

SEDIMENTATION TANKS FOR FINE SOLIDS
REMOVAL FROM FEEDLOT CATTLE DIP

FINAL REPORT

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BACKGROUND

Cattle dipping at feedlots produces waste pesticide solution that must be disposed of in an environmentally acceptable manner. Cattle dip solution in the vat must be replaced frequently at a substantial cost to the feedlot. The frequency of recharging a dipping vat is dictated in part by guidelines of the USDA's Animal and Plant Health Inspection Service (APHIS) that relate to useful life of active ingredients (120 days for coumaphos and toxaphene, versus 60 days for prolate); maximum use rate of 2 head per gallon of vat solution; and maximum solids concentration of 10 percent by volume, which is usually the limiting factor. Odors from anaerobic decomposition of vat solution or the soiled condition of cattle emerging from the vat are often used for determining when vat solution is recharged by feedlot personnel.

Disposal of waste cattle dip solution costs the feedlot money in several ways:

- a. Vat recharging costs--pesticide, direct labor, management, and equipment.
- b. Waste disposal costs--evaporation ponds, liners, pumps, tanker equipment, direct labor, and management.

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Current costs of vat recharging with the three registered pesticides² per gallon of vat solution are as follows: toxaphene--14¢, coumaphos--42¢, and prolate--32¢ (Sweeten, 1981). Use of toxaphene by feedlots has been almost curtailed as a result of U.S. Environmental Protection Agency hazardous waste regulations that went into effect November 19, 1980. Disposal of the other two compounds is regulated by the Texas Department of Water Resources. The currently approved method of disposal for organophosphate compounds in Texas used in cattle dipping is volume reduction in impermeable evaporation ponds followed by surface spreading and soil incorporation of the solid residue.

Cost Reduction by Static Screening: Previous Studies

The Texas Agricultural Extension Service conducted a field study in 1976 at Olton Feedyards, a 30,000-head cattle feedlot in Lamb County, involving use of a Hydrasieve static screen for solids removal from coumaphos dip solution (Sweeten, 1980). Treatments consisted of three Hydrasieve screen sizes (0.01, 0.02, and 0.03 inch aperture) and three screening durations (0.5, 1, and 2 hours/1,000 head). The Hydrasieve was evaluated on the basis of solids removal rate and efficiency, number of cattle dipped per vat charge, pesticide useage, solids concentration reduction, and odor abatement. Based on feedlot vat management records for four years, use of the Hydrasieve cattle dip screening system allowed an average of 71 percent more cattle to be dipped without vat recharging with pesticide (3,705 head versus 6,324 head). Pesticide useage was reduced by 24 percent from 83.5 gm/head to 63.1 gm/head. Pesticide disposal requirements were reduced by 53 percent from 3.2 to 1.5 l/head. Savings in coumaphos pesticide would amount to 19¢ per head at today's prices.

²Mention of commercial products does not imply endorsement by the Texas Agricultural Extension Service.

An average of 30 grams of dry matter per head of was removed from pesticide solution. Solids removal rate was 40 kilograms/hour (kg/hr) the first half-hour, decreasing to 15 kg/hr after 2 hours per 1000 head dipped. All screen sizes gave essentially equal performance at a filter time of 0.7 to 0.8 hours per 1,000 head dipped. Pesticide concentration was not measurably affected by use of the Hydrasieve. Total suspended solids concentration and settleable solids were reduced slightly by Hydrasieve treatment. Solids concentration in cattle dip was not significantly affected by choice of Hydrasieve screen size or filter time.

In another Extension field study, a Hydrasieve was successfully used for solids removal from prolate (GX-118) cattle dip solution at Cactus Feedyard, a 40,000-head Texas feedlot in Moore County. A detailed assessment of solids removal was not made. Using a Hydrasieve, an average of 9,600 head of cattle were dipped per 5,000 gallon vat charge as compared to only 4,500 to 5,000 head before the Hydrasieve was used. For this situation, cost of chemicals would be reduced by an estimated 17¢ per head. Evaporative disposal requirements for pesticide were reduced by approximately 50 percent to a level of 0.5 gallons/head.

A 28½-inch Bauer Hydrasieve currently costs \$4,600 (F.O.B. Concordia, Kansas). Including a suitable trash handling pump, piping, valves, and installation, the total system cost could run approximately \$7,000. At 17¢ per head savings, the unit should pay for itself when 41,000 head are dipped.

SEDIMENTATION TANK STUDY

Objectives

Despite progress being made with the Hydrasieve, pesticide solution is still being disposed of prematurely (i.e. before the full 60 to 120 days

registered-use period) because of the steady buildup of fine organic and inorganic particles that cannot be removed by static screening. In an effort to remove fine settleable solids from vat solution, continuous-flow sedimentation tanks were installed at dipping vats at two Texas Panhandle feedlots. Experiments were conducted to evaluate these units.

