GRANULAR ACTIVATED SLUDGE - PROJECT GENERATE PROGRESS

Construction of the demonstration Granular Activated Sludge treatment plant at the Rotorua WWTP site went smoothly. Initial teething problems have coincidentally all been related to air supply. Assembly and integrity (water-tightness etc) checking of the Pioneer Water Tank went without a hitch. Reaman Industries now have several tank installations completed within NZ and Fiji and would recommend these quality tanks to anyone looking for storage or process options.

The Reactor tank was initially filled with thickened WAS (waste activated sludge) from the Rotorua WWTP. This had the advantage of severely challenging the aeration system right from the start. The designers had more than adequately sized the blowers for a conventional activated sludge plant.

The blower was originally fitted with a 7.5kW electric motor with a duty of 6m^3/min at 410 MBAR. The electric motor is fitted with a (VSD) variable speed drive and the amount of air injected into the reactor can be manually changed or automatically changed via the D.O. Sensor. The blower sizing was correct but we needed to change the electric motor to 11kW in anticipation of what would obviously be failure, at the higher sludge densities planned for the granular sludge. This allowed for the additional head pressure at the elevated mixed liquor solids concentration.

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We installed two rubber sleeves in the pipe-work fabrication for ease of joining the pipework on site. One of the stainless steel bands holding the rubber sleeves required replacing.

Additionally, a brand new air delivery hose, correctly specified for 120°C and harsh environments only lasted approximately four months before significant deterioration in the form of a myriad of tiny perforations along the tube (both submerged and exposed) necessitated it’s replacement with sterner stuff.
The hose was replaced with a heavy duty PVC hose at a lower temperature rating and has proved successful to date.

Healthy biomass was achieved, operating the system firstly as an SBR, with 4 x six hour cycles per day. These six hour cycles consisted of a single filling period of 25minutes duration, during which the biomass was aerated. Then aeration continued to a total of four hours - including the 25 minute filling period (DO set-point controlled).A one hour settling period, was followed by an approx 12 minute decant. Finally an “Idle” period (aeration as intermittent pulses of air) made up the remainder of the six hours. It was great to observe excellent settlability and some granules forming just through the high mixed liquor solids.

Zero minutes- Just poured up | **5 minutes after pouring up ~ great initial settlability** | **25 then 30 minutes-after pouring up ~Excellent settlability with such high MLSS**

Cycle timing – innovation at its best. An exciting side benefit of Project Generate has been the development of a “unit programmable” PLC cycle control system.
This allows a program (cycle) to be assembled from “blocks” or “steps” e.g. AERATE, ANOXIC, SETTLE etc. The step order and parameters (i.e. duration time, DO set-point etc) are then able to be altered very quickly and easily at the site, using a touch sensitive display screen.

This is a fantastic benefit in terms of being able to modify treatment system operation to respond to changes in the influent, for example a significant increase in connected population. This makes it very suitable for plants serving growing communities. It is also ideal to allow the Operations staff to adjust for seasonal trade effluent discharges like dairy factory or winery effluent etc.
The cycle control system removes the need for expensive and time consuming reprogramming off-site whenever operational changes are desired. Quote from Liz:

“After only 5-10 minutes demonstration on-site, I was able to come back two weeks later and easily access the program and alter the cycle”.

The cycle was changed to operate with 6 x four hourly cycles, with a split feed and two (rather than a single) aeration period. To eliminate potential problems with oxidised nitrogen build up, the new cycle was structured with two fill, anoxic, then aeration segments, each followed by settling periods, before sludge wasting and decant at the end of each four hour cycle (after the second settling period was completed). This eliminated the potential situation where all the readily biodegradable material (“bug food” required to drive de-nitrification) would be consumed before the oxidised nitrogen, produced during the aeration segments, could be biologically “reduced” to nitrogen gas. The settling periods effectively act as additional anoxic segments, allowing any unconsumed readily biodegradable substrates (produced by metabolism of slowly degraded material during the aeration segments) to be completely removed (eliminating soluble BOD in the effluent). This also permits more complete nitrification of influent ammonia, as the split feed ensures cBOD (carbonaceous BOD) is reduced to a level where it does not inhibit nitrification.

This cycle change occurred just after the repairs to the air tube and resulted in a big decrease in biomass due to over aeration! We also had some problems with fouling of the DO sensor, giving falsely low DO readings, hence the blowers ran virtually continuously during the entirety of the aeration segments. Although the settlability test gave the appearance of denitrification causing rising sludge, actually the opposite effect was in play. Extreme over aeration caused a “DAF” effect in the mixed liquor, buoying solids to the surface with oxygen! De-nitrification virtually ceased for two reasons. The elevated DO in the aeration period “over-consumed” the available food - hence none available to drive de-nitrification, also the DO never really dropped down to anoxic levels.

The airflow rate was adjusted down to allow better DO levels to be maintained. This approach was taken, rather than reduction in aeration by lowering the DO set-points. The reasoning behind this strategy was to maintain the ability to optimise DO levels as mixed liquor suspended solids increase once again. We want to maintain a fairly consistent DO set-point range and it is better to control by manipulating the airflow rate to compensate for the increased head pressure than run the system at artificially low DO set-points to control aeration.

The next stage has been to stabilize operation under the new regime, including cyclic wasting (with it's associated timing choices and justifications). We are currently collecting a series of weekly test results for MLSS, SVI, plus the typical suite of effluent quality parameters i.e. pH, suspended solids, cBOD, TKN, ammonia-nitrogen, nitrate and nitrite nitrogen, total phosphorus.

Manipulation of feed volumes, wasting, aeration and settling periods will follow, to drive the mixed liquor solids back up and instigate granular sludge formation. Initially we will concentrate on reducing the duration of the settling period, possibly combined with increase in organic loading (if necessary) to select for stable, repeatable granule formation.
The paper presented by LWTS at the 2008 Christchurch NZWWA Conference contains much more detail about the specifics of granular sludge and its comparison with floccular activated sludge. Please contact Phil Read Phone : +64 6 843 3155 email: phil@reaman.co.nz for a copy of this paper.