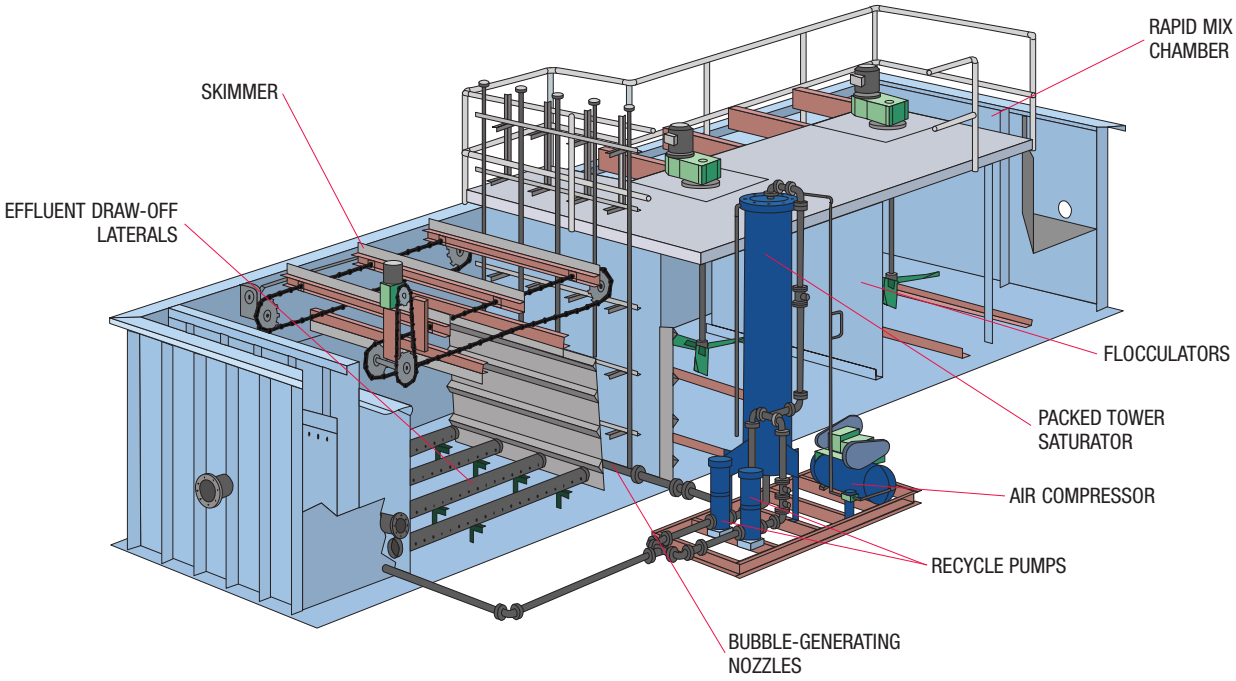
The Leopold® Clari-DAF™ System

Improve Clarified Effluent Water Quality, Improve Solids Handling, and Lower Your Total Cost of Operation

The Leopold Clari-DAF system is a proven, highly effective method of removing turbidity, insoluble metals (iron, manganese, arsenic), algae, color, taste and odor, Giardia, Cryptosporidium, and other low-density particulates from water. Its performance is superior to gravity sedimentation in providing consistent quality effluent, producing consistently high sludge solids, and operating at high loading rates (gpm/sf, m/hr)– results that can lower your total cost of operation.



Features and Benefits

Polymer or Flocculant Can Be Eliminated for General Operation

Formation of large, rapidly settling floc is not required, saving money. In addition to the chemical cost savings, typical Clari-DAF system effluent has greater compatibility with other subsequent treatment steps, such as membrane or gravity filtration.

Effective Operation in Low-Temperature Raw Water

The Clari-DAF system process is unaffected by low-temperature raw water. The presence of large numbers of bubbles increases the chance of bubbles attaching themselves to suspended floc. In fact, at an 8% recycle flow and 70 psi saturation pressure, the Clari-DAF system creates 681 million 40-micron bubbles per gallon at 40˚F (4.4˚C). At 68˚F (20˚C) the number of bubbles per gallon is 530 million. With conventional clarification, increased chemical addition–at increased expense–is necessary to achieve larger, heavier floc that will settle in dense, low-temperature raw water.

