9.5.3 Meat Rendering Plants

9.5.3.1 General[1]

Meat rendering plants process animal by-product materials for the production of tallow, grease, and high-protein meat and bone meal. Plants that operate in conjunction with animal slaughterhouses or poultry processing plants are called integrated rendering plants. Plants that collect their raw materials from a variety of offsite sources are called independent rendering plants. Independent plants obtain animal by-product materials, including grease, blood, feathers, offal, and entire animal carcasses, from the following sources: butcher shops, supermarkets, restaurants, fast-food chains, poultry processors, slaughterhouses, farms, ranches, feedlots, and animal shelters.

The two types of animal rendering processes are edible and inedible rendering. Edible rendering plants process fatty animal tissue into edible fats and proteins. The plants are normally operated in conjunction with meat packing plants under U. S. Department of Agriculture, Food Safety and Inspection Services (USDA/FSIS) inspection and processing standards. Inedible rendering plants are operated by independent renderers or are part of integrated rendering operations. These plants produce inedible tallow and grease, which are used in livestock and poultry feed, soap, and production of fatty-acids.

9.5.3.2 Process Description[1-3]

Raw Materials —

Integrated rendering plants normally process only one type of raw material, whereas independent rendering plants often handle several raw materials that require either multiple rendering systems or significant modifications in the operating conditions for a single system.

Edible Rendering —

A typical edible rendering process is shown in Figure 9.5.3-1. Fat trimmings, usually consisting of 14 to 16 percent fat, 60 to 64 percent moisture, and 22 to 24 percent protein, are ground and then belt conveyed to a melt tank. The melt tank heats the materials to about 43°C (110°F), and the melted fatty tissue is pumped to a disintegrator, which ruptures the fat cells. The proteinaceous solids are separated from the melted fat and water by a centrifuge. The melted fat and water are then heated with steam to about 93°C (200°F) by a shell and tube heat exchanger. A second-stage centrifuge then separates the edible fat from the water, which also contains any remaining protein fines. The water is discharged as sludge, and the "polished" fat is pumped to storage. Throughout the process, direct heat contact with the edible fat is minimal and no cooking vapors are emitted. For this reason, no emission points are designated in Figure 9.5.3-1.

Inedible Rendering —

There are two processes for inedible rendering: the wet process and the dry process. Wet rendering is a process that separates fat from raw material by boiling in water. The process involves addition of water to the raw material and the use of live steam to cook the raw material and accomplish separation of the fat. Dry rendering is a batch or continuous process that dehydrates raw material in order to release fat. Following dehydration in batch or continuous cookers, the melted fat and protein solids are separated. At present, only dry rendering is used in the United States. The wet rendering process is no longer used because of the high cost of energy and of an adverse effect on the

