Dissolved air flotation (DAF) is an operation by which solids or a liquid may be separated from the liquid phase. Gas is introduced into the clean process water by a number of techniques. The method used to saturate gas into the liquid will depend on a variety of factors. These include the nature of the materials to be separated, possible combinations with other processes (for example, sedimentation), in-flow and out-flow concentration limitations, total flow requirements, cost limitations and temperature, etc.

Dissolved air flotation (DAF) operates by dissolving (saturating) a gas into a certain volume of liquid under elevated pressure. Releasing the pressure precipitates fine gas bubbles which attach to the solids, reducing their net specific gravity to less than that of water. The driving force behind dissolved air flotation is the micron sized air bubbles. Typical bubble size range between 20 to 80 microns in diameter. The heart of a DAF system will be the saturation system.

The principal behind dissolved air flotation is based on Henry’s Law, which states that the amount of dissolved gas in the liquid is directly proportional to pressure and inversely proportional to temperature. This means you can dissolve more air at higher pressures. Increased temperature, however, will reduce the amount of gas dissolved.

Henry’s Law

\[ C_{eq} = K_H \times P_{gas} \]

\[ C_{eq} = \text{Liquid-phase gas concentration} \]

\[ K_H = \text{Henry's constant} \]

\[ P_{gas} = \text{Partial pressure of the gas above the liquid} \]
DAF Applications

Industrial applications of dissolved gas flotation are not limited to those listed below, but will serve as a foundation of applications that make use of the dissolved air flotation technology.

<table>
<thead>
<tr>
<th>Objective:</th>
<th>Maximize solids removal efficiency, while minimizing cost.</th>
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<tr>
<th>Municipal Water/Wastewater</th>
<th>Sludge thickening, Algae removal from oxidation ponds, Primary/secondary clarification, Storm sewer treatment</th>
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<tbody>
<tr>
<td>Chemical</td>
<td>Carbon manufacturing, Latex and rubber manufacturing, Paint manufacturing</td>
</tr>
<tr>
<td>Food Processing</td>
<td>Dairy, Fish hatcheries, Bakeries, Meat processing, Slaughterhouse, Potato processing, Poultry processing, Grilling plants</td>
</tr>
<tr>
<td>Refineries/Related Processes</td>
<td>Oil refining and production, Ballast waste (oil terminals), Off-shore oil platforms</td>
</tr>
<tr>
<td>Textiles</td>
<td>Dying and printing, Wool scouring, Carpet manufacturing</td>
</tr>
<tr>
<td>Steel Mills and Operations</td>
<td>Steel mills (cold and hot rolling mills), Piping manufacturing, Coke plants, Stamping plants</td>
</tr>
<tr>
<td>Pulp-and-Paper</td>
<td>Flooring plants (vinyl flooring backing), Pulp mills, De-inking mills, Hard board mills, Molded cartons plants, Roofing felt plants, Board mills (reclaimed paper mills)</td>
</tr>
<tr>
<td>Other Operations</td>
<td>Coal washing, Railroad terminals (car/locomotive washing), Airport terminals (fuel stations, wash racks,) Drum washing plants, Laundry (commercial), Rendering (animal fat and grease to tallow)</td>
</tr>
</tbody>
</table>
What Constitutes DAF Application?

When evaluating a potential DAF application, one should look for clues. Does the material want to float or tend to settle? Does it off-gas? Does the float buildup on the clarifier/thickener liquid surface and equipment? Solids specific gravity, land availability, and temperatures also affect DAF applicability. Listed below is critical information required for sizing DAF units.

Sample Characterization—Required Information

- Make sure you acquire a representative sample
- Total Solids (TS), mg/L
- Total Suspended Solids (TSS), mg/L
- Total Dissolved Solids (TDS), mg/L
- Feed Temperature, °C or °F
- pH
- Liquid Density, gm/cc
- Slurry Density, gm/cc
- Solids Specific Gravity (where applicable)
- Volatile Suspended Solids (VSS) (where applicable)

Plant Process Data

- What is the material to be tested (i.e., municipal wastewater, refinery, etc)?
- Influent Flow, gpm
- Process Temperature, °C or °F
- TDS, mg/L
- TSS, mg/L
- Fats, Oil & Grease, mg/L (where applicable)
- Biochemical Oxygen Demand (BOD) or Chemical Oxygen Demand (COD), mg/L (where applicable)
- pH
- Target Removal Efficiency, %
- Are chemicals being used?
- If yes, what type and amount?
- Are there any area constraints?
- Is the customer familiar with DAF?
- Is the customer familiar with EDUR DAF pump?
- What is the customer’s timeline?
- What is the existing treatment process (if any)?
Quick and Dirty DAF Testing

Not everyone has the luxury of having the proper equipment for testing various solid-liquid separation applications. By conducting simple quick and dirty tests upfront, the information generated can lay the foundation for additional testing. Listed below are some quick and dirty tests that can be conducted with materials that can be acquired from a local convenient store.