Rapid Start-Up

Good-quality effluent can be achieved within 45 minutes of start-up. Other high-rate processes can take several days to form a stable floc blanket during start-up. Rapid start-up is ideal where daily flow variations occur and continuous operation of full plant capacity is not needed. Rapid start-up plants are ideal, too, for automatic start-up and shut-down without an operator–and associated labor costs.

High Percentage Sludge Solids and Low Loss of Process Water

Solids content of the floating sludge at the time of discharge is 3% to 5%, compared to 0.5% to 1.0% for conventional clarification. This results in increasing the efficiency of sludge handling equipment and a reduction in the cost for sludge processing.

Longer Filter Runs

Because the Clari-DAF system removes more solids than conventional clarification, filters can run longer between backwash cycles. Fewer backwash cycles means less backwash water, less media breakdown, less filter-to-waste on filter start-up, and lower energy cost.

High Sludge Concentration

Dewatering can occur without additional thickening, eliminating expensive sludge thickeners. There is less volume of sludge to handle, less chemical conditioning, less time to dewater and lower energy costs. And because cake solids are higher, disposal costs are reduced.

High Loading Rates

The Clari-DAF system can accommodate loading rates of up to 10 gpm/sf (24.20 m/hr). This not only contributes to its compact design, but also means that flow-through can be increased by as much as 8 to 20 times that of conventional clarification tanks.

Compact Design

Because of its high loading rate, the area needed for a Leopold Clari-DAF system is approximately 15% of that required for conventional clarification. The small footprint of the Clari-DAF system improves land use, especially in existing plants with no room for expansion. Its compact design also means that it can be retrofit in existing conventional clarification tanks.

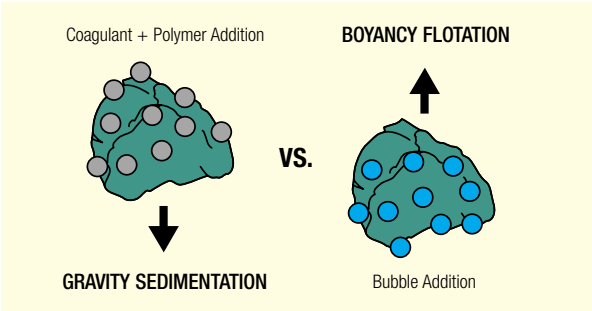
Steel or Concrete Tank Installation

The Leopold Clari-DAF system can be constructed above-ground using a steel tank when the design flow rates are low (0.25 to 1.0 MGD) or in-ground using a concrete tank for larger units. This flexibility contributes to keeping capital costs low.

The Leopold Clari-DAF System Is All About the Principle of Buoyancy Flotation

The Leopold Clari-DAF system employs a physical process whereby very fine air bubbles–microbubbles–attach themselves to low-density particles suspended in the water and float them to the surface where they form a floating sludge blanket that is easily removed. Good-quality water can be produced within 45 minutes from start-up.

Conventional gravity sedimentation requires chemicals–inorganic coagulants and polymers–to precipitate low-density particles out of solution. But these particles typically have a density close to that of water, which means low settling velocity.



The Clari-DAF System Is Applicable for a Variety of Source Waters

The Leopold Clari-DAF system process is versatile enough to be used for potable water applications or wastewater lagoon applications. For filter backwash water treatment, the Clari-DAF system typically can remove Giardia,Cryptosporidium cysts, and oocysts by >3.0 log.

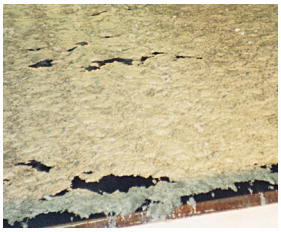
The Leopold Clari-DAF Can Lower Your Total Cost of Operation with Improved Water Quality

- Longer filter runs
- Less backwash water
- Less media breakdown
- Lower energy cost
- Less filter-to-waste
- Reduces or eliminates filter aids