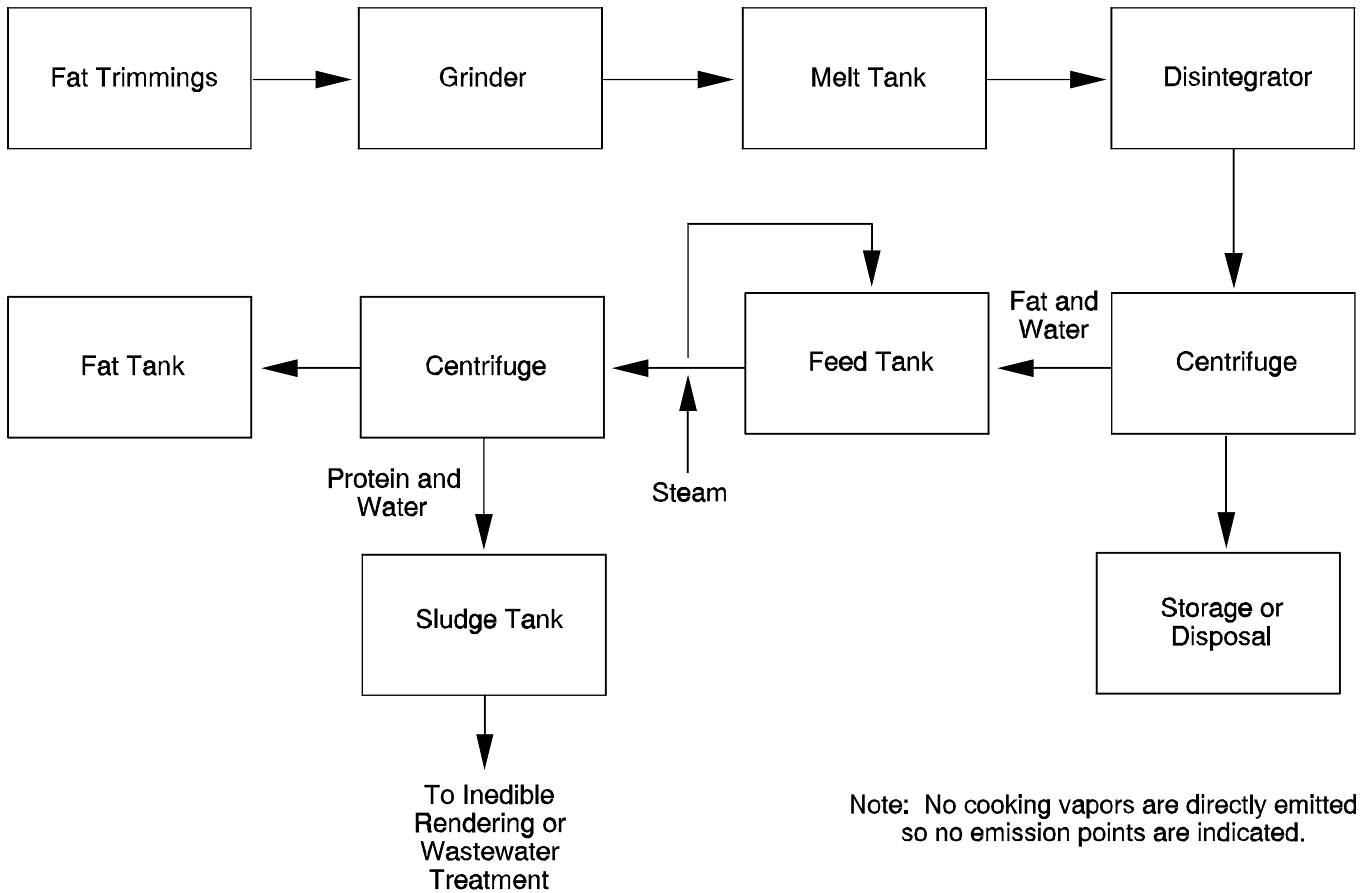

Figure 9.5.3-1. Edible rendering process.

fat quality. Table 9.5.3-1 shows the fat, protein, and moisture contents for several raw materials processed by inedible rendering plants.

Batch Rendering Process —

In the batch process, the raw material from the receiving bin is screw conveyed to a crusher where it is reduced to 2.5 to 5 centimeters (cm) (1 to 2 inches [in.]) in size to improve cooking efficiency. Cooking normally requires 1.5 to 2.5 hr, but adjustments in the cooking time and temperature may be required to process the various materials. A typical batch cooker is a horizontal, cylindrical vessel equipped with a steam jacket and an agitator. To begin the cooking process the cooker is charged with raw material, and the material is heated to a final temperature ranging from 121° to 135°C (250° to 275°F). Following the cooking cycle, the contents are discharged to the percolator drain pan. Vapor emissions from the cooker pass through a condenser where the water vapor is condensed and noncondensibles are emitted as VOC emissions.

The percolator drain pan contains a screen that separates the liquid fat from the protein solids. From the percolator drain pan, the protein solids, which still contain about 25 percent fat, are conveyed to the screw press. The screw press completes the separation of fat from solids, and yields protein solids that have a residual fat content of about 10 percent. These solids, called cracklings, are then ground and screened to produce protein meal. The fat from both the screw press and the percolator drain pan is pumped to the crude animal fat tank, centrifuged or filtered to remove any remaining protein solids, and stored in the animal fat storage tank.

Continuous Rendering Process —

Since the 1960, continuous rendering systems have been installed to replace batch systems at some plants. Figure 9.5.3-2 shows the basic inedible rendering process using the continuous process. The system is similar to a batch system except that a single, continuous cooker is used rather than several parallel batch cookers. A typical continuous cooker is a horizontal, steam-jacketed cylindrical vessel equipped with a mechanism that continuously moves the material horizontally through the cooker. Continuous cookers cook the material faster than batch cookers, and typically produce a higher quality fat product. From the cooker, the material is discharged to the drainer, which serves the same function as the percolator drain pan in the batch process. The remaining operations are generally the same as the batch process operations.

