

**ENVIRONMENTAL
PROTECTION**

Finnish Expert Report on
Best Available Techniques in
Slaughterhouses and Installations for
the Disposal or Recycling of Animal
Carcasses and Animal Waste



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Foreword

The primary objective of this report is to provide information about the Finnish slaughterhouses and the installations for the disposal or recycling of animal carcasses and animal waste, including the rendering plants and the fur animal feed production plants, in Finland for the preparation of the Best Available Techniques Reference Document (BREF).

First processes and techniques applied in the sector in Finland are reviewed and the consumption of energy and water by the installations as well as their emissions to air, water, and soil and the management of solid waste and by-products are described and quantified. Then techniques to consider in the determination of Best Available Techniques (BAT) in accordance with the EU Council Directive 96/61/EC concerning Integrated Pollution Prevention and Control (IPPC) are reviewed. Finally an overview of the future potential and current experience of emerging techniques is presented.

This report is a contribution from the Finnish Environment Institute and Finnish Food and Drink Industries' Federation, which we thank for the financial support.

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General information



1.1 Background

The aim of the EU Directive on Integrated Pollution Prevention and Control (IPPC) (96/61/EC) is to find the best environmental options in order to minimise the environmental impacts caused by industrial plants. The IPPC Directive has been implemented in Finland as part of the new national Act on Pollution prevention (86/2000), which entered into force on March 1, 2000. The emission limits, parameter values, and technical measures set in integrated environmental permits must be based on Best Available Techniques (BAT), considering at the same time the technical characteristics, geographical location, and local environmental circumstances of the installation. The Article 2(11) of the Directive defines BAT as the most effective and advanced stage in the development of activities and their methods of operation which indicate the practical suitability of particular techniques for providing in principle the basis for emission limit values designed to prevent and, where that is not practicable, generally to reduce emissions and the impact on the environment as a whole. Article 2(11) of the Directive clarifies further this definition as follows:

- “Techniques” shall include both the technology used and the way in which the installation is designed, built, maintained, operated, and decommissioned,
- “Available” techniques shall mean those developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced inside the EU Member State in question, as long as they are reasonably accessible to the operator,
- “Best” shall mean most effective in achieving a high general level of protection of the environment as a whole.

Competent authorities responsible for issuing permits are required to take account of the general principles set out in Article 3 of the Directive when determining the conditions of the permit. These conditions must include emission limit values, supplemented or replaced where appropriate by equivalent parameters or technical measures. According to Article 9(4) of the Directive, these emission limit values, equivalent parameters and technical measures must, without prejudice to compliance with environmental quality standards, be based on the BAT, without prescribing the use of any technique or specific technology, but taking into account the technical characteristics of the installation concerned, its geographical location and the local environmental conditions. In all circumstances, the conditions of the permit must include provisions on the minimisation of long-distance or transboundary pollution and must ensure a high level of protection for the environment as a whole.

Article 16(2) of the Directive requires the Commission to organise an exchange of information between Member States and the industries concerned on



best available techniques, associated monitoring and developments in them, and to publish the results of the exchange.

The Commission (Environment DG) established an information exchange forum (IEF) to assist the work under the Article 16(2) and a number of technical working groups have been established under the umbrella of the IEF. Both IEF and the technical working groups include representation from Member States and industry as required in the Article 16(2).

The aim of this series of documents is to reflect accurately the exchange of information which has taken place as required by the Article 16(2) and to provide reference information for the permitting authority to take into account when determining permit conditions.

In Finland, the Finnish Ministry of the Environment is responsible for ensuring that the environmental perspective is given proper consideration in international co-operation and society, and at all levels of government. The Ministry formulates environmental policies, carries out strategic planning and makes decisions in its own sphere of interest. It is also responsible for preparing legislation and drawing up its own budget, and for result management and setting binding standards.

The Regional Environment Centres are participatory and guiding authorities whose tasks are environmental permits-related supervision and general surveillance and generally the assurance of the prerequisites of sustainable development in the region.

The Finnish Environment Institute (SYKE) is the national environmental research and development centre of the environmental administration. Research and development in the SYKE deals with changes in the environment, cause and effect relationships, means of resolving environmental problems and effects of policy measures.

1.2 Objectives

The aim of this report is to provide information about the Finnish slaughterhouses and the installations for the disposal or recycling of animal carcasses and animal waste for the preparation of the BREF for this industrial sector.

The activities included in this report are:

- Slaughterhouses with a carcass production capacity greater than 50 tonnes per day.
- The plants for the disposal or recycling of animal carcasses and animal waste, including the rendering plants and fur animal feed production plants, with a treatment capacity greater than 10 tonnes per day.

1.3 Limitations

The information presented in this document has been collected by questionnaires and interviews to the sector as well as by a literature review on the technological processes, techniques, and equipment in use as well as on their environmental impacts. A total of six slaughterhouses, two rendering plants, and an animal feed production plant were visited.

The range of the collected data is presented, covering only those installations where data was available. Because limited data was available about the energy and water consumption and emissions of the individual processes of the installations the data presented refers to the energy and water consumption and the emissions of the installations as a whole (in some cases including also meat cutting, debon-

ing, and further processing of the carcasses into specific meat cuts, portions and further processed meat products, such as sausages). Where data was available the distribution of the energy and water consumption in the installations are also presented.

1.4 Sector overview

1.4.1 Slaughterhouses

There are ten slaughterhouses in Finland with a carcass production capacity greater than 50 tonnes per day, slaughtering about 83 percent of all the animals that are being slaughtered in Finland (Tables 1 and 2). In addition, there are a number of smaller slaughterhouses not considered in this report. The slaughterhouses vary a lot in the number and the type of animals being slaughtered as well as in the processes. Mainly pigs, cattle, chicken, and turkeys are being slaughtered in Finland, whereas smaller numbers of other animals, such as sheep, goats, and horses, are also being slaughtered on the same slaughter lines (Table 2). A few stand alone slaughterhouses only slaughter, dress, and chill carcasses, whereas most Finnish slaughterhouses with integrated meat cutting, deboning, and further processing further process the carcasses into specific meat cuts, portions and further processed meat products, such as sausages.

Table 1. The number of Finnish slaughterhouses with a carcass production capacity greater than 50 tonnes per day.

	Number of slaughterhouses
Pigs	2
Cattle	1
Poultry	1
Mixed species (pigs and cattle)	5
Mixed species (pigs and poultry)	1

Table 2. The total carcass weight and the number of animals being slaughtered in Finland in 1999, an average slaughtered animal carcass weight, and the contribution of the slaughterhouses with a carcass production capacity greater than 50 tonnes per day as percentages of the total amount.

	Total carcass weight (million kg)	Number of animals being slaughtered	Average animal carcass weight (kg)	The contribution of the slaughterhouses with a carcass production capacity > 50 tonnes/day of the total (%)
Pigs and sows	179	2 100 000	85	90.1
Cattle	88.6	340 000	260	75.5
Sheep and goats	0.537	33 000	16	73.6
Poultry	66.1 ¹	47 000 000	1.4 ²	75.2

¹ 60.8, 1.3, and 3.9 million kg of broilers, chicken and turkeys, respectively,
² Broiler carcass weight.

1.4.2 Installations for the disposal or recycling of animal carcasses and animal waste

The Finnish legislation on the disposal or recycling of animal carcasses and animal waste is in accordance with the current EU legislation. The legal basis in Finland for the disposal or recycling of animal carcasses and animal waste is the Act on Animal Diseases of 18 January 1980 (55/1980), as last amended by 100/99. Furthermore, the legislation specifies the animal and public health requirements for the disposal and processing of animal waste to destroy potential pathogens present in the waste. According to the Decisions of Ministry of Agriculture (1022/VFD/2000), animal waste may be defined as carcasses or parts of animals, including products of animal origin not intended for direct human consumption. Furthermore, animal waste can be classified as:

- “low-risk material” if it does not present a serious risk or
- “high-risk material” if it is suspected of presenting serious health risks to humans or animals, including animals which died on the farm, stillborn and unborn animals, and spoiled and condemned materials.

Furthermore, the Decision of Ministry of Agriculture (1197/VFD/2000) specifies the requirements for the disposal and processing of

- “Specified risk material (SRM)” including certain materials from cattle, sheep and goats, such as spinal chord or brain tissue, which have been found to carry a risk of transmitting the BSE (Bovine Spongiform Encephalopathy).

In Finland, about 200 million kg of animal derived by-products are generated annually (See Fig. 1) (Björklund *et al.* 2000). Of this amount, low-risk material contributes about 170 million kg, including slaughterhouse waste and waste from fur animal production, and high-risk material and SRM both contribute about 15 million kg, including slaughterhouse waste and dead farm animals.

There are two approved rendering plants in Finland for the treatment and the disposal and/or further recovery of the high-risk material and SRM. Furthermore, there are a number of plants, a total of 14 with a treatment capacity greater than 10 tonnes per day, for the recycling of the low-risk material for the further

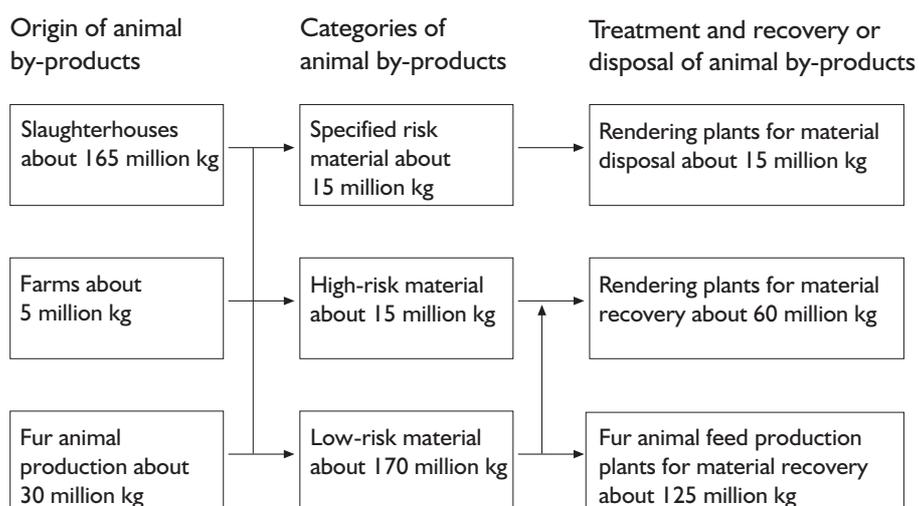


Figure 1. The amount and the disposal and the recovery of animal carcasses and animal waste in Finland.

recovery as fur animal feed. Finland is among the biggest fur animal producers in the world using an annual 370 million kg of fur animal feed, more than half of which are by-products from the meat and fish industry (Pulsa, 1996).

1.5 Public health

In Finland, the Veterinary and Food Department at the Ministry of Agriculture and Forestry promotes the health and welfare of animals, creating the prerequisites for the economic animal production and ensuring the safety and purity of foodstuff of animal origin (The Ministry of Agriculture and Forestry of Finland, 2001). In general, the situation with regard to animal diseases is very good in Finland and many animal diseases commonly occurring within the EU have occurred rarely or not at all in Finland (The Ministry of Agriculture and Forestry of Finland, 2001).

The National Veterinary and Food Research Institute (EELA) is a body subordinate to the Ministry of Agriculture and Forestry, which examines and defines animal diseases, manages and controls the monitoring of foodstuff of animal origin and is responsible for meat inspection at slaughterhouses.



2

Applied processes and techniques

In this chapter, the typical processes and techniques applied in Finnish slaughterhouses and installations for the disposal or recycling of animal carcasses and animal waste are briefly described. In general, the processes and techniques used are similar to those that are found in the other Nordic countries, reviewed previously in the Nordic BAT report (Toresen *et al.*, 2001).

