WASTEWATER TREATMENT QUESTIONS AND ANSWERS. – No. 2

1. **What is the impact of a wastewater treatment works of poor, inadequate or a lack of screening of the influent wastewater?**

   The purpose of screening is to remove solid matter that will adversely affect the downstream treatment processes. The material removed, called screenings, will consist of rags and other materials, pieces of wood and other solid matter that is discharged or thrown into sewers.

   These solid materials, especially rags and other material can get wrapped around mixer shafts, aerator shafts (or blades in horizontal shaft aerators) and block pumps and the medium of a biofilter. They can finish up in digesters using up valuable digester volume. They can even go right through a treatment works and end up in the final effluent.

   Certain treatment process such as the MBR (membrane Bio-Reactor) need very fine screening to remove hair etc. to prevent blockage of the membrane surfaces that would result in reduced flow rates of the treated wastewater through the membrane.

   Screenings can contain faecal matter and so washing of the screenings is usually recommended to reduce odour development and pollution from the disposal area.

2. **What is the impact on a wastewater treatment works of poor, inadequate or a lack of grit removal?**

   As above, the purpose of grit removal is to remove material that could adversely impact on downstream treatment processes.

   Grit, sand and other small materials can cause erosion of pumps and settle out in reactors and clog biofilters. The level of mixing of anaerobic and anoxic zones is low to avoid aerating the mixed liquor. This level of mixing is not enough to prevent grit etc. from settling out. With poor or inadequate grit removal, the grit will accumulate in these zones. This will reduce the effective capacity of the zones. If for example, the anaerobic zone is half full of sand after many years of operation (this has happened!); the actual retention time will be only half of the original retention time.

   This will be particularly important in anaerobic sludge digesters where the build-up of grit etc. in the digester will have a major impact on the digestion process due to the shortened digestion period. This will result in the sludge not being as well digested as required; leading to odour development and fly breeding in the area where the sludge is used.

3. **What is the cause of black sludge rising in a primary sedimentation tank and what steps must be taken the cure the problem?**

   If primary sludge is not removed frequently enough, it will start to undergo anaerobic digestion. This will result in the generation of carbon dioxide and other gases, which will cause the sludge to float to the surface.

Certain materials under anaerobic conditions darken in colour and can give rise to the black colour of the sludge as it floats to the surface.

The cause of this is usually insufficient removal of the primary sludge. This is where the Process Controller plays an important function by getting to know their plant and learning by trial and error, how often to desludge and for how long at each desludging cycle. For example the desludging time in the afternoon will often be longer than that in the morning due to increased flow during the day.

4. **As a percentage of the inflow, what approximately would be the volume of sludge withdrawn from a primary sedimentation tank?**

One can expect the volume of primary sludge withdrawn to be about 2% of the influent volume.

5. **What percentage reduction (from influent to effluent) in each of the following, would you expect in a well operated primary sedimentation tank: COD; Settleable Solids; Suspended Solids?**

A well operated and not overloaded primary sedimentation tank should be able to make the following percentage reductions

Chemical Oxygen Demand – about 40%
Settleable Solids – about 100%
Suspended Solids – about 60%

6. **What is the purpose of a humus tank on a biological filter treatment works?**

In the biofilter, the organisms that perform the treatment process grow on the stone or plastic medium. After some time, the layer of organisms gets so thick that oxygen and food cannot get to the inner layers and so those organisms die. They then fall off the stone or plastic medium, this is called sloughing.

The outflow from the biofilter passes into the humus tank (secondary sedimentation tank), where the organisms settle out. This material is often called humus. This is generally pumped back to a point upstream of the primary sedimentation tank where it settles out with the primary sludge.

7. **Why is it important that a biological filter not become dry?**

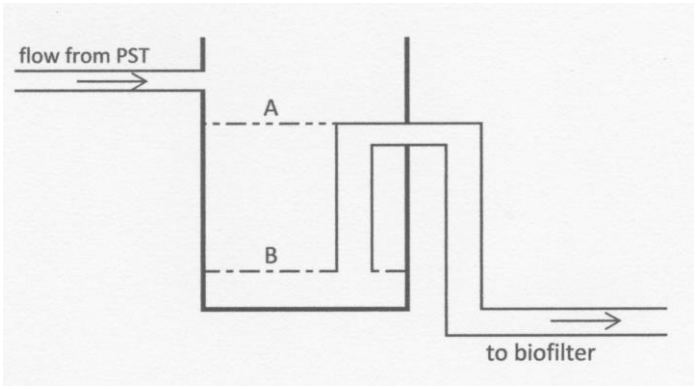
If the biofilter dries out that a large number of the organisms that perform the treatment process, will die. It will take time for new organisms to grow enough the adequately perform the treatment process.

