Increasing Plant Efficiency by Waste Stream Analysis

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Many meat processors may not understand that analysis of the wastewater stream can give valuable information on methods of increasing plant efficiency. The purpose of this session is to give processors an approach of waste stream analysis so that they can determine those times and operations they use excessive water and/or add excessive organics, ie., product to the waste stream.

Because I am employed by the Department of Poultry Science, most of my experiences are in the poultry industry; however, the approach is sound for all meat processors.

SOME SUCCESS STORIES

Throughout my career, my work with poultry processors, and to a lesser extent, other food processors, has stressed a conservation-minimization approach in processing plants as the most cost-effective method of reducing environmental costs and at the same time improving plant efficiency.

1. A Georgia poultry processor hired a recent graduate from The University of Georgia whose initial job was to reduce the water use of the plant. By reducing water consumption by 1.75 gallons per bird, the plant reduced their water and wastewater costs by $350,000 per year. This represented an approximate 10 to 1 cost-benefit ratio of funds spent on salary, benefits and capital costs to achieve this savings. Where else in your operation will a new graduate return his salary to the company by more than 10 times the first year?

2. A Georgia processor who slaughtered and cooked poultry was experiencing difficulty with excessive fat coating the media in trickling filters. By identifying fat sources, segregating the fat sources and capturing it for rendering, much of the fat was excluded from the waste stream. This improved the performance of the trickling filters and recovered fat which was sold to renderers for an additional $65,000 per year.

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3. A poultry integrator who took the conservation-minimization approach company-wide reported an annual cost savings that approached seven figures.

4. Not all benefits have been realized only by large processors. A small Georgia company that hard-boils and peels eggs was in danger of losing municipal sewer service due to long-term violation of their discharge permit. By taking the conservation-minimization approach, they have slowly come into compliance, reduced their BOD_5 concentration by 90%, their water use by 80% and recover an additional 300 pounds of previously-wasted egg products for sale each day. This approach will increase the profitability by approximately $50,000 per year.

5. A small poultry processor who reduced water use from 12.0 to 5.5 gallons per bird reported an annual cost savings of $225,000 in water and wastewater costs.

How to do it?

MANAGEMENT COMMITMENT

To gain these increases in efficiencies, the first thing that must happen is management commitment. It must be continuous and long-term. Without this commitment, little will be done to increase efficiency.

CONDUCT A WATER USE - WASTE LOADING STUDY

To determine plant efficiencies, data should be gained to determine water-use and waste-loading patterns. With these data, inefficiencies can be determined and corrected.

Water-Use Patterns

1. Read incoming water meters.

Water-use patterns can be determined by reading incoming water meters. Data gained by reading water meters can determine water use by shifts, during sanitation, on weekends or other periods of downtime. There is equipment available that will continuously read water meters and report the water use and variations in water use. Using this method, it was determined that the base flow of a poultry processing plant was 3,000 gallons per hour due to leaks, equipment left on, inoperative float valves in cooling towers, etc. This base flow cost the company approximately $65,000 per year. A maintenance person hired to correct these situations would return his salary 2 to 3 times each year.

2. Monitor discharged wastewater patterns.

Many plants have flow-measuring devices, such as flumes and weirs, installed in the wastewater stream. Few, if any, use these devices to measure discharge volumes. There are electronic flow-measuring devices costing $3,000-$3,500 that will measure these flow volumes and will report them into a data base. Using these devices, continuous measurement of the discharged wastewater volumes can be determined with minimum effort. The devices can also be used to signal automatic wastewater samplers to sample the waste stream so that organic concentrations in the waste stream can be determined.

3. Monitor water-use patterns of individual plant processes.

By placing water meters on water supply lines to individual processes, water-use patterns can be further defined. Operations that do not justify the cost of a water meter can many times be quantified, using devices as simple as a calibrated bucket and stop watch. Using this simple method, the following instances of excessive water use were determined.

1. The annual cost of hand wash stations varied from $375-$1500.
2. The annual water cost of bird washers varied from $5,400-$23,000. If birds can be properly washed with $5,400 of water per year, why spend $23,000 for water?
3. A processor paid $3,000 each year to wash the bottom of a clean stainless steel pan!

Waste Stream Analysis

The second phase of reducing environmental costs is to analyze the organic loading patterns of the waste stream. Excessive organics in the waste stream represent not only excessive wastewater treatment costs but also represent product not sold.

To determine the amount of organics being wasted into the waste stream, two types of data are required.

1. Determination of the volume of wastewater discharged.
2. Collection of wastewater samples based on a measured volume of flow.
3. Analysis of the wastewater to determine concentration of organics.

Using these data, the following equation will calculate the pounds of organics in a volume of wastewater.

$$\frac{\text{gallons of flow}}{1{,}000{,}000} \times 8.34^{*} \times \begin{array}{c}\text{concentration of}\\ \text{organics in mg/L}\end{array} = \text{pounds}$$

*1 gallon of water weighs 8.34 pounds.

An example of the use of this equation would be the following situation.

A broiler processor discharged 1,250,000 gallons of water to process 250,000 birds each day. Analysis of a flow-composited wastewater sample collected during this period showed a Total Volatile Solids (TVS) of 2,000 mg/L. TVS measures the concentration of organic matter in the waste stream. Using the previous equation, the data revealed that this processor was discharging 20,850 pounds of dry weight organics to the waste stream each day. If this processor was slaughtering 5.0-pound birds, this wastewater data shows that 6.7% of the live weight of the birds was winding up in the wastewater. If the wastewater was being discharged into a biological treatment system, then not only was the processor paying several hundred thousand dollars per year to treat this organic load but was also losing 2,700 tons of organics each year for rendering. At $200 per ton, there was an annual product loss for rendering worth $540,000.