2.1 Pig slaughtering

The Finnish pig slaughterhouses typically slaughter thousands of pigs per day. On arrival at the slaughterhouse, the pigs are held in lairage for a few hours. The animal delivery vehicles are washed in the slaughterhouse, which generates wastewater. In lairage excrement and urine are being generated, which are then taken to composting (Fig. 2). The pigs are then driven to stunning, which usually takes place with carbon dioxide or in a minority of slaughterhouses with electricity. Subsequently, the stunned pigs are hung by the back legs on an overhead rail, which carries the carcasses through the following slaughtering and processing operations. The bleeding then takes place. As much blood as possible, about 4 kg/pig is recovered usually for fur animal feed production, but also for human food. Following the bleeding, the pigs are scalded to loosen the hair. The scalding usually takes place either in a scald tank filled with hot water or by steam (vertical scalding) (Fig. 2). The following de-hairing may be performed by rubbing the scalded carcass with rotating rubber fingers and using pressurised water jets (Fig. 2). About 1.0 kg/pig of hair produced ends up in rendering. The singeing, usually with propane gas burners, then takes place to remove residual hair. Tails and ears are also removed for further recovery usually for pet food production (about 0.5 kg/pig). The following evisceration takes place involving the removal of the respiratory, pulmonary, and digestive organs (stomach, intestines, and pluck set i.e. heart, liver, and lungs). Materials, such as heart, liver, and kidneys as well as washed intestines may be sold for human consumption. Materials such as trimmings, lungs, and washed stomachs are usually taken to fur animal feed production, whereas the contents of the stomach and intestines are removed and taken to composting. The carcasses are then split and subsequently chilled to below 7 °C to control microbiological growth. After slaughtering, the pig weighs an average of 85 kg. Further processing produces trimmings and bones in varying amounts, depending on practices and processes and the degree of processing. These materials are taken to rendering, fur animal feed production or pet food production. Materials taken to fur animal feed production or pet food production amount to about 14 to 16 kg/pig. Materials for fur animal feed production are usually in slaughterhouses before further supply homogenised and preserved by lowering the pH to below 4. Materials, which end up to rendering amount to about 10 to 11 kg/pig. Wastewater treatment may yield wastes such as screenings, fat from grease traps, settlings, and excess activated sludge as well as flotation tailings, which are taken to composting together with the contents of the stomach and intestines and manure from lairage, altogether about 8 to 10 kg/pig.

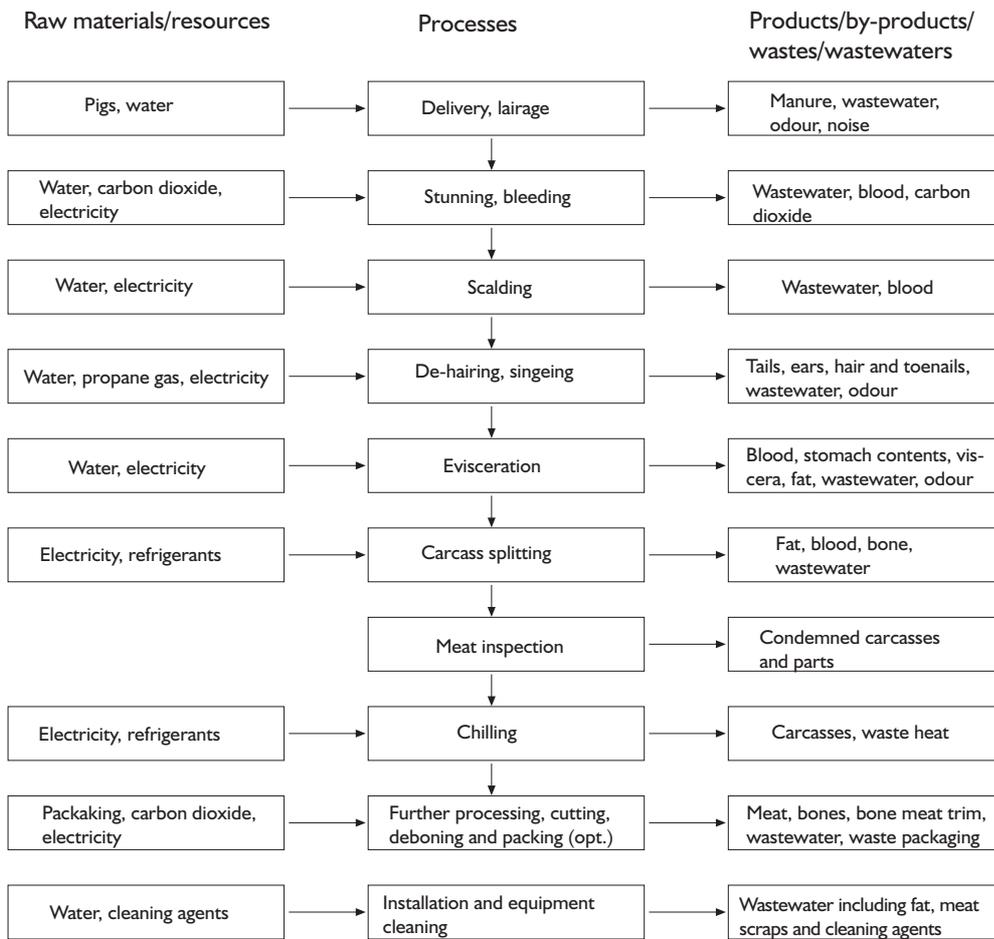


Figure 2. A typical flow scheme of pig slaughtering.

2.2. Cattle slaughtering

The Finnish cattle slaughterhouses typically slaughter hundreds of cattle per day. The cattle are held in lairage for a few hours after the delivery. Excrement and urine produced in lairage is then taken to composting (Fig. 3). From lairage cattle are driven to stunning, which usually takes place with a captive bolt pistol. Subsequently, the cattle are hung by the back legs on an overhead rail which carries the carcasses through the following slaughtering and processing operations and into the chilling. The bleeding then takes place. Blood, about 10 to 20 kg/head is recovered mostly for fur animal feed, but also for human food. After the bleeding, hide removal takes place. The hides (about 30 kg/head) are washed and salted to improve preservation and further supplied to tanneries for the production of leather goods. In the slaughtering, forelegs, tail, udder or testicles, and head are then removed and in the following evisceration stomach, intestines, and pluck are removed. Materials such as heart, liver, and kidneys may be recovered in human food, whereas materials such as udder, lungs, and washed stomach usually end up either for pet food production or for fur animal feed production. The stomach contents (about 60 to 80 kg/head) removed are taken to composting. Materials such as horns and hooves are taken to rendering, about 20 to 30 kg/head. The SRM, including skulls, tonsils, spinal cord, spleen, and intestines from cattle slaughtered at an age of greater than six months, which amount to about 40 to 50 kg/head. After

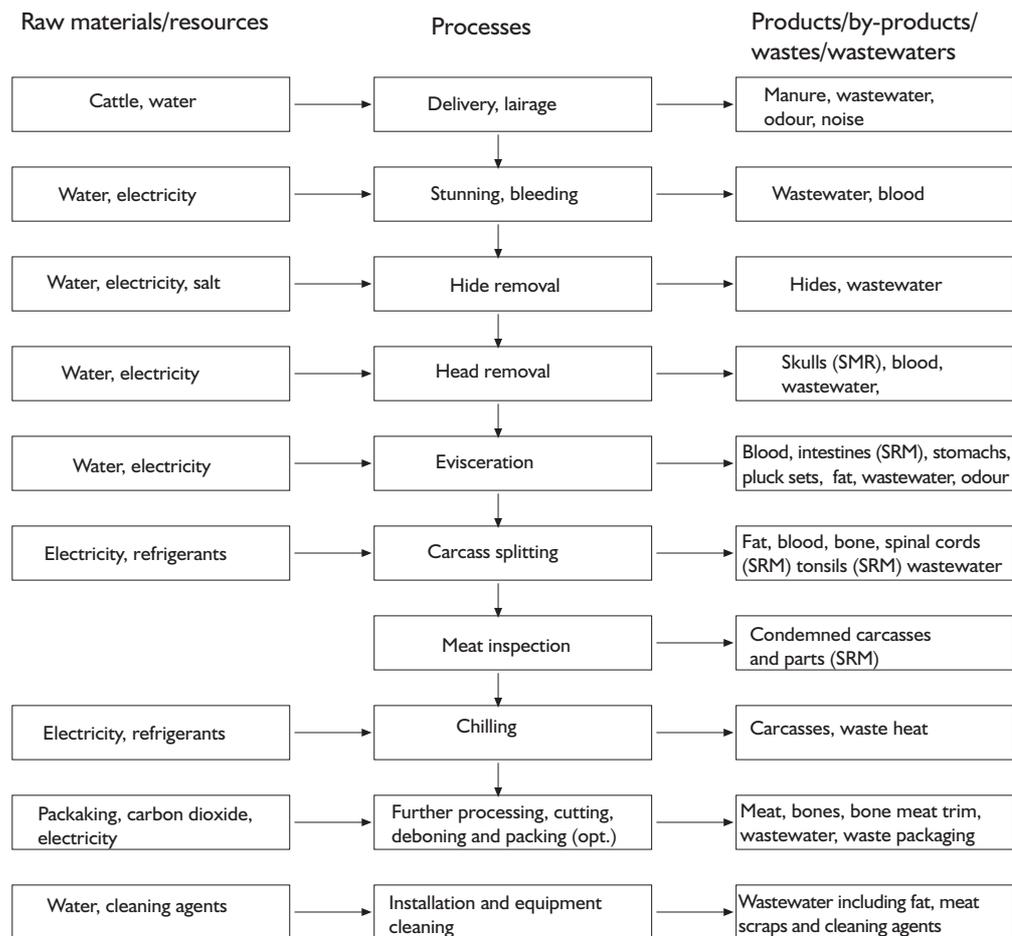


Figure 3. A typical flow scheme of cattle slaughtering.

slaughtering, the carcasses weigh about 250 to 260 kg, which are then split and subsequently chilled to 7 °C to control microbiological growth. Further processing produces trimmings and bones in varying amounts, depending on practices and processes and the degree of processing. These materials are taken to rendering, for animal feed or pet food production, altogether about 50 to 100 kg/head. Materials taken to for animal feed production are usually in the slaughterhouse before the supply homogenised and preserved by lowering the pH to below 4.