Current continuous systems may employ evaporators operated under vacuum to remove moisture from liquid fat obtained using a preheater and a press. In this system, liquid fat is obtained by precooking and pressing raw material and then dewatered using a heated evaporator under vacuum. The heat source for the evaporator is hot vapors from the cooker/dryer. The dewatered fat is then recombined with the solids from the press prior to entry into the cooker/dryer.

Blood Processing And Drying —

Whole blood from animal slaughterhouses, containing 16 to 18 percent total protein solids, is processed and dried to recover protein as blood meal. At the present time, less than 10 percent of the independent rendering plants in the U. S. process whole animal blood. The blood meal is a valuable ingredient in animal feed because it has a high lysine content. Continuous cookers have replaced batch cookers that were originally used in the industry because of the improved energy efficiency and product quality provided by continuous cookers. In the continuous process, whole blood is introduced into a steam-injected, inclined tubular vessel in which the blood solids coagulate. The coagulated blood solids and liquid (serum water) are then separated in a centrifuge, and the blood solids dried in either a continuous gas-fired, direct-contact ring dryer or a steam tube, rotary dryer.

Table 9.5.3-1. COMPOSITION OF RAW MATERIALS FOR INEDIBLE RENDERING[a]

Source	Tallow/Grease, wt %	Protein Solids, wt %	Moisture, wt %
Packing house offal[b] and bone			
Steers	30-35	15-20	45-55
Cows	10-20	20-30	50-70
Calves	10-15	15-20	65-75
Sheep	25-30	20-25	45-55
Hogs	25-30	10-15	55-65
Poultry offal	10	25	65
Poultry feathers	None	33	67
Dead stock (whole animals)			
Cattle	12	25	63
Calves	10	22	68
Sheep	22	25	53
Hogs	30	28	42
Butcher shop fat and bone	31	32	37
Blood	None	16-18	82-84
Restaurant grease	65	10	25

[a] Reference 1.
[b] Waste parts; especially the entrails and similar parts from a butchered animal.

