PROCESS DESCRIPTION OF AN INTERMITTENTLY DECANTED EXTENDED AERATION (IDEA) ACTIVATED SLUDGE SYSTEM – HYBRID DUAL TANK PROCESS

1 INTRODUCTION

Envitech provides various types of treatment systems that meet the Suruhanjaya Perkhidmatan Air Negara’s (SPAN’s) regulations. The Intermittently Decanted Extended Aeration (IDEA) Activated Sludge System is a SPAN’s approved system and has been widely adopted in Malaysia.

In the IDEA single tank treatment process, sewage is nitrified and denitrified in a same reactor. Total -N concentrations of 15 mg/l on a 90 percentile basis are typically achieved.

In the dual tank IDEA treatment process, Demand Aeration Tank prevents short-circuiting and maximises nitrification. The aerobic and anoxic periods are optimised by automatic dissolved oxygen control and variable PLC timer controls. Total -N concentrations of 6 mg/l on a 90 percentile basis are achieved.

The dual tank process also ensures Sludge Volume Index (SVI’s) is lower than 100 ml/g which provides process stability. The combination of the dual tank process and the gas locked syphon decanter results in a reliable process which can consistently produce low levels of Total-N.

2 SINGLE TANK IDEA PROCESS

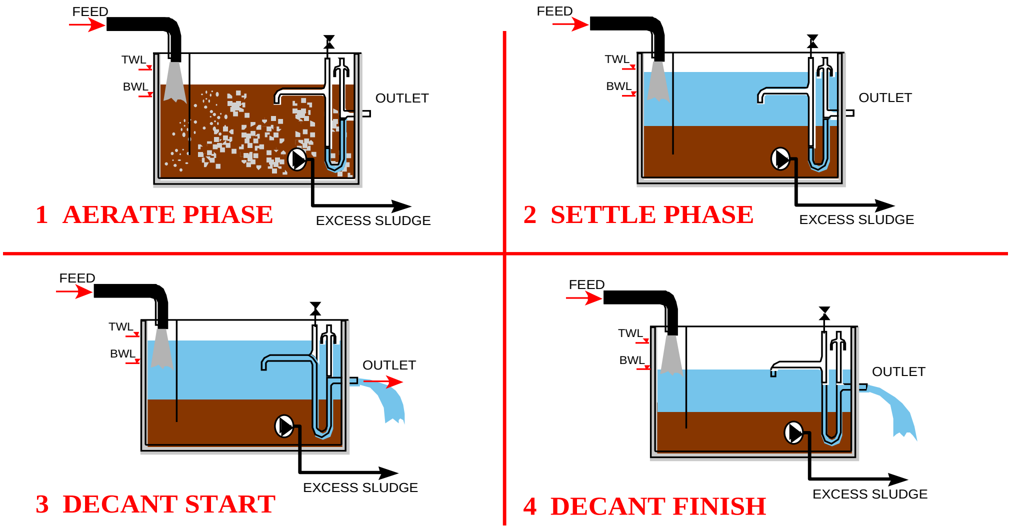
The IDEA process or Sequenced Batch Reactor (SBR) process are different names for similar processes. The essential difference is that the SBR process is normally sequence fed, whereas the IDEA process is continuously fed.

In its simplest form the IDEA process is one of carrying out the following functions in a single reactor.

- Synthesis
- Nitrification
- Denitrification
- Endogenous Decay
- Secondary Clarification

A typical dry weather cycle for a single tank system is: 2 hours aerate, 1 hour settlement, 1 hour decant. The process is illustrated graphically as Figure 1:

