



Essential Expertise
for Water, Energy and Air

Gallatin Steel Achieves Significant eROI Savings Through the Use of Nalco Innovative Technologies



Background

Gallatin Steel is a mini-mill that produces steel coils through the Compact Strip Process (CSP). The Direct Contact Water (DCW) system provides cooling water for both the caster and rolling mill in a single combined system. Return water, after contact with the process, drains through flumes to the 1.1 million gallon DCW scale pit, where separation of oil, water and iron fines occurs. Oil is removed from the surface of the water by

two rotating drum skimmers, while scale is removed from the base of the scale pit by a clam bucket.

After passing through the scale pit, the clarified water is then collected in the hot well and pumped by six 350 HP centrifugal pumps through a bank of deep bed pressurized sand filters that provide full flow filtration. After filtration, the water flows over a cooling tower and is stored in the cold well for use as DCW system cooling water (Figure 1).

ENVIRONMENTAL RESULTS	eROI	ECONOMIC RESULTS
179 million gallons saved for make-up water	 water	\$7,700 per year in pumping cost savings
From the process system, eliminated the need of operating a 350-HP pump and minimized filter media replacement	 asset	\$113,200 per year saved from electrical use and filter replacement costs
2.3 million kWh per year saved by reducing pump operations	 energy	Financial energy savings are related to water savings from reduced pump use
2,387 ton reduction of CO ₂ by eliminating pump use from both cooling and process operations	 air	Potential carbon credits based on market value
410-ton reduction of sludge use from both cooling and process operations	 earth	\$15,000 per year in waste disposal savings use from both cooling and process operations

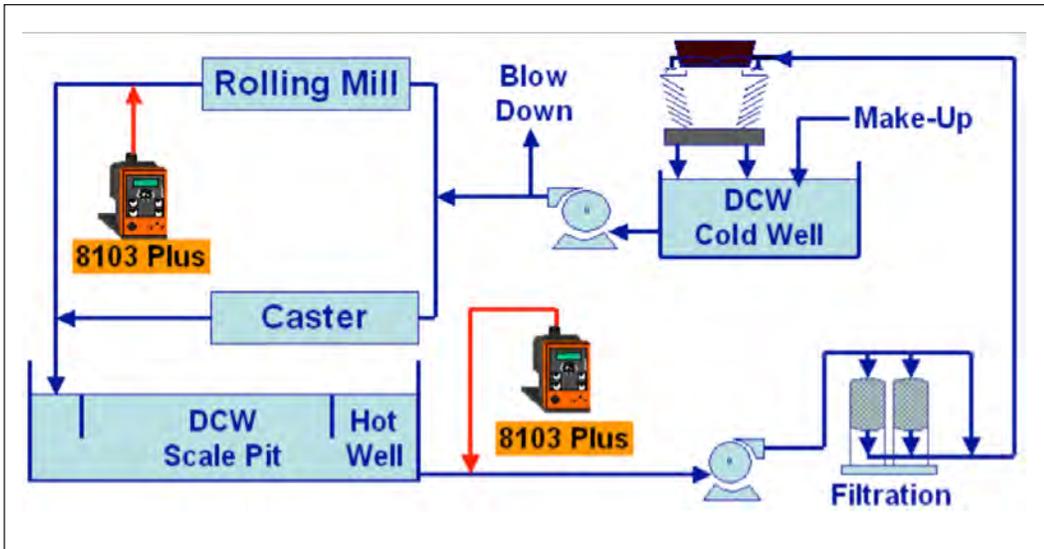


Figure 1 – DCW Simplified Line Diagram

Cold well level control is maintained by cycling the number of hot well pumps required to maintain system operation. Original design specifications utilized four hot well pumps, leaving the fifth pump as an inline spare. A sixth pump was added to the hot well due to system modifications that increased the head pressure and reliability issues with the pumps that created shortened service life.