2.3 Poultry slaughtering

In Finland, poultry are slaughtered and subsequently cut and portioned in highly automatised plants, typically slaughtering and processing tens of thousands of birds per day. After the delivery of poultry to the plant, they are first removed from crates and cages and hung on the slaughter conveyor (Fig. 4). Manure produced in the delivery is washed down into drainage. The poultry are then electrically stunned, and subsequently bleeding takes place. Blood about 40 g/ broiler is further recovered in animal feed. After the bleeding, and to ease feather removal, birds are scalded by immersing them in hot water (Fig. 4). De-feathering may be performed by rubbing the scalded carcass with rotating rubber fingers and using pressurised water jets (Fig. 4). Feather about 180 g/ broiler is produced. Subsequent

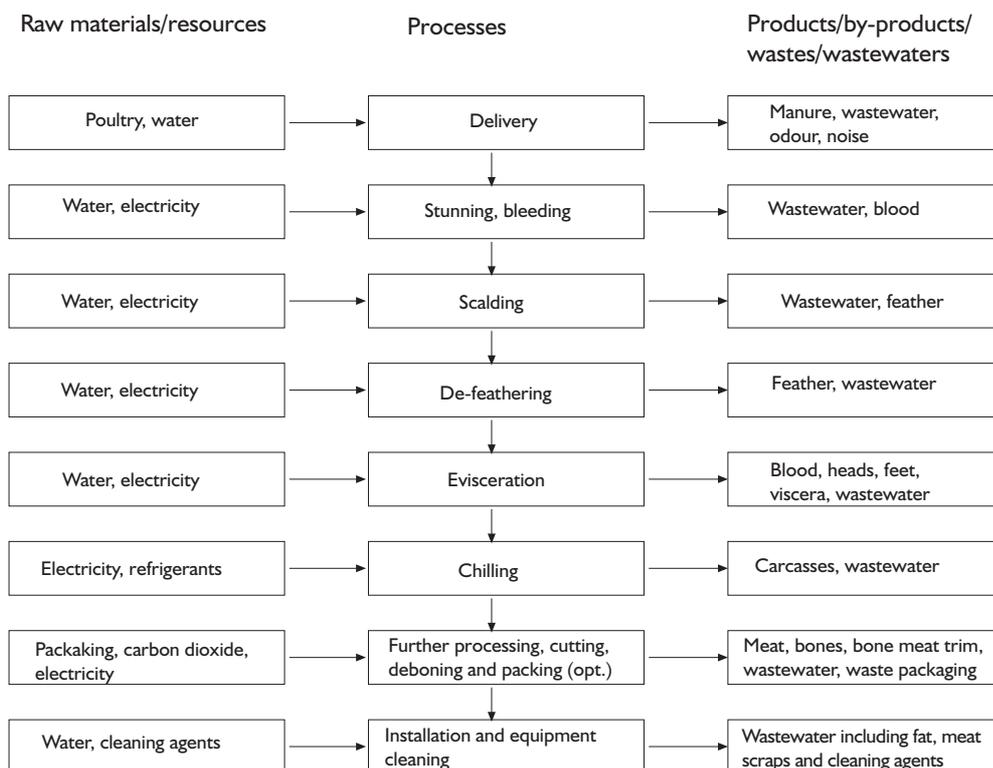


Figure 4. A typical flow scheme of poultry slaughtering.

evisceration produces, heads (about 80 g/ broiler), feet (about 120 g/ broiler), and viscera (about 170 to 180 g/ broiler) (Fig. 4). The slaughtered broiler weighs an average of 1.4 kg. After slaughtering, carcasses are chilled to below 4 °C upon evisceration to control microbiological growth. Further processing produces trimmings and bones in varying amounts, depending on practices and processes and the degree of processing, about 150 to 160 g/ broiler. The by-products are then homogenised and preserved by lowering the pH to below 4 for further recovery usually for fur animal feed, totally about 770 g/ broiler.

2.4 Rendering

In general, the term rendering refers to various heating processes to separate fat from meat. Homogenisation to a particle size below 50 mm and a subsequent rendering at 133°C for a minimum of 20 minutes at 3 bar, or an alternative treatment, is needed for the treatment of high-risk materials (the Decisions of Ministry of Agriculture, 1022/VFD/2000).

The two rendering plants treat all the high-risk materials and SRM generated in Finland. In addition, they treat low-risk materials. In a rendering plant the pre-drying of materials first takes place (optional). The pre-breaking, metal removal, and crushing of material to a particle size below 50 mm then take place (Fig. 5). Subsequently, the cooking, pressurising, and sterilising of material at 133°C for a minimum of 20 minutes at 3 bars is carried out. Materials are then pressed to remove fat and ground to produce meat-bone meal. Metal removal and post-heating of material may then take place (optional). Meat-bone meal produced from high-risk material is used for animal feed, whereas that produced from SRM is

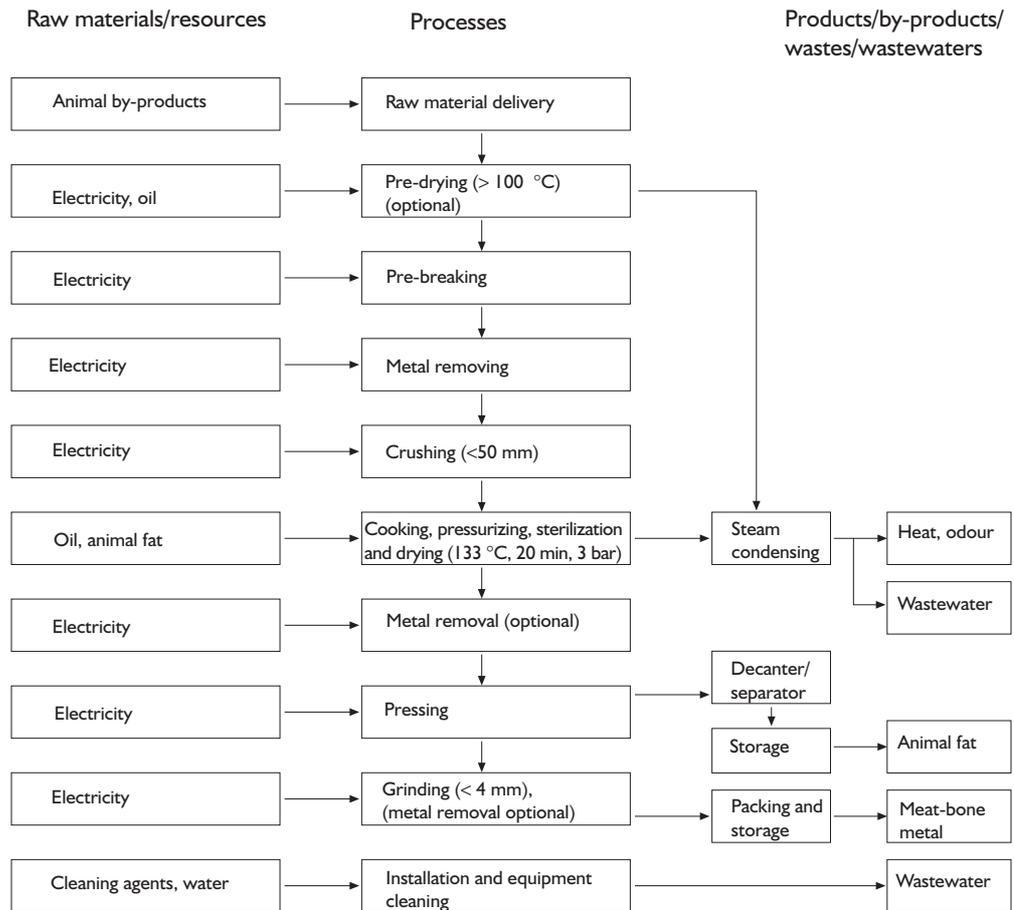


Figure 5. A typical flow scheme of rendering.

currently stored to be incinerated in the future. Fat removed from material is purified. Fat produced from high-risk materials is used for animal feed, technical purposes or as fuel in heat production, whereas that produced from SRM is used only as fuel. Steam produced is condensed.

2.5 Fur animal feed production

In Finland, there are a number of plants for the recycling of low-risk material for the production of fur animal feed. Slaughterhouse by-products and fish used for the preparation of fur animal feed are, after delivery to a fur animal feed production plant, either stored by freezing or used directly for the preparation of feed (Fig. 6). Materials are usually delivered acid preserved, whereas acid may also be added to improve the preservation. Fur animal carcasses also used for the preparation of feed are homogenised to a particle size below 50 mm, cooked at 115 °C for a minimum of 15 minutes, and subsequently fat is separated from the processed material. Then these materials may be used directly in the preparation of feed or they are stored by freezing for later use. In addition, vitamins, water, and grain are used. Grain is homogenised prior to use and then cooked in water at 80 °C. The preparation of feed finally takes place by mixing all the ingredients to the desired ratio. The prepared fur animal feed is then stored for further transport to fur animal farms.

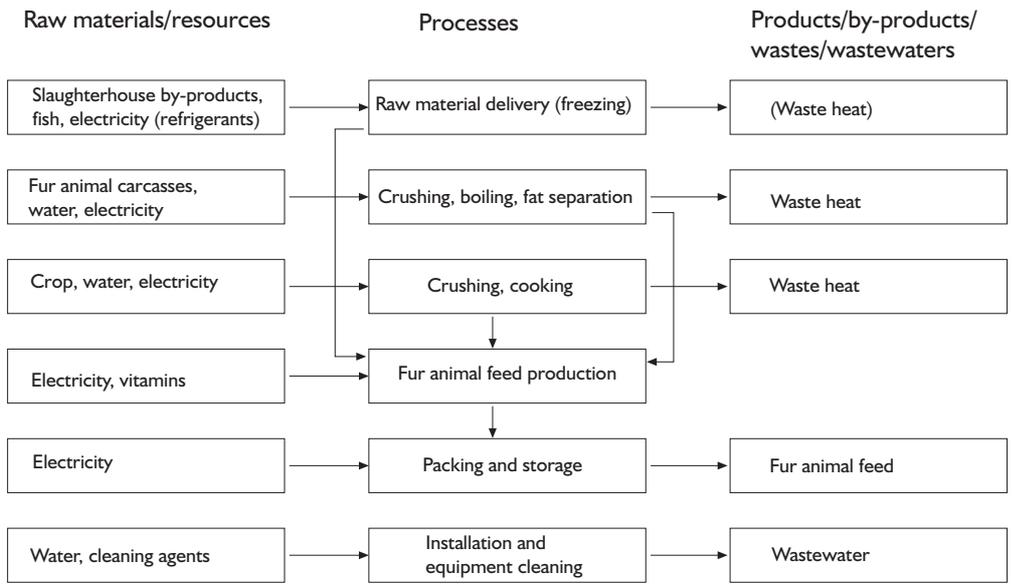


Figure 6. A typical flow scheme of fur animal feed production.

3

Current consumption and emissions

3.1 General information

In this chapter the consumption of energy and water by Finnish slaughterhouses and the installations for the disposal or the recycling of animal carcasses and animal waste, including the rendering plants and the fur animal feed production plants are described and quantified. Furthermore, their emissions to air, water, and soil and solid waste and by-product management are reviewed. The effects of the transportation of animals, products, and other materials are excluded from this report.

3.2 Energy consumption

3.2.1 Electricity consumption

Refrigeration, including chilled stores, air-conditioned areas as well as freezers and cold stores, is often the most significant electricity consumer in the sector. In addition, electricity is consumed in the production of compressed air, ventilation, and lightning as well as in the use of various pieces of equipment, such as saws, hoists, conveyors, and packagers.

The total electricity consumption of the Finnish slaughterhouses varies from 0.18 to 0.74 kWh/ kg slaughtered animals, being the lowest in stand alone slaughterhouses and the highest in plants with integrated meat cutting, deboning, and further processing. The number or type of animals being slaughtered appears, however, to have less effect on the electricity consumption (Table 3). Nevertheless, very little information is available on the distribution of the electricity consumption in the Finnish slaughterhouses. According to the literature (Toresen *et al.*, 2001) pig, cattle, and poultry slaughtering in the other Nordic countries consumes electricity 0.11 to 0.37, 0.09 to 0.48, and 0.16 to 0.86 kWh/ kg slaughtered animals, respectively, whereas the electricity consumption of cutting and deboning and the manufacturing of sausages is about 0.06 and 0.75 to 1.3 kWh/ kg finished products, respectively. Furthermore, according to the literature (Toresen *et al.*, 2001), based on the data from the Danish and Norwegian slaughterhouses, the energy consumption appears somewhat lower the larger the slaughterhouse.

The Finnish rendering plants and the fur animal feed production plants consume electricity about 0.07 and 0.18 to 0.33 kWh/ kg animal waste, respectively (Table 4). The electricity consumption of the fur animal feed production plants depends especially on the refrigeration capacity in use, which may vary considerably between the installations.