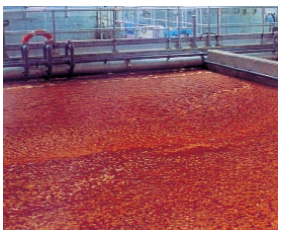
The Leopold Clari-DAF Can Lower Your Total Cost of Operation with Improved Solids Handling

- Less volume of sludge to handle
- Less time to dewater
- Lower energy cost
- Lower chemical cost
- Higher cake solids
- Lower disposal costs

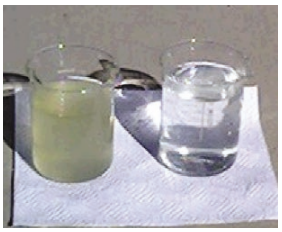
The Clari-DAF system creates a milky solution of hundreds of millions of microbubbles 20 to 100 microns in size that rapidly float suspended particles to the surface for removal.



The floating sludge blanket–a mass of solids formed by the microbubbles that have captured and floated the pin floc to the surface–is easily removed with a mechanical skimmer or by hydraulic overflow.

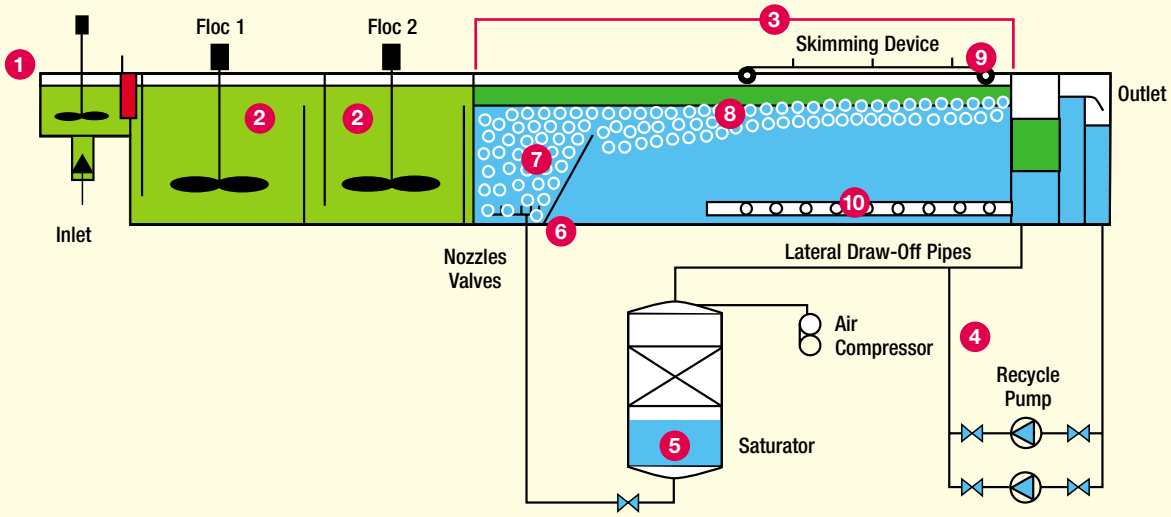


The next step for this sludge produced by a Clari-DAF system is dewatering equipment.



Shortly after start-up, the Leopold Clari-DAF system can produced crystal clear water.

How the Leopold Clari-DAF System Works



1. The Clari-DAF process starts with raw water being dosed with a coagulant in a rapid mix chamber, much like that of conventional sedimentation. Alum, ferric, and polyaluminum chloride are typical choices for coagulant. Lower doses than sedimentation are used because a pin floc is desired instead of a sweep floc.

2. Good coagulation is the most important factor affecting flotation. Two-stage tapered flocculation is standard. G values of 30 to 70 are typical for full-scale operations. Low tip speeds prevent the fragile floc from being sheared. Flocculation time is usually 10 minutes in each chamber but can be less, depending on the raw water quality.

3. Hydraulic loading rates normally range from 4 to 8 gpm/sf (9.68 to 19.36 m/hr), although pilot testing has shown that rates up to 10 gpm/sf (24.20 m/hr) are not unusual. As a result, the DAF requires a smaller footprint than sedimentation.

4. After a pin floc is formed, the raw water stream is injected with water that has been saturated with air at 60 to 90 psi. The saturation process is accomplished by taking a fraction of the throughput, typically 10% of design flow, and recycling it back to a pressure vessel. VFDs control the recycle pumps to maintain a balance in the saturator. A compressor provides a constant pressure of oil-free air to the saturator.