Specific objectives were (1) to determine the solids concentration in prolate vat solution before and after treatment with sedimentation tanks, (2) to determine the amount of solids removed under various test conditions, and (3) to determine whether pesticide disposal requirements are reduced with prolonged use of the sedimentation tanks.

Experimental Design

To achieve these objectives, sedimentation tanks of 300- and 975-gallon liquid capacity were installed in May and June, 1980 at two South Plains feedlots having dipping vats of 3300- and 5000-gallon capacity, respectively. The 975-gallon sedimentation tank was used in conjunction with a Hydrasieve. The experiment at each feedlot involved two flow rates and two flow durations through the settling tanks, as will be described later. Another field test at one of the feedlots involved a much longer flow duration than originally scheduled. Samples were taken of prolate (GX-118) pesticide solution at the inflow and outflow sections of the settling tanks. The amount and characteristics of sediment deposited in the sedimentation chambers were determined. Approximately one year after the settling tanks were placed in operation, a comparison was made of the numbers of cattle that could be dipped before and after use of the systems. Corresponding estimates were made of savings in pesticide cost and reduction of pesticide volume to disposed of.

Equipment and Procedures

At Sugarland Feedyards (25,000-head capacity) the sedimentation tank consisted of four compartments with a total liquid capacity of 300 gallons (Figure 1). This sheet metal unit, marketed under the trade name of Vat Clean (patent pending), was designed and fabricated by the Kugler Company of Cozad, Nebraska. Outside dimensions were 2' deep x 3' wide x 8' long.

The nominal flow rate capacity of the unit was 60 gpm. The first two vertical baffle plates were placed 2 feet and 5 feet from the inflow end of the tank. The third baffle, 7 feet from the inflow end, consisted of a one-foot-high sheet metal plate extending one foot vertically from the bottom and two screen wire baffles extending from mid-depth to the top of the chamber. The screens were individually removed and manually cleaned frequently during chamber operation to prevent clogging and recover cattle hair.

Flow through the Vat Clean sedimentation tank was provided by a Pacer 2-inch centrifugal transfer pump. During chamber operation, the dipping vat solution (3300 gallons) was well agitated using a 3-inch Homelite centrifugal trash-handling pump. Initially, the flow rate was measured using a 5-gallon bucket and stopwatch and was adjusted as necessary. In later experiments, discharge from the sedimentation chamber was routed through a one-foot depth H-flume for which standard head versus discharge charts were available for flow measurement and adjustment.

Prolate (GX-118) pesticide solution was sampled from the inflow and discharge pipes of the sedimentation tank. Nominal flow rates were 30 and 60 gpm. Samples were taken at timed intervals equal to the passage of 0, $\frac{1}{2}$, 1, and 2 times the 3,300-gallon vat contents through the settling system. After 1 and 2 vat turnovers, liquid was drained back into the vat and the sediment was removed, weighed, and sampled. Debris removed from the screens

