Dissolved Air Flotation is a tried and tested clarification technology

By Michael Albanese

Dissolved Air Flotation (DAF), a technology first introduced in the petrochemical industry, has been around for over forty years in the water and wastewater market. It has fallen out of favour in municipal wastewater applications, where it was mostly used for sludge thickening in medium to large municipalities. However, this clarification technology is still alive and doing very well in other areas.

DAF is still used extensively for wastewater treatment in food plants, oil and gas, mining, pulp and paper, and many types of industries. It is also a very good fit for clarification in drinking water treatment, especially for difficult to flocculate, low temperature, and coloured waters, and waters subject to algae blooms.

So, why has this technology lost ground in municipal wastewater applications? It is because of *where* it was used, i.e., primarily for sludge thickening of waste activated sludge. Infeed going to a DAF unit from a clarifier would be between 0.5 to 1% dry solids, with the objective being to thicken these solids to 3-6%, usually before digestion. Many other technologies have taken over this function, namely rotary drum thickeners, gravity belt thickeners and centrifuges. These are considered to be somewhat more modern devices.

But, for industrial applications and municipal drinking water, other technologies have not displaced DAF, because they cannot replicate its benefits.

DAF works extremely well for waters that have fats, oils, grease, or very fine particles. So, it has a much wider range of use than just waste activated sludge thickening. DAF can be used by itself as a clarifier. When used with chemistry, such as a coagulant and a flocculent, it becomes a physical/chemical process. A properly functioning DAF unit will remove 90-95% of Total Suspended Solids (TSS), 90-95% of Fats, Oils & Grease (FOG) and 90-95% of insoluble Biochemical Oxygen Demand (BOD).

DAF unit installed at a cookie factory.

Large DAF units at a meat packing operation.

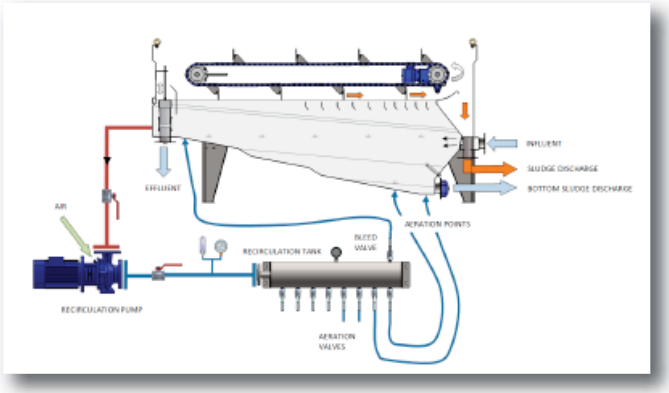
The technology of DAF has not changed a lot over the years. The main body consists of a steel (or concrete) tank, with a skimmer blade arrangement to remove floating sludge. The tank can be rectangular or round.

Where the technology has evolved is in the pump recirculation and saturation tank. Some later model DAF units also offer internal inclined plates, which are ideal in low solids applications.

Let's first understand how Dissolved Air Flotation actually works. A DAF unit would just be a gravity separator (essentially a sink/float tank) if it were not for the air being introduced. In DAF, micro-sized air bubbles are added to the water, providing buoyancy to the impurities to be separated. These will float to the surface, and will form a sludge layer, ready for separation.

Removal performance is largely dependent on chemical pre-treatment of the water. This process must be optimized, thus creating floc particles to which the micro bubbles can easily attach and float to the surface. This sludge layer is skimmed off with a top skimmer system and collected in the sludge compartment for discharge.

The type of chemicals and dosing rates are an important factor in the design of DAF treatment systems and can usually be obtained by jar testing.



DAF schematic

DAF pilot unit on trailer.

Heavy solids, which will not float, will sink to the bottom of the flotation unit and will be discharged with outlet valves. While the solids flocs are being separated and skimmed off, cleaned, treated water is leaving the unit through the effluent compartment.

The most common way to introduce the air to the DAF unit is via a recycle pump system. A fraction of the treated water leaving the unit is recirculated to the inlet. Within this loop air is introduced to create micro-sized air bubbles.

Older DAF systems had a big saturation tank, where pressurized air was introduced and mixed with the recycle pump flow. Modern systems use multistage centrifugal pumps, that are able to tolerate a certain amount of air flowing right through their impellers and chambers. This eliminates the need for a big, pressure-rated saturation tank. Air is usually injected right at the pump, and it does most of the air/water mixing.

The recirculation pump pressurises water to approximately 6 bar and saturates it with a controlled amount of air. Saturated recirculation water is collected in a recirculation tank and distributed at points underneath the DAF unit. Small air bubbles are formed by means of sudden depressurisation of the recirculation water with ball valves. The small size of the air bubbles (30-50 micron) is essential for the efficiency of the flotation unit. This air is what

attaches to solids particles and floats them to the surface.

At the surface of the flotation unit, a sludge thickener is installed to dewater the sludge. The skimmer skims off floating sludge into a sludge compartment. Its speed can be varied to influence dry solids content of the sludge. The per cent of dry solids can also be influenced by the water level in the unit. In general, dry solids being removed by the skimmer unit are between 4-12 per cent.

DAF units tend to do the work of gravity clarifiers in a much smaller footprint. It is common to find these units in industrial facilities, not only as primary clarifiers, but also as secondary clarifiers following biological treatment.

In the last few years, Moving Bed Biofilm Reactor (MBBR) treatment systems have become popular in industrial applications because of their robustness and ability to resist the fluctuating loads typical of such facilities. However, MBBRs produce a very light, fluffy secondary sludge which is difficult to settle with conventional clarifiers, but great for a DAF unit. This makes it a perfect application.

Important considerations when designing a DAF system are compressed air supply, influent flow equalization, adequate screening to protect the recycle pump, feed pumps, chemical reaction ahead of the DAF, either by mix tanks or in-line flocculation, sludge pumping, sludge storage, and a central control panel to run it.

Piloting is highly recommended for unusual applications to determine treatability of the water.

When considering DAF, it is very important to characterize contaminants in the water with a proper sampling program, prior to designing a full scale treatment system. As industrial plant flows fluctuate throughout any given day, depending on production and shifts, determining timing of flows is also very important as design criteria.

DAF treatment technology is easily piloted on site to confirm treatment results. Piloting is highly recommended for unusual applications to determine treatability of the water. Results from these tests can be utilized to effectively design a full-scale system.

You will still find a lot of Dissolved Air Flotation systems being used in industrial facilities, including oil and gas plants, automotive industry, paint finishing operations, food processors, chemical plants, pulp and paper mills, mining operations, chemical plants, beef, pork and chicken processing facilities. And let's not forget drinking water treatment plants as well….

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