

Upgrading Pre-Existing DAF Clarifiers

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ABSTRACT

This paper will outline the most cost-effective approaches to upgrading pre-existing Dissolved Air Flotation (DAF) equipment. The discussion will highlight how Dissolved Air Upgrades, Hydraulic Separation Zone Upgrades, & Solid Removal Improvements can be used to improve clarification performance of pre-existing DAF installations. Realized benefits such as 20-50% improvement in TSS removal, 15% gain in transmittance, 35% lower flocculant & coagulant polymer use, and 35% increase in overall handling capacity of the clarifier will be discussed. Cost-effective upgrades of pre-existing DAF Systems can result in immediate profitability, while minimizing capital costs associated with additional clarification or microfiltration equipment purchases.

INTRODUCTION

Whether a Mill is pursuing a facility wide directive to reduce water consumption or simply looking for better performance from a presently installed DAF clarifier, the advancements discussed in this overview offer proven techniques to optimize existing DAF system operations. Significant operational cost reductions can be achieved with DAF System Upgrades. In addition, increasing DAF performance offers many additional benefits. As an example: Maximizing the Total Suspended Solids (TSS) removal in DAF Clarification is the first step in cost-effectively achieving a Mill's water reduction goals. The lower the TSS in the clarified water, the correspondingly lower the capital costs of downstream microfiltration equipment. Although the scope of this overview only allows for specific discussion concerning the actual DAF performance improvement results, the expanded value of these benefits is impressive.

DAF EQUIPMENT MODIFICATIONS

DAF Technology has been in the Paper Industry for over 40 years. New DAF installations in the Pulp & Paper Industry generally involve designs that offer higher performance, while minimizing operational and capital costs. The fundamental advancements in DAF equipment have been associated with improving the hydraulic separation zone, air dissolving system, and sludge removal operation. Understanding the trend in the industry to get more value from pre-existing equipment, World Water Works has successfully applied these advancements, used in the www/RESOURCE DAF, to retrofit existing DAF Clarifiers. These upgrades are not limited to older ceramic tile systems such as Permutit DAF systems; system upgrades have been completed on all brands of circular & rectangular systems including recently installed "Lamella Plate" DAF configurations.

Dissolved Air Upgrade (DAU)

The Dissolved Air Upgrade has been cost-effectively installed in every type of DAF system utilized in the North American Paper Industry. Historically the conventional air systems generate large bubbles with very poor saturation efficiencies. Techniques used include Pressure Tank, Pressure Tube and Centrifugal Pump air dissolving systems that require Mill supplied compressed air, as well as Induced Air systems. The "Dissolved Air Upgrade" is designed to increase the efficiency of the DAF Clarifier by reducing the bubble size, while increasing the number of "DAF bubbles" generated. This effectively improves the removal of smaller particles during clarification and results in higher quality effluent, while lowering operating costs.

Installing a Dissolved Air Upgrade into a current DAF operating system incorporates the use of a proprietary two-stage pump technology and proper system engineering to produce the smallest (30 micron) and most consistent (93%+ saturation efficiency) microbubbles commercially available. No compressed air is used to operate this Dissolved Air System. Outlined below are the main features associated with a *Dissolved Air Upgrade*.

- Micron Bubble Size

The smaller, more uniform air bubbles the dissolved air system delivers, the smaller the suspended particles that can be removed. The dissolved air upgrade produces a 30-micron bubble versus a 100+ micron bubble associated with traditional pressurized tank/tube designs. The smaller microbubble development provides two benefits: first, it increases removal efficiencies of smaller particles; and second, it allows for reduction in polymer chemistry (30%-50% reductions in coagulant and flocculant are typically realized).

- Air Saturation

With 93+% “air in water” saturation capabilities, the dissolved air upgrade is capable of over twice the saturation efficiency of the traditional pressurized tank & pressure tube systems (1/3 more than leading Pump Systems). This generates a superior “air blanket”, improving removal efficiencies. It also allows for lower recirculation rates. Thus, the hydraulic capacity of the clarifier can be increased after an air system upgrade.

- Energy Consumption

The Dissolved Air Upgrade uses no compressed air and often uses 30-60% less energy than conventional pressurized tank, tube, or centrifugal pump oriented systems. The dissolved air upgrade is smaller and more reliable than existing air systems, cutting maintenance costs.

Hydraulic Separation Zone Upgrade

Hydraulic Separation Zone upgrades are engineered to minimize the turbulence and channeling throughout the DAF. This includes analysis of the inlet approach piping, the separation zone, water effluent area, polymer feed scheme and the solids removal system. By utilizing straightforward techniques to re-engineer the hydraulic design of an existing DAF; the clarifier performance can be dramatically improved, while reducing operational costs and minimizing troublesome upset conditions.

Solids Removal Upgrade

This technology is installed when the facility needs a more reliable, more effective floatable solids removal device or higher consistency mat solids are desired (required because of downstream thickening/solids dewatering equipment limitations). It includes a guaranteed rake system, solids dewatering grid, and engineered baffling to insure sludge does not get reintroduced to the clarification zone. This system upgrade incorporates the latest advances in quality materials and engineering.

This technology can be applied to all rectangular pre-existing DAF's. The installation of this advanced solids removal system assures non-invasive mechanisms will be used to minimize solids migration back into the “clarified water” and maximize high consistency solids removal. In applications to date such modifications have improved clarifier performance, while typically increasing the consistency of solids removed by 1-3 percentage points. The important features that insure operational reliability include durable materials, proper stress load evaluations, and the engineering of flexibility into the project.