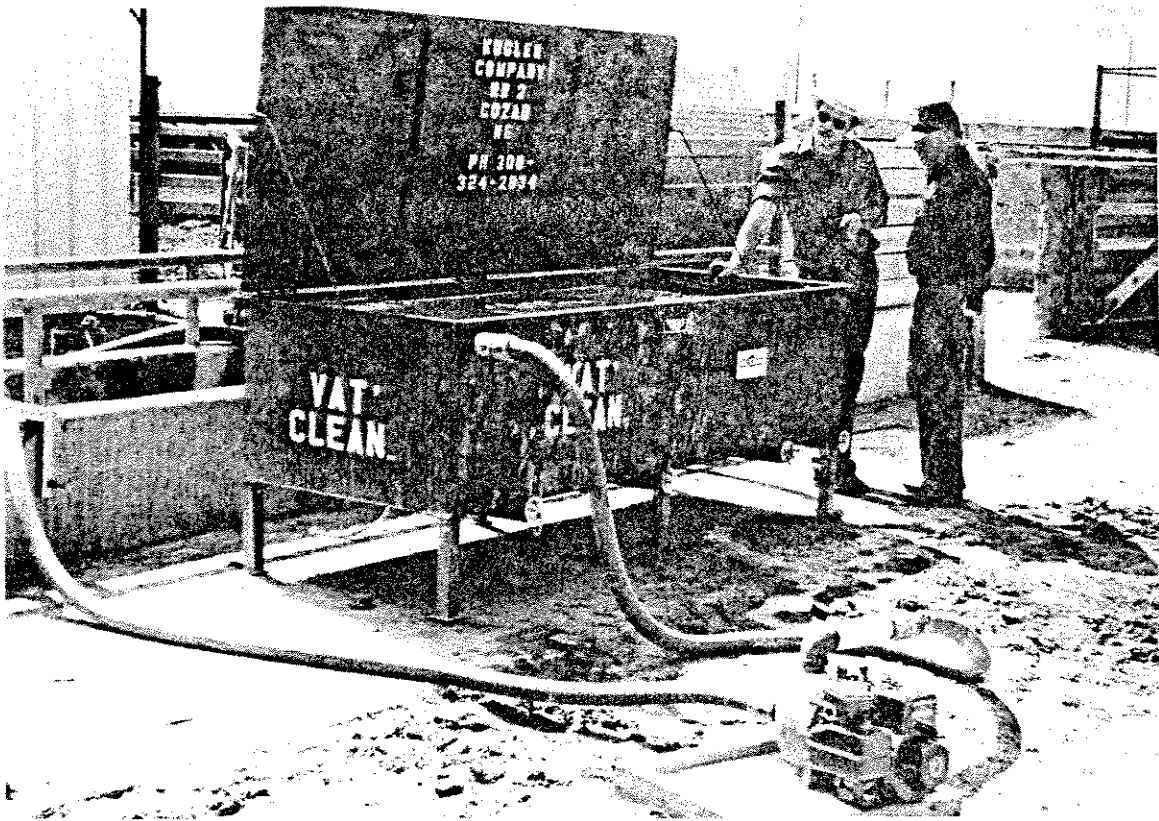


Figure 1. The 300-gallon Vat Clean sedimentation tank was operated at 30 and 60 gpm for various flow durations.

between the third and fourth compartments was also weighed and sampled. Sediment and debris were placed in the lined evaporation pond for volume reduction and later disposal.

Liquid samples were analyzed for the following parameters: moisture, ash, total suspended solids, volatile suspended solids, chemical oxygen demand (COD), biochemical oxygen demand (BOD), pH, and volumetric or settleable solids. On selected samples, particle size distribution was determined using a Coulter Counter, after wet sieving to remove particles larger than 400 microns (0.016 inches). Sediment samples were analyzed for moisture and ash content.

At Cactus Feedyards (50,000 head capacity) the 975-gallon sedimentation tank consisted of 3 compartments separated by vertical plywood baffles (Figure 2). This unit was designed by the Extension Agricultural Engineering staff and was fabricated by a welding shop in Calvert, Texas on consignment to Cactus Feeders, Inc. at a price of \$620. Dimensions of the settling tank were 4-ft deep x 4-ft wide x 8-ft long. Maximum flowrate without overtopping the tank was 125 gpm and was limited by the diameter and placement of the 4-inch outlet elbow. The first baffle (3-foot height) was only 0.5 ft from the inflow end and was used to direct the inflow upwards and toward the back of the tank in a relatively uniform fashion. The second plywood baffle was 3.25 ft high and was positioned 5 ft from the inflow end. This created two settling chambers.

Flow to the settling tank was provided by a 3-inch Gorman Rupp self-priming centrifugal trash pump (Model 13A2B). The same pump was used concurrently to provide flow to the Hydrasieve (28½-inch width), which was operated in parallel with the sedimentation tank. Discharge from the settling tank was measured with a type H-flume (1-ft depth), and the inflow rate was adjusted accordingly. Both the settling tank and Hydrasieve were operated while cattle were being dipped; consequently, there was no need to provide supplemental mechanical agitation.

