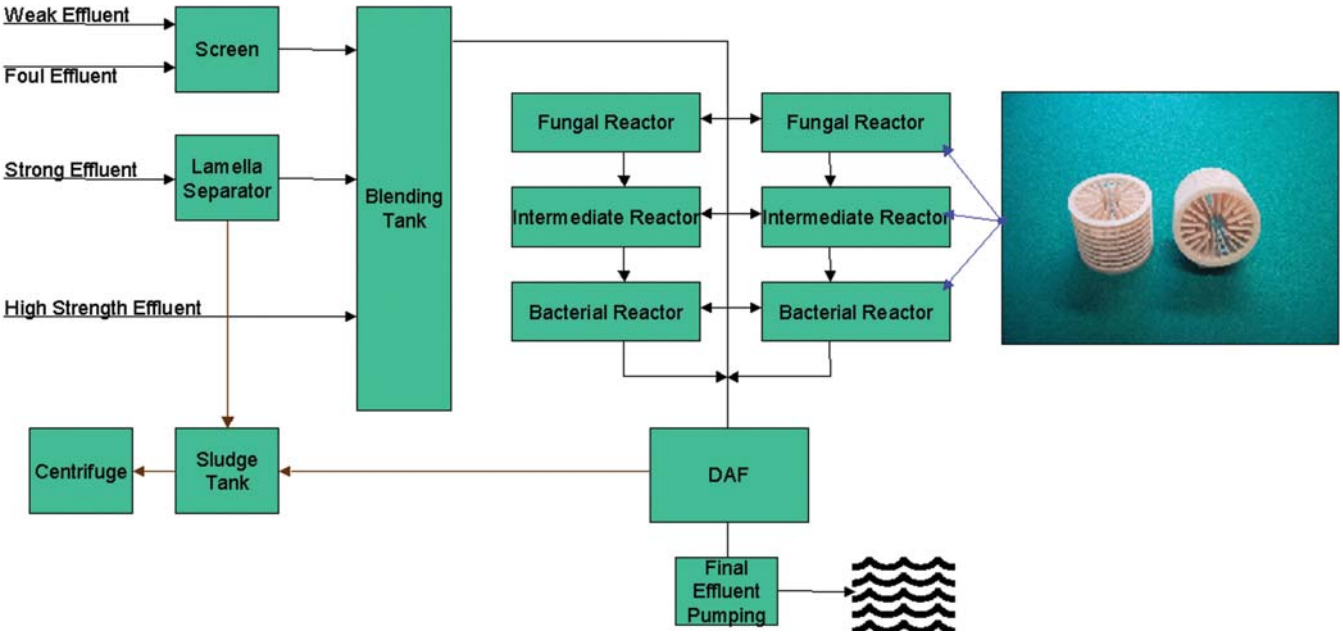
1. Strong effluent;
2. Weak effluent;
3. High strength effluent;
4. Foul effluent.

Streams 1 and 2 are currently blended together to form a waste stream, containing a COD concentration of up to 3000mg/l with a varying flow rate from 500-2500 m^3/day.

Stream 3 is normally loaded into road tankers for offsite disposal by incineration or treatment but some of the stream may be bled into the treatment plant, depending on the level of toxicity and amount of available dilution.

Stream 4 is a combination of sanitary effluent, effluent from the site restaurant and laboratories.

A **Best Practicable Environmental Option** study was undertaken



The Avlon works currently produces four effluent streams - Strong; Weak; High Strength & Foul courtesy Purac Ltd

to assess the present and longer term requirements for treatment of liquid waste at the works. The report indicated an aerobic oxidation process as the preferred treatment technology. Initial laboratory and pilot trials utilising SBR technology found that the process was not robust enough to cope with changes in influent conditions and the biomass settled out in the system.

AstraZeneca and Purac therefore moved towards the *Anox* moving bed bio-reactor process, which provides a more robust treatment route for this type of environment, followed by a Dissolved Air Flotation (DAF) plant. This was considered to be more appropriate technology for treating different waste streams from pharmaceutical and fine chemical processes.

In conjunction with further pilot trials at *AstraZeneca, Purac* developed a front-end engineering design producing a robust, flexible and fully automated plant capable of handling a wide range of effluents whilst maintaining performance.

Effluent treatment plant
The effluent treatment plant has been designed to receive all four streams at a battery limit.In addition a new weak effluent collection and pumping pit, designed by *Purac* will discharge to an existing interception facility upstream of the effluent treatment plant. All utility services required by the plant will also be piped to a termination point at the battery.

Preliminary treatment
First stage of the plant provides coarse solids separation for the weak effluent and foul arisings and balancing for all streams to provide a sufficient hold up volume for toxic shock control. Strong effluent is pumped via a Lamella separator to the blending tank to reduce the concentration of solids. Weak effluent is pumped via a heat exchanger to the blending tank to raise the mixed fluid temperature following process upsets, while the high strength stream is pumped via a balance tank into the blending tank which provides residence time for thorough mixing, nutrient addition and pH control prior to pumped discharge to the biological second stage.

