ADVENT INTEGRAL SYSTEM

OPERATOR-FRIENDLY ACTIVATED SLUDGE SYSTEM

WITH "NO MOVING PARTS"

"A revolutionary new configuration of activated sludge process with integral clarifier and self contained sludge recycle system has been developed by the Advent Group of U.S.A. and implemented commercially in U.S., Europe and India. The system is based on "no moving parts" concept and is much simpler to operate in terms of maintaining the desired biomass level in aeration tank. The system incorporates proprietary concept of "induced sludge velocity" operated in conjunction with "DTF biomass conditioning system" resulting in better clarifier operations and control.

Biological treatment of organically contaminated wastewaters has proved to be the most effective and inexpensive method right from the days of trickling filters and lagoons to more recent batch-mode activated sludge systems, fixed film reactors or membrane-based systems. In majority of the applications, aerobic activated sludge system operated either in conventional mode or extended aeration mode is found to be the most reliable and consistent performer with higher removal rates and lower area requirements. In India, though, many of the well-designed treatment plants are performing below-average for one crucial reason – lack of skilled operators. The field of wastewater treatment is facing tremendous shortage of good operators, the reason being that the seriousness to run the plant properly has come off-late only. Those who are into this have not undergone thorough training of tricky operations of a biological treatment system and have little experience or expertise to extract the designed performance out of the system.

The maintenance upsets in conventional plants are nightmare for operators since their efforts of months is developing and acclimating the biomass go down the drain once the aerator, clarifier mechanism or sludge recycle pump goes down. All of these equipment are in constant contact with effluent and highly prone to repairs.

The Advent Group and industries such as GE Plastics initiated a joint effort to arrive on a solution to the operational and maintenance problems of conventional activated sludge plants while still maintaining the high efficiency and reliability of performance. After three years of research and pilot studies, the design aspects of the new integral clarifier activated sludge system were finalized and first installation of Advent Integral System was done at GE Plastics, Scotland.

The Advent Integral System

The AIS operates on the principle of an activated sludge system in which a microbial population is trained to degrade a particular wastewater and is separated out and retained within the system as the treated effluent flows out. The biomass is retained in the form of suspended solids in the aeration tank and after clarification in the secondary (integral) clarifier, the active bio-sludge is recycled back into the aeration tank to treat fresh influent. The system operates in a continuous mode with raw wastewater addition done throughout the day and equivalent flow of treated wastewater going out of the clarifier.

Conceptually, AIS has the secondary clarifier placed off-bottom inside the aeration tank (Fig.1). The clarifier has steep sloping walls like a hopper to facilitate settled sludge movement and has an open bottom from where the settled biomass is recycled back into the aeration tank.

Since clarifier wall is mere partition dividing aeration tank and clarification zone, hydro-static head in aeration tank and clarifier is equal. This brings down the construction cost as compared to a liquid-retaining conventional clarifier.

An external force is required to recycle the settled sludge otherwise it would tend to accumulate in the clarifier bottom and turn septic. The AIS employs the patented concept of "induced sludge velocity" as a method of providing this required force. Using a complex velocity profile in the clarifier aided by bottom-sweep currents generated by aeration system, the recycle flow carrying settled bio-sludge is actually pulled into the aeration tank.