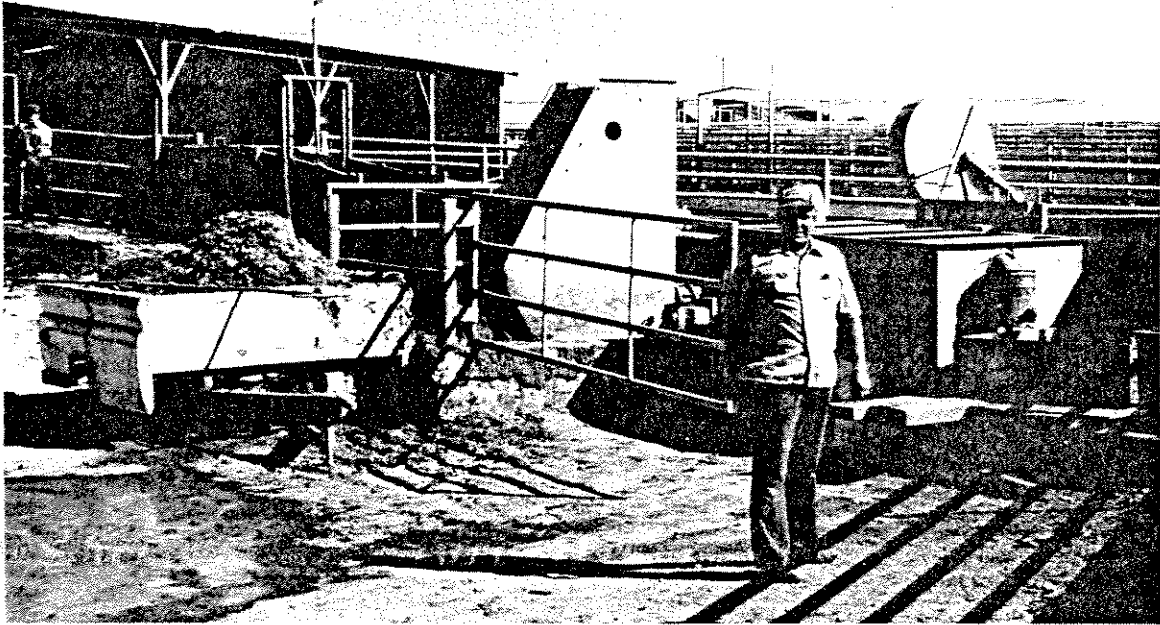


Figure 2. (a). The sedimentation tank (right) and Hydrasieve (center) were operated simultaneously during the cattle processing and dipping operation.

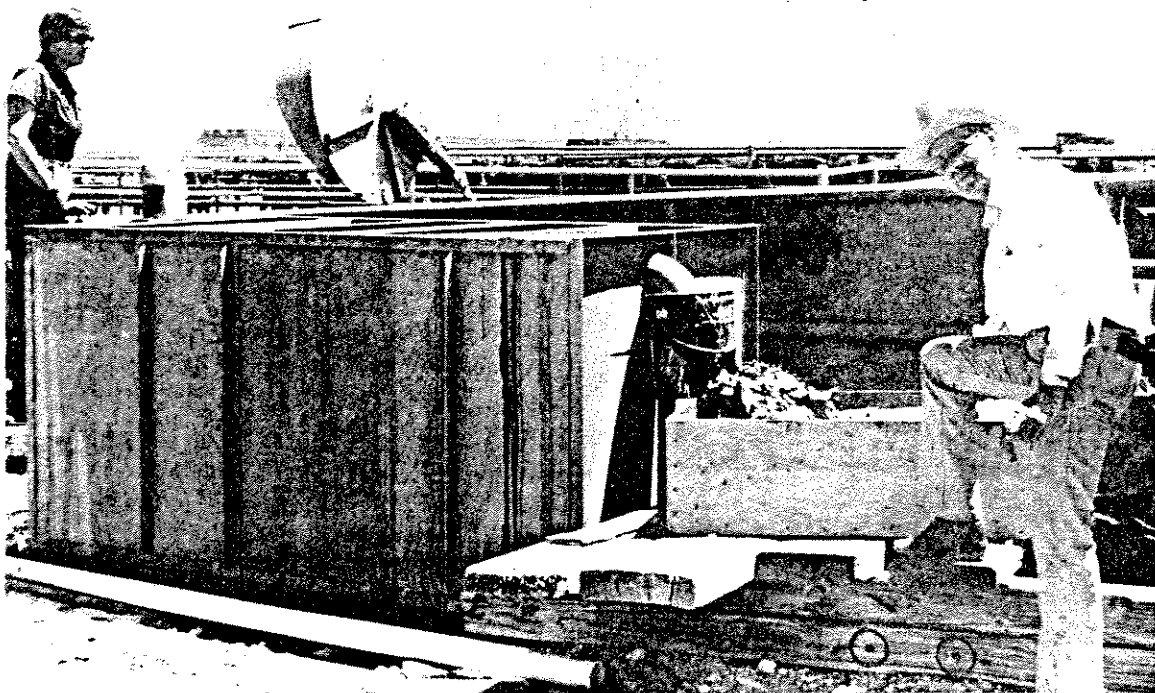


Figure 2. (b). The 975-gallon TAEX sedimentation tank was operated at flow-rates of 44 to 125 gpm for durations of 44 to 333 minutes.

The GX-118 pesticide solution was sampled from the inflow chamber and discharge pipe. On one occasion (June 25-26) the sampling intervals were equivalent to approximately 0, $\frac{1}{2}$, 1, 1.5, and 2 vat turnovers (i.e. 0, 2500, 5000, 7500, and 10,000 gallons of total flow through the tank). Sediment was manually removed from the settling tank after 1 and 2 vat turnovers at nominal flowrates of 50 and 120 gpm. This sediment was weighed and sampled. On the September 23, 1980 testing date, a single test was conducted using 120 gpm flowrate for 5½ hours (i.e. 7.9 vat turnovers). Inflow/outflow samples were obtained at 10, 60, 120, 200, 240, and 330 minutes. The resulting sediment was removed, weighed, and sampled. Liquid and sediment samples were analyzed for the same parameters listed previously for the Sugarland Feedyards experiments.

