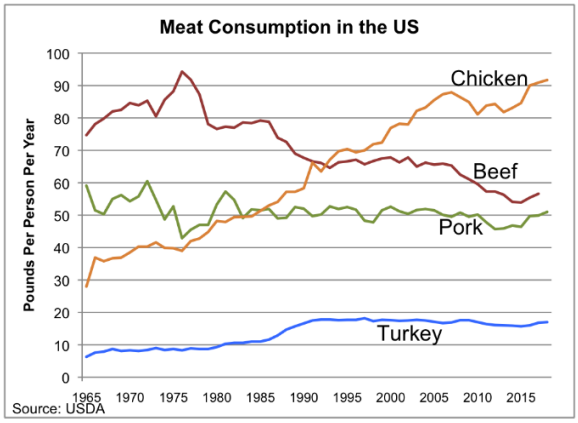
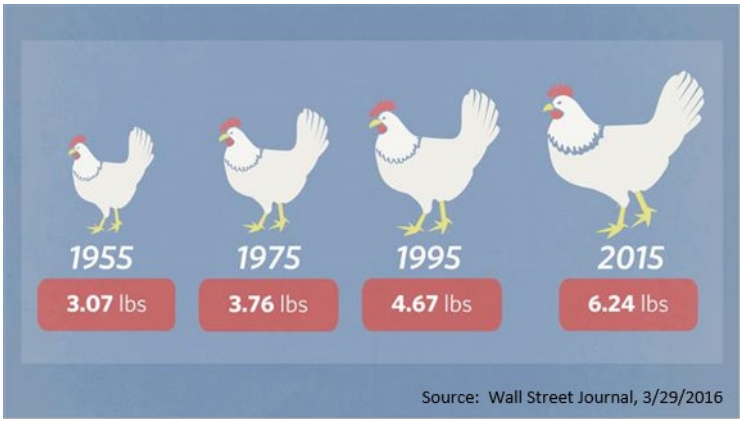
TPX™ Helps Solve Wastewater Challenges in Poultry Processing

Trends in Poultry Processing

Americans love chicken! According to the USDA, in 2018, over 9,000,000,000 broiler chickens were slaughtered to satisfy US consumers' and export markets' demand for chicken. The average American consumes more than 90 pounds of chicken per year, more than any other meat source. In addition to an increasing appetite for chicken, consumers are demanding larger chicken breasts, resulting in an enormous increase in the average size of a broiler chicken.





These trends toward more and larger broiler chickens greatly affect slaughter and processing plants, including their wastewater treatment efforts. According to the US Poultry and Egg Association, poultry processing typically utilizes approximately 7 gallons of potable water for each bird processed, and most of this water ends up in the plant's wastewater treatment operations. Because of the significant cost of water in the process, most plants are attempting to reduce water usage, reducing the gallons per bird (GPB). Efforts to reduce GPB, combined with increased production of larger birds, leads to much greater concentration of contaminants in poultry plant wastewater. Key parameters that plants increasingly need to control include total phosphorus (TP), total kjedahl nitrogen (TKN), biological oxygen demand (BOD), chemical oxygen demand (COD), and total suspended solids (TSS).

The Nutrient Problem

Among these contaminants, nutrients (phosphorus and nitrogen) are becoming an increasing concern to environmental regulators. High nutrient concentrations (eutrophication) in natural water

bodies can result in harmful algal blooms (HAB) and hypoxia (reduction in oxygen available to aquatic life). High nutrient concentrations can also help sustain and exacerbate red tides along the Gulf of Mexico once a red tide bloom has moved onshore. Regulators in Southeastern states, home to the nation's growing poultry industry, are thus focused on mitigating these effects. The five largest poultry producing states are Georgia, Arkansas, Alabama, North Carolina and Mississippi, according to the National Chicken Council. Producers in these states are increasingly facing newly imposed TP limits, or more stringent limits for plants with existing limits.

The most common means of treating poultry wastewater is chemical precipitation and flocculation through dissolved air floatation (DAF) systems. This typically involves the use of some combination of polymers, organic coagulants, and metal salts (typically ferric chloride, FeCl). Stringent TP limits often necessitate the use of FeCl. While FeCl in concert with polymer and coagulants is often effective at meeting TP and other discharge limits, it creates a high cost for sludge disposal.