Secondary treatment
The biological process is driven by gravity flow and consists of two reactor streams, each of three reactors fabricated from high molybdenum 316L stainless steel, arranged in parallel with cross connections providing operational flexibility.

The first reactors will operate at pH of 4.0 to promote fungal growth with the pH adjusted to 7.0 in either the second or third reactors to enable bacteria to establish a film on the carriers. The robust fungal stage removes approximately 60% of the COD load, while the bacterial stage further improves water quality prior to discharge.

Main flows from the reactor feed pumps are split by means of flow proportioning valves and flow meters to each reactor train. The flows pass through the reactors where, initially, fungal biomass degrades the various organic constituents and later in subsequent reactors bacterial biomass carries out a polishing role on the waste water prior to DAF separation.

In all reactor cases the biology is sustained by means of aeration and mixing. The organic substrate adheres to suspended *Anox* bio-carriers that have extended surface area to maximise the efficiency of aeration and mixing. Foaming is suppressed by a spray, via nozzles mounted in the tank roof, and is controlled by means of foam level probes. Additionally, antifoam can be dosed into the spray water to enhance foam collapse if required. Headspaces are forcefully extracted to atmosphere via the vent stack. The Anox bio-carriers are retained within each reactor by means of sieves.

Reactor tanks
All six stainless steel reactor tanks will be fabricated on site due to their size and will take approximately six months to construct. Each tank is 9.5m in diameter and 9m deep. Their complex internal construction required flatness of air laterals to close tolerances so that the airflow and the *Anox* media are evenly distributed.

Final effluent pumping station
The fluid gravitates into a final stage of treatment where polymer, ferric sulphate and Kalic (calcium hydroxide suspension) is dosed to flocculate the dislodged/sloughed biomass and precipitate phosphate salts. The sludge is then separated via dissolved air flotation (DAF). Floated and settled material is removed via a skimmer and hopper bottom while effluent discharges under gravity into final effluent balance tank. The final effluent is pumped via the existing effluent discharge pipeline to the River Severn.

AstraZeneca Avlon Works courtesy: Purac Ltd

Sludge treatment
Sludge removed from the primary lamella and DAF units is stored and dewatered using centrifuges on an intermittent basis. Sludge will be exported from site as sludge cake for final disposal elsewhere by landfill or incineration in agreement with the EA.

Purac's remit
The £19 million design and build contract was awarded to *Purac* with a remit which involves design, supply, erection and commissioning of the plant, including the process, mechanical and electrical and systems engineering, which is expected to be operational by summer 2005. As main contractor, *Purac* also takes on the role of CDM Planning Supervisor and Principal Contractor. *Purac,* the sole licensee in the UK for the robust *Anox* suspended carrier aeration system, is utilising this fungal and bacterial reactor process for Secondary Biological Treatment.

The contract type is reimbursable ie with Guaranteed Maximum Price (GMP) and is 101 weeks in duration, from main contract award to Takeover in August 2005.

The team includes *McAlpine Capital Projects* as the preferred civil partner and they have selected *Pell Frischmann Water Ltd* to undertake architectural, civil and structural design for the process halls and external features also architectural, structural and building services design for the administration building. *Pell Frischmann* appointed *Stride Treglown* as architect. *Thermal Transfer Ltd* is the nominated subcontractor to undertake design and installation of building services to the administration building.

Buildings
Power will be provided by a new HV sub-station and switchgear room.

The contract also includes the construction of:

* 390m^2 multi-storey design led administration building comprising offices, laboratory, plant room, welfare facilities and conference rooms, MCC and interface room and control room.
* 1200m^2 reactor hall housing the six Anox reactor tanks;
* 700m^2 multi-storey equipment hall for sludge holding tank, DAF units, centrifuges, inlet screens, odour extraction equipment and air blowers.
* 170m^2 chemical storage building.

Control & data acquisition
Purac are installing the latest control technology utilising *Profibus* distributed field-bus networks to control and monitor motor drives, actuators and field instruments. *Siemens S7* PLC will control the process, with data acquisition by WINCC SCADA system using servers with in-built redundancy. *Purac Systems* Department will design, test and install software to meet the exacting standards required by *AstraZeneca*.

Reporting methods.
Purac's project management reporting systems will be integral to the successful operation of this prestigious development. For this project the in-house Oracle based PuMA system is used to provide a 'no surprises' commercial environment for both *Purac* and *AstraZeneca* while *Primavera P3 Enterprise* is used by *Purac* and *McAlpine* for joint progress monitoring and reporting.■

Note: *The author of this article, Clive Davis, is Project Manager, Purac Limited.*