Figure 1 : Single Tank Schematic

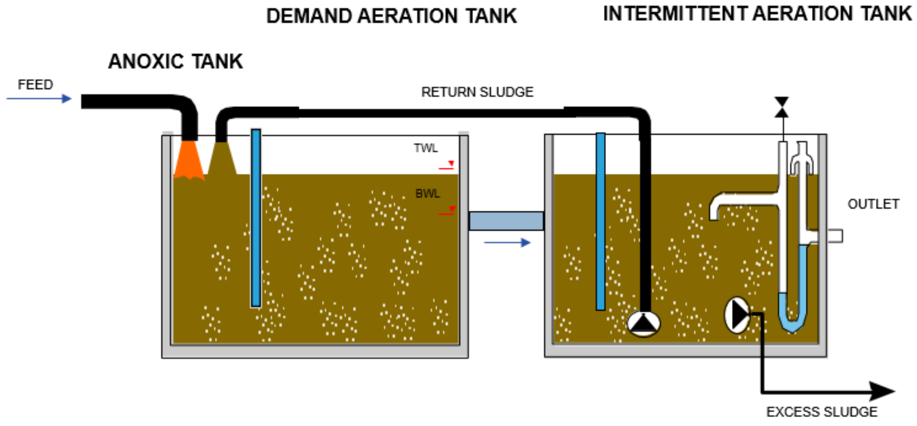


3 HYBRID DUAL TANK IDEA PROCESS

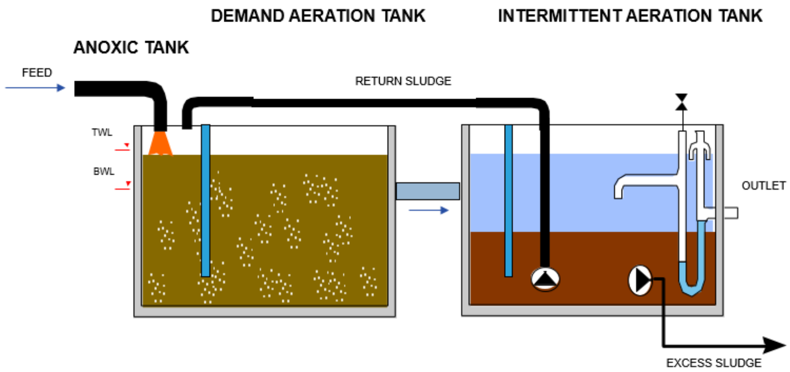
Experience has shown that most single tank IDEA processes, and to a lesser extend SBR processes, suffer from very poor sludge settlement characteristics under design load condition (SVI's greater than 200). This is primarily due to the fact that for almost 50% of the time (settle and decant period) microorganisms are trying to grow in as oxygen limited environment, which is a well known condition for promoting filamentous organisms (bulking sludge).

Dual tank IDEA process has addressed the limitations of single tank processes by providing a demand aeration tank prior to the intermittent tank, and incorporating a recycle activated sludge (RAS) stream. However the main advantages and features of the intermittently decanted process are still retained. Figure 2 illustrates the process.

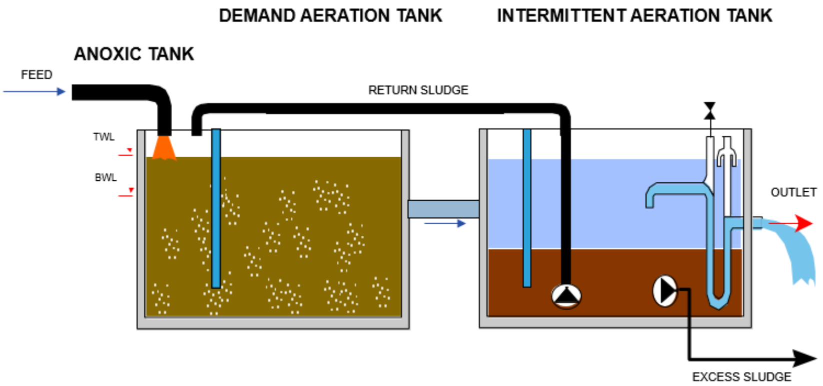
Figure 2 : Hybrid Dual Tank Process



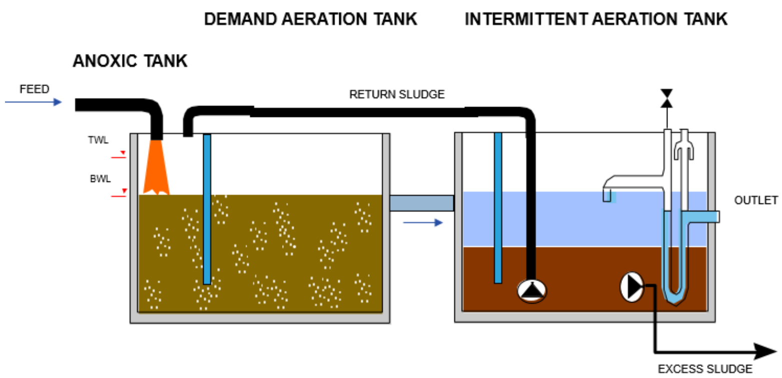
1. <u>Aeration Phase</u>



2. <u>Settle Phase</u>



3. <u>Decant Phase</u>



4. Decant Finish

3.1 Advantages of Hybrid Dual Tank Process

The main advantages of the two stage approach are summarized below:

