THE MEAT INDUSTRY'S RESPONSIBILITIES IN POLLUTION CONTROL*

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Introduction

Meat packers have, of necessity, practiced pollution control since the first centralized abattoir replaced on-the-farm animal slaughtering and dressing. Unlike many other processors and manufacturers, the packer must contend with raw materials, i.e., living animals, endowed by nature with gross amounts of by-products unsuitable for human consumption. The magnitude of the problem is demonstrated by the fact that, at best, 65 to 70% of the live weight of a meat animal can be converted to edible meat products; at least 30% of the weight of a slaughtered animal represents a potential pollution load. Modern abattoirs, processing as many as 200 cattle or 600 hogs per hour are capable of producing quantities of offal, which--if not converted to useful by-products--would impose tremendous pollutional loads on the environment.

To meet this challenge, and to realize maximum economic yield from every live animal purchased, the industry has developed in-plant controls and procedures which have dramatically decreased the pollution potential from animal slaughter and dressing.

Inedible offal, bones, entrails, etc., are rendered to produce tallow and animal feeds; blood and hooves are converted to glues and other products; hides are converted to leather; protein-bearing "stick waters" are concentrated to form animal food products. The importance of these and other in-plant controls is emphasized by the fact that although the national average of pollutants resulting from slaughtering operations is 10 to 12 pounds per 1,000 pounds of live weight kill, values are low as 5 to 6 pounds have been consistently obtained from properly designed and carefully operated abattoirs.

Despite realization of significant reductions in pollutional loads by the industry by adoption of intensive in-plant control measures, the number of animals slaughtered in this country results, inevitably, in pollutant loads which require ex-plant treatment to comply with current state and federal water and air control requirements. In addition, certain of the in-plant control practices generate smaller, but significant amounts of wastes which must be further controlled. Table 1 tabulates the pollution potential of the varied operations included in the category of "meat packing and related operations."

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TABLE 1. POLLUTION POTENTIALS IN MEAT PACKING AND RELATED OPERATIONS
CURRENT (C) AND POTENTIAL (P) POLLUTION PROBLEMS

	Water-borne										Air-borne				Solids disposal		
	Nutrients (N&P)	B.O.D. (Organic matter)	Suspended solids	F.O.G. (Fats, oils, grease)	Emulsions (F.O.G.)	pH	Dissolved inorganic solids	Fecal coliform bacteria	Sanitary wastes (personnel)	Surface water run-off contamination	Smoke	Particulate matter	Toxic gases	Nuisance odors	Paunch manure	Trash	Ground manure
Abattoirs	C	C	C	C	C	P	C	C	C	C	C*	C*	C*	C	C	C	C
Fabricating/processing	C	C	C	C	C	P	C		C		C*	C*	C*	P		C	
Canning	C	C	C	C	C	P	C		C		C*	C*	C*			C	
Smokehouses	C	C	C	C	C	P	P		C		C	C	P	C		C	
Rendering/blood drying	C	C	C	C	C				C		C*	P		C			
Holding pens/feedlots/ poultry ranges	C	C	C				P	C		C				C			C
Hide curing	C	C	C	C	P		C	P	C					P			
Stick water drying	C	C	P	P					C					C			
Feed/fertilizer production	C	C	P	P	P				C			C		C		C	

* Indicates actual or potential air pollution problems resulting from coal or oil fuel firing of boilers.

Appendix 1 defines the nature of some of the common pollutants cited in the table and specifies the limiting concentrations on their discharge frequently specified by municipal and state agencies.

Abatement practices currently employed in packing plants for control of water, air and solid wastes are separately outlined hereafter. Also included is a section outlining pollution problems which--at this time--have not been resolved satisfactorily.

Water-Borne Pollutants Control

The degree of treatment required for control of water-borne wastes discharged from packing plants is determined by the point of discharge. Many plants in urban areas contract with the municipality for ultimate disposal of waste materials remaining after in-plant control; the municipality conventionally levies a surcharge based on hydraulic load adjusted for Biochemical Oxygen Demand (BOD), suspended solids (SS) and chlorine demand, and processes the waste water in a combined municipal-industrial sewage treatment system. The municipality accepts the responsibility of meeting limits for surface water discharge applied by the state pollution control agency to the body of water, or sector of that body, designated as the receiving stream. Less stringent requirements usually apply to packing house discharges consigned to municipal treatment systems.