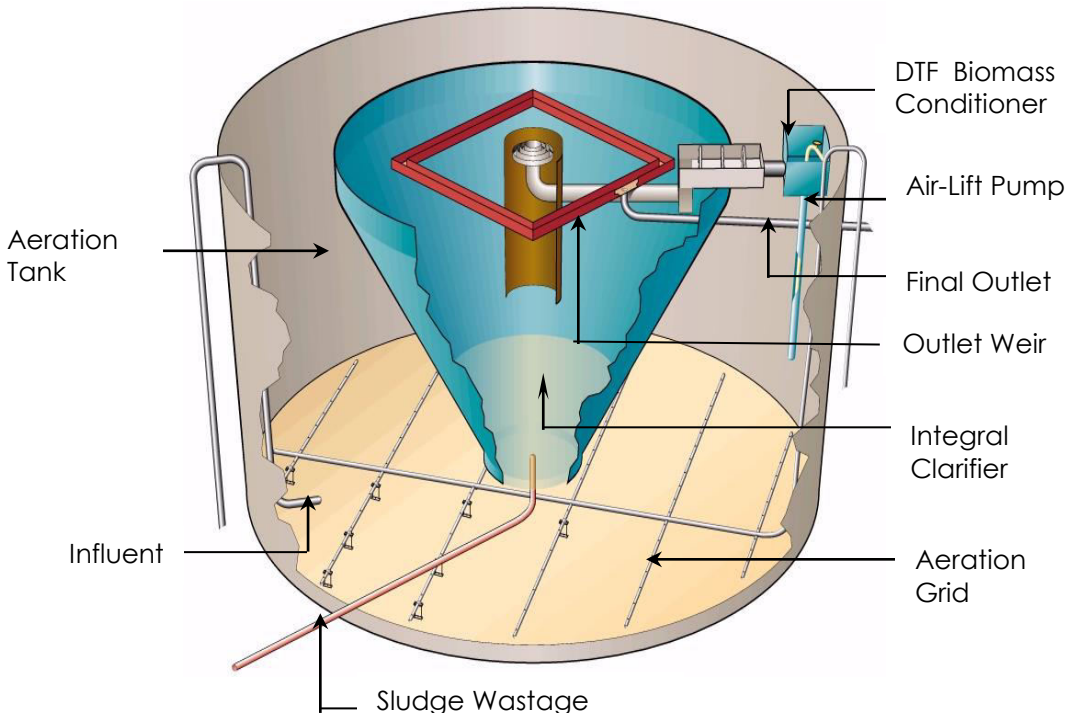

FIG. 1 ADVENT INTEGRAL SYSTEM

The process of clarification and recycling is thus done without any moving parts – no scrapper, no gear-boxes and no sludge pumps. A flow equivalent to incoming wastewater flow plus designed recycle flow is transferred to the clarifier from the aeration basin using a simple air-lift pump. A small bleed of compressed air used for diffused aeration is fed into the hollow-pipe type air-lift pump which lifts the desired or regulated flow by about a meter, and puts it into a channel feeding to the clarifier. This channel houses an innovative DTF Biomass Conditioning System which promotes formation of large bioflocs by removing entrapped air and generating eddies. Large heavy flocs are key to performance of the clarifier and the DTF system does a significant work to this effect. Cationic polymer addition to the DTF system ensures excellent clarification with outlet TSS reducing to less than 50 mg/L. Such a clarity is essential for sustained performance in low-strength effluents where biomass yield is low.

Operations

Primary treated effluent is generally introduced near the bottom and opposite to air-lift pump location. The aeration tank is a completely mixed reactor wherein this wastewater gets dispersed throughout the tank. Aeration is done using diffused aeration grid supported on adjustable clamps. AIS permits use of both fine bubble and coarse bubble diffusers and

the selection is based on the application and type of pretreatment.

The aeration tank is operated at a predetermined F/M (Food to Micro-organism) Ratio and based on influent BOD load, corresponding MLSS (mixed liquor suspended solids) level is maintained in the aeration tank. The biomass consumes the organics as food thereby reducing COD-BOD values of wastewater. Approximately 25 to 40% of the BOD load on a weight basis gets converted into new biomass cells, depending upon operating F/M ratio.

A flow equivalent to incoming wastewater flow has to go out of the system. This outflow has to be first clarified so as to meet outlet TSS norms and also to recycle the acclimated biomass. The biomass can not be recycled as merely settled solid mass and requires a high liquid flow to carry itself. Thus, a total of actual effluent flow plus the recycle flow is to be fed to the clarifier.