a) Synthesis is optimised and growth does not take place in an oxygen depleted environment. SVI's less than 100 are consistently achieved.
b) With a rapidly settling sludge in the intermittent tank, a high degree of anoxic denitrification is difficult to achieve. The demand tank is used to optimize denitrification by the readily available carbon in the feed sewage.
c) In the demand tank oxygen is provided on demand. Hence a more efficient usage of installed aeration capacity is achieved.
d) Endogenous decay is not limited, by providing oxygen on demand to the decaying organisms. Hence a lower more stabilized sludge make is achieved.
e) The potential for short circuiting, particularly in cold climates, during the settlement and decant period is eliminated.
f) In the demand tank oxygen is provided on demand even during peak wet weather flow, ensuring adequate treatment during wet weather.

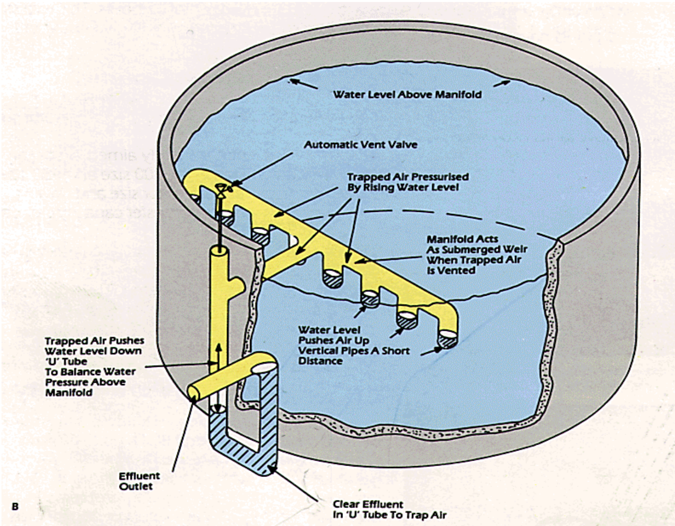
3.2 Gaslocked Syphon Decanting

Another innovative aspect of the hybrid process is the patented gaslocked syphon decanter. This is a major Australian development and has been used in over 280 plants since 1983. It is simple idea with only one moving part and it is an improved alternative to lowering or hinged weir decanters.

The operation of the GLS is described in Figure 3 below. When the water level is rising in the intermittent extended aeration cycle, air is trapped in a submerged weir and pressurized against a balancing water column contained in the outlet pipe. Mixed liquor or unsettled effluent is prevented from entering the submerged weir at all tank levels by the trapped air.

After a settlement period the trapped air is vented, priming the syphon and allowing solids-free effluent to leave the plant. The syphon is broken at bottom water level to stop the decanting and the treatment cycle is then repeated. See Figure 3.

Figure 3 : Gas Locked Syphon Decanter



The main features are:

a) The GLS decanter can be supported on a basic concrete footing. No complex civil structures are required.
b) Weir loading rates are comparable to conventional continuous clarifiers
c) It can sustain relatively high MLSS concentrations and has a greater ability to handle bulking sludge.

The performance of the GLS decanter was compared to a lowering weir decanter in December 1994, at a Council owned plant on the Central coast of NSW, Australia. The plant comprises 3 x 12,000 EP identical IDEA modules receiving identical loads except tanks 1 and 2 use a conventional lowering weir and tank 3 a GLS decanter. The plant was being subjected to organic overload problems due to industrial discharges.

The SSV and the decant rate of the lowering weir was used to minimize sludge washout during the decant period. The study showed that at almost three times the decant rate and with similar SVI's the GLS decanter achieved a much <u>lower</u> suspended solids in the effluent.

3.3 Constituents of Total N

Total N is the sum of NH_3-N, organic-N and NOx-N. The sum of NH_3-N and organic -N is referred to as Total Kjeldahl Nitrogen (TKN). NOx is predominately present as NO_3-N. At water temperatures of 20°C and sludge ages of 15-20 days activated sludge processes can produce NH_3-N of less than l mg/l. Also for typical domestic sewage effluent organic-N is predominantly a function of the nitrogen concentration in the cell mass. For a 20 mg/l suspended solids (SS) in the effluent an organic-N concentration of 1.5-2.0 mg/l is common.