Kit Supplies

- 5 ea. 6 ounce clear party cups
- 2 ea. Bottles of tonic water 20 fluid ounces
- 1 ea. Magic marker
- 3 ea. Plastic spoons for mixing
- Chemicals can be acquired from the plant or from your local polymer rep

Prep Work

- Label the first cup ‘1’
- Pour feed (material to be tested) into cup 1 to approximately 1/2 the volume
- Mark cup 1 at the 1/2 mark
- Mark the second cup ‘2’
- Pour the feed material into the second cup
- Fill cup 1 to the 1/2 mark again
- Pour the contents into cup 2
- You should now have a full cup of feed (mark to the full level)
- Pour off 1/2 the volume (cup 2)
- You are now ready to conduct your test work

Let’s get started

- Cup 2 should now have 1/2 full cup (for those who prefer, you have a 1/2 empty cup)
- With the feed in cup 2, pour in the tonic water to the full mark
- Allow the contents to float for a period of 5 minutes
- If the material all floats, note the clarity
- If the material does not float, reduce the feed to 1/4 and add tonic water to the full mark (recap the bottle of tonic water)
- Allow the material to float for a period of 5 minutes
- If the clarity is poor, fill cup to 1/2 mark—add in some polymer (add slowly while mixing—just until the floc starts to form)
- Note the floc structure
- Add in the tonic water to the full mark (recap the bottle of tonic water)
- Allow to float for 5 minutes
- Note clarity
- You have now completed your testing
- Contact Sciential for conducting onsite testing/testing in-house or rental

NOTE: THIS IS A QUICK AND DIRTY TEST AND SHOULD NOT BE USED TO SIZE EQUIPMENT.
Dissolved air flotation is undergoing changes that promote simplicity, reduction in cost, and a smaller footprint. Those who participate in dissolved air flotation (DAF), be it the original equipment manufacturer (OEM), engineering firm, or municipality, know that this benefit allows the end-user the flexibility in retrofitting existing DAF units or ease of new equipment installations.

When comparing costs of conventional DAF saturation systems to that of the EDUR pump, the cost/benefit can easily be evaluated. Figure 1 shows the saturation system for a conventional DAF system.

The components of a conventional DAF saturation include an air control panel, ASME coded saturation tank, and an air compressor.

In this particular application (steel mill), the plant was off line for almost 2 months pending a service and process startup engineer.

Upon arrival, the plant operator indicated that the conventional DAF system was very difficult to balance, due to the liquid level within the saturation tank. In addition, the air bleed valve was problematic. After a few hours of troubleshooting, the system was brought online.

Over a period of a week, the plant went through startup and shutdown training of the DAF unit.

In short, the plant was very hesitant in letting the engineer return home due to the lack of confidence in operating the DAF units.

Those who are familiar with conventional systems know that it is not complicated to operate. But to operators who have never seen this technology, it can be very challenging.

EDUR has a solution to this anecdote, “simplicity.”

The pump in Figure 2 illustrates a 220 gpm pump that was installed in a nearby wastewater treatment plant in 1999. The pump has been in continuous use since this time.

The operators indicated that the pump operation was so simple, they have now requested this pump be installed into the plant expansion. The plant purchased two 220 gpm EDUR pumps. I should also mention that the added benefit of the EDUR pump is its ability to be installed in existing building, which has made promoting EDUR pumps “simple.”

For a copy of the EDUR pump study as shown in Figure 2, contact Sciential via e-mail at www.info@scientialsupply.com.
Sciential Supply & Equipment LLC (Sciential) is a global provider of technical services, supplies, and equipment for the solid-liquid process equipment industry.

With over 50 years of combined experience, Sciential’s skilled and experienced engineers are available to assist in the evaluation of new or existing process equipment, either to optimize operation, or to determine design criteria for new equipment selection.

Sciential provides equipment for dissolved air flotation, belt press filtration, pressure filtration, vacuum filtration, thickening, clarification, sand filtration, specialty chemicals, test kits and supplies. In addition to supplying the tools necessary for plant optimization, Sciential also provides contract process engineering services. Sciential provides contract testing services for laboratory, pilot, full-scale testing and commissioning.

For more information about Sciential’s products and services, please visit our website at www.scientialsupply.com or by phone at 801-523-3741.