In non-urban areas where municipal plants cannot be utilized, packing houses must provide the equivalent of municipal treatment, i.e., primary, secondary and sometimes tertiary treatment, plus chlorine disinfection, for direct discharge to surface waters.

BOD, FOG, SS Reduction

Primary treatment includes screening, sedimentation or flotation to reduce (and recover) these offending substances. When discharge is to a municipal system, no further BOD reduction measures are usually applied.

When direct discharge of waste waters to surface courses is practiced, substantially higher levels of treatment are required; secondary biological treatment methods include:

1. Anaerobic digestion (anaerobic contact process).
2. Anaerobic (naturally aerated) aerobic lagoon process.
3. Aerobic digestion (activated sludge processes).
4. Trickling filter processes.

Except for substantially higher concentrations of BOD, FOG and SS, packing house wastes are very similar to domestic (municipal) wastes and respond to similar treatment methods.

Most municipalities accepting packing house wastes for treatment limit the FOG content to no more than 100 ppm, although substantially higher concentrations (400-600 ppm) are readily digested in activated sludge treatment systems. With the need for scrupulous cleaning practices to meet MIS sanitation standards, detergents capable of emulsifying fats are more widely used. Meat packers discharging to municipal systems cannot readily remove stable FOG emulsions in standard separation equipment without the use of auxiliary, emulsion-breaking chemicals.

pH Control

Control of pH to meet municipal standards is a problem only when excessive amounts of alkalis and detergents in sanitation procedures are utilized (high pH). Formulation changes, and/or revised cleaning procedures can be instituted to control pH.

Dissolved Inorganic Solids Control

Dissolved solids limits imposed on municipal and direct discharges are of concern primarily in hide curing operations where periodic discharge of saturated sodium chloride brines occur. Pickling solutions utilized in preparation of some smoked meats are occasionally responsible for over limit discharges. In these instances resolution requires storage facilities and controlled discharge of the spent curing and pickling solution over the period of time required to equalize the discharged load. No other resolution is technically feasible.

Nutrients Control

Nutrients discharged from packinghouse operations are primarily organically combined nitrogen and phosphorous compounds which are converted in biological waste treatment systems to inorganic forms capable of accelerating algae and other plant life growth.

Packinghouse waste waters are rich in nutrient precursors and no economically practical process is currently available for removal of nitrogen and/or phosphorous.

Fecal Coliform Bacterial Contamination

The potential for contamination of receiving waters--which are also used for public recreation (fishing, swimming, etc.) purposes--by enteric bacteria may require disinfection of such wastes before discharge. This requirement applies to wastes discharged from abattoir operations and holding pens (fecal contaminants) and those in which plant personnel sanitary wastes are combined with the process waste before treatment and discharge. Although fecal

coliform and other organisms do not multiply in sewage treatment plants, they are not totally destroyed; when coliform counts exceed specified limits, chlorine or equal treatment may be required to disinfect the effluent before discharge. Wastes consigned to joint municipal/ industrial treatment systems generally do not require disinfection beforehand, as most municipalities final treat digested wastes with chlorine to meet state standards.

Air-Borne Pollutants Control

Air pollution control requirements in the meat packing industry may be classified into four major categories:

1. Those common to any industry using fossil fuels for generation of steam, i.e., smoke and particulate matter (ash). Where high sulphur fuels are employed, control of toxic gases, primarily sulphur dioxide, must also be practiced. Incineration of trash (paper, plastics, shipping containers, etc.) incidental to industry operations is included in this category.

2. Process dusts from operations related to meat packing operations, such as animal feed and bone meal processing.

3. Odors classified as "nuisance odors" from inedible rendering, blood drying and protein concentrating operations, and from feedlots, holding pens and paunch and ground manure storage areas, or even from the anaerobic digestion basins utilized to control water-borne process wastes from abattoir operations.