Figure 2 - Multi-media Filter after Backwash
Note the residual oil and grease and evidence of channeling

Problem

During equipment inspections, heavy oil and grease buildup was observed on the sand filter media (Figure 2). Backwash water channeling was also noted, indicating poor filter conditions. Sand filter media fouling resulted in high filter pressure differentials and an increase in required system pumping requirements. Consequently, to ensure proper system

flow and to maintain peak production cold well levels, additional pump capacity and filtration appeared to be required. Budgetary analysis began on the purchase of a seventh centrifugal pump to maintain design level in the cold well. Additionally, engineering changes to the existing filter bank were made to remove a multi-media filter from the Indirect Cooling Water (ICW) system and add the filter to the DCW system in

an effort to decrease system pressure. The removal of filtration for the ICW system was a temporary solution that was undesirable because of the subsequent increase in the suspended solids concentration of the ICW system cooling water. Engineering and construction commenced for the addition of two multi-media filters to the DCW system.

Sustainable Solution Development

A structured DCW system audit process was conducted by the Nalco field sales force with assistance from the Nalco Primary Metals Technical Consultants. Audit results indicated that the scale pit was not being optimized for maximum DCW system performance. Poor system performance was evident in reduced filter media life, with severe solids and hydrocarbon deposition of filter media. System mechanical, operational and chemical variables were examined to ensure a sustainable solution could be recommended. Nalco proposed maximizing the efficiency of the scale pit through the application of Nalco CAT-FLOC® technology.

This Nalco global steel industry best practice technology is specifically designed to enhance oil and suspended solids reduction in steel industry direct contact water systems. Nalco worked with Gallatin Steel to implement a program that would maximize product efficacy through an understanding of the mechanical and operational factors influencing contact water system performance. This included the choice of appropriate treatment chemistry, application points and routine performance monitoring.

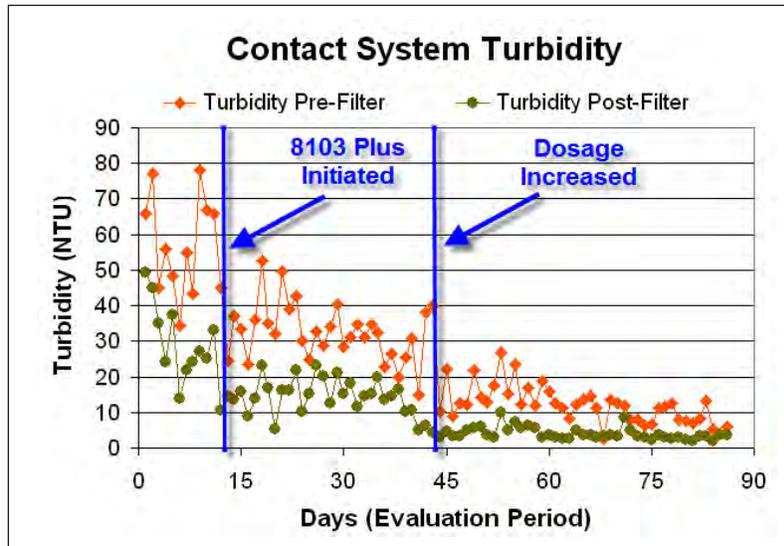


Figure 3 – DCW Turbidity

Upon implementation of the Nalco CAT-FLOC technology, system turbidity levels improved markedly across both the scale pit and sand filters, as shown in Figure 3. The DCW system blowdown point is directed into a surface waterway and requires environmental permit water testing. This independent environmental testing confirmed system water quality improved, with oil and grease levels less than 2.5 mg/l and TSS less than 2.0 mg/L. As a result of the improved filter cleanliness, filter inlet pressure dropped from an operating range of 52 - 56 psig in 2006 to an operating range of 44 - 46 psig in 2008, allowing the system to operate as designed by utilizing only five hot well pumps (four pumps in continual operation and a fifth pump cycling for level control.)

