

INTECUS GmbH

Waste Management and Environment-Integrating Management



Cleaner Production in Food Industry – Main Water and Energy Consuming Processes and Pollution Sources in Food Industry

Durango, March 09th, 2011

Agenda

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3. Conclusions

1. General

- it is quite difficult to give quantitative data on the environmental aspects of individual processing techniques
- due to a lack of reliable data or due to natural variations, e.g. seasonal, in many of the raw materials
- ranges in the quantitative data are very largely due to the very wide variation in individual process applications
- better quantitative information is available on the environmental aspects of the whole production line rather than on individual processing techniques, because measurements have not been made at unit operation level
- nevertheless it is important to know about the material streams and environmental data of single units for planning reasons
- pollution pathways are generally waste water, air emissions and solid waste

1. General

Pollution sources

Unit operation	Environmental impact		
	Air	Water	Solid Waste
Materials reception and preparation	-odor -dust -organics	-soluble organic material (BOD/COD) -total suspended solids -acid/alkali -FOG -nitrate, nitrite, ammonia, phosphate	-organic, e.g. waste product/processing materials -oils/fats/greases -inorganic, e.g. soil, calcium carbonate and bleaching earth -solvent -metals, e.g. nickel catalyst -packaging from process operations, e.g. paper, cardboard or drums
Size reduction, mixing, forming	-odor -dust -organics	-soluble organic material (BOD/COD) -total suspended solids -FOG -nitrate, nitrite, ammonia, phosphate	-organic, e.g. waste product/processing materials
Separation techniques	-odor -organics, -CO ₂	-soluble organic material (BOD/COD) -total suspended solids -acid/alkali -FOG -nitrate, nitrite, ammonia, phosphate	-organic, e.g. waste product/processing materials -oils/fats/greases -inorganic, e.g. soil, calcium carbonate and bleaching earth -solvent -metals, e.g. nickel catalyst
Product processing technology	-odor -dust -organics -CO ₂ -NO ₂ -SO ₂ -NH ₃	-soluble organic material (BOD/COD) -total suspended solids -FOG -dissolved solids	-organic, e.g. waste product/processing materials -oils/fats/greases -inorganic, e.g. soil, calcium carbonate and bleaching earth -metals, e.g. nickel catalyst -packaging from process operations, e.g. paper, cardboard or drums

1. General

Pollution sources

Unit operation	Environmental impact		
	Air	Water	Solid Waste
Heat processing	-odor -dust -organics -CO ₂ -NO ₂	-soluble organic material (BOD/COD) -total suspended solids -acid/alkali -FOG -nitrate, nitrite, ammonia, phosphate -dissolved solids	-organic, e.g. waste product/processing materials -oils/fats/greases
Concentration by heat	-odor -dust	-soluble organic material (BOD/COD), total suspended solids, Nitrate, nitrite, ammonia, phosphate	-organic, e.g. waste product/processing materials
Processing by removal of heat	-CO ₂ -NH ₃	-soluble organic material (BOD/COD), total suspended solids	-organic, e.g. waste product/processing materials -inorganic, e.g. soil, calcium carbonate and bleaching earth
Post processing operations	-dust -CO ₂	-soluble organic material (BOD/COD), total suspended solids	-organic, e.g. waste product/processing materials -packaging from process operations, e.g. paper, cardboard or drums
Utility processes	-odor -dust -CO ₂ -NO ₂ -SO ₂ -NH ₃	-soluble organic material (BOD/COD) -total suspended solids -acid/alkali -FOG -nitrate, nitrite, ammonia, phosphate	-organic, e.g. waste product/processing materials -inorganic, e.g. soil, calcium carbonate and bleaching earth

2. Data on unit operations

2.1 Materials reception and preparation

- Processes:

- materials handling and storage
- sorting/screening, grading, dehulling, destemming/destalking and trimming
- peeling
- washing and thawing

2. Data on unit operations

2.1 Materials reception and preparation

- Water:
 - during transport by water of solid raw materials (vegetables, roots and tubers) both organic and inorganic SS and soluble compounds are released to water
 - wet screening may result in a waste water stream containing soluble organic matter and SS
 - by peeling operations, a water spray is used to remove the peeled skin. generated waste water contains SS

2. Data on unit operations

2.1 Materials reception and preparation

- Water:
 - waste water from washing operations typically contains dissolved organic matter, SS and salts
 - cleaning also contributes to water usage and waste water load, waste water contains soluble organic material, such as small particles of meat, fruit and vegetables and also soluble proteins, FOG and other solids, such as curing salts
 - waste water may also contain acid/alkali solutions, FOG, nitrate, nitrite, ammonia and phosphate

2. Data on unit operations

2.1 Materials reception and preparation

- Energy:

- materials handling is almost exclusively electrically driven, no significant heat is involved
- environmental issues are minor and relate to electrical consumption
- are large variations in electrical energy consumption in sorting operation, e.g. in vegetable processing electrical energy consumption is 0–20 kWh_e/t frozen vegetable
- flash steam peeling, caustic peeling and flame peeling require heat, other peeling operations use electrical energy
- electricity consumption for washing operations heavily depends on the raw material concerned, hot water can be used to increase the speed and efficiency of the washing