3.2.2 Heat consumption

The Finnish slaughterhouses consume heat from about 0.16 to 1.0 kWh/ kg slaughtered animals to produce hot water and industrial steam by burning light and

Table 3. Energy consumption by Finnish slaughterhouses (including stand alone slaughterhouses as well as plants with integrated meat cutting, deboning, and further processing). (The number of installations where data was obtained varies from 1 to 5).

	Mixed species	Pig	Cattle	Poultry
Electricity, kWh/slaughtered animal	Na	18–28	47–55	0.66–0.67
Electricity, kWh/kg slaughtered animals	0.31–0.74	0.21–0.33	0.18–0.22	0.48–0.49
Heat, kWh/slaughtered animal	Na	31–51	41–57	0.69
Heat, kWh/kg slaughtered animals	0.34–1.00	0.36–0.60	0.16–0.22	0.50
Heat recovery, kWh/slaughtered animal	Na	Up to 10	Up to 16	Up to 0.31
Heat recovery, kWh/kg slaughtered animals	Na	Up to 0.12	Up to 0.06	Up to 0.22

Heat energy amount calculated from the fuel heating value, Na = data not available.

Table 4. Energy consumption by the Finnish rendering plants and the animal feed production plants. (The number of installations where data was obtained varies from 2 to 4).

	Rendering plants kWh/kg animal waste	Fur animal feed production plants kWh/kg animal waste
Electricity	0.065–0.072	0.18–0.34
Heat	0.85–0.91	Na
Heat recovery	Up to 0.17	Na

Na = data not available.

heavy oil as well as natural gas in boilers, or they obtain heat from a district-heating network. The heat consumption is the lowest in the stand alone slaughterhouses and the highest in the plants with integrated meat cutting, deboning, and further processing and appears somewhat lower in cattle slaughterhouses as compared to pig and poultry slaughterhouses (Table 3). Nevertheless, little measured data is available on the distribution of the heat consumption in the slaughterhouses. In comparison, pig, cattle, and poultry slaughtering in the other Nordic countries consume heat from about 0.14 to 0.24, 0.07 to 0.27, and 0.03 to 0.16 kWh/kg slaughtered animals, respectively, whereas the heat consumption of cutting and deboning and the manufacturing of sausages are 0.06 kWh/kg finished products and 0.45 to 1.24 kWh/kg finished products, respectively (Toresen *et al.*, 2001).

The rendering of animal carcasses and animal waste consumes heat mostly for the drying and sterilisation of animal waste, amounting to about 0.8 to 0.9 kWh/kg animal waste (Table 4). On the other hand, the rendering plants use varying amounts of animal fat as fuel in heating to replace the use of oil. Little data is available on the heat consumption of the fur animal feed production plants (Table 5), which is partly because many installations use varying amounts of animal fat as fuel in addition to light and heavy oil.

3.2.3 Heat recovery

Many slaughterhouses recover residual heat in-situ up to 0.22 kWh/kg slaughtered animals (Table 3). In pig slaughterhouses, the heat of the exhaust of the singeing unit is recovered to heat water. In some slaughterhouses, the residual heat from refrigeration and air-conditioning is recovered to heat water. In some slaughterhouses and fur animal feed production plants, the heat of cooling water from the air compressors is used to heat buildings. The residual heat from a rendering plant is recovered in a district-heating network, about 0.17 kWh/kg animal waste (Table 4).

3.2.4 Propane

Most pig slaughterhouses use propane for singeing to remove residual hair from the carcasses, about 250 to 290 g/slaughtered animal.

3.3 Water consumption

Installations mostly obtain water from municipal waterworks, although lakewater and groundwater are also used.

3.3.1 Slaughterhouses

The total water consumption of the Finnish slaughterhouses varies from 2.0 to 17.5 l/kg slaughtered animals, the lowest being in stand alone pig and cattle slaughterhouses and the highest in the poultry slaughterhouses and those pig and cattle slaughterhouses with integrated meat cutting, deboning, and further processing (Table 5). On the other hand, little of information is available on the distribution of water consumption in the slaughterhouses. Table 6 shows the distribution of water consumption by a Finnish slaughterhouse. In comparison, pig, cattle, and poultry slaughtering in the other Nordic countries consume water about 1.2 to 5.3, 2.0 to 7.8, and 5.1 to 16.3 l/kg slaughtered animals, respectively, whereas cutting and deboning and the manufacturing of sausages consume water about 1.2 l/kg and 5.3 to 10 l/kg finished products, respectively (Toresen *et al.*, 2001). Furthermore, the utilisation of casings varies between the slaughterhouses, which effects their total water consumption. Pig casing-cleaning consumes water about 0.5 l/kg slaughtered animals (Toresen *et al.*, 2001).

Many slaughterhouses reuse water in various washings. A slaughterhouse uses chlorinated lakewater for purposes such as vehicle and hide washing.

Table 5. Water consumption by Finnish slaughterhouses (including stand alone slaughterhouses as well as installations with integrated meat cutting, deboning, and further processing). (The number of installations where data was obtained varies from 1 to 4).

	Mixed species	Pig	Cattle	Poultry
Water, l/slaughtered animal	Na	166–703	1 200–1 300	17.9–18.7
Water, l/kg slaughtered animals	9.9–17.5	2.0–8.3	4.6–5.1	12.8–14.0

Na = data not available.

3.3.2 Installations for the disposal or recycling of animal carcasses and animal waste

The Finnish rendering plants consume water about 0.44 to 0.51 l/kg animal waste (Table 7), of which water addition to boilers contributes about 30 to 45 percent.

The fur animal feed production plants consume water about 0.31 to 1.67 l/kg animal waste (Table 7). A fur animal feed production plant estimates that animal feed and cleaning contribute to about 10 and 70 percent of the total water consumption, respectively.

Table 6. The distribution of water consumption by a Finnish slaughterhouse.

	The distribution of water consumption % of total	Water consumption l/kg slaughtered animals
+ 4 – +7 °C WATER		
Cleaning of intestines	17.34	0.73
Slaughter	8.90	0.38
Lairage	1.30	0.06
Vehicle washing	0.03	< 0.01
Cleaning of hides and heads	3.09	0.13
Wastewater treatment plant	0.11	< 0.01
Refrigeration	0.24	0.01
Sanitary	0.31	0.01
Total + 4 – +7 °C water	30.59	1.29
+ 40 °C WATER		
Slaughter	7.80	0.33
Cleaning	0.87	0.04
Various	15.39	0.65
Total + 40 °C water	24.06	1.02
+ 55 °C WATER		
Cleaning of intestines	2.43	0.10
Cleaning	21.64	0.92
Various	0.75	0.03
Total + 55 °C water	24.82	1.05
+ 90 °C WATER		
Slaughter	15.23	0.64
Cutting/ deboning	3.77	0.16
Cleaning of intestines	1.53	0.06
Total + 90 °C water	20.53	0.87
TOTAL WATER	100.00	4.23

Table 7. Water consumption by Finnish rendering plants and fur animal feed production plants. (The number of installations where data was obtained varies from 2 to 7).

	Rendering plants	Fur animal feed production plants
Water, l/kg animal waste	0.44–0.51	0.31–1.67

3.4 Chemical consumption

Finnish slaughterhouses and installations for the disposal or recycling of animal carcasses and animal waste use a wide range of chemicals, including detergents, refrigerants, fuels, and carbon dioxide as well as preserving agents.

A variety of detergents are used in cleaning. Many installations sub-contract a specialist cleaning company to carry out the cleaning. Table 8 shows the cleaning chemical consumption by a Finnish slaughterhouse.

Table 8. Cleaning chemical consumption by a Finnish slaughterhouse.

	Amount g/kg slaughtered animals
Alkaline detergents	28.6
Acid detergents	0.9
Disinfectants	1.3
Total	30.8

Ammonia and glycol are commonly used refrigerants. Heavy and light oil as well as natural gas are used as fuel for heating. Carbon dioxide is used for pig stunning, refrigeration, and meatpacking. For the preservation of animal waste, chemicals such as formic acid, lactic acid, sulphuric acid, and sodium benzoate are used.

3.5 Emissions to water

3.5.1 Slaughterhouses

The volume and the characteristics of wastewater from the different slaughterhouses and in the different wastewater streams of the unit processes and the departments of slaughterhouses vary considerably, depending on the water consumption, processes, operations, and practises as well as on the number and the type of animals being slaughtered (See Table 9).

Table 9. The amount and the characteristics of the wastewater discharge into the public sewer by Finnish slaughterhouses. (The number of installations where data was obtained varies from 1 to 4).

	Mixed species	Pigs	Cattle	Poultry
Q, l/slaughtered animal	Na	166–703	1 200–1 300	17.9–18.7
Q, l/kg slaughtered animals	9.9–17.5	2.0–8.3	4.6–5.1	12.8–14.0
SS, mg/l wastewater	50–1 100	60–610	2 300–3 100	5
SS, g/slaughtered animal	Na	9.9–430	2 900–4 000	0.94
SS, g/kg slaughtered animals	0.4–8.4	0.12–5.1	11.2–15.9	0.70
BOD ₇ , mg/l wastewater	720–1 700	340–980	3 100–4 100	730
BOD ₇ , g/slaughtered animal	Na	56–690	3 900–5 300	13.7
BOD ₇ , g/kg slaughtered animals	4.1–12.6	0.66–8.1	15.3–20.9	10.2
P, mg/l wastewater	7–150	7–26	49–51	3
P, g/slaughtered animal	Na	1.3–18.3	60–67	0.056
P, g/kg slaughtered animals	0.04–1.5	0.02–0.22	0.23–0.26	0.042
N, mg/l wastewater	60–230	92–250	320–370	40
N, g/slaughtered animal	Na	15.2–176	400–470	0.75
N, g/kg slaughtered animals	0.85–1.48	0.18–2.1	1.55–1.84	0.56

Q = Wastewater flow, SS = Suspended solids, BOD₇ = 7-day biological oxygen demand, P = Total phosphorus, N = Total nitrogen.

Wastewater from vehicle washing and sheds contains manure, whereas wastewater from slaughtering, evisceration, and cutting operations contains fat and proteins and their degradation products, such as volatile fatty acids, amines and other nitrogenous compounds (reviewed by Johns, 1995). To minimise the pollution load it is important to avoid blood and meat scraps entering the drainage. This is because blood has a considerable pollution potential having a total chemical oxygen demand (COD) of about 300 g/l and a total nitrogen content of about 30 g-N/l (reviewed by Cooper and Russel, 1992). Meat scraps entering wastewater streams

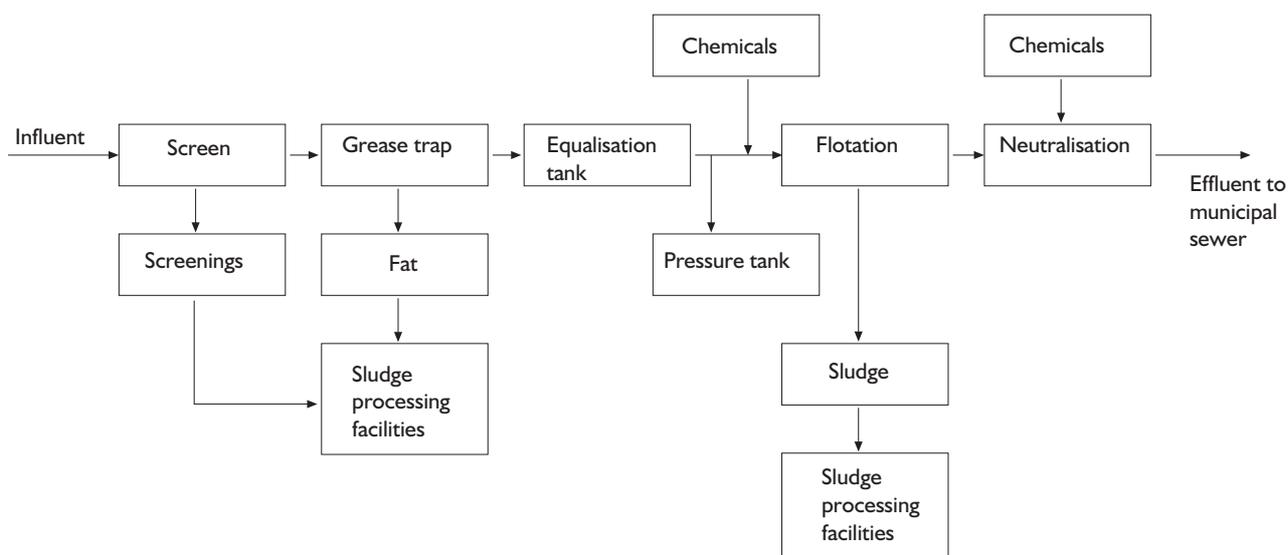


Figure 7. A typical flow scheme of slaughterhouse wastewater pre-treatment.

may further break down into soluble, suspended, and colloidal material, which are difficult to separate from the wastewater stream afterwards. Different wastewater streams also contain carbohydrates, such as glucose, cellulose in dissolved or colloidal forms. Different wastewater streams may also contain varying amounts of chemicals, such as detergents, as well as pathogenic micro-organisms (reviewed by Johns, 1995).

