Meat, Food, and Dairy Processing Industry- Waste Streams & Pollution Prevention

Wastewater Pollutants

- Biochemical oxygen demand
- Dissolved + suspended solids
- Nitrogen + phosphorus
- Fats, Oils & Grease
- pH
- Metals: *possibly due to corrosion (CIP chemicals)*
- Chlorine
- Pesticides

Wastewater Sources

- Washing, cleaning (& CIP), sanitizing of all pipe lines, pumps, process equipment, tanks, tank trucks, filling machines and floors
- Startup, shutdown, product changeovers
- Loss in filling operations
- Washing and rinsing of raw materials
- Cooking/cooling
- Utilities (condensate, blowdown)
- Runoff from trucking (un)loading areas

BOD Contributions

Whole milk	104,600 mg/L
Skim milk	67,000 mg/L
Blood	1,000,000 mg/L
Orange juice	7.85 lb./100 lb. product
Almonds	80.9 lb./100 lb. product
Sugar	68.8 lb./100 lb. product
Potatoes	4.2 lb./100 lb. product
Potato chips	1.25 lb./100 lb. product

Reference: Carawan, R. E., NC State University, Water and Wastewater Management in Food Processing, 1979.

BOD Calculations

- BOD is directly related to the amount of food products in wastewater. It can be estimated by using the following factors:

Food	lb. BOD/lb. Food constituent (est.)
Carbohydrate	0.65
Fat	0.89
Protein	1.03

Reference: Emerging Issues.

Meat Processing

Process Area	Wastes Produced
Transportation, Receiving, Holding	Manure, hair, grit, (poultry-feathers)
Slaughter	Blood, fluids
Cleaning	Skin, bone, hides, (poultry-feathers, beaks, claws)
Bleeding	Blood
Trimming	Trim scrap, paunch material
Inspection	Contaminated, rejected materials
Further processing	Meat scraps, bone, fat, hides, feet
Cooling and Storage	Contaminated ice, damaged product, off-spec inventory
Prepared foods	Additives, oils, grease, sauces, damaged products

Meat Processing - Overall Waste Characteristics

	Simple Slaughterhouse	Packinghouse
BOD	1130	1290
TSS	1050	840
O & G	400	720
Total N	130	100
Chlorides	490	1250
Total P	10	30

Water Consumption – Meat (Beef & Pork) Processing

Stockyard washdowns, animal watering	7 to 22%
Slaughter, evisceration, boning	44 to 66%
Casings production	9 to 20%
Rendering	8 to 38%
Domestic Uses	2 to 5%
Chillers	2 %
Boiler losses	1 to 4%

Meat Processing – Some Treatment Alternatives

*Screening: Static, Vibrating, or Rotary
*Grease Interceptors
*Dissolved Air Flotation Units: chemical addition enhances performance
*Anaerobic Lagoons
*Aerated Lagoons
*Activated Sludge
*Anaerobic Fluidized Bed Reactor: ww is pumped up through a sand bed in which microbial growth has developed.

Pollution Prevention in Meat Processing (Case Study)

Current conditions:

Water use	200,000 gpd
BOD_5 load	4500 lb/day
Production	2 shifts/day
Cleanup	1 shift/day
Chicken nugget production	2,500,000 lb/day
Employees	275

Meat Processing Case Study

The Problem:

- Extremely high water use
- Extremely high wastewater loadings:

Product loss to sewer on each shift	385 lb of meat
	21 lb of tempura
	105 lb of batter

- POTW permit violations

P2 Process – Case Study

1. Provided education on water use and waste load
2. Surveyed the plant for problem areas
3. Evaluated plant processes
4. Promoted the use of dry cleanup
5. Provided for waste recovery and utilization
6. Enhanced waste pretreatment

Specific P2 Actions – Case Study

- Repair or replace equipment causing high product loss
- Redesign trays under breaders to catch spillage
- Routine maintenance of equipment, leaks, containment trays, etc.
- Hire employees specifically for supervising floor and equipment waste pickup
- Train all employees on proper cleanup procedures

Specific P2 Actions – Case Study

- Emphasize minimum water usage to employees and management
- Conduct frequent employee retraining sessions
- Encourage employees to express new P2 ideas
- Install DAF to recover grease/solids → renderer

P2 Results – Case Study

Water cost/product/ingredient savings	$100,000/yr
Surcharge costs avoided	$200,000/yr
Pretreatment system expansion avoided (capital)	$1,500,000
Pretreatment system expansion avoided (O&M)	$100,000

P2 Results – Case Study

	Before	After
Water use (gal/month)	4,250,000	3,000,000
BOD_5 load (lb/day)	4,500	1,000
Landfill disposal (tons/wk)	30	0
Animal food collection (tons/wk)	0	50
Dry cleanup pollution prevented (lb BOD_5/day)	0	2,200

Typical Rates for Water Use for Food Processing

	Range of Flow (gal/ton product)
Fruits and Vegetables	
Green beans	12,000 – 17,000
Peaches and pears	3,600 – 4,800
Other fruits and vegetables	960 – 8,400
Food and Beverage	
Beer	2,400 – 3,840
Bread	480 – 960
Meat packing	3,600 – 4,800
Milk products	2,400 – 4,800
Whiskey	14,400 – 19,200

Reference: Metcalf and Eddy's *Wastewater Engineering: Treatment, Disposal, and Reuse* 3rd ed., 1991.