5. The saturator, a packed tower for water or unpacked tower for wastewater, mixes the water and air.

6. The aerated water is delivered to a distribution header that spans the width of the DAF cell. This distribution header has a series of specially designed orifices or nozzles. As the pressurized water exits the nozzles, the pressure drop produces a cloud of hundreds of millions of microbubbles that are 20 to 100 microns in size.

7. The contact zone is given a milky appearance like that of a whitewater blanket. The tiny air bubbles rise through the coagulated water, capturing floc as they ascend to the surface. The tiny spherical bubbles rise under laminar flow at a rate following a modified Stokes Equation.

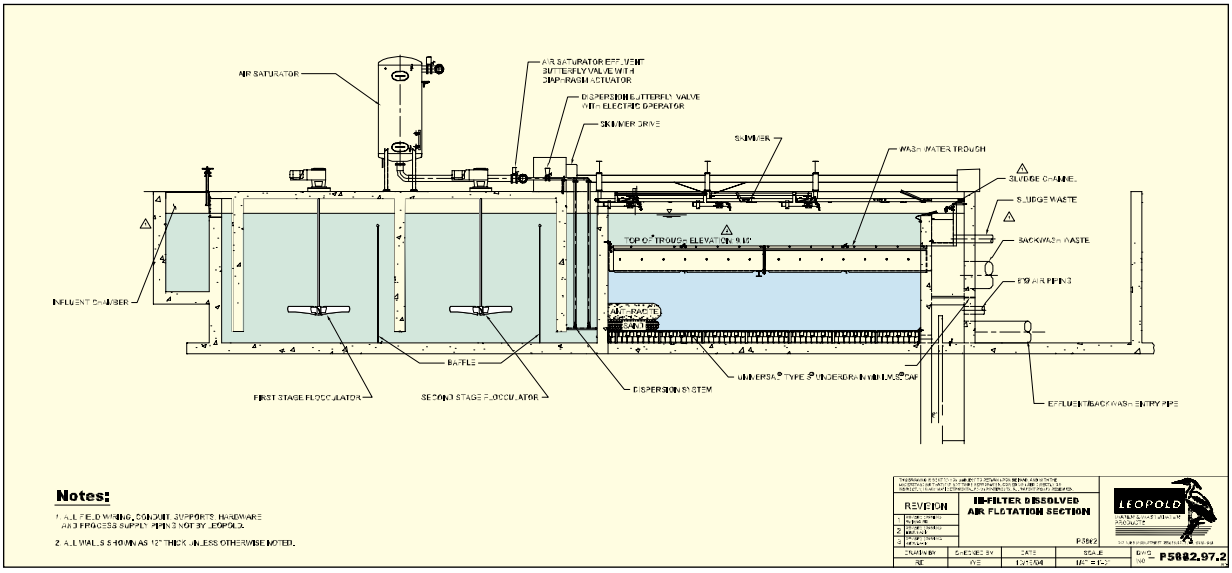
8. A blanket of sludge forms on the surface of the DAF cell. The blanket is supported from beneath by the tiny air bubbles.

9. The sludge blanket that forms on the top of the DAF cell is removed periodically by either a mechanical scraper or by hydraulic means. Under certain conditions scum removal can be achieved using a combination of both mechanical and hydraulic processes.

10. The clarified effluent water is drawn off the bottom of the tank by a series of lateral draw-off pipes that allow for uniform distribution along the bottom of the DAF cell.

Combine Cutting-Edge Filtration with High-Rate Clarification

The Leopold Clari-DAF system can be fitted with a rapid gravity filter, which can save cost by decreasing the footprint of the total water treatment plant. Patented, state-of-the-art Leopold® Universal® Type S® or Type SL® underdrain, IMS® (Integral Media Support) cap, and Leopold® Engineered Filter Media® anthracite all work together to optimize your treatment plant's operation with one goal in mind: to produce the highest quality water at the lowest cost.



Call Leopold to learn more about how the Clari-DAF system can lower your total cost of operation.

