Disinfecting Garbage in Truck Bodies By Direct Steam Injection

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FEEDING of raw garbage has been shown to be the primary mode of transmission of trichinosis in swine (*1*) and thus is indirectly the source of human infection. It is felt that this practice contributes greatly toward the dissemination and perpetuation of other swine diseases.

The escape of vesicular exanthema, a highly contagious swine disease, from its two-decade isolation in the swine herds of California and its subsequent wildfire spread through the herds of the Nation have further motivated a critical review of the practice of feeding garbage to swine. The exact path the disease followed from the time it escaped from California until it was detected among swine at a hog cholera serum plant in Nebraska was investigated by the United States Department of Agriculture and various State agencies concerned. Indications were that garbage containing infected pork scraps had been fed raw to swine at a farm in Wyoming and that infected animals had been shipped to other areas of the country before the disease was recognized. As of May 1953, 468 of 493 herds in which the disease had appeared had been fed raw garbage, and outbreaks had occurred in 41 States (*2*).

The work of Wright and Bozicevich (*3*) showed that the worm *Trichinella spiralis*, the infectious agent in trichinosis, could be destroyed or made nonviable by subjecting pork scraps containing the organism to adequate heat. The degree of heat that constitutes adequate treatment will depend upon the thickness of the pork scraps and the duration of heat. Experiments have shown that the actual temperature required throughout the mass to destroy *Trichinella spiralis* is 131° F. (*4*) and a temperature of 145° F. maintained for 30 minutes is thought to render the virus of vesicular exanthema nonviable (*5*). However, the work of Wright and Bozicevich (*3*) led to the conclusion that for practical purposes disinfection of the garbage by boiling for 30 minutes was desirable and that this degree of heat treatment is sufficient to "effect the destruction of trichina larvae in pieces of pork up to 3 inches in thickness and probably in pieces of pork of greater thickness provided the garbage is allowed to cook gradually." This statement is the basis for general recommendation that all garbage be boiled for at least 30 minutes prior to feeding to swine unless some other manner of disinfection is approved by health or agricultural authorities concerned as being equally effective.

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The application of this heat treatment principle on a nationwide basis in England and Canada tends to substantiate the experimental work. In these two countries, where garbage is cooked prior to swine feeding, most swine diseases have practically disappeared and the incidence of trichinosis in humans is estimated to be only about 1 case in 75 persons (*6*). In the United States, where raw garbage is used as swine feed, the incidence of trichinosis in humans is estimated to be 1 case in 6 persons (*7*). More accurate figures on the prevalence of this disease are not available due to its many manifestations and the absence of a specific diagnostic confirmation other than recovery of the organism by biopsy.

If garbage, a valuable waste product of the American home, is to continue to be reclaimed in the form of pork, some economical method of disinfecting it must be found.

At the present time the general feeling among the swine farmers of the country is that an installation which could provide the necessary heat treatment of garbage in the truck in which it was collected would be most practical. This procedure would eliminate the necessity of rehandling the waste and would thus be a saving in time and labor. In order to ascertain if such treatment in truck bodies could produce satisfactory temperatures, the Region II office of the Public Health Service conducted an experiment at the North Bergen Stock Farm, North Bergen, N. J., during February, March, and April 1953 on the heat treatment of garbage in truck bodies, using direct steam injection as the source of heat and agitation.

Equipment

The truck used in this experiment was equipped with a rectangular metal tank body 15 feet long, 8 feet wide, and 34 inches deep. The tank was covered with semicylindrical sliding doors and had two arched wheel wells over the rear wheels of the truck.

A 2-inch steam supply line entered the tank high on the left side of the front, ran across to the middle of the front, and down to the bottom, where it was connected to a 1½-inch header. From the header, 1-inch laterals, numbering from four to seven during the course of the experiment, were run the length of the tank to distribute the heat. One-eighth inch holes were drilled on a horizontal plane through both walls of each lateral, on 12-inch centers in the forward half of the tank and on 6-inch centers in the rear half. Where necessary, the laterals were curved over the two arched wheel wells and welded in place.

A 2-inch flexible rubber hose fastened to a universal coupling by a heavy-duty hose connection was used to connect the steam manifold system in the truck to a 150-hp, oil-fired, horizontal boiler. This boiler was capable of providing steam at a pressure of 125 psi, but in this series of tests the automatic control was set to maintain a pressure between 45 and 55 psi. As these tests were being run the boiler was concurrently providing heat for the animal barns.