The temperature of wastewater considerably affects the solubilisation of various pollutants and microbial decomposition as well as the viability and the economics of different wastewater treatment operations (reviewed by Johns, 1995). The temperature of wastewater in the Finnish slaughterhouses is typically 25–35 °C. In general, biological processes perform faster at higher temperatures, whereas fat emulsification at the higher temperatures causes substantial difficulties in fat removal and flotation as well as in an activated sludge plant (reviewed by Johns, 1995).

All the Finnish slaughterhouses discharge their wastewater to the municipal sewer after pre-treatment. Fig. 7 shows a typical flow scheme of slaughterhouse wastewater pre-treatment.

Table 10 shows the performance of a wastewater pre-treatment plant in a Finnish slaughterhouse discharging its wastewater to a public sewer.

Table 10. The performance of a wastewater pre-treatment plant in a Finnish slaughterhouse discharging its wastewater to a public sewer.

	Influent mg/l	Effluent mg/l	Reduction %
SS	3 800–5 500	1 100–2 000	64–71
BOD ₇	6 200–6 300	2 600–4 000	37–58
P	91–92	45–63	32–51

SS = Suspended solids, BOD₇ = 7-day biological oxygen demand, P = Total phosphorus.

Slaughterhouses use screens and grease traps to remove coarse particulate and suspended solids as well as fat, oil, and greases from wastewater. Equalisation tanks may be used to equalise wastewater flow and pollution load.

A few Finnish slaughterhouses use dissolved air flotation (DAF) to enhance the removal of suspended solids and fat, oil, and greases after the removal of the coarse particulate and suspended solids. In DAF, wastewater previously saturated with air is released into the base of the treatment facility, allowing the resulting fine air bubbles to flow uniformly through the wastewater flow resulting in enhanced gravity separation through the flotation of particulate matter (reviewed by Johns, 1995).

The pH of the wastewater may be adjusted and precipitation chemicals, such as iron(III)salts or aluminum(III)salts, may be added to the wastewater to enhance the removal of suspended solids from the wastewater. Ferric salts are also used for odour removal from wastewater, which eliminate hydrogen sulphide in the wastewater.

After the removal of coarse particulate and suspended solids, a few slaughterhouses have a biological activated sludge plants to achieve organic matter removal from wastewater and a partial biological conversion of ammonia by biological nitrification to nitrate. The activated sludge process is a dispersed or suspended growth system comprising of a mass of micro-organisms constantly supplied with organic matter and, for aerobic treatment, oxygen (reviewed by Johns, 1995). The micro-organisms grow in flocs, and in aerobic treatment, these flocs are responsible for the transformation of organic material into new bacteria, carbon dioxide and water, and for ammonia reduction into nitrite and nitrate. In an anoxic treatment, the nitrate and nitrite are further reduced to gaseous nitrogen. Detergents may cause trouble in a biological wastewater treatment plant.

Sludge from various wastewater treatment processes, screenings and fat from grease trap, and flotation tailings as well as excess activated sludge may be dewatered by using drying beds or filter and belt presses, with parallel chemical conditioning. These materials are usually further taken to composting.

The discharge of the pre-treated slaughterhouse wastewater to a public sewer is often economically and technically the most viable solution. Municipal sewage treatment balances out the peak loads of pollutants and dilutes the shock doses of toxic chemicals, such as detergents, which may worsen the performance of a wastewater treatment plant. Table 11 shows the range of the performance of three Finnish municipal sewage treatment plants treating also slaughterhouse wastewater.

Table 11. The range of the performance of three Finnish municipal sewage treatment plants treating also slaughterhouse wastewater.

	Influent mg/l	Effluent mg/l	Reduction %
BOD ₇	260–290	8.5–25	85–98
P	8.4–14	0.4–1.5	85–96
N	41–74	17–39	31–59

BOD₇ = 7-day biological oxygen demand, P = Total phosphorus, N = Total nitrogen.

3.5.2 Installations for the disposal or recycling of animal carcasses and animal waste

Most of the Finnish installations for the disposal or the recycling of animal carcasses and animal waste discharge their wastewater to the public sewer after pre-treatment, whereas some installations located in areas where no municipal sewer lines

exist, discharge their wastewater into a nearby natural water body as treated. The amount and the characteristics of the wastewater discharge into a public sewer or into a natural water body by the Finnish rendering plants and fur animal feed production plants are shown in Tables 12 and 13, respectively.

Table 12. The amount and the characteristics of the wastewater discharge into a public sewer or into a natural water body by two Finnish rendering plants.

	The rendering plant discharging wastewater into a public sewer	The rendering plant discharging wastewater into a natural water body
Q, l per kg animal waste	0.46	0.63
BOD ₇ , mg/l wastewater	2 500	2 200
BOD ₇ , g/kg animal waste	1.2	1.4
P, mg/l wastewater	19	0.21
P, g/kg animal waste	0.01	0.00013
N, mg/l wastewater	240	220
N, g-N/kg animal waste	0.11	0.14

Q = Wastewater flow, BOD₇ = 7-day biological oxygen demand, P = Total phosphorus, N = Total nitrogen.

Table 13. The amount and the characteristics of the wastewater discharge into a public sewer or into a natural water body by Finnish fur animal feed production plants. (The number of installations where data was obtained varies from 1 to 3).

	Plants discharging wastewater into a public sewer	Plants discharging wastewater into a natural water body
Q, l per kg animal waste	0.23–0.48	0.06–0.22
SS, mg/l wastewater	400–670	39–300
SS, g per kg animal waste	0.091–0.16	0.007–0.09
BOD ₇ , mg/l wastewater	150–2 200	7–200
BOD ₇ , g per kg animal waste	0.034–0.55	0.003–0.017
P, mg/l wastewater	5–110	0.7–50
P, g per kg animal waste	0.001–0.027	0.00016–0.015
N, mg/l wastewater	100–1 100	60–180
N, g per kg animal waste	0.023–0.27	0.006–0.03

Q = Wastewater flow, SS = Suspended solids, BOD₇ = 7-day biological oxygen demand, P = Total phosphorus, N = Total nitrogen.

Mostly similar pre-treatment unit processes are in use in the installations for the disposal or the recycling of animal carcasses and animal waste as in the slaughterhouses. On the other hand, some installations located in areas where no municipal sewer lines exist treat their wastewater by using septic tank systems as well as soil filtration. Table 14 shows the performance of a wastewater treatment plant in a fur animal feed production plant discharging its wastewater into a nearby natural water body as treated. Fig. 8 shows a flow scheme of the wastewater pre-treatment of a fur animal feed production plant discharging its wastewater into a natural water body as treated.

The rendering plants treat process steam using condensing. A rendering plant, subsequently to condensing, treats the condensate by using a stripper and an evaporator. This process gives 7-day biological oxygen demand (BOD₇) and total nitrogen reductions of about 60 % and 80 %, respectively. The flow scheme of the process is shown in the Fig. 9.

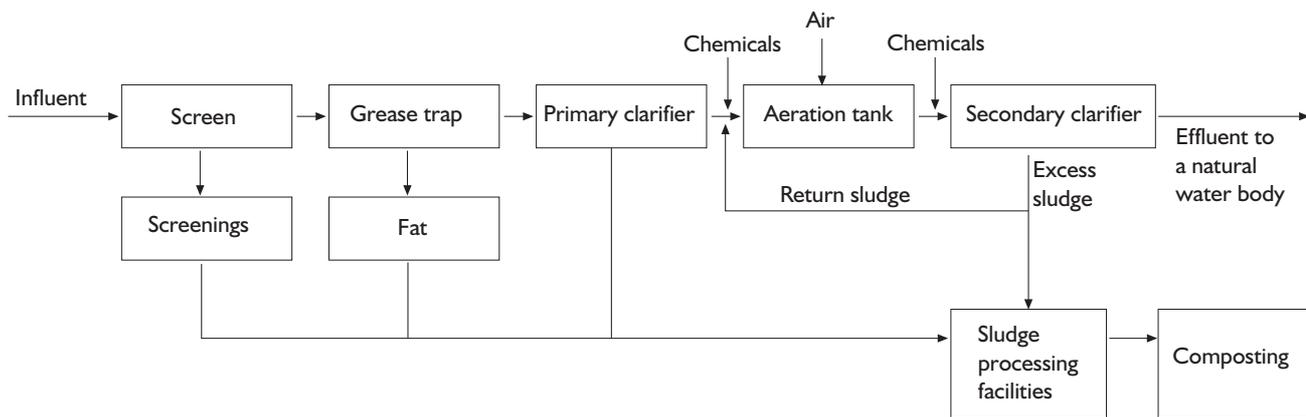


Figure 8. A flow scheme of the wastewater pre-treatment of a fur animal feed production plant discharging its wastewater into a natural water body.

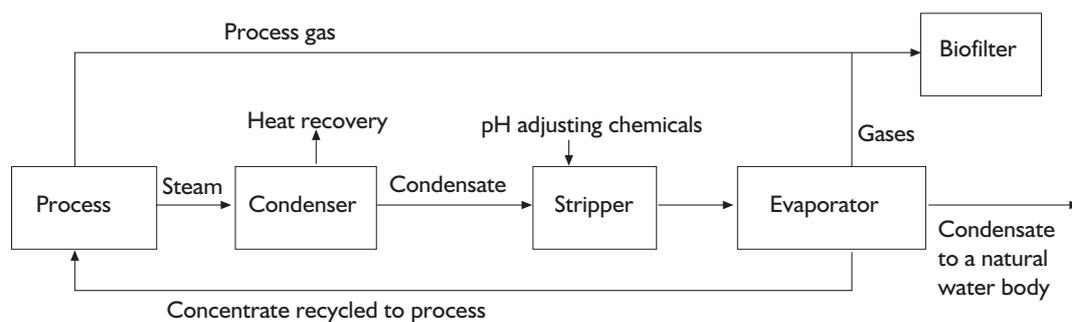


Figure 9. The flow scheme of a rendering plant wastewater treatment process.

Table 14. The performance of a biological wastewater treatment plant in a fur animal feed production plant discharging its wastewater into a nearby natural water body as treated.