8. **What is one method of preventing a biological filter from drying out?**

The best way is to pump humus tank effluent back to the head of the works or to a point just downstream of the primary sedimentation tank. Even if there is little food left in the wastewater, this recirculation will keep the organisms wet and supplied with oxygen.

9. **What is the syphon feed on a biological filter?**

The arms of a biofilter require a certain flowrate through the nozzles to make the arms turn. When the flow rate through the works is too low to make the arms turn, then one makes use of a syphon. This system is shown below:



Starting with the water level at level "B". With the flow from the PST, the water level will rise until it reaches level "A". Then the syphon will start – the water will flow quickly to the biofilter and the level in the tank will drop. When the level drops to level "B", air will enter the syphon and the water will stop flowing. Then the cycle begins again. This higher flow rate, although not continuous, will move the arms and so spread the wastewater over the surface of the biofilter. To avoid having a too long a period with no movement of the arms, humus tank effluent can also be pumped to the syphon tank.

10. **Must a biological filter treatment works always have primary sedimentation?**

Yes, without primary sedimentation, it is most likely that material that would have been removed in the PST will block the spaces between the stones etc. that make up the media in the biofilter. This will leading ponding on the filter and can lead to total process failure.

11. **What does activated sludge consist of?**

Activated sludge is a mixture of a large number and variety of micro-organisms used to purify wastewater. The organisms use the organic material present in the wastewater as food to grow. They also require oxygen to metabolise the food. Most of them obtain this from oxygen in the air that is introduced into the mixture by diffused aeration (from the bottom of the reactor); or by surface aeration (from the top of the reactor).

Some of the organisms are able to use the oxygen present in nitrates (NO_3), when there is no free dissolved oxygen the mixture.

12. **Why is returned activated sludge necessary?**

After the aeration stage, the wastewater and activated sludge (called mixed liquor) passes into the secondary sedimentation tank. The overflow from the tank is the treated effluent. The sludge will settle and if not removed, will quickly fill the tank and overflow with the treated effluent. The sludge is removed continuously and returned to the reactor. This is called the returned activated sludge or RAS.

While the wastewater passes through the system in 16 to 24 hours, because the sludge is being continuously returned to the reactor; the average time that the sludge will stay in the system is generally between 15 and 22 days. This time period is known as the Solids Retention Time (SRT) or Sludge Age.

By returning the sludge continuous, one is making sure that the activated sludge and the wastewater are mixed, so that the organisms have access to food upon which to feed.

13. **If the 30 minutes settling test of the mixed liquor gave a reading of 800 mls; would you repeat the test and if so how?**

Yes, in order to get an accurate reading, it is always recommended that where the settleable solids in the 30 minute Sludge Volume Index (SVI) settling tests exceeds 400 mL; that the mixed liquor be diluted 1:1 with TREATED EFFLUENT – (DO NOT USE WATER) and the test repeated. This is then known as the Diluted Sludge Volume Index (DSVI).

One will usually find that the volume of the sludge in the Diluted SVI test is less than half the volume of the straight SVI. The measuring cylinder walls have an effect on the settling of the sludge and give a higher value than the true reading.

After diluting 1:1, one must, of course, multiply the answer by 2 to get the real Sludge Volume Index.

14. **Must an activated sludge works always have a primary sedimentation tank?**

In the so-called conventional activated sludge plant, there will be a primary sedimentation tank.

The primary sedimentation tank treatment stage is not used in the Extended Aeration activated sludge works. Here a bigger reactor is necessary as a longer retention time and a longer Solids Retention Time is necessary for complete treatment. It was seen in question 5, that about 40% of the influent load (as COD) would have been removed in the primary stage.

With the higher organic load, more aeration is required for complete treatment.

15. **What is a typical range of suspended solids in the reactor (aeration tank)?**

This is usually 3 500 to 7 000 mg/L. In the membrane plant, the range is up to 12 000 mg/L. This is possible because is the activated sludge separate from the treated wastewater by filtration and not by settlement.

16. **What is Sludge Age (Solids Retention Time)?**

This is the AVERAGE time that the activated sludge remains in the system. Some sludge will remain in the system for a shorter period and some for a longer period.