Fruit and Vegetable Sector

- Primary steps:
  - General cleaning and dirt removal
  - Removal of leaves, skin, seeds
  - Blanching
  - Washing and cooling
  - Packaging
  - Cleanup

Fruit/Vegetable Waste Streams

- Six major wastewater sources: high in SS, organic sugars and starches – may contain traces of pesticides
  - Raw produce washing, grading, trimming
  - Washing after steam/lye peeling and size reduction
  - Blanching and fluming
  - Filling
  - Sanitation/Plant cleanup
  - Processed product cooling

Fruit/Vegetable Waste Reduction

- Most waste reduction/P2 in area of water conservation
  - Use of air floatation
  - Recovery and reuse of process water
  - Decrease of water volume use in peeling and pitting
  - Separation of waste streams
  - Countercurrent reuse of water
  - Separation of low and high strength waste

Caustic vs. Dry Caustic Peeling Operations (Fruits and Vegetables)

	Conv. Caustic Peeling	Dry Caustic Peeling
Water usage	850 gal/ton	90 gal/ton
COD	10.8 lb/ton	4.2 lb/ton
BOD	6.7 lb/ton	2.8 lb/ton
TSS	5.6 lb/ton	1.9 lb/ton
Total Solids	17.8 lb/ton	4.0 lb/ton
pH range	6 - 9	4 - 6

Fruit/Vegetable Waste Reduction

- Water conservation (cont.)
  - Low-volume, high pressure cleaning
  - Water to steam blanching
  - Air cooling
  - Mechanical conveyors for flumes
  - Separation of can cooling water or the reuse of cooling water to make up caustic soda peeling baths or rinsing, canning belt lubrication and plant cleanup

Dairy Processing-Areas to Consider

- Raw Product off-loading
  - Tankers washed onsite?
  - Do they need to have a slug control plan?
- Filling Room: spills, overflows
- Crate washing
- Equipment Cleaning
- General Washdown
- Cooling systems (ammonia?)

Dairy Processing

- Avg. BOD5: 2,700 mg/L
- Avg. COD: 4,700 mg/L
- BOD/COD ratio: 0.57

- Raw product BOD5 (no treatment)
  - Milk 104,600 mg/L
  - Ice Cream 292,000 mg/L

Dairy Processing- Sources of Product loss to sewer system

- Pipe, hose and equipment leaks
- Spills from storage tanks, off-loading area, damaged containers
- Overfilling containers, vats
- Cleaning (CIP) of pipes, hoses, equipment

Waste Reduction Opportunities – Meat, Food, Dairy

- Conserve energy
- Prevent wastewater discharge
- Reduce water usage
- Byproduct utilization

Reduce Wastewater Contamination

- Process Modifications
  - Keep product off floor
  - Prevent spills, leaks and overruns from pipes, valves, pumps and tanks
  - Use drip pans and splash guards
  - Install screens in effluent lines to catch solids (and remove frequently)
  - Implement system for catching solids from rinses

Reduce Wastewater Contamination

- Process Modifications (cont.)
  - Dry sweep and pick up rather than hose to sewer
  - Wipe up spills immediately
  - Cover floor grates to facilitate dry sweeping
  - Segregate concentrated waste streams
  - Modify pipes to minimize residual product
  - Remove residual product mechanically

Reduce Wastewater Contamination

- Operator practices
  - Use non-phosphate, biodegradable cleaner and sanitizers
  - Use correct concentration of cleaner

Reducing Water Use

- Measure water usage
- Calculate BOD/COD charges
- Install traps and sumps
- Low-flow spray nozzles
- Hose shut-offs
- Confirm wastewater flow measurement device (primary and secondary devices) are accurate

Water Conservation

- Monitor water use
  - Include all shifts, cleaning crew, contractors
- Controls
  - Shut off water when not in use; should have easy access or automatic shut off valves
  - Use low volume, high pressure hoses/wands
  - Use low flow nozzles or flow restrictors

Water Conservation

- Install solenoid valves on equipment that operates intermittently such as washers, condensers
- Eliminate excess overflow from washing and soaking tanks
- Install controls on filling stations
- Utilize statistical process control (SPC)

Water Conservation

- Operator practices
  - Training
  - More efficient cleaning: scraping, pre-cleaning, burst rinse (capture and segregate)
  - Dry mechanical peeling
  - Repair leaky valves or lines as soon as detected
  - Reduce product spills (reduces clean-up)
  - Scheduling