4. Smoke, grease aerosols, toxic gases and odors peculiar to operation of sausage and provision smokehouses.

In a recent survey of air control regulations either enacted by state agencies, or under active consideration, it was evident that most of the more highly industrialized states have enacted regulations directed toward control of combustion emissions and process dusts, and that many of the predominantly agricultural states are rapidly adopting similar controls. Regulations defining the control of non-toxic, but "nuisance," odors were much less prevalent, but a scattering of regulations centered in states and towns with historically severe pollution problems, e.g., California and St. Louis, were documented. In many instances these regulations were designed to meet specific problems of a particular area; other local and state agencies, attempting to enact control legislation, have frequently proposed and adopted such existing codes without extensive evaluation to establish the real necessity for, or applicability of, such stringent and restrictive control measures in their own rural, agricultural or less highly industrialized areas. In a few

instances, the technique for control, rather than the objective of control, has been written into the ordinance. As a result, meat packing and related industries face difficult and costly measures in complying with currently existing and proposed air pollution control regulations.

Thirty-five states have promulgated, publicly heard, and adopted regulations covering controls restricting the more obvious air pollutants (e.g., smoke, particulate matter, incineration or open burning, etc.).

Two states have adopted general regulations, with delegation of authority to enact specific regulations to designated air basin districts within the state itself, so that the rules finally adopted answer the needs peculiar to the affected area.

Only thirteen states are either in the process of adopting general and specific regulations or report that such regulations "are being prepared and will be adopted shortly."

Every state contacted has indicated that specific regulations aimed at control of harmful and/or particularly offensive emissions from industrial operations will be adopted; in addition, municipalities and counties are enacting similar rules, which in many instances are more stringent than state law.

The incidence of discharge of air pollutants within these four categories by meat packing and meat packing-related operations is defined hereafter, and abatement measures developed for control are examined and evaluated.

Table 1 summarizes the sub-processes within the industry which are capable of discharging contaminants in violation of currently existing or proposed rules and regulations of states, air shed districts, municipalities, or counties.

Combustion (Boiler Operations)

Pollution control problems in the steam and/or power generating area of the packing plant are those common to any industry using fossil fuels, i.e., smoke and particulate matter (ash). Where high sulphur content fuels are employed, control of toxic gases, primarily sulphur dioxide, must also be practiced.

36 states have adopted regulations limiting smoke (Ringlemann opacity limit) and particulates (fly ash) discharges; all of the major cities and many moderately sized municipalities have enacted equivalent limits.

Because the techniques proposed for removal of sulphur dioxide from stack gases have not been fully confirmed on a practical scale

for a qualifying period of time, few stack emission limits have been fixed by state, city or county agencies; limits are indirectly established, however, by fuel specifications limiting the percentage of sulphur in fuels. When the technical feasibilities of the gas cleaning methods proposed are proved, regulations prescribing the controlling limits on the use of high sulphur fuels will be established.

Conventional measures commonly employed to control air pollutants from fossil fuel-fired systems include:

1. Scrubbers or electrostatic precipitators for reduction of smoke and particulates.

2. Conversion of coal or heavy oil firing to light oil or gas fuel firing to reduce smoke and particulates to acceptable levels.

3. Use of low sulphur coal and oil, or of gas, to eliminate sulphur dioxide emissions.

Inasmuch as dry scrubbers and precipitators have little effect on sulphur dioxide, plants which install such devices to meet current smoke and ash particulates limits will require additional sulphur dioxide control equipment when limits on stack emissions become applicable. The obvious total resolution to both requirements is conversion to the use of lighter oils of low sulphur content, or to gas fuel. Conversion to total gas firing is dependent on ability to contract for non-interruptible service.

Incineration/Open Burning (Trash Disposal)

Combustible trash (paper, packing cartons, pallets, etc.) which is generated incidental to abattoir and related processing operations will require disposal by techniques which eliminate the smoke, particulates and odors discharged from open burning, the prevalent method at this time; 35 states have already prohibited open burning, and an additional 8 are proposing similar prohibitions at this time. The remaining 7 are in the process of drafting equivalent rules. Additionally, those states prohibiting open burning of combustibles prescribe that incinerators for on-site trash disposal must be of the multiple chamber type, with a supplementary fuel-fired section (afterburner) to assure compliance with Ringelmann opacity standards.