Environmental Return of Investment

Earth - Reduction in Waste Generation

Through a continuous improvement approach, Gallatin Steel and Nalco reduced the amount of filter sludge generated by more than 28 percent. This decreased the amount of material to be landfilled by more than 410 tons in 2009 and more than 1,040 tons since the application of Nalco CAT-FLOC technology was initiated into the Rolling Mill flume in the fall of 2007 (Figure 4). More efficient removal of material in the scale pit reduced the solids loading on the sand filters and provided for more efficient system operation. Mill scale removed from the scale pits is recycled back to the steelmaking

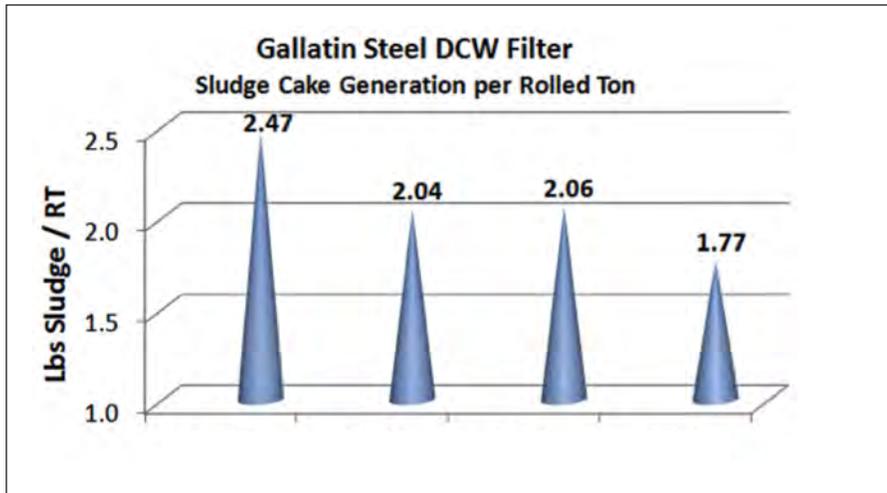


Figure 4 – Gallatin Steel Annual Sludge Generation

process as an iron-bearing material or is utilized as a raw material for other products. Solids removed from the sand filters is transported by truck and disposed of as solid waste. Due to the characteristics of the material, filter sludge is more difficult to recycle internally, and the lack of markets for this material created the need to landfill. The reduced load on the sand filters translates directly to lower sludge generation from the filter backwash clarification system, reducing the environmental impact.

The influence of Nalco CAT-FLOC technology on the reduction of solids sent to the multimedia filters was immediate. Plant operations documented that the number of dumpsters trucked to the solid waste facility dropped from 4.5 per week to 3.5 per week. Evaluating the actual weights of material hauled off-site revealed that the cost of Filter Cake Sludge (FCS) was reduced by US \$41,430 since the inception of the project, or an average of US \$11,990 per year.

Water - Reduction in Water Usage Through Enhanced Recycle

Gallatin Steel, through water system design, recycles water through a cascaded blowdown arrangement, as shown in Figure 5. Cascade blowdown takes blowdown water from higher quality water systems and successively moves the water to systems with less stringent requirements. System heat flux, potential for process contamination, potential for water system stresses (such as corrosivity and scaling) at higher cycles of concentration and water system mechanical equipment all factor into mill cascade water recycle plans.

The DCW system receives water from various cooling water systems and sumps throughout the plant. Cascading flow impacts the DCW system hydraulic balance and influences DCW cycles of concentration, so it must be considered when making cooling water changes.

DCW performance improvements increased overall system water quality by reducing the concentration of recirculated suspended solids and hydrocarbons. These improvements, along with the stress management capabilities of Nalco 3D TRASAR® technology, created an opportunity to reuse additional water as filter backwash. The use of reclaimed DCW water to backwash the multi-media filters reduced mill usage of raw water and maximized the efficacy of the cooling tower treatment program. The implementation of the water reuse plan had a significant impact on the amount of water utilized by the DCW system, and as a result of the 3D TRASAR enhanced monitoring and control capabilities, the additional cooling water stresses realized were managed and all water system leading indicators were maintained.

Figure 6 is a graph showing the volume of water that is discharged from the DCW system to the Ohio River. As seen in the graph, there was a 492,500 gallon per day (GPD) reduction in the volume of water discharged from the plant on a daily basis, or 180 million gallons of water per year (572 million since the the source of filter backwash water was changed in October of 2007).