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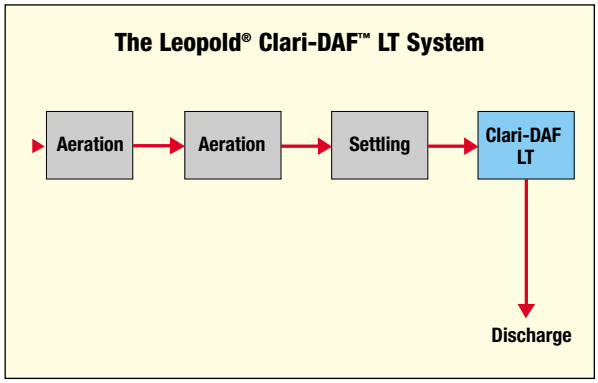
The Leopold® Clari-DAF™ LT System

The Leopold Clari-DAF LT (Lagoon Treatment) system is a clarification technology for the removal of algae, colloidal and suspended solids, precipitated dissolved solids, and BOD (Biochemical Oxygen Demand) associated with suspended solids from wastewater lagoon treatment systems. It is a proven, highly effective technology for providing consistent effluent water quality and lowering your total cost of operation.

Helps Meet Effluent Permit Requirements

Installing a Leopold Clari-DAF LT system after a wastewater lagoon settlement pond and before discharge to creeks, streams, rivers, or lakes can help wastewater treatment plants stay within effluent permit requirements by removing low-density solids that have not settled out. The Clari-DAF LT system can help wastewater plants stay within permit requirements during summer months when seasonal algae blooms can lead to regulatory issues.



Additional Benefits

Creating hundreds of millions of microbubbles of air to float suspended low-density particles out of the effluent, the Clari-DAF LT system increases the dissolved oxygen content in the discharged water. By adding small amounts of iron or aluminum coagulants, the Clari-DAF LT system can effectively remove phosphates, too.

Results Prove the Clari-DAF LT System Effective

Prior to the installation of a Clari-DAF LT system as the final process step at a 0.4 MGD wastewater treatment plant in Johnstown, Colorado, the average effluent TSS achieved by sedimentation was 25 ppm (versus an average 195 ppm influent TSS) and the average effluent BOD achieved by sedimentation was 9.6 ppm (versus an average 227 ppm influent BOD). This was within the plant's U.S. EPA National Pollutant Discharge Elimination System (NPDES) permit for effluent of <75 ppm TSS and <30 ppm BOD. However, the plant routinely exceeded its permit limits due to algae bloom in the summer.

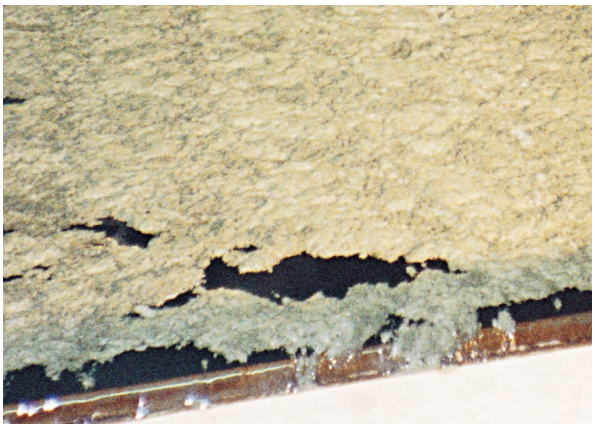
After installation of a Clari-DAF LT system to handle the algae and additional TSS and BOD from a moving bed biofilm reactor that had been installed to remove ammonia, not only were permit excursions due to algae growth eliminated, but also further reductions in TSS and BOD resulted. Average TSS dropped from 25 ppm to 8.1 ppm and average BOD dropped from 9.6 to 1.2 ppm. In addition, the coliforms previously leaving the settling pond decreased from 5,000 cfu/100 ml to 250 cfu/100 ml leaving the Clari-DAF LT system.

Potential to Process Increased Flow-Through

The Johnstown, Colorado wastewater treatment plant with the Clari-DAF LT system installed is presently operating at 4 gpm/sf. But pilot tests show that it can operate at 8 gpm/sf. This means that the plant can handle increased flow-through without having to add additional capacity–a capital cost savings.