The SPN Challenge

Secondary Protein Nutrients (SPN) are the DAF skimmings that result from the poultry wastewater treatment process. These skimmings are high in valuable fats, oils and grease from poultry processing. Like other processing by-products (such as trimmings, blood, bones and feathers), SPN can be recycled by rendering plants, and used for animal feed, biofuels, lubricants and other products. When processing plants sell DAF skimmings as SPN to renderers, not only do they realize some revenue, but they avoid the alternative very expensive disposal cost. DAF sludge that cannot be rendered is usually disposed of through land application or, increasingly, landfill disposal. As with other biosolids and sewage waste, this sludge can be land applied as fertilizer. While this represents a beneficial use, it is very costly, given the role of brokers in securing available land and very high transportation costs. In addition, suitable land is becoming more scarce, and nearby residents are often opposed to land application permits due to odor concerns. Because of these factors, poultry processors are much better off selling SPN to renderers rather than paying for disposal through land application.

However, plants that use FeCl or other metal salts in their wastewater treatment often are unable to sell DAF skimmings to renderers as SPN. This is due to potential toxicity and the increased risk of combustion in the heat processing in the rendering operation. Plants using FeCl thus are forced to use land application for disposal of DAF sludge. Often multiple DAFs are used so that some skimmings can be generated and sold as SPN prior to the application of FeCl in a secondary DAF.

The TPX™ Solution

NClear's patented TPX™ nanocrystal technology was designed as a non-toxic, effective and efficient means to remove certain contaminants, especially phosphorus, from water and wastewater. Because TPX™ is a calcium-silicate synthetic mineral, it does not contain any toxic metals. Unlike FeCl treatment systems, TPX™-treated DAF skimmings can be sold to rendering plants as SPN,

providing a revenue source. More importantly, these solids no longer need to be land applied or sent to landfill. The ability to recycle solid waste can help poultry processors meet their sustainability goals in addition to improving their bottom line. In addition to enhancing phosphorus removal, TPX™ has coagulative properties that, used in conjunction with certain polymers or other coagulants, can help meet stringent discharge levels for TSS, COD and BOD. TPX™ can also help reduce operating costs. The ability to render all DAF solids often eliminates the need for a secondary DAF, streamlining operations. Because TPX™ will boost pH it also can eliminate the need for quicklime (CaO) additions. Finally, TPX™ is hydrophobic, meaning that the skimmings generated will dewater easier, greatly reducing transport costs and potentially reducing dewatering costs.

Pilot Study Overview

NClear partnered with a large poultry processor to extensively test TPX™ at its poultry kill plant in North Georgia in a series of 72-hour sidestream tests. NClear's mobile pilot system included a custom-built 10 gallon per minute (gpm) DAF with multiple chemical injection points and floc tubes, polymer and coagulant feed tanks, acidulation system, equalization (EQ) tanks and the TPX™ slurry system.

NClear's pilot trailer, with custom-built DAF, chemical feed tanks, floc tubes.

The pilot system allows NClear to effectively simulate the plant's entire wastewater processing plant. EQ tanks are sized to simulate the retention time and aeration characteristics of the plant's flow equalization basin(s), as well as any equalization tanks or ponds at the effluent end of the wastewater

process. This allows us to replicate the plant's operating environment to ensure that results are consistent with the plant's process, including DAF retention time.

Pilot Evaluations were conducted around the clock for 72-96 hours, with daily composite testing of both direct DAF effluent and aerated EQ tank effluent. NClear's portable lab provided real-time analysis of pH, TP, Ortho P (OP), and COD. Composite samples were also sent to both the customer's corporate lab as well as a third-party lab for independent verification of results and additional analyses of BOD, TKN and TSS. Results were compared with the customer's own wastewater effluent, and were used to evaluate full scale treatment costs.

Minimum criteria for demonstrating successful treatment included meeting all of the plant's permit discharge levels, with a total treatment cost (including chemicals, solids disposal, etc.) less than the plant's current total wastewater costs.