17. **How is sludge age measured?**

There are a number of ways to measure (calculate) the sludge age:

1. If wasting by MASS, then the sludge age is mass of sludge in the reactor DIVIDED BY the mass removed each day by sludge wasting. The mass of sludge in the secondary sedimentation tank is usually ignored as it is a very small percentage of the total mass in the system;

2. If wasting by VOLUME, then sludge age is the volume of the reactor DIVIDED BY the volume of sludge removed each day. The volume of the secondary sedimentation tank is ignored;

3. If one is wasting from the sludge return system, then the MASS based calculation must be used.

18. **What is a typical range for sludge age in a conventional activated sludge works?**

Generally, it will be in the range of 15 to 22 days. One can go down to about 8 days, but then there are 2 major disadvantages – increase sludge production and a less stable sludge increasing odour and fly breeding problems. One advantage, less aeration is required.

Extended aeration plants, will generally operate at 25 to 30 days or even longer if one wants the minimum amount of sludge. This however uses more aeration and therefore costs more.

19. **Why is it necessary to remove some activated sludge from the system at regular intervals?**

The quantity of organisms in the system is growing all the time due to the food in the influent wastewater. With time, the solids concentration will become too high. The secondary sedimentation tank will fill up with sludge even with the return sludge running. Also the oxygen demand of the activated sludge can exceed the available rate of oxygen being transferred into the activated sludge.

Even without food, the organisms will continue to require oxygen to live.

20. **What is Nitrification?**

This is the two step oxidation of the ammonia ion (NH_4^+) to nitrite (NO_2^-) and then to Nitrate (NO_3^-).

21. **What is De-nitrification?**

This is the reduction of Nitrate (NO_3^-) to nitrogen gas. This process takes place in the anoxic zone where there is no dissolved oxygen. Here certain organisms can use nitrate as their source of oxygen.

22. **If the dissolved oxygen content of the reactor (aeration tank) suddenly rises for no apparent reason; should one be concerned and why?**

Yes, one must be concerned. There are two possible causes:

1. a reduction in flow due to a blockage and overflow in the sewer system draining to the treatment works;

2. a toxic or poisonous material in the influent has seriously affected the micro-organisms in the activated sludge.

In the latter case, a common fault is to reduce the aeration – in fact one must increase the aeration. This is because, the micro-organisms are under severe stress and a lower dissolved oxygen content will only make things worse for them. In an extreme case of poisoning, one must increase sludge wasting for a few days and then try to get some sludge from another wastewater treatment works or even from one's own stockpile of sludge wasted from BEFORE the poisoning incident. Even drying bed sludge can be used to "re-seed" a poisoned treatment works

23. **In the above example which two tests do you consider to be the most important to do following such an incident:**

The best test is the oxygen uptake test in the laboratory. Here one calculates the rate of oxygen usage as mg per Litre per 1 000 mg/L MLSS. Hopefully one has figures with which to compare to the latest result.

The other test will be the SVI or DSVI – as this will almost certainly show an increase in result.

24. **If one notices gas bubbles rising in the secondary sedimentation tank and lifting sludge – what are the bubbles and what is causing it?**

These bubbles are nitrogen gas and come from denitrification taking place in the sludge on the floor of the secondary sedimentation tank.

25. **What steps would you take to resolve the problem?**

1. Check that sludge return is working properly. If syphons are used, one or more may be blocked;

2. Check dissolved oxygen at reactor effluent weir. Should be about 2 mg/L. This should prevent any denitrification if sludge return system is working properly Increase if necessary.

26. **In a Rotating Disc Unit (Bio-disc); is it necessary to desludge the septic tank? If so, why?**

It is necessary to desludge the septic tank upstream of the bio-disc unit. This may be at intervals of 1 year or so. This is because there will be a gradual build-up of non-biodegradable solids in the tank. They will slowly reduce the effective capacity of the septic tank. This will result in less effective treatment at this stage that will increase the load on the bio-disc (secondary) treatment stage.

27. **In anaerobic digestion; is pH a reliable parameter to rely on? If not, why:**

pH is NOT a reliable parameter to assess the effectiveness or performance of an anaerobic reactor. If the pH starts dropping, all it tells you is that you ALREADY have a problem.

28. **Why is the Volatile Acid to Alkalinity ratio important?**

The first stage in the anaerobic digestion is the breakdown of organic material into volatile acids (acetic, propionic and butyric. This causes an increased in the volatile acids to alkalinity ratio. The second step in the digestion process is the breakdown of the volatile acids into methane and carbon dioxide. This will reduce the volatile acids and increase the alkalinity so that volatile acid to alkalinity ratio should stabilise at about 0.3.

Due to the high alkalinity, the pH value will change only slightly even when the volatile acids content increase significantly.

Because the second stage reaction is much more prone to upsets, it is important that the two steps run effectively at the same rate. If the second stage slows down, the volatile acid to alkalinity ratio will start to increase. This will give one an early warning that there is a problem coming. Once the pH starts dropping, the problem has already arrived.