RESULTS

Experiments With Vat Clean System

The 300-gallon sedimentation tank at Sugarland Feedyards was operated at two flowrates intended to be 30 and 60 gpm. These flowrates corresponded to theoretical surface-loading rates of 1.25 and 2.5 gpm per square foot of surface area and detention times of 10 and 5 minutes. Experiment I was conducted on May 22-23, 1980 after only 1,204 head of cattle had been dipped in the 3,300-gallon vat. Floating hair (214 lbs wet weight) was skimmed off the surface, the vat was agitated for 20 minutes, and flow to the sedimentation tank was adjusted to an average flow of 66 gpm. Flow duration was 41 minutes or 0.57 hours per 1,000 head dipped. After flow had ceased, liquid was decanted from the Vat Clean back into the dipping vat using the Pacer pump, leaving a darker-colored layer with high solids content. Liquids drained from these "settled solids" weighed a total of 98.25 lbs, had a solids content of 5.7%,

and had an average bulk density of 57.8 lbs/foot³. Sediment scraped from the bottom of the four settling chambers weighed a total of 107.3 lbs, contained 21.3% solids concentration, and had a weighted average bulk density of 65.5 lbs/ft³. The bulk density of these settled solids decreased progressively from the first through the fourth chambers (70.7 to 59.5 lbs/ft³ range). In addition, 3.3 lbs of hair containing 22 % solids content was removed from the screen baffle. As shown in Table 1, total solids removal from this first run was 30.0 lbs dry matter, of which 45 % was ash and 55 % was volatile solids (i.e. organic matter). Seventy-two percent of the solids were caught in chambers 1 and 2. All the sediment was discarded into the pesticide evaporation pond.

A flowrate of 55 gpm was realized in the second trial which lasted 50 minutes. After liquids in the Vat Clean were decanted back into the dipping vat, sediment in each chamber was thoroughly mixed, weighed, and sampled. The total sediment load removed by the settling tank was 417.2 lbs of wet material and 56.5 lbs of dry matter, of which 36% was ash and 64% was volatile solids (Table 1). The first two chambers of the settling tank contained 69% of the dry matter removed. The greater solids removal with this trial may have been due to the lower flowrate and longer flow time as compared to the previous trial. Both trials involved pumping a similar amount of vat solution (2750 gal).

The third trial involved a flowrate of 29 gpm for 100-minutes duration. The total sediment load removed was 22.5 lbs, which contained 39% ash and 61% volatile solids. The first two chambers removed 73% of the sediment captured in this trial. The fourth trial (25 gpm flowrate for 82 minutes) removed an additional 19.4 lbs of dry matter containing 38% ash (Table 1). Two-thirds of the sediment was trapped in chambers 1 and 2.

Together these four trials involved 4.6 hours of net system operation or 3.8 hours/1,000 head dipped. A total of 10,4000 gallons of vat solution was

TABLE 1
 SUMMARY OF SOLIDS REMOVAL FROM VAT CLEAN SYSTEM, EXPERIMENT I,
 SUGARLAND FEEDYARDS
 (1,204 head)

Date	Flow rate gpm	Flow Duration min.	Wet Material lbs	Dry Matter		Ash lbs	Volatile Solids lbs
				lbs	lbs/hr		
5/22/80	66	41	208.8	30.0	43.9	13.6	16.4
"	55	50	417.2	56.5	67.8	20.3	36.1
"	29	100	281.1	22.5	13.5	8.8	13.7
5/23/80	25	82	196.1	19.4	14.2	7.4	12.0
Totals		273	1103.2	128.4	--	50.1	78.2
-hrs/100 hd.		3.78	--	--	--	--	--
-lbs/hd.		--	0.92	0.11	--	0.04	0.06
-gm/hd.		--	416	48.4	--	18.9	29.5

pumped with 128.4 lbs of dry matter removed, which is equivalent to 48 grams per head dipped. By comparison, the 1976 Hydrasieve experiments at Olton Feedyards succeeded in removing a maximum of 33 grams/head of dry matter at operating times of 1.0 and 2.0 hours/1,000 head (Sweeten, 1980); this relationship is shown in Figure 3. The evidence indicated that the Vat Clean system may require a longer operating period and lower flowrate than the Hydrasieve but also may remove more solids. This pesticide solution was kept in service with the Vat Clean system used each day that cattle were dipped until a total of 5,674 head had been dipped, at which time the vat was recharged.

Experiment II with the Vat Clean system was conducted on June 24, 1980 after 3,116 head of cattle had been dipped on the next vat recharge cycle. The same treatment combinations (flowrate and duration) were used as for the first series of trials. Total flow duration required for these four trials was 4.2 hours.

The June 24 tests did not furnish a true picture of sediment removal capability because the vat manager had already operated the Vat Clean system at 60 gpm flowrate while dipping all 3,116 head before these trials commenced. His efforts produced 157 gallons of sediment containing 190 lbs of dry solids, or 28 grams/head.

