A Nitrogen Removal System for Cargill Meat Solutions Turkey Processing Plant

Kelly Ferguson, Gabriela Larus, Brian Shenk

Department of Biological Systems Engineering, Virginia Tech, Blacksburg, Virginia

Background

Cargill Meat Solutions has been a staple in the community of Dayton, VA for over 50 years. Recently, Cargill has become aware of increasing standards for their WWTP and decided that they wanted to update their current system for more nutrient and solid removal. Currently, the team is allowed to take over the space of the equalization tank shown in red.

Problem Statement

Nitrogen, in all of its forms, has become an increasing concern for water quality, especially in the Chesapeake Bay watershed. Cargill Meat Solutions is located in the western part of the watershed in Dayton, VA. Limits are being established for total nitrogen, which means poultry processing facilities are under pressure to develop systems to remove nutrients. The project team will revise the current wastewater system for Cargill Meat Solutions to decrease the concentrations of nutrients from the effluent of the plant while being both cost efficient and practical.

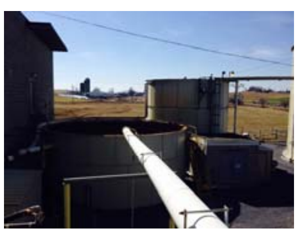
Objectives

Design a system to manage the nitrogen in the wastewater generated from the turkey processing plant by:

- Understanding the current removal process
- Determining a nitrogen limit
- Revising the current wastewater treatment system to remove excess nitrogen

Constraints

1. Simple to operate
2. Cost effective
3. Minimum maintenance
4. Reduce nitrogen in effluent
5. Limited space available



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Wastewater Characteristics

Parameter	Amount
Flow (max)	9464 m^3/day
Flow (regular)	7570 m^3/day
COD	365 mg/L
BOD	170 mg/L
TKN	38.6 mg/L
NH_3	11 mg/L
Nitrite/Nitrate	3.0 mg/L
TSS	15 mg/L
Phosphorus	0.6 mg/L

Biological Aerated Filter

A BAF combines biological and physical removal mechanisms for carbon and nitrogen. This is achieved through the uptake by microorganisms growing on suspended filter media. This process allows for high efficiency removal of nitrogen while maintaining high flow rate and staying within space requirements.

Modeling the Biological Aerated Filter

Media Volume Required: $V_m = (V_w * COD_{in})/TOL$

Total Hydraulic Loading: $THL = V_w/A_{BAF}$

Required O_2 - Heterotrophs: $RO_a = V_w * Y_{O2}(COD_{in} - COD_{out})$

Biomass produced: $W_m = V_w * Y_n*(COD_{in} - COD_{out})$

Heterotrophic bacteria: $C_{60}H_{87}O_{23}N_{12}P$

Autotrophic TKN removal: $TKN_a = 1000*r_n*V_m/V_w$

Required O_2 - Autotrophs: $RO_a = 4.57*TKN_a*V_w$

Standards and Codes

12VAC5-590-880 Filtration

Section A.4. c-i,m: maintenance and structural requirements

Section A.9 a: Sampling tap between filter and the effluent rate of flow controller with auxiliary spigot.

Section A.10 a-g: Provisions for backwashing filters

Section C.3: Number of filters. At least 2 in the event that 1 is down.

EPA-821-R-04-011, 6.2.1: Volume of Wastewater Generated

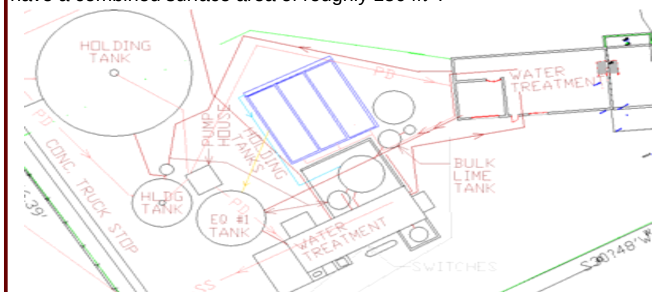
Specifications

The following characteristics were chosen for the design:

- Polystyrene beads (2-5 mm diameter) for the suspended substrate
- Three BAF tanks for optimum efficiency and space utilization
- Carbon steel piping for low cost
- Backwashing intervals set for optimum nitrogen removal

Results

The 2nd equalization tank will be taken out for the proposed design. AutoCAD was used to produce the following results. The three tanks will have a combined surface area of roughly 150 m^2.



The modeling, evaluation and optimization of the biological aerated filters were facilitated using Excel.

Characteristics of Wastewater

Parameter	Max Flow	Standard Flow	Units
Flow	9,464	7,570	m^3/day
Bioreactor Volume = V_m	600	600	m^3
Surface Area	150	150	m^2
Y_{O2}	0.65	0.65	g O_2/g COD removed
Y_n	0.35	0.35	g Biomass COD/g COD removed
Nitrification rate	0.4	0.4	kg ammonia / (day*m^3)
Total Organic Loading	5765	4611	g COD/day/m^3
Estimated Effluent COD	73.87	62.92	mg/L
Total Nitrogen Loading	609	487	g TKN/day/m^3
Total Hydraulic Loading	2.63	2.10	m/h
TKN in	365.31	292.20	kg TKN
TKN out	3.34	0	mg/L
Phosphorus in	5.75	4.60	kg P
Required Phosphorus	11.41	9.64	kg/day
Required O_2	2891	2586	kg/day
Required Air to supply O_2	13898	12431	kg/day

Conclusions and Future Work

The modeling of the BAF shows that nitrogen is capable of being removed. The next step in the design process would be to implement a pilot scale BAF to verify the findings.