Loss of high-value further-processed products to the waste stream can have an even greater economic impact. The following three case studies illustrate this point.

1. A further processor who produced breaded-and-fried and roasted broiler products was experiencing wastewater compliance problems. Analysis of the waste stream revealed that the plant was discharging approximately 100,000 gallons of wastewater per day with an average concentration of organics in the wastewater (meat, oil, flour, etc.) of 3,000 mg/L. The plant was losing 2,500 pounds of dry-weight product per day. If the product was 50% water, then about 5,000 pounds of edible product was being sent to wastewater treatment each day. At $1.00 per pound value, this represented a product loss of $5,000 per day. All processes have wastes; however, using these data, the processor was able to reduce water use, send less product to the waste stream and consequently more to the shipping dock.

2. A slaughter plant that also produced ready-to-eat poultry products was experiencing environmental problems because excessive fat in the wastewater was killing the grass in the wastewater spray fields. Inspection of the wastewater pretreatment system revealed that a 60-foot diameter wastewater clarifier had a foot of cooking oil on its top. This represented a loss of approximately 21,000 gallons of cooking oil per week. The plant had a more severe process control problem than a wastewater problem. The question should have been: Why are we wasting this much cooking oil? rather than: Why are we having environmental problems?

3. An egg processor producing liquid and dried egg products was experiencing problems with its biological wastewater treatment system. Analysis of the waste stream revealed that they were sending approximately 60,000 of the 1,00,000 eggs processed each day to the wastewater treatment system. Loss of saleable product to the waste stream which consequently causes environmental problems is a lose-lose situation.

Better in-plant process control through water conservation-product loss minimization is the best, most cost-effective first step in solving environmental problems.

Is It Worth It?

In conversations with Dr. Roy Carawan, recently retired from North Carolina State University, we estimated that the meat processors of the United States waste about $400 million each year due to lack of attention to excessive water use and product loss to the waste stream. Look at the wastewater side of your plant and figure out how much of this $400 million waste herd you can round up to your bottom line each year.

AN APPROACH FOR PROCESSING WASTEWATER MANAGEMENT

Know the Local Requirements and Conditions of Your Country

An American, German, British or Scandinavian solution may not be the most cost-effective solution in your country. When selecting a wastewater treatment system or process, analyze the conditions in your country. Some of the questions that should be asked are:

A. What will an engineered system cost to treat wastewater? If an engineered system is selected, will treatment chemicals and replacements be available at a reasonable cost? In a trip to Venezuela during the past two years, I visited a broiler processing plant that processed 40,000 birds per day. Due to governmental pressure for environmental improvement, the plant had installed a wastewater treatment system that included clarifiers, chemical flocculation and biological digestion. If this wastewater treatment system were constructed in the United States, it probably would have cost at least $1.5 million. The wastewater treatment plant was very efficient. The processor was required to produce a wastewater with a BOD of 60 mg/L so that it could be discharged into a small river. The wastewater treatment system produced a BOD of 5 mg/L. This was a technology "overkill" and a waste of money. The processing plant was located in an isolated rural area surrounded by tens of thousands of hectares of pasture land. It would have been much more cost-effective to construct simple oxidation ponds and to spray the effluent from these ponds onto the pasture land. This system would have a cost of perhaps $100,000 and the nutrients in the wastewater (nitrogen and phosphorus) could have been utilized to grow a higher quality animal forage.

During this same trip, another plant was considering a wastewater treatment system similar to the first plant. The plant was using water to flow away intestines, heads, feet, feathers, etc., as is common with all poultry processors. Labor costs 65 cents per hour. Would it have been more cost-effective to hire laborers to haul offal from the plant in containers and prevent the wastewater from becoming highly contaminated? If the capital and operating cost of treating wastewater suing an engineered system was $1.50 per 1,000 gallons, using labor at 65 cents per hour to remove offal would be cost-effective if that laborer could prevent the use of 400 gallons of water per hour.

Flowing offal from the plant wastes precious proteins and fat for rendering. Studies of wastewater discharged by American processing plants have shown that 8% to 10% of the live weight of the bird can wind up in the wastewater in the form of blood, small tissue and fat particles. This can be a significant amount of material lost for rendering. Using these data, a plant processing 500,000 4-lb. birds per week would be sending 30 tons of dry-weight protein and fat to wastewater treatment rather than recovering it for poultry meal through rendering. In the US, poultry meal costs approximately $200 per ton. At this rate, $6,000 per week of feed product is lost. The cost of treating this wastewater by an engineered system could be $3,000 per week. At the Venezuela wage rate of $26 per week, product loss and wastewater treatment costs would equal the wages of 350 workers.

B. What is the most cost-effective solution based on my local situation?

The summary of this presentation is to understand the local conditions and to determine the most cost-effective method in dealing with environmental problems. The American poultry industry has wasted more than 100 million dollars due to inefficient wastewater handling. As you are faced with more rigid environmental regulations, determine your local situation and then develop solutions that are the most cost-effective based on those situations.

C. There are two basic guiding principles of efficient wastewater management:

- Pollution problems occur because too much product is being lost to the waste stream.
- If you don't put materials into the waste stream, then you don't have to pay to take them out.