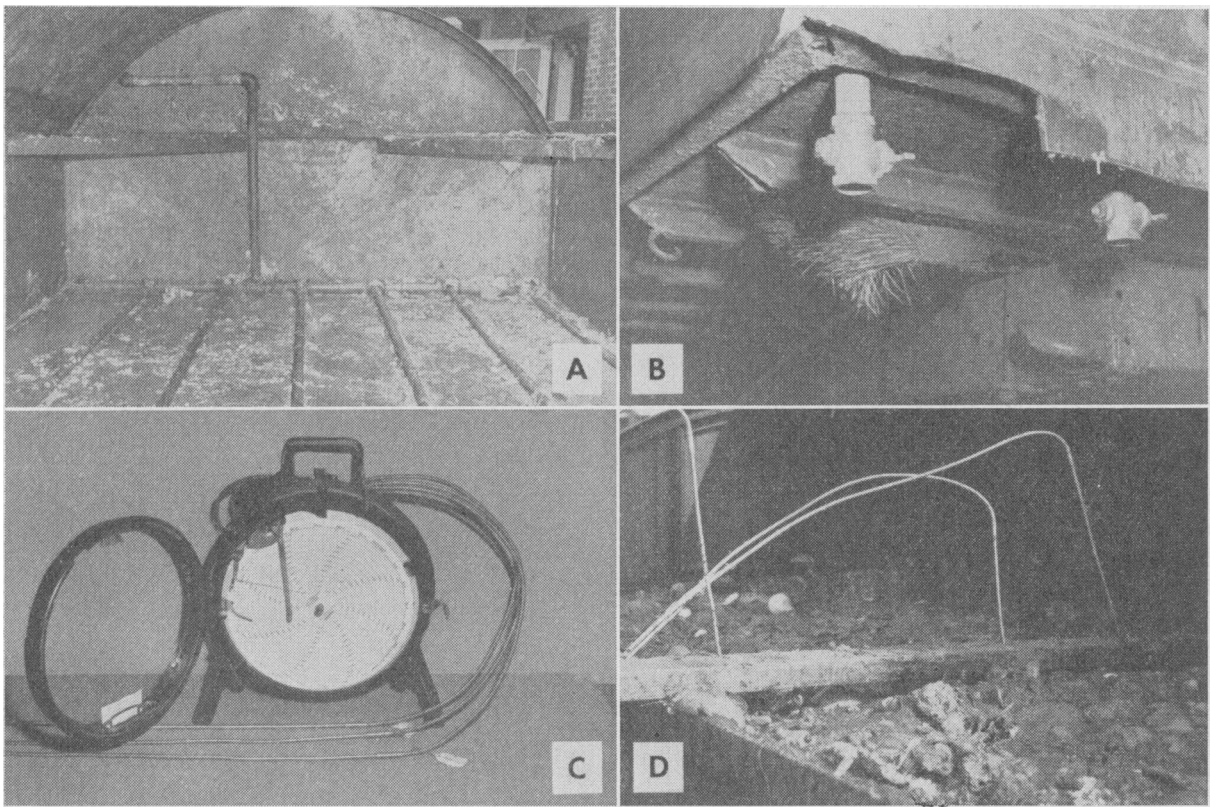
A specially designed, portable, three-pen recording thermometer was used to record temperatures at various points in the garbage mass during each cooking cycle. This instrument had a class IV thermal system (liquid expansion), 0°–300° F. temperature range, a mechanically driven clock on a 24-hour cycle, and three 14-foot acid-resistant leads (10 feet flexible and 4 feet rigid stainless steel).

A wooden beam was used to support the thermometer leads in the garbage mass during each test, with the thermometer bulb located at the end of each lead. The locations of the leads were varied during the tests, as shown in the table.

Procedure

Prior to each test in this experiment, the garbage, which had been collected from the hotels and restaurants of New York City during the preceding night, was leveled in the tank with a garden rake. Often this garbage was of such a solid nature that a man experienced no difficulty in walking on top of it as it was prepared for treatment. Three to six inches of clearance was normally allowed between the surface of the waste and the rim of the tank to accommodate the accumulation of steam condensate. Under these conditions the tank held about 300 cubic feet (2,244 gal.) of waste, which weighed from 8 to 10 tons.

After the garbage had been leveled, the ther-



(A) Interior of truck, showing seven distribution laterals. (B) Ground key blowoff valves for laterals, located under rear of truck. (C) Portable recording thermometer with 3 bulbs and 3 indicating pens. (D) Thermometer bulbs placed in garbage and held secure by wooden support.

mometer support was placed across the tank above the section of the truck body to be investigated during the test. The three thermometer bulbs were inserted into the garbage through holes in the timber to the desired depth and were locked in place with set screws. By varying the location of the thermometer bulbs longitudinally, laterally, and vertically, temperatures in all sections of the tank were investigated during the course of the experiment.