2. Data on unit operations

2.1 Materials reception and preparation

- Pollution sources:
 - waste water is generated during the cleaning of equipment as well as peeling operations and contains primarily soluble organic material and SS and may also contain nitrate, nitrite, ammonia and phosphate
 - air emissions (dust, odor) are usually minor in quantity and local in effect
 - solid residues can be re-used in the installation or elsewhere, sold as animal feed or may be disposed of as waste
 - noise may occur from certain types of vehicle-mounted blowers used to discharge solids and liquids from road vehicles into silos and other vessels

2. Data on unit operations

2.2 Size reduction, mixing and forming

- Processes:

- cutting, slicing, chopping, mincing, pulping and pressing
- mixing/blending, homogenization and conching
- grinding/milling and crushing
- forming/moulding and extruding

2. Data on unit operations

2.2 Size reduction, mixing and forming

- Water:

- use of water in this group of operations is normally restricted to cleaning the equipment
- amount used depends on the type of equipment
- special operations, like wet grinding, need large quantities of water

- Energy:

- electrical energy is used for various equipment, often in amounts of greater significance (e.g. grinding, extrusion)

2. Data on unit operations

2.2 Size reduction, mixing and forming

- Pollution sources:
 - waste water usually contains soluble organic material, such as small particles of meat, fruit and vegetables, SS and also nitrate, nitrite, ammonia and phosphate
 - waste water from meat processing may also contain soluble organic material (e.g. proteins), FOG and other solids, such as curing salts
 - solid residues are mainly by-products usable for other manufacturing processes, which might even be outside the FDM sector, such as bones for soap manufacture
 - high noise levels can be generated by high-speed, power-operated equipment, but normally inside of facility buildings
 - air emissions can occur as odor and dust

2. Data on unit operations

2.3 Separation techniques

- Processes:
 - extraction
 - deionization
 - fining
 - centrifugation and sedimentation
 - filtration
 - membrane separation
 - crystallization
 - removal of free fatty acids by neutralization
 - bleaching
 - deodorization by steam stripping
 - decolourization
 - distillation

2. Data on unit operations

2.3 Separation techniques

- Water:

- water usage is an issue when water is used e.g. as a solvent and cooling water
- in extraction processes the amounts of water consumption and of pollution depend on the cooling water system, e.g. once-through or with recycling, and on the kind of material to be extracted
- on the other hand water consumption for the pressing of oil is minimal
- also equipment cleaning is of greater importance

2. Data on unit operations

2.3 Separation techniques

- Energy:
 - mainly electrical energy is used for pumping and, of greater amount, for centrifugation
 - extraction, bleaching and neutralization processes additionally need thermal energy (steam)

2. Data on unit operations

2.3 Separation techniques

- Pollution sources:
 - waste water contains soluble and insoluble organic material and SS
 - solid residues from extraction, centrifugation and sedimentation can normally be reused as products or by-products
 - solid residues from filtration need suitable methods for disposal and can normally not be reused in the process
 - solid output from bleaching is known as spent earth with high oil content, because there is a risk of self-ignition; can be reused as a by-product of for energy generation because of its high calorific value
 - high noise levels can be generated by centrifuges
 - air emissions are important as odor, VOC-emissions only play a role in extraction processes

2. Data on unit operations

2.4 Product processing technology

- Processes:

- soaking
- dissolving
- solubilization/alkalizing
- fermentation
- coagulation
- germination
- brining/curing and pickling
- smoking
- hardening
- sulphitation
- carbonatation
- carbonation
- coating/spraying/enrobing/agglomeration/encapsulation
- ageing

2. Data on unit operations

2.4 Product processing technology

- water:
 - water is mainly used for soaking, cooling, washing
 - cleaning processes play always an important role
- energy:
 - steam and electricity are used for different processes in larger amounts

2. Data on unit operations

2.4 Product processing technology

- Pollution sources:
 - waste water contains dissolved organic material, dissolved solids, FOG and SS; waste water from brining contains larger amounts of salt
 - solid residues contains organic and inorganic material and also packaging and can mainly be reused; ashes from smoking must be landfilled
 - high noise levels may arise from cooling towers, compressors or vacuum systems
 - air emissions can occur as dust and VOC containing vapor steam, odor can be a problem; fermentation produces alcohol and CO₂; strong odors are produced during the smoking and drying operations; carbonation has a risk of accidental releases of CO₂;

2. Data on unit operations

2.5 Heat processing

- Processes:

- melting
- blanching
- cooking and boiling
- baking
- roasting
- frying
- tempering
- pasteurization, sterilization and UHT

2. Data on unit operations

2.5 Heat processing

- Water:
 - water is used for cleaning purposes and for cooling after heat treatment
 - water usage plays a minor role in these processes
- Energy:
 - energy plays a significant role in heating processes
 - electric energy is used for most of the processes in a larger amount
 - steam is used for: melting, cooking/boiling, frying as well as pasteurization, sterilization and UHT
 - ovens for baking and frying can use natural gas or oil