Pilot Study Results

NClear's pilot DAF system was utilized at the North Georgia processing plant on several occasions to test multiple operating characteristics. Representative results from the customer's own lab are shown in Table 1, and demonstrate that NClear's TPX™ solution achieved better results for all analytes than their current FeCl treatment system. For example, the composite TP effluent was 2.5 mg/L, compared to the plant's 5.3 mg/L, and a reduction of 90.2% from the raw water concentration. Likewise, BOD concentrations achieved in the sidestream were approximately half of the current plant effluent levels.

Table 1. Pilot results from North Georgia poultry processing plant, as reported by client's corporate lab. Results are from a representative 24-hour composite sample from July 2018. Similar results were replicated over 11 separate 24-hour test periods at this location.

Analyte (mg/L)	DAF Influent	Current DAF Effluent	NClear Pilot DAF Effluent
Total Phosphorus (TP)	25.6	5.3	2.5
Total Suspended Solids (TSS)	1090	43	38
NH_3	11	20	9
Total Kjeldahl Nitrogen (TKN)	133	64	42
Chemical Oxygen Demand (COD)	3780	N/A	316
Biological Oxygen Demand (BOD)	1645	333	161

DAF skimmings from multiple pilot tests were tested and processed by a rendering facility and were confirmed to be dryer sludge that contained no metals or toxicity and was acceptable for rendering. In addition, client plant personnel estimated that the total wet volume of skimmings produced was

reduced by approximately 30%, which translates to significant savings due to less water transport and more efficient cake production.

Treatment Costs

Together with client personnel, NClear analyzed current total wastewater costs at the Cornelia facility. The plant currently operates two EQ basins and two DAFs. The DAFs are sometimes run in sequence with FeCl addition in the second DAF, and sometimes run concurrently with FeCl in both DAFS. When they are run in sequence, some of the solids from DAF1 can be sold as SPN; when run concurrently all DAF solids are land-applied. Current costs evaluated include: Chemicals (anionic and cationic polymers, FeCl, quicklime, and an organic coagulant); transport costs for DAF solids (both to land application and, when DAFs are run in sequence, to rendering); and land application fees. As an offset to current costs, there is some SPN revenue when DAF's are run in sequence. The total of these current costs is approximately $7,800 per day, or $4.60 per 1,000 gallons treated (based on average flow of 1.7 MGD).

As shown in Table 2, the TPX™ solution results in a savings of 27% in total wastewater treatment costs, reflecting a savings of over $2,000 per day, which adds up to more than $550,000 per year.

Table 2. Current and estimated future wastewater processing costs at North Georgia poultry processing plant, per day based on approximately 1.7 MGD flow rate. Future Cost reflects the full scale costs associated with NClear's TPX™ solution.

Cost or Revenue Element	Current Cost	Future Cost	Savings
Chemicals	$2,464	$6,134	($3,670)
Solids Transport to Land Application	$1,134	$0	$1,134
Solids Transport to Rendering Plant	$324	$972	($648)
Land Application Costs	$4,200	$0	$4,200
SPN Revenue Offset	($321)	($1,446)	$1,125
Total Cost per Day	**$7,801**	**$5,660**	**$2,141**
Cost Per 1,000 Gallons Treated	*$4.64*	*$3.37*	*$1.27*
Percent Savings			*27%*

Future chemical costs include TPX™, anionic and cationic polymers, and an organic coagulant. The data above shows that there is a significant increase in total chemical costs, as TPX™ is substituted for FeCl and quicklime. TPX™ is an engineered mineral manufactured by NClear; whereas FeCl is a commodity chemical. The higher cost of TPX™, however, is more than offset by the savings in land application, the SPN revenue increase, and the total reduction in transport costs due to less total DAF solids. But the significant savings is only part of the benefit. TPX™ is more

environmentally friendly than metal salts, as it maximizes the plant's ability to recycle biproducts and eliminate land application practices (or even landfill disposal). It also provides operating benefits by eliminating the need to operate multiple DAF's in sequence, reducing total solids production, and eliminating manual tasks such as lime mixing.

Conclusion

The substantial cost savings, operational benefits and, most importantly, the advancement of sustainability objectives make this an ideal solution for poultry wastewater processing.

To determine whether NClear can help you meet your operational and sustainability goals, contact NClear at sales@NClear.us or visit www.NClear.us.