The steam was turned on after the initial temperature of the garbage mass had been determined. Erratic heat distribution in the first tests quickly established the need for a means of eliminating condensate and garbage liquor, which tended to clog the lines, and blowoff valves were installed. During the tests made after the valves were installed, the laterals were drained as soon as pressure was applied to the system, and any condensate or garbage liquor in the lines was removed. This draining operation was repeated several times during each test.

When the desired temperature had been reached and maintained for the required length of time the steam was turned off and the garbage was allowed to cool. The thermometer bulbs remained in the mass during the first part of this cooling period in order to ascertain the cooling characteristics of each section of the tank. The center portions of the garbage cooled very slowly and it was normally the following day before it was unloaded and fed to swine.

Since the tests were conducted out of doors the atmospheric temperature was noted during each run.

Results

In the first series of tests in this experiment a steam distribution system was used. The system contained 4 laterals connected to the main

header across the front of the tank, and spaced on 30-inch centers. The 2 outside laterals were elbowed and extended about 3 feet across the rear of the tank. When steam was introduced into the garbage mass through this system, a liquid channel soon formed directly above each lateral and most of the steam took this path of least resistance to escape. This flow of steam caused a mound of waste to be thrown up between the laterals which heat did not penetrate. Upon one occasion, after 4 hours of heating, including 3 hours of boiling in the watery channels, a temperature of 98° F. was found in 1 of these mounds.

In an effort to overcome this channeling tendency, 2 additional laterals were added, making a total of 6 laterals on 16-inch centers. The elbowed extensions of the two outside laterals across the rear of the tank had been found to be ineffective, and were omitted. This new design reduced the channeling tendency, but a critical condition was located directly behind the wheel wells on each side of the tank. Either condensate or garbage liquor appeared to be filling the pipe lines at a point immediately after they curved over the wheel wells, and very little steam reached the garbage in these two areas. The design did produce acceptable results on occasions but generally the results were erratic and uncertain.

To eliminate channeling completely, the number of laterals was increased to 7, on 14-inch centers, and to remove condensate and garbage liquor from the lines, each lateral was

Temperature-time results with improved steam distribution design

Run No.	Date of test and air temperature during test	Heating time (minutes)	Pen No.[1]	Location [2]			Temperature variation and time each temperature maintained (min.)		
				x	y	z	Above 170° F.	Above 190° F.	Above 210° F.
					Feet	*Feet*			
6	Mar. 12 41°–43°	105	1	Bottom	3. 5	12	230	140	65
			2	Bottom	2. 5	12	130	60	(206° F. max.)
			3	Bottom	. 5	12	115	85	25
7	Mar. 18 41°–40°	80	1	Bottom	3. 5	13	130	95	70
			2	Mid-pt	2. 5	13	360+	360+	75
			3	Mid-pt	. 5	13	195	200	65
8	Mar. 20 42°–43°	105	1	Near surf	3. 5	13	130+	70	(199° F. max.)
			2	Near surf	2. 5	13	160+	125	95
			3	Bottom	. 5	13	105+	85	45
9	Mar. 25 49°–50°	98	1	Mid-pt	4. 5	8	95+	90+	60
			2	Near surf	2. 5	8	45+	30+	5
			3	Bottom	. 5	8	95	50	(195° F. max.)
10	Mar. 27 40°–41°	110	1	Mid-pt	4. 5	3	165	10	(191° F. max.)
			2	Mid-pt	2. 5	3	345+	345	(209° F. max.)
			3	Bottom	. 5	3. 4	220	145	90
11	Mar. 30 43°–44°	65	1	Near surf	3. 4	3. 4	210	85	10
			2	Bottom	1. 8	1. 8	110	70	40
			3	Mid-pt	. 5	. 5	55	15	(198° F. max.)
12	Apr. 1 48°–49°	135	1	Near surf	4. 2	2. 2	310+	35	(200° F. max.)
			2	Mid-pt	6. 0	3. 2	310+	300	270+
			3	Mid-pt	7. 7	4. 2	280+	20	(193° F. max.)
13	Apr. 3 46°–49°	90	1	On surf	4. 5	10. 6	80	30	5
			2	Bottom	6. 2	11. 6	75	(180° F. max.)	(180° F. max.)
			3	Mid-pt	7. 9	12. 6	240+	240+	60

[1] No. 1 pen, red; No. 2 pen, violet; No. 3 pen, green.