2. Data on unit operations

2.5 Heat processing

- Pollution sources:
 - waste water generally has a high BOD level and may contain SS and FOG
 - solid residues are produced containing organic material; some residues may result from dry cleaning; nevertheless solid residues play not a significant role in these processes
 - noise levels are low
 - as important air emissions steam/water vapor may be discharged to the air; depending on the raw material, the exhaust air may contain VOC which may generate odor; also roasting processes can produce larger amounts of VOC

2. Data on unit operations

2.6 Concentration by heat

- Processes:
 - evaporation (liquid to liquid)
 - drying (liquid to solid)
 - dehydration (solid to solid)

2. Data on unit operations

2.6 Concentration by heat

- Water:

- water is only used for cleaning purposes

- Energy:

- energy consumption is important in these processes

- for evaporation of water, theoretically 0.611 kWh/kg (2.2 MJ/kg) energy is required

- however, in practice, this very much depends on the type of equipment used and can range from 0.5 – 1.1 kWh/kg (2.0 – 4.0 MJ/kg)

- in particular steam requirements are significant

2. Data on unit operations

2.6 Concentration by heat

- Pollution sources:
 - waste water from condensates can contain organic, inorganic and SS
 - solid residues play a minor role
 - noise plays a role by evaporation processes (in particular from compressors)
 - hot drying processes produce air emissions like exhaust gases and vapors, containing VOC; dust and odor can be a problem

2. Data on unit operations

2.7 Processing by removal of heat

- Processes:
 - cooling, chilling and cold stabilization
 - freezing
 - freeze-drying/lyophilization

2. Data on unit operations

2.7 Processing by removal of heat

- Water:

- water is used as cooling medium and for cleaning purposes

- Energy:

- energy consumption is the major environmental issue, mainly electrical energy is used
- consumption depends on:
 - the type of food to be frozen
 - the temperature of the food at the entrance to the freezing tunnel
 - the mass flow-rate of the food
 - the residence time
 - the energy consumption which is determined by the airflow rates in the freezing tunnel
 - the efficiency of freezing tunnels

2. Data on unit operations

2.7 Processing by removal of heat

- Pollution sources:
 - waste water from condensates can contain organic, inorganic and SS
 - solid residues play a minor role
 - noise may occur from fans and cooling towers
 - in cryogenic cooling air emissions of gaseous N₂ or CO₂ occur. Leaking refrigeration equipment can lead to emissions of refrigerant

2. Data on unit operations

2.8 Post processing operations

- Processes:
 - packing and filling
 - gas flushing and storage under gas

2. Data on unit operations

2.8 Post processing operations

- Water:
 - water is used for cleaning purposes (equipment, glass containers, kegs, refillable bottles)

- Energy:
 - energy consumption is of minor relevance

2. Data on unit operations

2.8 Post processing operations

- Pollution sources:
 - waste water typically contains dissolved organic material and SS
 - solid residues includes cast-offs due to, e.g. packaging machine faults/inefficiencies during filling, capping process waste, off-cuts from PET-bottle blowing, aluminum or steel can manufacturing as well as forming of laminated cartons or pouches
 - noise may occur from bottle filling lines
 - air emissions of dust may be a problem, also accidental gas emissions from gas flushing

2. Data on unit operations

2.9 Utility processes

- Processes:
 - cleaning and disinfection
 - energy generation and consumption
 - water use
 - vacuum generation
 - refrigeration
 - compressed air generation

2. Data on unit operations

2.9 Utility processes

- Water:

- large quantities of water are required for cleaning and disinfection with amounts depending on the type and size of equipment to be cleaned and the materials processed
- water is also used in vacuum generation for cooling and sealing and for cooling in refrigeration processes
- minimization of water consumption by process optimization and water recycling can be applied.

- Energy:

- refrigeration equipment needs a high electricity input

2. Data on unit operations

2.9 Utility processes

- Pollution sources:
 - waste water from cleaning operations typically contains soluble organic material, FOG, SS, nitrate, nitrite, ammonia and phosphate from product remnants and removed deposited soil, also residues of cleaning agents, e.g. acid or alkali solutions
 - solid residues, like ashes from solid fuel must be sent to landfill; also mineral sludge and spent resins from water treatment processes need to be disposed of
 - noise may occur due to the operation of the fans associated with the cooling towers and of compressors
 - air emissions from energy generation is mostly CO₂ and vapor; contaminants generated and emitted depend on the fuel type, combustion process and combustion plant design and can be SO₂, CO, NO_x and dust

3. Conclusion

- Water:
 - mostly used for cleaning and cooling
- Energy:
 - some processes, in particular heating processes are of high relevance for energy consumption
- Pollution sources:
 - waste water is contaminated with an great variety of pollutants, mostly organics
 - solid residues are mostly organic wastes, which can be reused
 - noise plays a minor role, only for some special operations
 - air emissions occur mostly from heating processes, VOC and odor are of relevance

Muchas gracias por su atención!

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