	Influent mg/l	Effluent mg/l	Reduction %
SS	3 490	38.5	98.9
BOD ₇	5 810	6.8	99.9
P	116	0.72	99.4
N	788	58.7	92.6
NH ₄	107	4.8	95.5

SS = Suspended solids, BOD₇ = 7-day biological oxygen demand, P = Total phosphorus, N = Total nitrogen, NH₄ = ammonium nitrogen.

3.6 Emissions to air

Many installations use boilers to produce hot water and industrial steam. Boilers with a heat production capacity of 5 MW or more require an environmental permit and these plants are also obliged to monitor their air emissions (See Tables 15 and 16). On the other hand, many installations obtain heat from a district-heating network thus not causing air emissions directly.

Table 15. The range of air emissions by three Finnish slaughterhouses.

	Range g/kg slaughtered animals
CO ₂	22–200
SO ₂	0.45–1.1
NO _x	0.29–0.52

CO₂ = Carbon dioxide, SO₂ = Sulphur dioxide, NO_x = Nitrogen oxides.

Table 16. Air emissions by two Finnish rendering plants.

	Range g/kg animal waste
CO ₂	10.2–146
SO ₂	1.2–1.6
NO _x	0.51–0.59
Particles	0.19–0.21

CO₂ = Carbon dioxide, SO₂ = Sulphur dioxide, NO_x = Nitrogen oxides.

The storage, handling, and treatment of by-products and wastes as well as wastewater treatment and singeing are typical sources of foul odours in the sector.

The leakage of refrigerants from refrigerators could potentially result in uncontrolled air emissions. Ammonia is the most commonly used refrigerant in the sector.

Any installation cleans the air emissions generated in boilers. The rendering plants use condensing and/ or a biofilter to reduce their air emissions. A biofilter has a carried medium for growing micro-organisms using the contents of organic materials in the air for their growth thus removing the odour from the air.

3.7 Emissions to soil

Leakage from drainage pipes and tanks could possibly cause emissions to soil. However, materials discharged into sewers are easily biodegradable and therefore unlikely to cause any significant soil contamination issues. On the other hand, bulk storage depots for fuels and other chemicals pose risks of accidental spills and leaks, which could potentially result in contamination of soil and groundwater. According to our knowledge, past activities associated with the installation are not expected to result in site restoration.

3.8 Solid by-product and waste management

In the Finnish legislation, the Waste Act (1072/1993) and Waste Decree (1390/1993) aim to support sustainable development by promoting the rational use of natural resources, and to prevent and combat hazards and harm to human health and the

environment arising from wastes. They emphasise preventive measures for minimising the waste generated and diminishing the harmful properties of waste and require the recovery of waste if this is technically and economically feasible, primarily in the form of material, and secondarily as energy. (The Finnish Environment Institute, 2001)

Fig. 10 shows the current recovery and disposal of solid by-products and wastes produced in the Finnish slaughterhouses, rendering plants and fur animal feed production plants. The amount of solid by-products and wastes by Finnish slaughterhouses and the installations for the disposal or recycling of animal carcasses and animal waste are shown in the Tables 17 and 18, respectively.

Many slaughterhouse by-products are being further recovered in rendering plants, in fur animal feed production plants or in pet food production as described earlier.

The waste management of the installations in the sector is mostly carried out in co-operation with the companies taking care of the transportation of waste and recyclable materials as well as with local municipalities and municipal waste management centres taking care of the collecting, treating, and the recycling of waste and recyclable materials. However, some installations have on-site waste treatment facilities for certain waste fractions, such as the composting of organic wastes.

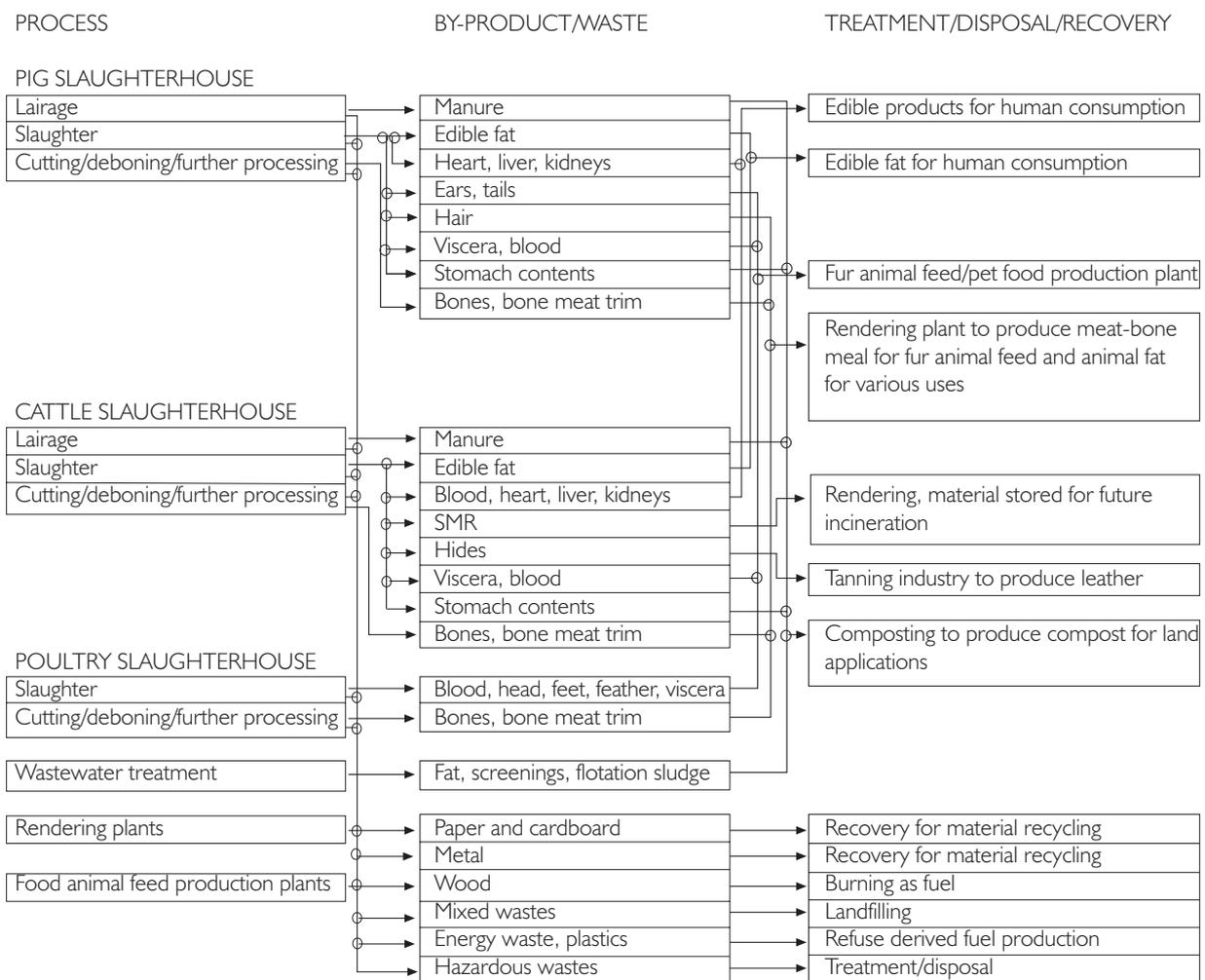


Figure 10. Current recovery and disposal of solid by-products and wastes produced in the Finnish slaughterhouses, rendering plants and fur animal feed production plants.

Table 17. The amount of solid by-products and wastes by Finnish slaughterhouses. (The number of installations where data was obtained varies from 3 to 7).

	Range g/kg slaughtered animals
Material for pet food production or fur animal feed	200–400
Specified risk material	0–200
Material to rendering	80–230
Material to composting for further recovery in land applications	14–200
Paper and cardboard to recovery	0.09–2.4
Metal to recovery	0.25–1.1
Material to landfilling or energy recovery	0.8–37
Hazardous wastes	0.04–0.37

Table 18. The amount and the treatment and disposal of solid by-products and wastes by the Finnish installations for the disposal or recycling of animal carcasses and animal waste. (The number of installations where data was obtained varies from 1 to 6).

	Rendering plants g/kg animal waste	Fur animal feed production plants g/kg animal waste
Material to rendering	Na	0–14
Material to composting	10.8	0.73–13.0
Paper and cardboard to recovery	Na	0.09–1.0
Metal to recovery	0.42–1.8	0–0.05
Wood to recovery	Na	0–5.1
Material to landfilling	0.51–4.3	0.87–16.7
Hazardous wastes	Na	0.05–0.13

Na = data not available.

Composting is an aerobic biological process to decompose organic material, carried out in windrows or reactors. It is a common method of treating materials such as manure and stomach and intestines content as well as wastes from wastewater treatment such as screenings and flotation tailings for further recovery in land applications (Fig. 7). The legal basis in Finland for the further recovery of materials in land applications is Act No. 232/1993 on Fertilisers.

In composting, methane emissions to air, water, and soil may present a problem, especially in windrow composting. For these reasons, reactor composting is increasing in popularity over windrow composting. Composting inactivates pathogenic micro-organisms only up to a certain extent and not all viruses (Commission of the European Communities, 1999).

Waste that is disposed of at landfill sites consists largely of inert, non-hazardous, mixed, inorganic materials, such as plastics. The operation, monitoring, and control of landfill sites have become more tightly regulated (Council of State Decision No: 861/1997, amended by 1049/99). Landfill sites must prevent or reduce their adverse effects on the environment, which also increases the costs of waste disposal at landfill sites.

Increasing amount of materials, such as metal, glass and paper are being recycled as material. Furthermore, an increasing number of Finnish municipal waste management centres recover the energy content of wastes by incinerating refuse derived fuels.

Hazardous wastes are mainly disposed of at Ekokem's National Hazardous Waste Treatment Plant in Riihimäki, while small amounts are also collected and treated by several licensed companies around Finland specialising in certain hazardous wastes.

3.9 Noise and vibration

Animals, vehicles, compressors, and air conditioners cause limited noise, although no on site noise measurements are available.

3.10 Environmental management

All the installations in the sector have an approved internal control system approved by a local authority. In addition, many installations have a certified ISO 9000 quality management system. The number of ISO 14001 environmental certificates has also grown rapidly among slaughterhouses and the installations for the disposal or recycling of animal carcasses and animal waste, partly because many companies were already applying the ISO 9000 quality management system. In addition, a number of installations have quality management systems that are not certified.

Candidate best available techniques

In general, the optimised processes, motivation and participation of the personnel, and regular documented maintenance to keep site equipment and processes in good working order are considered important for a good environmental performance of all the installations in the sector. The installations should consider performing the systematic evaluation of environmental effects throughout the processes and the introduction of control, monitoring, and verification procedures at steps in those operations where they are considered essential to minimise the effects on the environment. As a systematic procedure installations should consider establishing and maintaining a structured environmental management system integrated with overall management activity.

Any specific set of the best available techniques (BAT) is presented because site specific circumstances, such as product range and plant size as well as existing processes and their technical characteristics are very diverse in the sector and little information is available on the environmental effects of the existing processes. Nevertheless, a range of techniques to consider in the determination of the BAT is reviewed. They are grouped as follows: energy minimisation techniques, water and chemicals consumption minimisation techniques, abatement techniques for emissions to water, air emission abatement techniques, abatement techniques for emissions to soil, and solid waste minimisation techniques.

4.1 Energy minimisation techniques

Installations should monitor their energy consumption per production unit. Furthermore, monitoring and targeting programmes should be established to identify and implement opportunities to reduce the electricity and heat consumption of different processes.

Refrigeration, including chilled stores, air-conditioned areas as well as freezers and cold stores, is often the most significant electricity consumer in the sector. Therefore, installations should keep the refrigeration equipment in good working order by carrying out their regular maintenance.