Compliance with the ban on open burning of trash requires:

1. Incinerators of approved design, including afterburners, for on-site disposal.

2. Disposal via scavenger in land-fill operations.

Land-fill disposal is widely practiced by municipalities, and the number of suitable disposal sites is decreasing as the growth of urban areas progresses. Land-fill disposal is, therefore, an interim solution for industries and municipalities alike; the long term resolution appears to be incineration in properly controlled equipment.

Particulates Discharge from Process Operations (Fertilizers, Feeds Preparation)

The allowable discharge of particulates from any industrial processing operation in which reacting, drying, or pelletizing of a product is carried out is currently regulated by 26 states. Approximately 15 others have proposed similar restrictions and are at the public hearing stage. In general, the process weight rate limits applied restrict particulates discharge per hour to a fraction of the product being processed; the fraction varies from 0.005% (in high capacity operations) to 0.5% (in operations where less than 100 pounds of product is produced hourly).

Discharge of particulates from packing house-related operations is generally confined to bone meal processing, animal feeds preparation, etc.; occasionally improperly operated blood drying facilities may discharge particulates.

Process dusts control requires:

1. Dry dust collectors (bag houses, dry cyclones, precipitators, etc.) where the product dust is recovered.

2. Wet collectors (wet cyclones, venturi scrubbers, etc.) where the product dusts are captured in water sprays.

Unless the effluent quality limit requires wet scrubbing, dry collection systems are preferred; not only is product recovered, but the possibility of creating a water pollution problem is eliminated.

Smokehouse Operations

Modern smoking operations result in discharge to the atmosphere (in certain portions of the total cycle) of moisture, excess smoke and grease aerosols, plus a variety of organic acids, aldehydes, ketones, phenols and tars or resins. Some of the latter substances are highly odorous and irritating to the eyes. The complex nature of smokehouse emissions control (smoke, odor, particulates and potentially toxic gases) is recognized by 4 states which have already enacted specific smokehouse regulations. In addition, another 18 are considering similar rules. Those states which are not considering specific smokehouse emission laws rely on the general Ringelmann opacity limit for control.

Typically, the smokehouse control regulation reads:

"All meat smokehouses or groups of meat smokehouses which consume in excess of 10 pounds of wood or sawdust per hour shall be equipped with gas cleaning devices or shall be controlled in such manner that the particulate matter in the gas discharged to the atmosphere shall not exceed 0.10 grain per standard cubic foot of exhaust gas (adjusted to 12% CO_2)."

Applicable smokehouse emissions control techniques include:

1. Electrostatic precipitators--primarily for smoke and grease particulates control.

2. Wet scrubbers--for partial smoke, grease, and odor control.

3. Direct flame incineration in (gas-fueled) thermal incinerators--for essentially complete control.

Of the three techniques, the wet scrubbing system has the lowest first cost and operating cost. It is the least effective, however, in reducing smoke, grease aerosols, odors, and the water insoluble tars and acids, etc.

Electrostatic precipitators are generally substantially higher in initial cost, but are much more economically operated than fueled thermal incinerators. Comparative analytical data indicate that the afterburning and electrical precipitating techniques obtain approximately equal removals of smoke, particulates and other solid matter; the precipitator has little effect on odors and volatilized organic contaminants, however, so that thermal incineration is frequently selected as the first choice method, despite greater operating cost. The maintenance requirement of afterburners is somewhat less than that required by precipitators.

Odor Discharge from Process Operations (Rendering, Blood-Drying, etc.)

Only 8 states have adopted regulations specifically directed to rendering and other "animal matter reduction" operations. On the other hand, more than 30 have general "nuisance odor" rules which may be effectively applied to control of odorous emissions associated with common meat packing-related processes, inedible rendering, blood drying, stick water evaporation and feeds formulation and drying.

In a few instances, state and municipal laws specify the technique by which control of vapors from reduction operations shall be achieved, typically stating that:

> No person shall operate any device for the inedible rendering of animal matter unless all gases, vapors and gas-entrained effluents from such processes are thermally incinerated at 1300°F for not less than 0.3 second.

The incineration temperature and dwell time varies somewhat with different regulatory agencies, but the intent--thermal incineration--is common to all. The rule was originally promulgated to control odors from operations of the renderer who collects aged stock (meat and tallow scrap, dead animals, etc.); however, as written it allows no differentiation and applies equally to the meat packer who daily renders the fresh offal produced from the slaughtering and processing conducted that day.