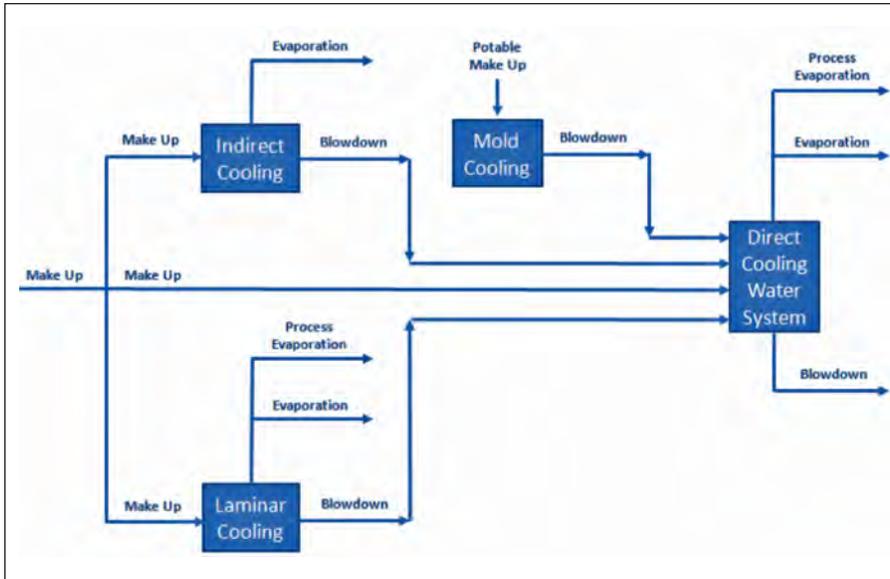


Figure 5 – Gallatin Steel's Cascade Blowdown System

Cascading blowdown required the evaluation of overall mill water balance to determine the degree in which increasing make-up flow directly to the DCW system would have on the overall water flows throughout the plant. Period averages for the mill-wide make-up water data showed that, as a facility, the volume of raw water utilized per day was reduced by 571,300 GPD, or 208.5 million gallons of water per other incremental gains that were made through further optimization of the mill-wide water balance. Confirmation of the water volumetric flow-rate of water pulled from the river and discharged to the environment confirms the magnitude of the water recycle project. This quantity of water represents a significant improvement to mill water optimization and would meet the daily water requirements of 7,204 U.S citizens.

