TECHNICAL NOTES

How DAF Recycle Saturation Systems Work

Pan America Environmental, Inc.

RSS Recycle Saturation System

How Does It Work: DAF Recycle Saturation System

What is a DAF System?

Dissolved Air Flotation (DAF) is a water treatment process that removes suspended solids, oils, greases, and other contaminants by floating them to the surface using microscopic air bubbles. It is widely used in industrial wastewater treatment (food processing, oil & gas, pulp & paper, chemical plants, etc.), drinking water clarification, and sludge thickening.

The recycle saturation system (also called recycle flow pressurization or whitewater system) is the heart of most modern DAF units. It generates the microbubbles that make flotation possible.

Core Principle

Air is dissolved into water under high pressure (typically 4–7 bar / 60–100 psi). When this pressurized water is suddenly released to atmospheric pressure in the DAF tank, the dissolved air comes out of solution as millions of tiny (30–100 micron) bubbles — the "white water." These bubbles attach to flocculated particles, reducing their density so they float rapidly to the surface.

Main Components of the Recycle Saturation System

1. Recycle Pump
   Takes a portion (usually 10–30%) of the clarified effluent from the DAF tank and pumps it to high pressure.
2. Air Compressor / Air Injection System
   Supplies compressed air into the recycle flow. Some systems use a venturi eductor or direct injection with precise control.
3. Saturation Vessel (Air Dissolving Tank / Saturator)
   - Pressurized vessel where water and air are held in contact long enough for air to dissolve.
   - Designed with baffles or packing to maximize gas transfer efficiency.
   - Maintains pressure (typically 5–6 bar) and residence time (0.5–2 minutes).
4. Pressure Regulating Valve / Release Valve
   Controls the pressure drop and releases the saturated water into the DAF contact zone.
5. Distribution Manifold / Nozzles / Diffusers
   Evenly injects the pressurized recycle water into the flotation tank, creating uniform white water.
6. Controls & Instrumentation
   Pressure transmitters, flow meters, level controls, air flow control, and automatic valves to maintain optimal saturation.

Step-by-Step Operation

1. Recycle Flow Extraction
   Clarified water leaves the DAF tank and a side stream is sent to the recycle pump.
2. Pressurization
   The pump raises the water pressure to the design setpoint (e.g., 5.5 bar).
3. Air Introduction
   Air is injected either before or inside the saturator. The high-pressure forces air into solution (Henry's Law: solubility of gas increases with pressure).
4. Saturation
   Water spends enough time in the saturator for near-complete saturation (typically 70–90% saturation efficiency in well-designed systems).

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5. Pressure Release
   The saturated recycle water passes through a pressure reduction valve or special release assembly and enters the DAF tank's contact zone.
   - Rapid pressure drop-causes supersaturation.
   - Microbubbles nucleate and grow (20–100 μm ideal size).
6. Bubble-Particle Attachment
   In the contact zone, bubbles collide with and attach to chemically conditioned flocs (formed by coagulants and flocculants).
   The bubble-floc agglomerates rise to the surface at 0.1–0.5 m/min.
7. Sludge Removal & Effluent Discharge
   Floated sludge (float layer) is skimmed off the top.
   Cleaned water exits from the bottom and most is discharged while a portion is recycled.

Key Performance Factors

- Recycle Ratio: 10–30% of influent flow (higher for difficult waters).
- Air-to-Solids Ratio (A/S): Critical design parameter — typically 0.01–0.06 kg air per kg solids.
- Bubble Size: Smaller, uniform bubbles = better performance.
- Pressure: Higher pressure dissolves more air but increases energy and compressor cost.
- Saturation Efficiency: Modern systems achieve >80% efficiency.
- Chemical Conditioning: Coagulants (e.g., PAC, alum, ferric) and polymers are essential for good floc-bubble attachment.
  Advantages of the Recycle Saturation System
- Reliable and proven technology.
- High bubble generation efficiency.
- Flexible — recycle rate can be adjusted for varying loads.
- Lower energy use compared to full-flow pressurization (only recycle stream is pressurized).

Common Variations

- Full-Flow Pressurization: Entire influent is pressurized (rare, high energy).
- Partial-Flow Pressurization: Recycle system (most common).
- Vacuum Flotation: Uses vacuum instead of pressure (less common).
- DAF with Integrated Saturation.
  This recycle saturation loop continuously generates the microbubbles that drive the entire DAF process.

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