Odors discharged from inedible rendering, blood drying, and stick water evaporation may be successfully controlled by:

1. Condensation of the odor-bearing steam vapors in heat exchangers, or (waste-water operated) scrubbers or counter-current heaters, or by air cooled exchangers.

2. Chemical oxidation of odor bodies in the steam vapor with ozone.

3. Chemical oxidation of odor bodies by vapors condensation in wet scrubbers using oxidants, e.g., permanganate solution.

4. Deodorization or odor neutralization with odor reactants.

5. Condensation of steam vapor and incineration of the odorous non-condensibles remaining in (gas fueled) direct thermal incinerators or catalytic combustion incinerators, or as primarily air to boiler operation.

6. Direct flame incineration in (gas-fueled) thermal incinerators.

Odor Discharge, Miscellaneous Operations

There are no state regulations at this time specifically directed to control of odors emitted from holding pens, from paunch manure and ground manure storage areas, or from anaerobic lagoons which may be used in treating the slaughter plant's liquid wastes. However, the nuisance odor regulation cited earlier is sufficiently broad to include odors from these sources; similar municipal and county "nuisance" regulations and ordinances are equally applicable.

No completely adequate control measures for odors discharged from the large, exposed areas of animal holding-pens or of anaerobic liquid waste lagoons have been developed. Control of odors from accumulations of ground and paunch manures is equally difficult:

1. The best current practice for holding-pen odor control is a program involving frequent dry-cleaning and water-washing of pre-cleaned pen areas. Permanganate treatment of cleaned pens, or application of odor counteractants, improve overall control, but even these combinations may fail to control pen odors to the satisfaction of urban neighbors.

2. The large volumes of paunch and ground manures associated with even moderate size abattoirs make incineration disposal economically impractical. Field fertilization, or land-fill operation are currently the best disposal practices, but are not final resolutions.

3. Anaerobic lagoon odors are usually caused by sulfate-reducing organisms which reduce any sulfate ions naturally present in the raw water supply, or introduced in process operations, to volatile hydrogen sulfide and/or mercaptans; a water supply containing over 200 mg/liter of sulfate is on the threshold of producing sulfide odors. An adequate "cover" mat of straw and grease over the waste water will minimize, but not eliminate, odor dissipation.

Solids Disposal

Trash Disposal

Requirements for disposal of plant trash and rubbish have been presented in the previous section; incineration or sanitary landfill of trash and other dry refuse are the two primary methods for disposal.

Paunch Manure, Ground Manure, Hair Disposal

The large volumes of paunch and ground manures associated with even moderately sized abattoirs make disposal by incineration economically impractical. Field fertilization, or landfill operation currently represent the best disposal practices, but are not final resolutions. Efforts to recover and reuse paunch content as animal feeds are meeting with some success, but it is apparent that whole paunch (including the liquid fraction from "dry" opening of the rumen) will not serve as a growing ration without supplementary feed

materials. Further study of the use of paunch content as cattle, hog, poultry and fish feeds is being conducted by several major packers.

Disposal of waste hog hair presents a similar problem; the loss of the market for hair in the upholstery industry requires that this waste be either recovered by hydrolysis and addition to renderable stock, or disposed of by land-fill techniques. Neither resolution is complete.

Waste Plant Solids Disposal

The recovery and consignment of floating fats from pre-treatment (clarification) equipment to rendering operations permits the economic disposal of this fraction of packinghouse wastes.

The settleable portion of such plant wastes, however, presents an acute problem:

The underflow from clarification equipment contains, at best, about 3 to 4% solids by weight. This slurry cannot be economically rendered, and common practice is wet land-filling. With increasing opposition by county and state agencies to wet fills, which pose obvious problems of ground water contamination, and of runoff contamination, rough dewatering of underflow solids is being attempted in newer plants; the thickened, semi-dry solids discharged from dewatering screens, centrifuges, or vacuum filters are rendered, with the filtrate consigned to the municipal or plant biological secondary treatment.