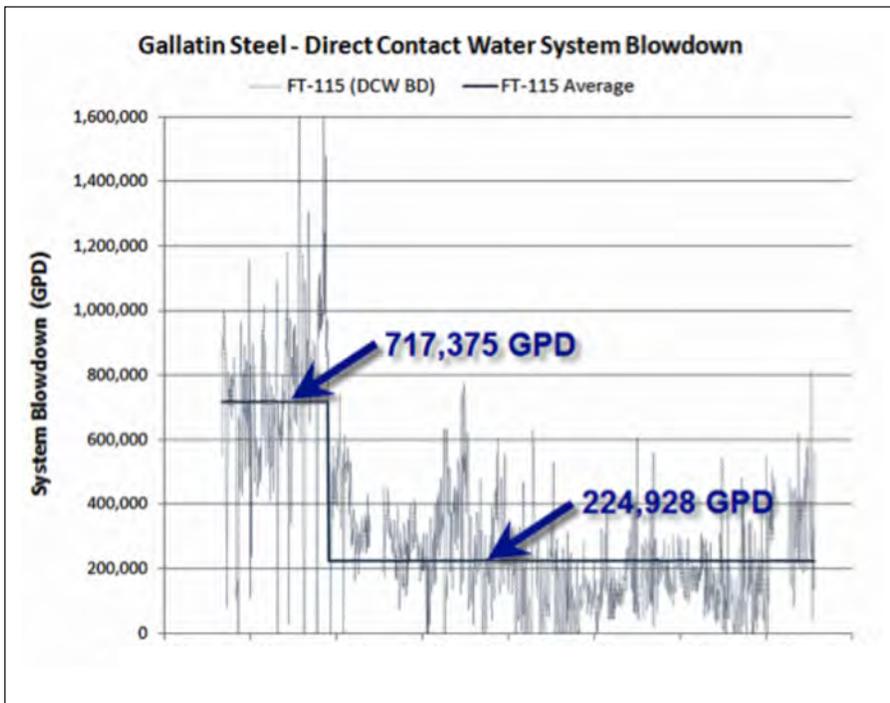


Figure 6 – Gallatin Steel Annual Sludge Generation

Energy - Reduction in Electrical Pumping Requirements

Raw water is pumped by a 50 HP, 1500 gpm, vertical turbine pump (651 Pump) from the Ohio River, through an intake pipe and into the mill. The water is pumped from the intake caisson into a 5 million-gallon reservoir, through multi-media filtration and to the process cooling water clear well with an additional 100 HP vertical turbine pump (653 Pump). From the clear well, water is delivered to the various cooling systems through a bank of make-up water supply pumps. Figure 7 is a simplified schematic of the make-up water system.

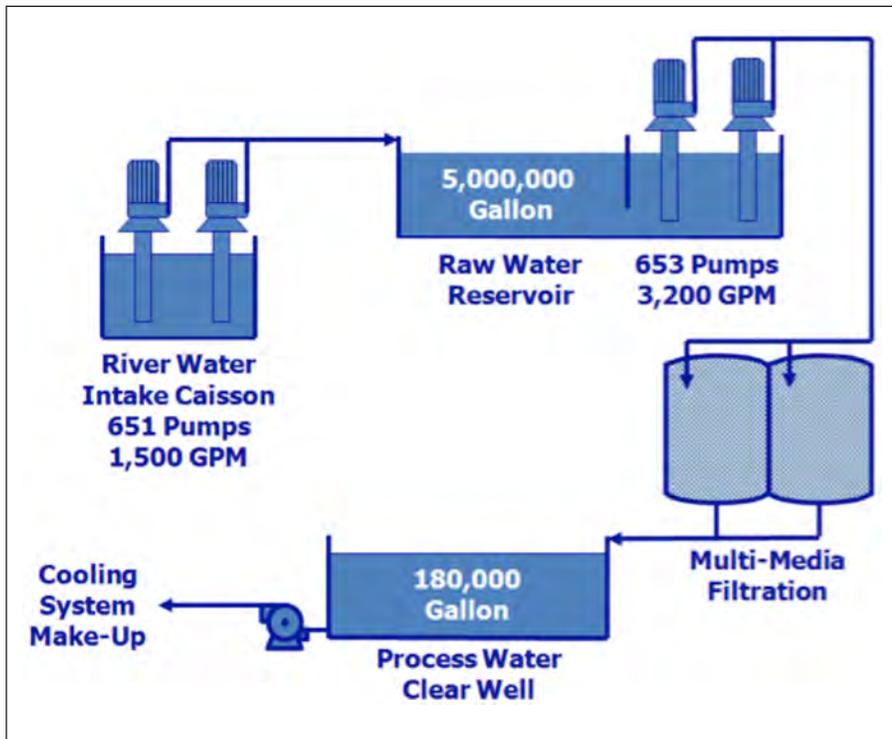


Figure 7 – Gallatin Steel Make-Up Water System

Pump	Power (kilowatts)	Run time (min/day)	Energy (kWh/Day)	Lbs CO ₂ /Day
651	39	381	248	508
653	68	179	203	416
632	247	1,440	5,928	12,158

Figure 8 – Reduction in Energy Consumption System

A decreased daily volume of water drawn from the river and pumped to the clear well results in decreased energy used by the mill — specifically, the energy used by the 651 Pump and the 653 Pump. The aforementioned reduction in the amount of make-up water required by the plant corresponds to a reduction in runtime for the 651 Pump of 381 minutes per day and a reduction of run time for the 653 Pump of 179 minutes per day. The reduction in pumping energy for the make-up

system is combined with the reduction of pumping energy in the DCW system in Figure 8.

On a daily basis, the system improvements made to the DCW system reduce the energy requirements of Gallatin Steel by 6,378 kilowatt-hours. This reduction in energy requirement reduces the Carbon Dioxide generated by power producers by 13,082 pounds per day (utilizing the USEPA local factor of 2.051 pounds of CO₂ / kWh).