MILL EXPERIENCES

Below are various mill circumstances associated with operating Dissolved Air Flotation equipment. The “Upgrade” work completed on these systems and the results achieved are outlined in detail.

Newsprint Deinking DAF Clarifier Upgrade

This washing ONP newsprint deinking facility was in the process of expanding and improving water clarification mill-wide to improve ink removal (higher transmittance water for deink stock washing to improve pre-bleach pulp brightness) and reduce mill water consumption/discharge. Three DAF clarifiers marketed in the Paper Industry were evaluated in head to head evaluations. The benefits of the World Water Works www/RESOURCE DAF enabled superior performance at substantial operational & capital costs savings and was an impressive victor of the trial evaluation work.

Understanding our capabilities in the DAF Upgrade area, the Mill asked World Water Works to review their present clarifiers to determine if they could be modified to handle higher throughput. This would save the mill the capital expense of having to purchase multiple new DAF units and erect a new building to house this equipment. A Dissolved Air Upgrade along with minor hydraulic separation cell and solids improvement changes were recommended to upgrade a Permutit Clarifier with a Pressure Tank air system. To the skepticism of many suppliers, the project to upgrade the 2000 GPM Permutit clarifier to treat a minimum of 2500 GPM was initiated. The only success criteria was to increase the capacity of the DAF treating 2000-2500 ppm TSS influent, while maintaining the clarified water specifications of <200 ppm TSS with a transmittance of 68-70%.

The results were quite impressive (see table I). The installation of the Dissolved Air System initially enabled the mill to improve transmittance (from 70% to 80%) and improve TSS removal, while reducing coagulant polymer by 35% and flocculant polymer by 40%. Once the mill increased clarifier pump capacity, the flow was successfully increased from 2000 GPM to over 3000 GPM, while maintaining the initial benefits of increased performance and lower polymer use. The Solids Removal upgrade increased the consistency of the sludge from 2.4% to 3.4%. This 1+-point gain enabled the mill to overcome the previously experienced thickening & dewatering equipment limitations. The performance and operational savings justified the project in less than one month. Subsequently, the mill is upgrading their two additional Permutit clarifiers.

I. Benefits of Dissolved Air & Solids Dewatering Upgrades

Improvement Area	Standard Performance	After DAF Upgrades
Clarifier Capacity	2000 GPM	3000 GPM
TSS Removal	170 ppm TSS	120 ppm TSS
Transmittance	68-72%	79-82%
Polymer Costs	Substantial	Reduced 36%
Floatable Solids	1.8-2.4% Consistency	3.4-4.0% Consistency

Specialty Linerboard DAF Clarifier Upgrade

Mill had received recommendations and quotations to install a 400 GPM Primary and Secondary treatment system (\$1,200,000 US) to meet environmental regulations to reduce the BOD discharge from the facility. After evaluation of the facility, WWW proposed a process water reuse approach that involved upgrading their present process DAF and installing advanced Micro-Filtration. The mill moved forward with the water reuse option because of two main factors:

- The capital costs associated with the water reuse project would be 20% of the costs associated with installation of a complete treatment system.
- The water reuse approach would not increase the cost of operations. In addition the mill would gain the production & operating benefits associated with maintaining the higher temperature water in their process.

A Dissolved Air Upgrade and Hydraulic Separation Zone Upgrade were recommended and installed on a pre-existing 500 GPM clarifier that was operating at 800 GPM. These upgrades improved Total Suspended Solids removal by 50%, while reducing polymer cost by 35%. Since 50% less solids would be fed forward to the 20 um microfiltration system (designed to close the water loop), it was possible to scale this microfiltration system back to half the originally engineered size. In addition to conforming to the discharge permit, the mill has recovered valuable hot water (reducing energy costs) and substantially reduced fresh water intake. Furthermore the high machine production efficiencies have been maintained. As a result of the successful closure of the mill's water loop and meeting BOD discharge requirements, this operation avoided the expense of a wastewater treatment system installation.

Specialty Kraft Air System Upgrade

This facility operated a 500 GPM Krofta DAF Clarifier and was happy with the 350 - 450 ppm TSS clarification results that were achieved most of the time. Occasionally, the clarifier would experience surges to 800 ppm TSS that were directly related to paper machine operating difficulties. Investigation revealed that the mill utilized a 40 HP motor on the pump for the recirculation line feeding a Pressure Tank dissolved air system. Due to compressed air limitations in the mill, it was determined that the Pressure Tank system was not reliably receiving the required volume of compressed air.

The installation of a Dissolve Air Upgrade achieved reliable 200 – 250 ppm TSS clarification results with no deviation. The 6 month justification of the project was directly related to reduced energy consumption of 60% (by using the 15 HP motor associated with the Dissolved Air Upgrade compared to the previous 40 HP motor) and eliminating the need for compressed air.

CLOSING

Based on demands from all industries this new generation of advanced DAF Technology has been developed. Although most of this technology was originally designed for new DAF construction, it is being made available for retrofitting pre-existing equipment. These low cost DAF Upgrade innovations truly offer the papermaker remarkable value. Significantly reducing chemical and operating costs, while improving clarification efficiencies often dramatically increase profits.