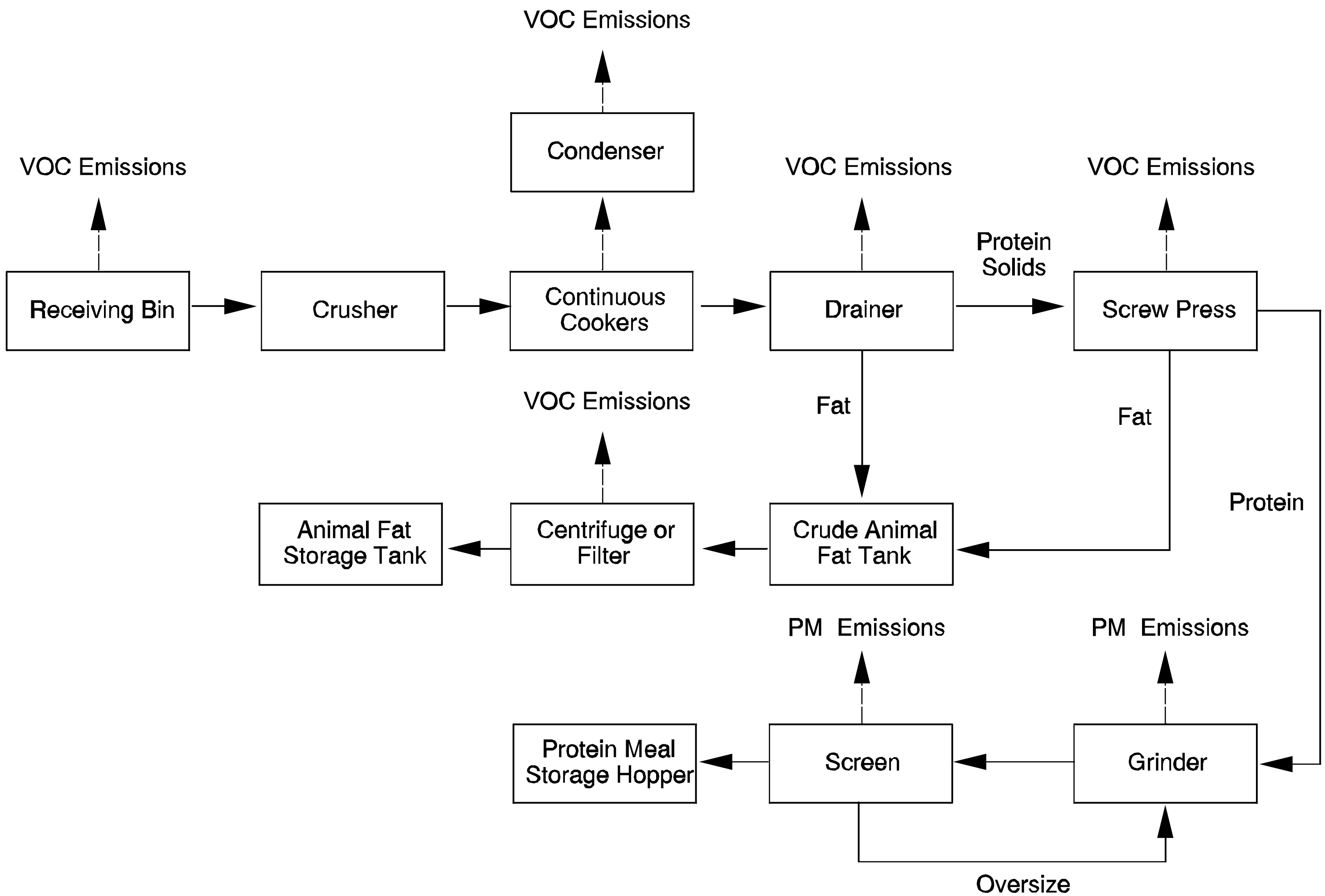

Figure 9.5.3-2. Continuous rendering process.

Poultry Feathers And Hog Hair Processing —

The raw material is introduced into a batch cooker, and is processed for 30 to 45 minutes at temperatures ranging from 138° to 149°C (280° to 300°F) and pressures ranging from (40 to 50 psig). This process converts keratin, the principal component of feathers and hog hair, into amino acids. The moist meal product, containing the amino acids, is passed either through a hot air, ring-type dryer or over steam-heated tubes to remove the moisture from the meal. If the hot air dryer is used, the dried product is separated from the exhaust by cyclone collectors. In the steam-heated tube system, fresh air is passed countercurrent to the flow of the meal to remove the moisture. The dried meal is transferred to storage. The exhaust gases are passed through controls prior to discharge to the atmosphere.

Grease Processing —

Grease from restaurants is recycled as another raw feed material processed by rendering plants. The grease is bulk loaded into vehicles, transported to the rendering plant, and discharged directly to the grease processing system. During processing, the melted grease is first screened to remove coarse solids, and then heated to about 93°C (200°F) in vertical processing tanks. The material is then stored in the processing tank for 36 to 48 hr to allow for gravity separation of the grease, water, and fine solids. Separation normally results in four phases: (1) solids, (2) water, (3) emulsion layer, and (4) grease product. The solids settle to the bottom and are separated from the water layer above. The emulsion is then processed through a centrifuge to remove solids and another centrifuge to remove water and any remaining fines; the grease product is skimmed off the top.

9.5.3.3 Emissions And Controls[1-5]

Emissions —

Volatile organic compounds (VOCs) are the primary air pollutants emitted from rendering operations. The major constituents that have been qualitatively identified as potential emissions include organic sulfides, disulfides, C-4 to C-7 aldehydes, trimethylamine, C-4 amines, quinoline, dimethyl pyrazine, other pyrazines, and C-3 to C-6 organic acids. In addition, lesser amounts of C-4 to C-7 alcohols, ketones, aliphatic hydrocarbons, and aromatic compounds are potentially emitted. No quantitative emission data were presented. Historically, the VOCs are considered an odor nuisance in residential areas in close proximity to rendering plants, and emission controls are directed toward odor elimination. The odor detection threshold for many of these compounds is low; some as low as 1 part per billion (ppb). Of the specific constituents listed, only quinoline is classified as a hazardous air pollutant (HAP). In addition to emissions from rendering operations, VOCs may be emitted from the boilers used to generate steam for the operation.

Emissions from the edible rendering process are not considered to be significant because no cooking vapors are emitted and direct heat contact with the edible fat is minimal. Therefore, these emissions are not discussed further.

For inedible rendering operations, the primary sources of VOC emissions are the cookers and the screw press. Other sources of VOC emissions include blood and feather processing operations, dryers, centrifuges, tallow processing tanks, and percolator pans that are not enclosed. Raw material may also be a source of VOC emissions, but if the material is processed in a timely manner, these emissions are minimal.