To achieve total -N concentrations of less than 6 mg/l the following would need to be achieved on a 90 percentile basis;

NH_3-N 0.5 - 1 mg/l
Organic -N 1.5 - 2 mg/l
NO_3-N 3 - 4 mg/l

3.4 Total -N in Single Tank IDEAS

Short circuiting r break through of ammonia periodically occurs in Single Tank Idea's particularly in colder climates and during periods of peak flow. During the aeration period cut short and the oxygen supply becomes limiting, restricting the nitrifier from doing their work. In cold climates the mixed liquor temperature may drop to 10-12°C (or lower) and the incoming sewage entering at 15°C causes thermal short circuiting. Hence 90 percentile organic-N concentrations of approximately 3 mg/l in the effluent.

Single tank IDEAS with bottom water levels of 2.5-3.5m can normally achieve NH_3-N of less than 5 mg/l on a 90 percentile basis because the SVI's are typically higher than 200 mls/gm and hence a high percentage of the supernatant is subjected to contract with the mixed liquor during anoxic conditions.

Single tank IDEA's which incorporate a separate, well mixed pre anoxic zone with a mixed liquor recycle can reduce NO_3-N levels lower than 5 mg/l.

Single tank IDEA plants under design load conditions, including wet weather periods, will typically produce the following effluent quality when composited during the decant period on a 90 percentile basis:

NH_3-N	5 mg/l
Organic - N	3 mg/l
NO_3-N	5 mg/l
Total-N	13 mg/l

3.5 Total-N in Hybrid Dual Tank IDEAs

As all of the sewage is introduced into the demand tank, oxygen is provided on demand, even during peak wet weather flows conditions. Hence the nitrifiers keep working and ammonia is fully nitrified even during the storm flow cycle. Short circuiting is eliminated even in cold climates where the warmer sewage is fully mixed with the cooler mixed liquor. 90 percentile NH_3N of less than 0.5 mg// are achieved.

Due to the combination of the demand tank preceding the intermittent tank, which results in SVI's of less than 100 and the conservative weir loading rates of the GLS decanter, 90 percentile suspended solids of 15 mg/l (or lower) are achieved.

Hybrid dual tank IDEA processes normally have bottom water levels ranging between 1.5 and 2.5 m and SVI's less than 100. If dependent on the intermittent tank only NO_3-N of only 10-15 mg/l on a 90 percentile basis would be achieved. This is because a lower percentage of the supernatant is subjected to contact with the mixed liquor during anoxic conditions. Also denitrifiers are primarily dependent on the endogenous carbon source rather than a mixture of carbon from the raw sewage and endogenous carbon. If incorporated into the original design an anoxic mix period could precede the settle period in the intermittent tank.

The demand tanks acts as a combined aerobic and anoxic tank. Automatic dissolved oxygen (DO) controllers and PLC timer controls optimise the anoxic periods. The rate of rise of DO during the aerobic period is continuously monitored to sense the plant which in turn varies the anoxic period to coincide with the diurnal load on the plant. Hence, peak load periods have long anoxic periods. The tanks ensure low NO_3-N levels. 90 percentile NO_3-N of 4 mg/l can be achieved.

The Hybrid dual tank process under design loads and conditions (including wet weather periods) typically produce the following effluent quality when composited during the decant period 90 percentile basis when composited during the decant period:

NH_3-N	0.5 mg/l
Organic - N	1.5 mg/l
NO_3-N	4.0 mg/l
Total-N	6.0 mg/l

4 CONCLUSIONS

Tighter Environmental Standards will necessitate sewage treatment plants which are reliable and can consistently produce good quality effluent. The need for very low levels of Total-N in some receiving waters is debatable. However, reason does not always prevail in the setting of effluent standards in some communities, so we need to design secondary plants which produce low N in the effluent.

The IDEA process has been used to produce good quality effluents which nitrify and denitrify for many years. With more recent standards being tightened, in particular for nutrient removal (nitrogen and phosphorus) the use of processes which consistently operate at high SVI's should be reviewed. Plants which produce the Total-N and which operate with SVI's less than 100 on a consistent basis should be employed. The use of alum or pickle liquor for P-removal reduces the SVI of mixed liquor and goes a long way towards meeting these requirements in single tank IDEA's. However, the use of these chemicals will not always be required or acceptable.

The Hybrid IDEA process has been proven to produce a mixed liquor with a low SVI and low Total-N in the effluent.