[2] Location of thermometer bulb is indicated by x, y, and z axes. The bottom left front corner of the truck body serves as the origin, x being the vertical axis, y the transverse axis across the truck from left to right, and z the longitudinal axis from front of truck to rear.

elbowed down through the rear of the tank bottom and terminated with a 1-inch ground key blow-off valve. A watertight, bolted, and removable tail gate necessitated placing the valves under the tank rather than on the rear wall. This improved design gave a uniform distribution of steam and normally produced acceptable heat treatment. A tabulation of the results of eight runs using this improved design is given in the table.

Several times during the course of the experiment "dead spots" were located in the garbage mass which heat did not penetrate. These spots were usually in a tightly packed wad of material held together by napkins or papers.

After a uniform distribution of steam was obtained, heat was found to rise to the surface of the mass in a distinct horizontal blanket except around the perimeter of the tank, where steam followed the metal sides to the surface very quickly.

Conclusions and Comments

1. Garbage can be disinfected in a metal tank truck body using steam injected directly into the mass through laterals placed on 14-inch centers and terminated with blowoff valves. (There were seven laterals in the truck body used in the experiment.) Due to the many possible sources of error in this type of system, however, steam injection in truck bodies is not the ultimate solution to the problem, either from the viewpoint of the operator or of the regulatory agency, and this system of treating garbage with heat should be used only as an interim measure until a properly designed built-in-place installation is available.

As a result of an analysis of general steampipe layout design procedures, made after completion of the heat treatment experiment, the following theoretical conclusions seemed indicated:

(*a*) The cross-sectional areas of the header pipe should be approximately equal to or slightly larger than the cross-sectional area of the supply line.

(*b*) The total cross-sectional area of the laterals should be approximately equal to the cross-sectional area of the header pipe.

(*c*) The aggregate area of the drilled holes should be approximately one-half that of the steam supply line. In general, the smaller the aggregate area of the holes, the more uniform the steam flow will be out of each hole, and smaller holes will allow the use of a greater number of holes, thus insuring more even heat distribution through the garbage.

These theoretical conclusions may be checked in future experiments.

2. Separation of edible and nonedible waste material is very desirable. However, if any glass bottles should accidentally be included in the garbage they will not be broken by this type of heat treatment.

3. Breaking up any semisolid masses of material as the garbage is placed in the tank will help reduce the possibility of "dead spots" and inadequate heat penetration.

4. Manual agitation of the garbage with a wooden paddle will help insure proper distribution of heat.

5. Three to six inches should be allowed between the surface of the garbage and the top of the tank to prevent spillage when steam condensate accumulates.

6. The surface of the garbage should be covered to conserve heat and prevent spattering. If possible, the treatment should be provided in an insulated building, especially during the winter.

7. Laterals should be blown off as soon as steam pressure is applied and at half-hour intervals thereafter.

8. The equipment should be cleaned after each use. Special care should be given to the interior of steam lines and orifices because cooked garbage is sucked into the lines by the vacuum formed when the steam pressure is turned off. This cooked garbage will solidify as it cools and may block the line.

9. Uniform spacing of orifices on 6-inch centers over the entire length of the laterals would probably produce results as good as, if not better than, the results obtained with this equipment.

10. When the cooked garbage is allowed to cool in the tank it usually requires up to 24 hours for it to cool sufficiently to be fed to swine. This means the truck in which garbage is treated would be out of service every other

day and twice the original number of trucks would be required. If the cooked garbage was unloaded and spread in thin layers it would cool much faster and the truck would be free for operation.

11. The swine farmer who cooperated in this experiment reports that cooking made less desirable particles of garbage, such as citrus rinds and potatoes, more attractive to the pigs, resulting in a much smaller amount of waste.

12. The adequacy of heat treatment can be determined only through an investigation of the entire mass of garbage after the installation of the equipment.

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Children's Bureau Studies Childhood Accidents

Accidents kill and cripple more children in the United States than all infectious diseases of childhood combined, according to a report on childhood mortality recently released by the Children's Bureau of the Department of Health, Education, and Welfare. Data collected by the National Office of Vital Statistics of the Public Health Service were used in the study.

The report shows the two major causes of accidental death in 1949 for children of all ages over 1 year were motor vehicles and drowning. Children under 1 year of age died from accidents of all types at a rate of 72.1 per 100,000; home accidents accounted for 43 per 100,000; fire, explosions, and burns, 9.8; motor vehicles, 6.5. A rate of 28.5 for deaths caused by inhalation or ingestion of objects was reported.

During the period 1940–49 the death rate from accidents among children of ages 1–19 was cut only 16 percent as compared to a 46 percent slash in the rate for all other causes of death among children of these ages.