Improved Sludge Solids Lowers Cost

With the Clari-DAF LT system, the solids content that can be achieved is 3% to 5% compared to 0.5% to 1% for gravity sedimentation. This results in increasing the efficiency of sludge handling equipment and reduction in the cost for sludge processing. Dewatering can occur without additional thickening, eliminating expensive sludge thickeners. There is less volume of sludge to handle, less chemical conditioning, less time to dewater, and lower energy costs. Because cake solids are higher, disposal costs are reduced.



This floating sludge blanket is a mass of solids created by floating low-density suspended particles that have not settled out in the wastewater lagoon.

The next step for this sludge produced by a Clari-DAF LT system is dewatering where higher cake solids result in lower disposal cost.

How the Leopold Clari-DAF LT System Can Lower the Overall Cost of Wastewater Lagoon Treatment

Improved solids handling	High percentage sludge solids for lower chemical cost, less time to dewater, lower energy cost Higher cakes solids for lower disposal cost
High loading rate	Handles increased flow-though without additional capital expense

Call Leopold to learn more about how the Clari-DAF LT system can lower your total cost of wastewater lagoon treatment.

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The Leopold® Clari-DAF™ System Design and Optimization

Designing and Optimizing Your Clari-DAF System to Improve Clarified Effluent Water Quality, Improve Solids Handling, and Lower Your Total Cost of Operation

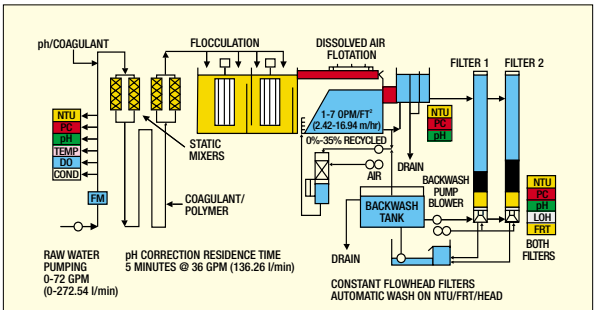
Leopold takes a flange-to-flange approach to designing a Clari-DAF system installation. We employ a variety of resources in designing a Clari-DAF system plant.

Mobile Clari-DAF System Pilot Plant

Leopold uses a mobile pilot plant to secure exhaustive, accurate data under actual operating conditions to establish process limits within which Leopold will guarantee performance. In addition, treatability studies conducted with the Leopold Clari-DAF system pilot plant provide filter plant operators with data for obtaining state and environmental regulatory agency approvals.

Designed with Leopold controls, the pilot plant can run unattended. On-line data logging with automatic filtration backwash sequencing and sludge removal allows the pilot plant to gather data and operate around the clock. It can log data every 5 minutes. A three-week study can yield 2 million results for statistical control. Flocculation volumes, times, and mixing energy can be varied to better target the most appropriate flocculation requirements.

Two chemical feeders using in-line static mixers control the water chemistry. One is used for pH adjustment while the other is used for coagulant dosing. Four-stream particle-counting capability allows flexibility for particle analysis of influent, clarified, and effluent water.



Leopold Clari-DAF Pilot Plant Process Design Parameters

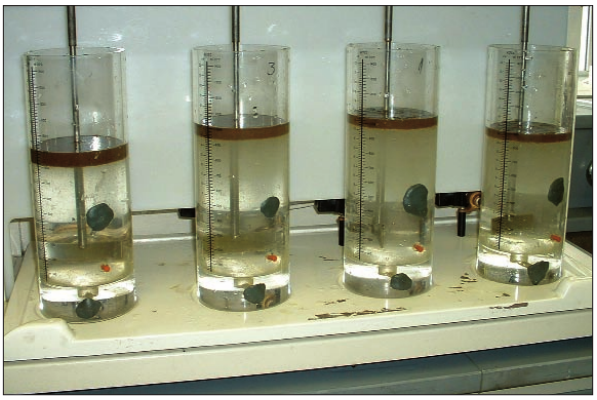
Design Flow	36 gpm (136.26 l/min)
Design Load	4 gpm/sf (9.68m/hr)
Maximum Flow	80 gpm (302.80 l/min)
Maximum Design Load	9 gpm/sf (21.78 m/hr)
Floc Time	25 minutes @ 4 gpm\sf (9.68 m/hr)
Floc Stages	Up to 4 (2 typical)
Rapid Mixing	Static Mixer
Filters	2
Filter Area	1 ft² (0.9 m²) Cross Section
Filter Height	10 ft (3.05 m)

The Leopold mobile Clari-DAF system pilot plant gathers data every five minutes around the clock for weeks under actual operating conditions to determine the most appropriate flocculation conditions for designing and engineering a full-scale Clari-DAF system installation.