Pollution Control Expenditures

Table 2 tabulates capital expenditures of the industry for actual and projected pollution control facilities in the five year period from 1969 through 1973. These data were obtained from a survey of the members of the American Meat Institute, the Western States Meat Packers Association, and the National Independent Meat Packers Association in late 1970. The total industry figures were projected from returns by the 200 plants from which information was obtained. It can safely be assumed that expenditures of the industry for both privately owned and shared facilities will exceed $25 to 30 million annually for the next three years.

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It is apparent from this presentation that the majority of water, air and solids disposal problems resulting from meat packing and related operations can be resolved with currently available technology, provided that funds for control are available and can be economically justified. A smaller number of problems exist for which no complete practical resolution has yet been found, but investigations are proceeding in these areas.

TABLE 2. CAPITAL EXPENDITURES FOR POLLUTION CONTROL

Year	200 Plants Responding	Estimate, Total Industry
Direct Capital Expenditures		
1969	$7.05 million	$21.15 million
1970	7.02	21.06
1971	8.32	24.96
1972	7.25	21.75
1973	6.68	20.04
Joint Industry/Municipality Capital Expenditures, Shared Facilities		
1969	$3.28 million*	$31.12 million*
1970	4.76	19.04
1971	1.13	4.52
1972	2.13	8.52
1973	1.69	6.76

* Industry share.

APPENDIX 1

DEFINITIONS OF AIR, WATER, SOLID POLLUTANTS; CURRENT DISCHARGE LIMITS

Biochemical Oxygen Demand (BOD) -- An indirect measurement of biologically degradable organic matter present in a waste water, as determined by the amount of dissolved oxygen in the water which is required by bacteria/protozoa in consuming the organic food-stuff present. The test is made by diluting samples of the waste with oxygen-saturated water, inoculating with biological "seed" and incubating at 37°C for 5 and 20 days. BOD_5 is the usual value reported; BOD_{20} (ultimate) usually equals the COD (Chemical Oxygen Demand), a shortcut dichromate oxidation chemical method requiring 1 to 4 hours to perform. BOD_5 roughly equals the ODI (Oxygen Demand Index), a modified dichromate oxidation method.

Domestic sanitary waste is considered to have a BOD_5 of 250 ppm (mg/l). Abattoir wastes average 500 to 2000 ppm after primary settling.

Municipal treatment plants accepting process wastes generally levy a surcharge for treatment of 2 to 20¢ per pound of BOD over the domestic level.

The BOD_5 limit for direct discharge to intra- and interstate rivers ranges from 3 to 40 ppm, depending on flow and assimilation capacity of the receiving water.

Total Suspended Solids (TSS) -- The total floating, suspended, settling particulates present in a waste water; determined by filtration and drying at 103°C. TSS are further divided into volatile suspended solids (VSS), the organic fraction, and non-volatile suspended solids (NVSS), the inorganic fraction, by ignition at elevated temperatures.

Domestic waste is considered to have a TSS content of 300 ppm typically. Abattoir wastes average 500 to 1500 ppm after primary settling.

Municipal treatment plants accepting process wastes levy surcharges of 2 to 15¢ per pound of TSS over the domestic level for treatment of industrial wastes.

The TSS limit on direct discharge to intra- and interstate rivers ranges from 5 to 30 ppm.

Fats, Oils, Greases (FOG) -- FOG is empirically measured by solvent extraction of the waste water with hexane, ether, etc. The procedure measures both animal/vegetable glyceride esters and mineral (hydrocarbon) oils, plus a host of organic materials which are not true FOG substances.

Municipal sewage treatment plants generally prohibit discharge of industrial wastes at FOG levels higher than 100 ppm.

Direct discharges to receiving waters generally must be "free of visible floating oil, and not to exceed 15 ppm."

Abattoir wastes range from 400 to 1000 ppm after grease skimming. Where emulsifying agents (detergents, etc.) are co-discharged, or are employed in clean-up operations, FOG levels approach the upper level reported.

pH -- Sewage treatment plants generally prohibit acid or alkali discharges below 5 or above 9. State levels are in the same range. Packing plant discharges generally fall within the specified ranges; exceptions include discharges from foods and chemicals processing plants during clean-up operations.