In addition to VOC emissions, particulate matter (PM) is emitted from grinding and screening of the solids (cracklings) from the screw press and other rendering operations such as dryers processing blood and feathers. No emission data quantifying VOC, HAP, or PM emissions from the rendering process are available for use in developing emission factors. Only test data for a blood dryer operation were identified.

Controls —

Emissions control at rendering plants is based primarily on the elimination of odor. These controls are divided into two categories: (1) those controlling high intensity odor emissions from the rendering process, and (2) those controlling plant ventilating air emissions. The control technologies that are typically used for high intensity odors from rendering plant process emissions are waste heat boilers (incinerators) and multistage wet scrubbers.

Boiler incinerators are a common control technology because boilers can be used not only as control devices but also to generate steam for cooking and drying operations. In waste heat boilers, the waste stream can be introduced into the boiler as primary or secondary combustion air. Primary combustion air is mixed with fuel before ignition to allow for complete combustion, and secondary combustion air is mixed with the burner flame to complete combustion. Gaseous waste streams that contain noncondensibles are typically "cleaned" in a combination scrubber and entrainment separator before use as combustion air.

Multistage wet scrubbers are equally as effective as incineration for high intensity odor control and are used to about the same extent as incinerators. Sodium hypochlorite is considered to be the most effective scrubbing agent for odor removal, although other oxidants can be used. Recently, chlorine dioxide has been used as an effective scrubbing agent. Venturi scrubbers are often used to remove PM from waste streams before treatment by the multistage wet scrubbers. Plants that are located near residential or commercial areas may treat process and fugitive emissions by ducting the plant ventilation air through a single-stage wet scrubbing system to minimize odorous emissions.

In addition to the conventional scrubber control technology, activated carbon adsorption and catalytic oxidation potentially could be used to control odor; however, no rendering plants currently use these technologies. Recently, some plants have installed biofilters to control emissions.

No data are currently available for VOC or particulate emissions from rendering plants. The only available data are for emissions from blood dryers, which is an auxiliary process in meat rendering operations. Less than 10 percent of the independent rendering plants in the U. S. process whole blood. Table 9.5.3-2 provides controlled emission factors in English units for particulate matter (filterable and condensible), hydrogen sulfide, and ammonia from natural gas, direct-fired blood dryers. The filterable PM was found to be 100 percent PM-10. Emission factors are calculated on the basis of the weight of dried blood meal product. In addition to natural gas, direct-fired dryers, steam-coil, indirect blood dryers (SCC 3-02-038-12) are also used in meat rendering plants. No emission data were found for this type of dryer. The emission control system in Reference 4 consisted of a cyclone separator for collection of the blood meal product followed by a venturi wet scrubber and three packed bed scrubbers in series. The scrubbing medium for the three packed bed scrubbers was a sodium hypochlorite solution. The emission control system in Reference 5 was a mechanical centrifugal separator.

Table 9.5.3-2. EMISSION FACTORS FOR CONTROLLED BLOOD DRYERS

EMISSION FACTOR RATING: E

Pollutant	Emissions, lb/ton[a]
Filterable PM-10[b] (SCC 3-02-038-11)	0.76
Condensible PM[b] (SCC 3-02-038-11)	0.46
Hydrogen sulfide[c] (SCC 3-02-038-11)	0.08
Ammonia[c] (SCC 3-02-038-11)	0.60

[a] Emission factors based on weight of dried blood meal product. Emissions are for natural gas, direct-fired dryers.
[b] References 4-5.
[c] Reference 4.

References For Section 9.5.3

1. W.H. Prokop, Section on rendering plants, in Chapter 13, "Food And Agriculture Industry", *Air Pollution Engineering Manual*, Van Nostrand Reinhold Press, 1992.

2. H.J. Rafson, *Odor Emission Control For The Food Industry*, Food And Technology, June 1977.

3. *Emission Factor Documentation for AP-42 Section 9.5.3, Meat Rendering Plants*, EPA Contract No. 68-D2-0159, Midwest Research Institute , Kansas City, MO, September 1995.

4. *Blood Dryer Operation Stack Emissions Testing*, Environmental Technology and Engineering Corporation, Elm Grove, WI, September 1989.

5. *Blood Dryer Particulate Emission Compliance Test*, Interpoll Report No. 7-2325, Interpoll Laboratories, Inc., Circle Pines, MN, January 1987.