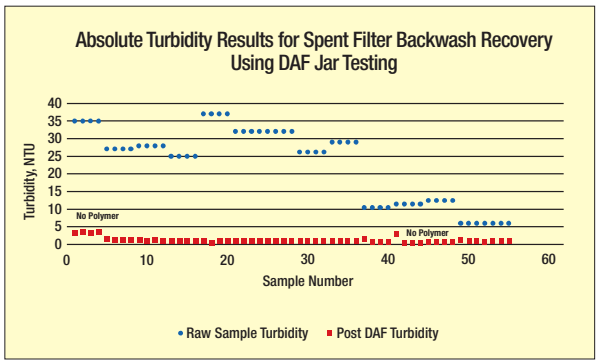
DAF Jar Testing

Coagulation and flocculation is a complex process. A number of factors affect it: coagulant dosage, pH, turbidity, TOC (Total Organic Carbon), NOM (Natural Organic Material), soluble ions in solution, mixing effects, and temperature. Leopold employs jar testing to simulate the process of coagulation and flocculation and gather data for optimizing the selection and dosages of coagulants for a specific raw water:

- Coagulant selection and dosage
- Coagulant aid selection and dosage
- Determination of optimum pH
- Point of addition of all chemicals
- Optimization of mixing energy



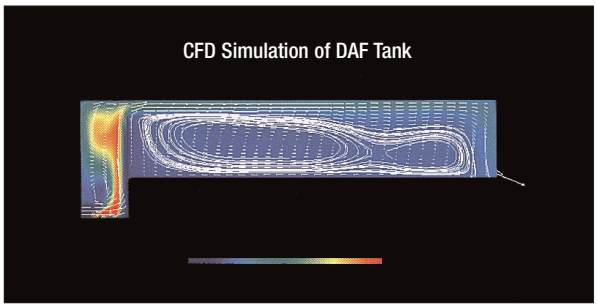
The Leopold Jar Testing Unit is a stand-alone system designed to test four samples independently and simultaneously, giving flexibility and variable control.



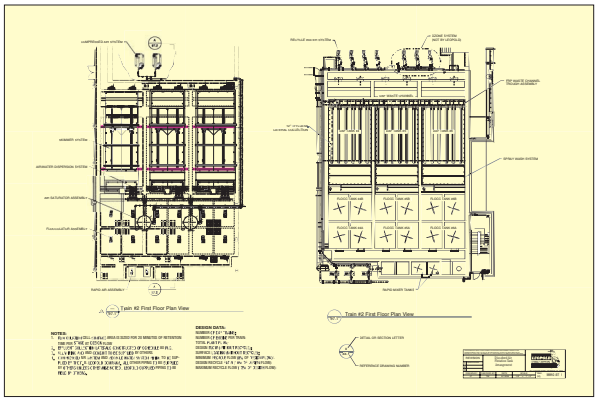
This is an example of data obtained with the Leopold Jar Testing Unit

Computer Modeling

Using the data obtained from treatment studies, Leopold optimizes Clari-DAF system installations with sophisticated computer modeling. Leopold CFD (Computational Fluid Dynamics) simulation allows "operating" the unit before it is built so the installation can be designed with the most efficient flow patterns for the most effective treatment. CFD simulation also allows Leopold to check existing plant designs and verify the hydraulics of the process units under different operating conditions.



Computer modeling allows Leopold to optimize each Clari-DAF system installation to each plant's particular needs and operating conditions.



Leopold assists engineers in preparing custom plans for each Clari-DAF system based on treatability study data and Leopold experience and knowledge.

Call Leopold to learn more about how the Clari-DAF system can lower your total cost of operation.

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