Total Dissolved Solids (TDS) -- The total soluble organic and inorganic materials present in a waste water; determination is made by evaporating a filtered sample to dryness at 103°C. Ignition of this residue differentiates between volatile dissolved solids (VTDS), or soluble organic matter, and non-volatile (NVTDS), or inorganic solubles. Evaporation of a non-filtered sample at 103°C reports the total solids (TS) and includes suspended and dissolved matter. Ignition of the residue reports the volatile total solids (VTS), or organic fraction, and the non-volatile total solids (NVTS), or inorganic ash fraction.

Municipal sewage plants generally prohibit NVTDS or NVTS at levels exceeding 1000 to 2000 ppm. The volatile (organic) fraction limit is coincidentally fixed by BOD, FOG, etc., limits.

Direct surface discharge limits generally fix TDS levels at 500 ppm (above the raw water supply TDS) as a monthly average, and at no more than 750 to 1000 ppm for 24 hour periods.

Packing house operations may exceed TDS limits for direct discharges, occasionally for sewage plant discharges; examples include:

1. Hide curing brine discharge.

2. Meat pickling brines.

3. Holding pens runoff (dissolved and suspended).

Smoke -- The opacity of suspended particles in gases discharged from combustion is generally measured by the arbitrary Ringelmann Method. The usual limit in urban areas is Ringelmann 2. Coal (and occasionally oil) fired boilers discharge in excess of this value unless control equipment (scrubbers, cyclones, precipitators) is applied.

Almost all older, coal-fired, packing plants will violate the Ringelmann 2 value.

Particulate Matter -- The amount of suspended solids present not only in combustion gases but in process emissions, e.g., fertilizer manufacture, feed drying, smoke house operations, blood drying, etc.

Rigorous regulations requiring application of extensive wet scrubbing apparatus, thermal incineration, etc., have been enacted by many states, counties, cities.

Toxic Gases -- Substances discharged from combustion apparatus and process operations considered to be harmful to human, animal or plant life. Sulphur and nitrogen oxides, halogens and halogen acids, etc., are typical examples.

Agency limits vary widely at this time, but will ultimately narrow and reduce allowable limits. With few exceptions, packing plants in violation are those using coal, or oil, for boiler operations.

Nuisance Odors -- Odorous discharges into the ambient air which extend beyond the "fence line" and "adversely affect human comfort and enjoyment of life," etc.

Few state agencies have promulgated specific regulations, but discharges of this type are broadly defined by city, county nuisance ordinances. Almost all packing houses are subject to violation of such ordinances (rendering, blood drying, smoking, holding pens, feed drying).

Surcharges -- Fees charged by municipal or private sewage treatment systems for acceptance and treatment of industrial wastes which are of "higher strength" than domestic wastes. Surcharges are applied to four categories of high strength wastes:

1. Hydraulic Load; rate varies from 2 to 10¢/1000 gallons.

2. BOD Load; rates vary from 1 to 20¢/lb. BOD.

3. TSS Load; rate varies from 2 to 15¢/lb. TSS.

4. Chlorine Demand; rate variable with chlorine cost, but ranges from 2 to 5¢/1000 gallons.

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J. F. PRICE: Thank you, Dr. Hesler. I would like to ask Dr. Bryan to join Hesler at the discussion table. In leading off the discussion it is brought to mind the increasing thought that occurred at Michigan State University by an esteemed lecturer in agriculture, who predicts that inevitable with the continued growth in humans we will come to a point where there will be wide-spread famine in the world. A need for protein sources and the need for a uniform distribution system will become critical and require our strict attention. On the other hand, there are a number of people who are talking much about the green revolution--the advance in technology we have experienced--to produce more food for an expanding population. In their judgement the only problem is distribution. To lead off the discussion I would like to ask a question and make a comment that just before the green revolution gives its last gasp and we enter into this famine situation, widespread starvation, is it going to be worth living in the environment that exists? So it seems to me the challenge faces each of us. We must try to preserve or salvage all the usable protein and precious animal products for our human population and at the same time enjoy some sort of quality of life as far as our environment is concerned. I open it up for discussion. Is there any individual specific question or comment directed to either of the speakers?

UNIDENTIFIED SPEAKER:

J. F. PRICE: Which single operation contributes the most?

J. C. HESLER: I think there is no question about that. It is the slaughtering and dressing operation which is the greatest contribution to water pollution.

NOTE: Balance of tape of discussion could not be transcribed.

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