29. **What is the main danger of digester gas?**

Methane is highly flammable. It will explode when the concentration in air lies anywhere in the range between 4.4% by volume to 16.4% by volume.

30. **Why is sludge dewatered? Name a few methods.**

Primary sludge as drawn from a primary sedimentation tank will contain between 2 and 4% solids – that is 96 to 98 % water.

Secondary sludge as wasted from the system will contain between 0.4 and 1% solids – that is 99 to 99.6% water.

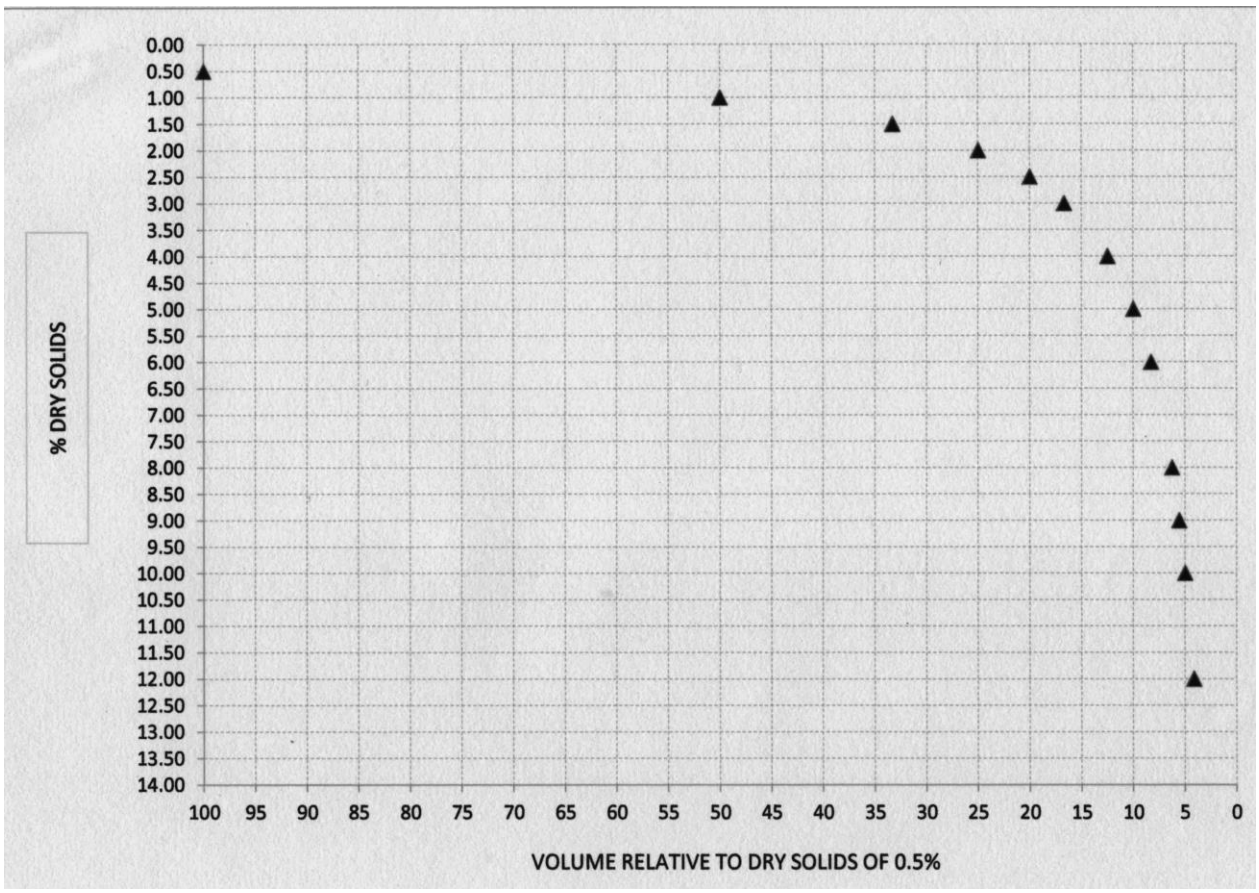
This means that the volume occupied by the sludge is very large. The reduction in volume with an increase in solids content is quite dramatic as shown in the graph below. It may be seen that increasing the dry solids content from 0.5% to 14% reduces the volume to 5% of the original volume – that is a 20 fold reduction.

To increase the dry solids content, a number of different processes are used:

1. gravity thickening or dissolved air flotation as a first step to get to 4 – 5 % dry solids;

2. centrifuges, belt presses, screw press, vacuum filter to increase dry solids content up to about 16% for waste activated sludge and about 35% for raw primary sludge. Digested and mixed sludges will fall somewhere within this range

Each of these will have their own advantages and disadvantages.



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