In Advent Integral System, the clarifier is inside the aeration tank and is open from bottom, while an air-lift pump is used to lift the wastewater (mixed liquor) from aeration tank and transfer it to the clarifier. Before entering the clarifier, the mixed liquor passes through a DTF (Dispersion – Transition – Flocculation) Biomass Conditioning System. This system removes air entrapped within bioflocs and promotes formation of large and heavy flocs by gentle intermixing of dispersed flocs. When lower outlet TSS is desired, suitable polyelectrolyte solution is dosed in the DTF.

The clarifier in AIS is a large cone or hopper with about 6 to 8 m liquid depth, typically. The side walls are sloped generally at 60° to facilitate easy descend of separated biomass. In conventional secondary clarifiers, settlement is in the form of a zone and there is a formation of a non – compressible sludge – blanket at clarifier bottom. This limits the recycle flow and quantum of biomass which can be recycled without disturbing the blanket or creating turbulent currents. On the other hand, settlement in integral clarifier is effected by two means – majority of the large flocs are carried downwards by the recycle flow with an "induced velocity" while the fines and smaller flocs rise up and traverse a large surface area above. The wastewater velocity on top of the clarifier is lesser than the settling velocity of these fines resulting into their separation by gravity. The fines so separated get into the downward stream of recycle flow. The actual wastewater flow, equivalent to influent flow, goes out of the clarifier. The weirs are adjustable in nature to ensure that the flow distribution on top surface of the clarifier is even.

Advantages of Advent Integral System

1. The process of the sludge recycling by induced sludge velocity allows a higher biomass level to be maintained in aeration tank. Typical design MLSS level in AIS are in the range of 5000 – 8000 mg/L as against 2000- 4000 mg/L in conventional plants.

2. AIS is generally operated at a constant recycle rate, being a self-contained system. Thus, the operator does not have to monitor and change recycle flows in order to maintain desired MLSS in aeration tank.

3. In a stabilized plant where operating MLSS levels are not required to be changed frequently, operators just have to calculate the time required to waste the excess sludge and no complicated calculations of MLSS in aeration and clarifier underflow are required for determining rate of wastage.

4. The clarifier performance in AIS is much better as compared to conventional secondary clarifiers. The biomass separation is done by pre-determined controlled induced sludge movement and horizontal liquid separation instead of arbitrary horizontal sludge movement in conventional clarifier and resultant uncontrolled vertical separation.

5. Since the bio-sludge moves with a force in the integral clarifier, even poor settling biomass and filaments can be pushed back into the aeration tank to a reasonable extent. Further, as the integral clarifier is maintained aerobic throughout, the system eliminates odours associated with conventional clarifiers and minimizes chances of denitrification.

6. Diffused aeration system, levelled perfectly using adjustable clamps, provides complete uniformity of mixing and aeration. There are no dead zones of anoxic conditions or sludge deposition and there is not short-circuiting of influent wastewater stream.

7. The AIS can be configured to have two-stage aerobic or anaerobic – aerobic arrangement in a single tank and can even be designed to have two clarifiers if required.

8. The most advantageous feature of AIS is the concept of "no moving parts" on which the design is based. There are no moving parts in contact with corrosive effluent. The AIS does not require any surface aerators, scraper mechanisms with gearbox and recycle pumps to handle solids. All these equipments are potential maintenance troubles. The significance of "no moving parts" in a biological treatment system can be guessed by the fact that the system takes one or two weeks to stabilize in case of minor upsets and two to twelve weeks if a restart is warranted.

SUMMARY

Aerobic biological treatment of wastewaters is an area starved of major technical advances in many years. The integral clarifier activated sludge system is potentially first major break-through in this direction which can revolutionize the configurations of future biological treatment systems. The simplification of operations and elimination of maintenance within the system are two key area in which AIS scores very high over conventional plants. The concept of induced sludge velocity operated in conjunction with DTF biomass conditioning is truly a technological leap instead of arbitrary gravity settling in conventional systems. This technology has been successfully implemented in versatile applications like textiles, dyes, pharmaceuticals, petrochemicals, silicones, coke-oven plant, paper, etc. and for flows ranging from 100 m^3/day to 100,000 m^3/day.