The total amount of dry matter removed on June 24 was only 77.0 lbs (Table 2), which amounted to 11 grams per head dipped in addition to what the vat manager had removed. Deposition of sediment in the Vat Clean unit followed a slightly different pattern than in the May 22-23 experiments (Table 3). A smaller percentage of solids were collected by the first two chambers while the third and fourth chambers retained relatively more solids. This may have been due to the fact that most of the heavier solids had already been removed by prior operation of the settling tank during this vat cycle.

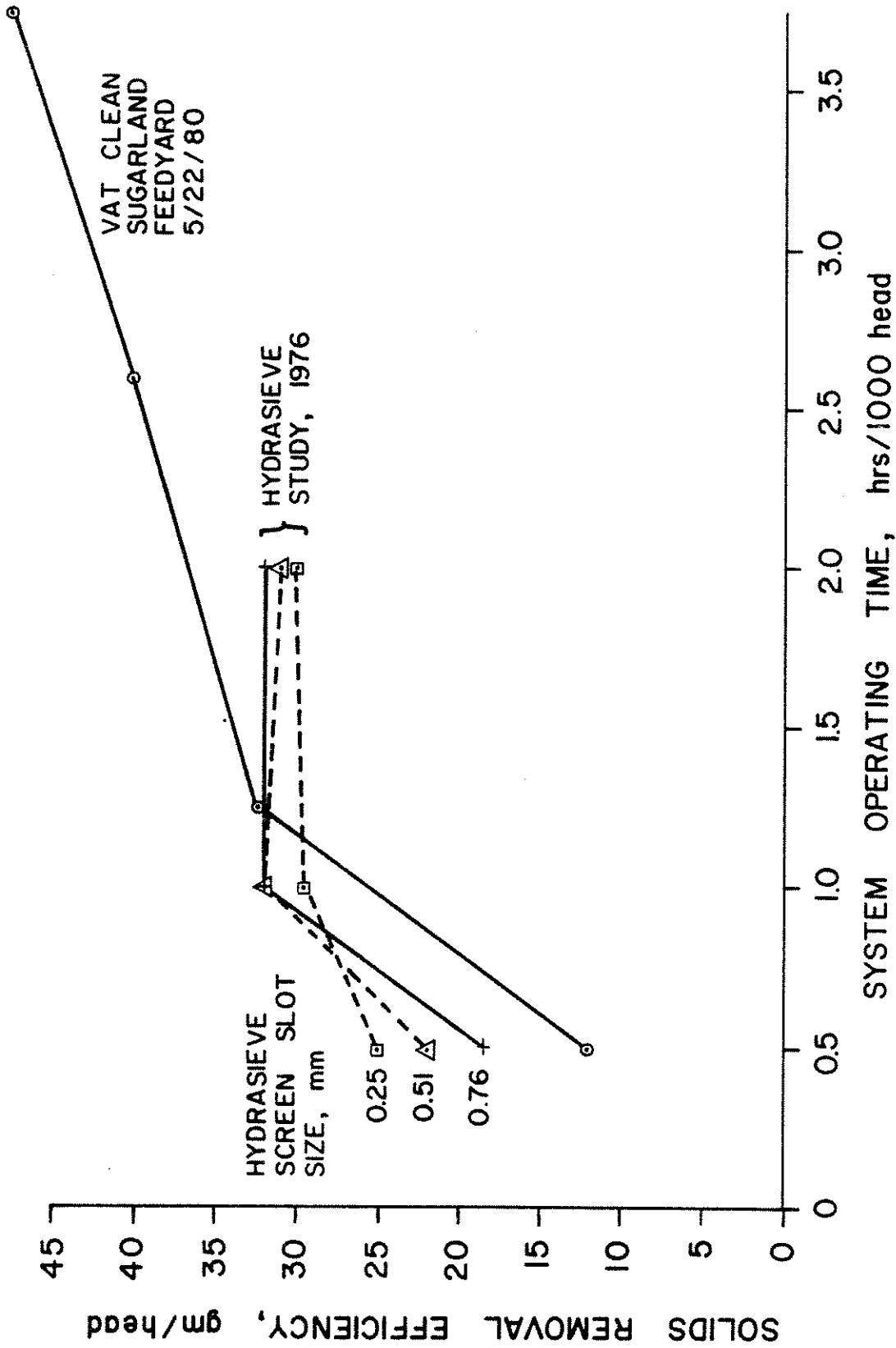


Figure 3. Solids removal efficiency of Vat Clean sedimentation tank exceeded that of previous Hydrasieve results after operating time of 1.25 hour per 1000 head dipped (Experiment I).