Since the inception of this project, a reduction in energy requirement of over 8.9 million kilowatt-hours has been achieved, thereby reducing the Carbon Dioxide discharged to the atmosphere by 9,150 tons. The energy saved by Gallatin Steel represents enough energy to supply 206 households (2007 US DOE average of 936 kWh / month).

Return on Investment

In addition to reducing the environmental impact of Gallatin Steel, the DCW application of CAT-FLOC technology provided direct savings by reducing energy, maintenance and sludge disposal costs. Based upon DCW system improvements, this steel mill realized a return on investment of over 121 percent, as detailed in Figure 9.

In addition to providing annual savings of \$135,900, implementation of the Nalco CAT-FLOC technology provided the mill with \$150,000 in capital avoidance. This was a direct result of eliminating the need for procurement of a seventh hot well pump. The system currently operates with five hot well pumps, with an idled installed spare. The inclusion of two additional multi-media filters, although now included in the system, was not necessary to achieve design cooling flow at peak production rates. The cost of the filter installation was in excess of \$591,000.

Operational Savings

Pumping Costs **\$ 103,700**

632 Pumps 350 HP Pump
\$0.05 USD per kW-hr
1440 Minutes per Day

Sand Filter Media Savings **\$ 9,500**

Filter media replacement cost = \$220,000
Extension of media life from 7 to 10 years

Water Consumption Savings

Pumping Costs **\$ 7,700**

651 Pumps 100 HP Pump
\$0.05 USD per kW-hr
381 Minutes per Day

653 Pumps 100 HP Pump
\$0.05 USD per kW-hr
179 Minutes per Day

Waste Savings

Trucking and Landfill Costs **\$ 15,000**

Reduction of 410 tons per year of sludge generated
Average landfill cost = \$36.70/ton generated

TOTAL ANNUAL SAVINGS **\$ 135,900**

Cost of Nalco CAT-FLOC® Treatment Program **\$ (60,000)**

$$\text{ROI Calculation} = \frac{\$135,900 - \$60,000}{\$60,000} = \mathbf{127\%}$$

Figure 9 – Financial Return System

Solids Generation

	Filter Cake Solids Dumpsters / Week	Filter Cake Sludge Generation / Rolled Ton	Filter Cake Sludge Generation Tons / Year	Filter Cake Sludge Generation Tons Since Inception
2006	4.5	2.47		
2009	3.5	1.77		
Savings	1.0	0.70	410	1,040

Water Reduction

	Daily Water Discharge (Gallons per Day)	Annual Water Discharge (Gallons per Year)	Total Water Savings (Gallons)	Usage Equivalents Annual Supply (Citizens of Rwanda)
2006 - 2007	717,375	262,000,000		
2007 - 2010	224,928	82,100,000		
Savings	492,447	179,900,000	572,200,000	144,000

Energy Savings

Energy Savings (kWh / Day)	Energy Savings (kWh / Year)	Energy Savings (Total kWh)	Households Off Grid (936 kWh / Month)
6,378	2,330,000	8,920,000	206

Carbon Dioxide Reduction

CO ₂ Reduction (lbs. CO ₂ / Day)	CO ₂ Reduction (Ton CO ₂ / Day)	CO ₂ Reduction (Total Tons)	Automobiles Off Road (annual)
13,082	6.5	9,144	434

Figure 10 – Summary Tables

Nalco reports Environmental Return on Investment (eROI) values to customers to account for contributions in delivering both environmental performance and financial payback.

NALCO COMPANY Locations

North America: Headquarters – 1601 West Diehl Road • Naperville, Illinois 60563 • USA
Energy Services Division – 7705 Highway 90-A • Sugar Land, Texas 77487 • USA

Europe: A-One Business Center • Z.A. La Pièce 1 • Route de l'Etraz • 1180-Rolle • Switzerland

Asia Pacific: 2 International Business Park • #02-20 The Strategy Tower 2 • Singapore 609930

Latin America: Av. das Nações Unidas 17.891 • 6° Andar 04795-100 • São Paulo • SP • Brazil

www.nalco.com

CAT-FLOC, 3D TRASAR, NALCO, the logo and tagline are Trademarks of Nalco Company

All other trademarks are the property of their respective owners

©2011 Nalco Company All Rights Reserved 4-11