Installations should seek every opportunity to recover residual heat, whether for example the residual heat from the exhaust of singeing, from refrigeration, or of cooling water from air compressors could be recovered. Furthermore, the recovery of residual heat from rendering plants in a district-heating network is suggested a technique to consider in the determination of the BAT.

The environmental effects of acquisitions and new investments should always be evaluated.

4.2 Water and chemicals consumption minimisation techniques

Installations should monitor their water and chemicals consumption per production unit. Monitoring and targeting programmes should be established to identify

fy and implement opportunities to reduce the water consumption of different processes. Optimised processes and operations as well as regular documented maintenance of equipment may considerably reduce water consumption.

A reviewed control and management of cleaning operations to minimise water and chemical consumption as well as to find the most appropriate chemicals for each purpose is suggested. The use of self-closing low or medium pressure pistols in washing may considerably reduce water consumption.

Installations should consider the reuse of water such as washing, chilling, or cooling water to vehicle, lairage, or hides washing taking into consideration the hygiene and quality requirements.

4.3 Abatement techniques for emissions to water

Installations should draw attention especially to the avoidance of wastewater load at its source as well as the reduction of water consumption.

Blood and solid materials and wastewater should never be lumped together. Blood and solid materials should be collected and treated separately from wastewater streams and should be scraped to containers before washing with water in order to avoid them from entering the drainage. This is because blood has a considerable pollution potential having a total chemical oxygen demand (COD) of about 300 g/l and a total nitrogen content of about 30 g-N/l (Cooper and Russel, 1992). Meat scraps entering wastewater streams may further break down into soluble, suspended, and colloidal material, which are difficult to separate from the wastewater stream afterwards. Reduction in chemical consumption may also reduce wastewater load.

Installations should consider a systematic monitoring of the separate wastewater streams to find alternatives to their reuse or separate treatment.

Installations should keep the wastewater pre-treatment processes, as well as drainage and pipe work, in good working order, by carrying out their regular maintenance.

A reviewed control and management of cleaning operations should, with regard to wastewater treatment, target especially the avoidance of peaks in the wastewater flow, which may considerably worsen the performance of wastewater treatment processes, such as grease traps.

On the other hand, considerable amounts of detergents are used in cleaning. The shock doses of detergents may destroy the micro-organisms of a biological wastewater treatment process, which should be avoided in every possible way.

The site specific circumstances, such as the amount and the characteristics of the wastewater as well as the existing processes and their technical characteristics greatly effect the technical viability and economic sustainability of wastewater treatment processes. Both the discharge of adequately pre-treated wastewater to a municipal sewer as well as a well maintained and well-functioning adequate on-site wastewater treatment plant are suggested techniques to consider in the determination of the BAT. Some well-functioning wastewater treatment processes existing in the sector and their performance were reviewed in the section 3.5. Johns (1995) presented a comprehensive review of progress in the treatment of wastewater from slaughterhouses to identify the latest trends in wastewater management and technology in the meat process industry and to discuss the design and performance data available.

4.4 Air emission abatement techniques

The use of boilers to produce hot water and industrial steam is the most significant source of air emissions in the sector. Therefore installations should operate regular preventive maintenance of boilers to ensure good combustion conditions.

Installations should avoid uncontrolled emissions or refrigerants to the air by the regular maintenance of refrigeration equipment. Chlorinated fluorocarbons, halons, and other substances, which are known to deplete the ozone layer and which may still exist in old refrigerators and insulating boards, should be replaced by more environmentally sound refrigerants.

Installations should consider using heat and electricity generated from renewable energy sources when it is technically and economically feasible. The use of rendered animal fat as fuel in heating is suggested as a technique to consider in the determination of the BAT when it is technically and economically impracticable or legally prohibited to recover it as material.

The storage, handling, and treatment of by-products and wastes as well as wastewater treatment and singeing are typical sources of foul odours in the sector. Installations should consider establishing a procedure for monitoring smell at the site boundary and consider ways of reducing odour, especially in built up areas where odour complaints have been received. The rendering plants use condensing and/or a biofilter for air cleaning, which are suggested as techniques to consider in the determination of the BAT.

4.5 Abatement techniques for emissions to soil

Regular maintenance of storage tanks, drainage, and pipes should be carried out to avoid accidental spills and leaks of fuels, which could potentially result in contamination of soil and groundwater. Storage tanks should have appropriate spill and overflow prevention devices.

4.6 Solid waste minimisation techniques

Installations should aim on minimising the waste generated and on diminishing its harmful properties. Furthermore, the installations should evaluate all possibilities for the recovery of wastes by the installation itself or by another company, primarily in the form of material and secondarily as energy.

Both co-operation in waste management, as well as a well maintained and well functioning adequate on-site waste treatment are suggested techniques to consider in the determination of the BAT.

In general, different kinds of waste materials should be handled and stored separately from each other. If they were lumped together, they would be more difficult to further recover.

Organic by-products and wastes are preferably stored on closed containers to prevent foul odour and their transport from installation should take place as often as possible.

Installations carrying out the composting of organic wastes should draw attention especially to the amount of moisture-sorbing and structural support, the frequency of the turning of material, and the material retention time in the treatment for sanitation and degradation of the total material and to keep the process fully aerobic.

5

Best available techniques

Any specific set of the best available techniques (BAT) applying to all the slaughterhouses, rendering plants or fur animal feed production plants is presented, because site specific circumstances, such as product range and plant size as well as existing processes and their technical circumstances are very diverse in the sector and little information is available on the environmental effects of the existing processes. Nevertheless, the following techniques can be considered as BAT.

Slaughterhouses

1. The regular maintenance of equipment to keep them in good working order,
2. The recovery of residual heat from the exhaust of singeing, from refrigeration, and of cooling water from air compressors to heat water and buildings,
3. A monitoring of the electricity, heat, and water consumption of the whole installation and in different unit processes,
4. The use of heat and electricity produced from renewable energy sources when it is technically and economically feasible,
5. The optimisation of unit processes and operations in order to minimise their energy and water consumption and emissions to air and water,
6. The reuse of washing, chilling, and cooling water to vehicle, lairage, and hides washing,
7. The use of self-closing low or medium pressure pistols in washing,
8. A reviewed control and management of cleaning operations to minimise water and chemical consumption and wastewater load,
9. The collection and treatment of blood and solid materials separately from wastewater streams
10. The dry scraping of blood and solid materials before cleaning with water,
11. A monitoring of the separate wastewater streams to find alternatives to their reuse or separate treatment,
12. Measures taken to remove the suspended solids, fat, oil, and greases as well as organic matter and nutrients from wastewater before its discharge into a natural water body.
13. The use of appropriate spill and overflow prevention devices in storage tanks,
14. The use of closed containers for organic by-products and wastes,
15. The transport of wastes from slaughterhouse as often as possible,
16. Measures taken to minimise the waste generated and to diminish its harmful properties or recovery of waste if this is technically and economically feasible, primarily in the form of material and secondarily as energy.
17. Different kinds of waste materials should be handled and stored separately from each other.

Rendering plants

1. The regular maintenance of equipment to keep them in good working order,
2. The recovery of residual heat in a district-heating network,
3. A monitoring of the electricity, heat, and water consumption of the whole installation and in different unit processes,
4. The use of heat and electricity produced from renewable energy sources when it is technically and economically feasible,
5. The optimisation of unit processes and operations in order to minimise their energy and water consumption and emissions to air and water,
6. The reuse of condensed water,
7. The use of animal fat as fuel when it is technically and economically impracticable or legally prohibited to recover it as material,
8. The use of appropriate spill and overflow prevention devices in storage tanks,
9. Measures taken to remove the suspended solids, fat, oil, and greases as well as organic matter and nutrients from wastewater before its discharge into a natural water body.
10. The use of condensing and /or a biofilter for air cleaning,
11. Measures taken to minimise the waste generated and to diminish its harmful properties or recovery of waste if this is technically and economically feasible, primarily in the form of material and secondarily as energy,
12. Different kinds of waste materials should be handled and stored separately from each other.

Fur animal feed production plants

1. The regular maintenance of equipment to keep them in good working order,
2. The recovery of residual heat from cooling water from compressors to heat water and buildings,
3. A monitoring of the electricity, heat, and water consumption of the whole installation and in different unit processes,
4. Use of heat and electricity produced from renewable energy sources when it is technically and economically feasible,
5. The use of animal fat as fuel, when it is not technically and economically feasible to recover it as material,
6. The use of appropriate spill and overflow prevention devices in storage tanks,
7. The optimisation of unit processes and operations in order to minimise their energy and water consumption and emissions to air and water,
8. The reuse of washing and cooling water to feed preparation and washing,
9. Dry collection of solid residues before cleaning with water to avoid them from entering the drainage,
10. Measures taken to remove the suspended solids, fat, oil, and greases as well as organic matter and nutrients from wastewater before its discharge into a natural water body.
11. Measures taken to minimise the waste generated and to diminish its harmful properties or recovery of waste if this is technically and economically feasible, primarily in the form of material and secondarily as energy.
12. Different kinds of waste materials should be handled and stored separately from each other.

6

Emerging techniques

6.1 Waste incineration

Incineration is high temperature oxidation which converts materials into gaseous products and solid residues with a high degree of volume reduction. Recent advances in incineration technologies have made it possible to use an increasing diversity of fuels, such as different kinds of waste.

It is generally accepted that high temperature oxidative technologies are the most effective methods for destroying all organic material including all infectious agents. Furthermore, it is generally assumed that incineration is a completely effective method of destroying TSE-like agents (Commission of the European Communities, 1999).

6.2 Anaerobic digestion of by-products and wastes

Anaerobic digestion is a biological process in which organic matter is degraded to methane under anaerobic conditions. Methane can be recovered in energy production to replace fossil fuels and thereby to reduce carbon dioxide emissions. In anaerobic digestion, releases to air, water, and land from the process can be well controlled, whereas it may treat wet and pasty wastes too (reviewed by Braber, 1995). Most of the nutrients also remain in the treated material and, as in composting, materials can be recovered for agriculture (Salminen *et al.*, 2001).

Recent advances in anaerobic digestion technologies have made it possible to treat an increasing diversity of wastes and wastewaters. Anaerobic treatment is well suited to the treatment of slaughterhouse wastewater. A few full-scale plants operate in slaughterhouses in the Netherlands, Belgium, and New Zealand (reviewed by Johns, 1995), and anaerobic lagoons or covered anaerobic ponds are used to treat slaughterhouse wastewater in warm climates and where land cost is low as in Australia and New Zealand (reviewed by Cooper and Russel, 1992). The technology has not been applied to slaughterhouses in Finland.

Assuming that operation conditions are carefully optimised and economic viability can be achieved, anaerobic digestion competes well also with other treatments of solid slaughterhouse by-products and waste (Banks, 1994; Salminen, 2000; Tritt and Schuhardt, 1992).

Co-digestion of manure and industrial organic wastes, including slaughterhouse waste, takes place in Denmark in a number of anaerobic digestion plants (Danish Institute of Agricultural and Fisheries Economics, 1999). Manure and slaughterhouse waste, including blood, fat, stomach, and visceral contents, and residues from a slaughterhouse, are also being treated anaerobically in a plant in Sweden (Ling, 1997).

Executive summary

The aim of this report is to provide information about Finnish slaughterhouses and installations for the disposal or recycling of animal carcasses and animal waste, including the rendering plants and the fur animal feed production plants, for the preparation of the Best Available Techniques Reference Document (BREF).

The Finnish slaughterhouses slaughter mainly pigs, cattle, and poultry, producing in 1999 about 179, 88.6, and 66.1 million kg of meat, respectively. Rendering plants and fur animal feed production plants treat animal derived waste generated in Finland, totally about 200 million kg/year.