TABLE 2
SUMMARY OF SOLIDS REMOVAL FROM VAT CLEAN SYSTEM,
SUGARLAND FEEDYARDS, EXPERIMENT II,
June 24, 1980 (3,116 head)

Flow rate gpm	Flow Duration min.	Wet Material lbs	Dry Matter		Ash lbs	Volatile Solids lbs.
			lbs	lbs/hr		
61	36	196.3	23.5	39.2	11.0	12.5
62	51	331.8	21.3	25.1	7.3	14.0
31	86	299.0	13.3	9.3	5.1	8.2
29	80	362.6	18.9	14.2	7.0	11.9
Totals	253	1189.7	77.0	--	30.4	46.6

TABLE 3
 PERCENT OF SOLIDS REMOVED BY COMPARTMENT OF VAT CLEAN SYSTEM
 AT SUGARLAND FEEDYARDS

	Flowrate gpm	Time min.	Total Solids Removed lbs.	Chamber No. or Location				
				1	2	3	Screen Baffle	4
				Percentage of Total Solids				
Experi- ment I	66	41	30.0	30	43	16	2	10
	55	50	56.5	42	27	13	14	4
	29	100	22.5	31	36	14	10	9
	25	82	19.4	41	26	17	8	9
Experi- ment II	61	36	23.5	17	39	33	5	6
	62	51	21.3	14	31	33	9	13
	31	86	13.3	30	36	17	6	11
	29	80	18.9	19	26	30	1	25

The solids concentration of sediment in the Vat Clean ranged from 2.2 to 16.2%, averaging 7.6%. The highest solids concentration was obtained from the first treatment (61 gpm flowrate for 36 minutes). This experiment also produced the highest ash content (55% dry basis). Overall, the ash content averaged 42% of dry matter.

Settleable solids volume, as measured by 2-hour settling time in a 125-ml graduated cylinder, decreased from 10.6% (v/v) to 9.6% between the start of the initial treatment (i.e. inflow at time = 0) and the termination of the fourth treatment (i.e. outflow at time = 253 minutes). As shown in Figure 4, this settleable solids reduction occurred mostly with particles that settled in less than 10 minutes in a graduated cylinder.

Initial total solids concentration of the vat solution was 3.1% (31,000 mg/l) for Experiment I and 2.7% (27,000 mg/l) for Experiment II. Following operation of the Vat Clean system for 273 and 253 minutes, respectively, final total solids concentration was 2.2% (22,000 mg/l) for both experiments.

Overall, settleable solids (percent by volume) decreased from 12% to 5.6% for Experiment I and from 10.6% to 9.6% for Experiment II. However, no discernable reduction in solids concentration or oxygen demand could be attributed to individual treatment combinations.

Statistical analysis was conducted on paired observations of inflow and outflow concentrations at the various sampling intervals. When data for both experiments was combined there was a highly significant statistical difference ($\alpha = 1\%$ error probability) between the inflow and outflow concentrations of total solids (2.42 vs. 2.28%). Likewise, there was a significant difference ($\alpha = 5\%$ error probability) between inflow and outflow concentrations of settleable (volumetric) solids (9.0 vs. 8.2%). The total suspended solids (TSS) concentration decreased significantly between inflow and outflow for only the