In general, the optimised processes, motivation and participation of the personnel, and regular documented maintenance to keep site equipment and processes in good working order as well as the systematic evaluation of environmental effects throughout the processes and the introduction of control, monitoring, and verification procedures are considered important with regard to the environmental effects of the installations (techniques to consider in the determination of best available technique (BAT)).

The total electricity and heat consumption of the Finnish slaughterhouses vary from 0.18 to 0.74 and 0.16 to 1.0 kWh/kg slaughtered animals, respectively, being the lowest in stand alone slaughterhouses and the highest in plants with integrated meat cutting, deboning, and further processing. The slaughterhouses recover residual heat in-situ up to 0.22 kWh/kg slaughtered animals. The installations should seek every possibility to recover residual heat (a technique to consider in the determination of BAT). The rendering plants consume electricity and heat about 0.07 and 0.8 to 0.9 kWh/kg animal waste, respectively, recovering residual heat up to 0.17 kWh/kg animal waste. The fur animal feed production plants consume electricity about 0.18 to 0.33 kWh/kg animal waste.

The total water consumption of the Finnish slaughterhouses varies from 2.0 to 17.5 l/kg slaughtered animals, the lowest being in stand alone pig and cattle slaughterhouses and the highest in the poultry slaughterhouses and those pig and cattle slaughterhouses with integrated meat cutting, deboning, and further processing. The rendering plants and fur animal feed production plants consume water about 0.44 to 0.51 and 0.31 to 1.67 l/kg animal waste, respectively. Installations should consider the reuse of water when it is possible (a technique to consider in the determination of BAT).

The volume and the characteristics of wastewater from the different installations in the sector and in the different wastewater streams of the processes vary considerably, depending on the water consumption, processes, operations, and practises. Installations should draw attention especially to the avoidance of wastewater load at its source (a technique to consider in the determination of BAT). All the slaughterhouses and most of the installations for the disposal or the recycling of animal carcasses and animal waste discharge their wastewater to the municipal sewer after pre-treatment, whereas some installations located in areas where no municipal sewer lines exist, discharge their wastewater into a nearby natural water body as treated.

The use of boilers to produce hot water and industrial steam is the main source of air emissions in the sector. The installations should consider increasing

the use of heat and electricity produced from renewable energy sources when it is technically and economically feasible (a technique to consider in the determination of BAT). The storage, handling, and treatment of by-products and wastes as well as wastewater treatment and singeing are potential sources of foul odours. The rendering plants use condensers and/ or a biofilter to reduce their air emissions (techniques to consider in the determination of BAT).

Waste management of the installations in the sector is mostly carried out in co-operation with the companies taking care of the transportation of waste and recyclable materials as well as with local municipalities and municipal waste management centres taking care of the collecting, treating, and recycling of waste and recyclable materials. The key environmental aspects with regard to the waste management of the installations are minimising the waste generated as well as the recovery of waste if this is technically and economically feasible, primarily in the form of material and secondarily as energy (a technique to consider in the determination of BAT).

Literature

- Banks, C.J., 1994. Anaerobic digestion of solid and high nitrogen content fractions of slaughterhouse wastes. *Environmentally Responsible Food Processing, AIChE Symp Ser 90*, 48–55.
- Banks, C.J., Wang, Z., 1999. Development of a two phase anaerobic digester for the treatment of mixed abattoir wastes. *Water Sci Technol 40(1)*, 67–76.
- Björklund, K., Lahtinen, M., Rantajärvi, P., Timonen, R., Vertanen, P., Viitasaari, S. 2000. Perquisites for destroying TSE-material and the incineration of animal waste in Finland. 15 p. (in Finnish).
- Braber, K., 1995. Anaerobic digestion of municipal solid waste: a modern waste disposal option on the verge of breakthrough. *Biomass Bioenergy*, 9, 365–376.
- Cooper, R.N., Russel, J.M., 1992. Meat industry processing wastes: characteristics and treatment. In: Hui, Y.H. (Ed.), *Encyclopedia Food Science Technol*, vol. 3., pp. 1683–1690.
- Danish Institute of Agricultural and Fisheries Economics, 1999. Centralised biogas plants – integrated energy production, waste treatment and nutrient redistribution facilities. 30 p.
- The Finnish Environment Institute, 2001, <http://www.vyh.fi/eng/fei/fei.html>
- Johns, M.R., 1995. Developments in wastewater treatment in the meat processing industry: a review. *Bioresource Technol 54*, 203–216.
- Ling, D.T., 1997. A concept for processing carcass together with energy production. In: *Proceedings of the 8th International Conference on Anaerobic Digestion, Japan, Sendai*, vol. 3., 25.–29. May 1997, pp. 436–439.
- The Ministry of Agriculture and Forestry of Finland, 2001. <http://www.mmm.fi/english/>.
- Pulsa, A., 1996. Fur animal farms need slaughterhouse by-products of high quality. *Lihalehti*, 3, 38–41 (in Finnish).
- Salminen, E., 2000. Anaerobic digestion of solid poultry slaughterhouse by-products and waste. PhD thesis, University of Jyväskylä.
- Salminen, E., Rintala, J., Härkönen, J., Kuitunen, M., Högmander, H., Oikari, A., 2000. Anaerobically digested solid poultry slaughterhouse wastes to be used as fertiliser on agricultural soil. *Bioresource Technol 78*, 81–88.
- Commission of the European Communities, 1999. Scientific report on the risks of non conventional transmissible agents, conventional infectious agents or other hazards such as toxic substances entering the human food or animal feed chains via raw material from fallen stock and dead animals (including also: ruminants, pigs, poultry, fish, wild/ exotic/ zoo animals, fur animals, cats, laboratory animals and fish) or via condemned materials. Submitted to the Scientific Committee at its meeting of 24.–25. June 1999.
- Toresen, K., Kjött, N., Herlevsen, S., Pontoppidan, O., Hansen, P.-I.E., 2001. Nordic slaughterhouses BAT document. The Danish Meat Research Institute, Roskilde, Denmark.
- Tritt, W.P., Schuchardt, F., 1992. Materials flow and possibilities of treating liquid and solid wastes from slaughterhouses in Germany. A review. *Bioresource Technol 41*, 235–245.

Documentation page

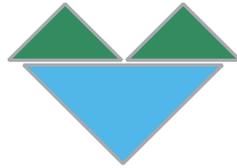
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Title of publication	Finnish Expert Report on Best Available Techniques in Slaughterhouses and Installations for the Disposal or Recycling of Animal Carcasses and Animal Waste	
Parts of publication/ other project publications		
Abstract	<p>The aim of this report is to provide information about Finnish slaughterhouses and installations for the disposal or recycling of animal carcasses and animal waste. The Finnish slaughterhouses slaughter mainly pigs, cattle, and poultry. Rendering plants and fur animal feed production plants treat animal derived waste generated in Finland.</p> <p>The slaughterhouses and installations for the disposal or recycling of animal carcasses and animal waste consume a lot of electricity and heat, whereas they can save energy by recovering residual heat in-situ. Slaughtering consumes a lot of water and produces a high amount of wastewater. Wastewater has a high biological oxygen demand (BOD) because it contains a lot of proteins and fat. To minimize the pollution load it is important to avoid blood and fat entering the drainage. All the slaughterhouses and most of the installations for the disposal or recycling of animal carcasses and animal waste discharge their wastewater to the municipal sewer after pre-treatment. The use of boilers to produce hot water and industrial steam is the main source of air emissions. The storage, handling and treatment of by-products and wastes as well as wastewater treatment and singeing are potential sources of foul odours.</p>	
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Tekijä(t)	Esa Salminen	
Julkaisun nimi	Suomalainen asiantuntijaraportti parhaista käytettävissä olevista tekniikoista teurastamoilla ja eläinperäisten sivutuotteiden käsittelyssä	
Julkaisun osat/ muut saman projektin tuottamat julkaisut		
Tiivistelmä	<p>Tässä BAT-raportissa esitellään menetelmiä, joita käyttämällä voidaan vähentää päästöjä ja energiankulutusta teurastamoilla ja eläinperäisten sivutuotteiden käsittelyssä. Suomalaisilla teurastamoilla teurastetaan lähinnä sikoja, nautoja ja siipikarjaa. Eläinperäisiä sivutuotteita käsitellään Suomessa renderöintilaitoksilla ja turkiseläinrehua valmistavilla rehusekoittamoilla.</p> <p>Teurastamot ja eläinperäisten sivutuotteiden käsittelylaitokset kuluttavat merkittävästi sähköä ja lämpöä. Energiankulutusta voidaan vähentää ja energiatehokkuutta parantaa lämmön talteenotolla. Teurastamoiden vedenkulutus on suuri ja ne tuottavat myös paljon jätevettä. Teurastamoiden ja eläinjätteen käsittelylaitosten jätevesien biologista hapenkulutusta kuvaava arvo (BOD) on vesien sisältämästä rasvasta ja valkuaisaineista johtuen yleensä hyvin korkea. Jätevesikuormituksen vähentämiseksi tulisi erityisesti veren ja rasvojen pääsy jäteveteen pyrkä estämään mahdollisimman tehokkaasti. Suomessa kaikki teurastamot ja useimmat eläinperäisten sivutuotteiden käsittelylaitokset johtavat toiminnassaan syntyvän jäteveden esikäsittelyn jälkeen kunnalliselle jätevedenpuhdistamolle. Ilmapäästöjä syntyy pääasiassa lämmön ja höyryn tuotannossa. Sivutuotteiden, jätteiden ja jätevesien käsittely sekä sikojen karvan poltto ovat mahdollisia hajuhaittojen aiheuttajia.</p>	
Asiasanat	BAT, paras käytettävissä oleva tekniikka, säästävä teknologia, teurastamot, sivutuotteet, jätevedet, orgaaninen aines, hajuhaitat, energiansäästö	
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Författare	Esa Salminen	
Publikationens titel	Den finska expertrapporten om bästa tillgängliga teknik i slakterier och vid behandling av animaliska biprodukter	
Publikationens delar/ andra publikationer inom samma projekt		
Sammandrag	<p>I denna BAT-rapport presenteras metoder med vilka man kan minska utsläppen och energiförbrukningen i slakterier och vid behandling av animaliska biprodukter. I finska slakterier slaktas främst svin, nötkreatur och fjäderfå. Animaliska biprodukter behandlas i Finland i anläggningar för behandling av animaliskt avfall och i anläggningar som blandar foder för pålsdjur.</p> <p>Slakterier och anläggningar för behandling av animaliska biprodukter förbrukar betydande mängder elektricitet och värme. Energiförbrukningen kan minskas och energieffektiviteten förbättras genom att ta till vara värmen. Slakteriernas vattenförbrukning är stor och de producerar också mycket avloppsvatten. Den biologiska syreförbrukningen (BOD) hos avloppsvatten från slakterier och anläggningar för behandling av animaliskt avfall är på grund av fett och proteinerna mycket hög. För att minska avloppsvattensbelastningen borde i synnerhet utsläppen av blod och fett hindras så effektivt som möjligt. I Finland leder alla slakterier och de flesta anläggningarna för animaliska biprodukter sina avloppsvatten efter en förbehandling till det kommunala reningsverket. Utsläpp i luften uppkommer i huvudsak vid produktionen av värme och ånga. Behandlingen av biprodukter, avfall och avloppsvatten sam förbränning av svinhår är möjliga orsaker till luktolägenheter.</p>	
Nyckelord	BAT, bästa tillgängliga teknik, resurssnål teknik, slakterier, biprodukter, avloppsvatten, organisk substans, luktolägenheter, energisparande	
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