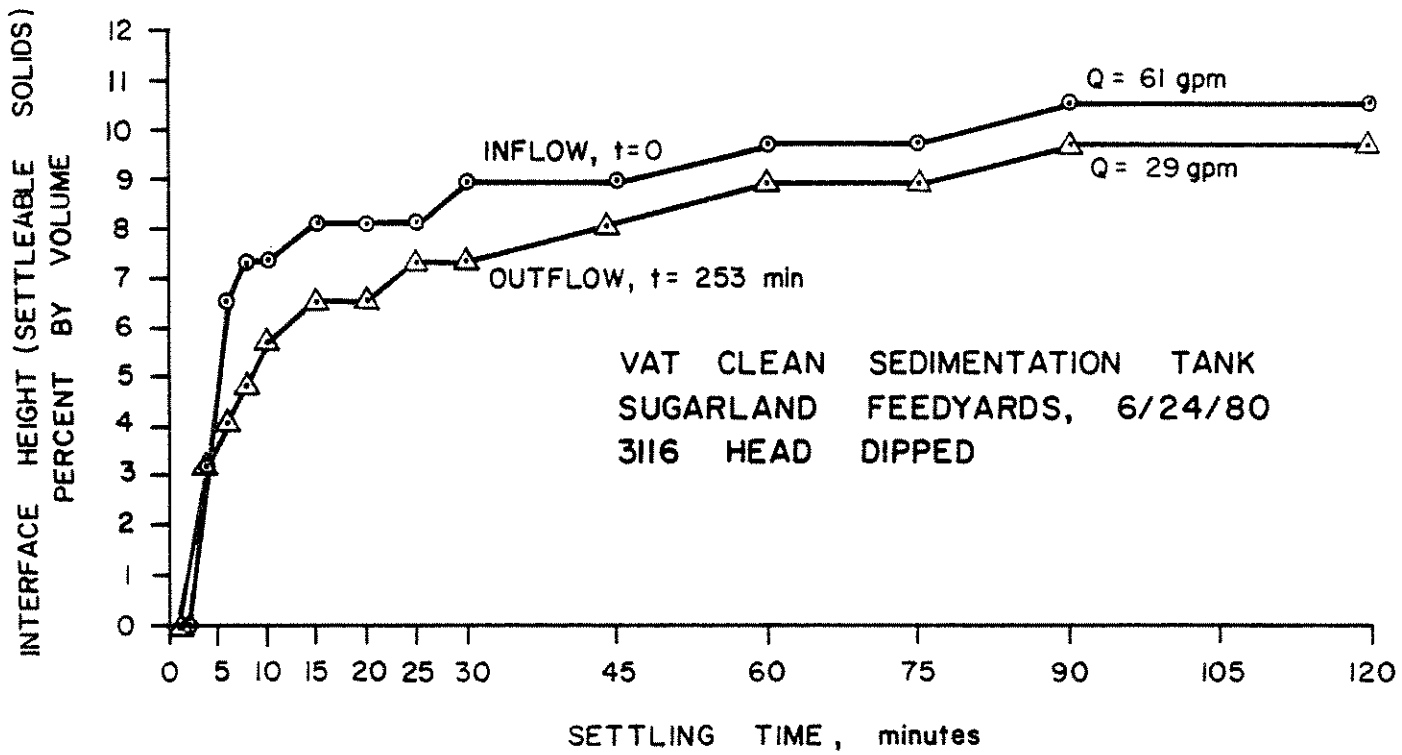


Figure 4. Settleable solids concentration in vitro was reduced by operating Vat Clean unit for 87 minutes at 61-62 gpm and for 186 minutes at 29-31 gpm, Experiment II.

30 gpm flow rate tests. There was no significant difference in inflow and outflow concentrations for any of the following parameters: total volatile solids (VS), volatile suspended solids (VSS), chemical oxygen demand (COD) or biochemical oxygen demand (BOD). The mean and range of concentrations of these parameters are included in Table 4.

In comparing inflow and outflow values, there was essentially no change in either pH or prolate concentration as a result of Vat Clean treatment. Prolate concentration in the inflow averaged 0.167% as compared to 0.169% in the outflow. pH values averaged 5.4% in both inflow and outflow.

TABLE 4
SUMMARY OF CATTLE DIP SOLIDS AND OXYGEN DEMAND CONCENTRATIONS*,
SUGARLAND FEEDYARDS
MAY-JUNE 1980

Parameter	Experiment I		Experiment II	
	Mean	Range	Mean	Range
Total Solids, mg/l	25,300	23,000-31,000	24,000	22,000-27,000
Volatile Solids, mg/l	14,100	12,000-19,000	14,700	13,000-17,000
Total Suspended Solids, mg/l	16,500	14,200-24,000	18,200	12,800-21,600
Volatile Suspended Solids, mg/l	11,600	10,000-14,600	11,400	7,200-14,200
Chemical Oxygen Demand, mg/l	54,100	49,900-66,400	47,200	44,300-50,300
Biochemical Oxygen Demand, mg/l	--	-- --	6,600	6,000- 7,500
pH	5.1	5.0-5.1	5.9	--
Prolate	0.176	0.164-0.186	0.148	0.145-0.150

*Inflow samples only.

Experiments With TAEX Sedimentation Tank

The TAEX-designed sedimentation tank installed at Cactus Feedyards was operated at nominal flowrates of 50 and 125 gpm. As constructed, it had a fluid capacity of 882 gal at zero flow and 977 gal at maximum flowrate.

The first test (Experiment III) consisted of four treatment combinations that were intended to provide flow durations equal to one and two vat turnovers (5000 gal per turnover) at each of the two flowrates. This experiment was conducted on June 25 and 26, after a total of 8,433 head of cattle had been dipped. An additional 509 head were dipped during the two tests at 115-125 gpm flowrate, and approximately 500 head more were dipped throughout the two trials at the 44-45 gpm flowrate. It should be noted that for this experiment all the sediment removed from one trial was put back into the dipping vat before starting the succeeding trial. This provided two replications of the flowrate treatments. A total flow volume of 19,800 gal was passed through the sedimentation tank.

Actual experimental conditions and solids removal are reported in Table 5. The flowrates of 44 to 45 gpm corresponded to surface loading rates of 1.4 and 3.9 gpm per square foot and detention times of 20 and 7.8 minutes, respectively. There was essentially no difference between moisture or ash contents of sediments collected in the two settling chambers. Solids removed in this experiment contained an average of 43% ash and 57% organic matter. Wet sediment had a bulk density of 71.3 lbs/ft.

System operating time for these trials was very short, ranging from 0.08 to 0.19 hours per 1,000 head dipped. Consequently, the total amount of solids removed was disappointedly low. As shown in Table 5, the high flowrate removed an average of 50.9 lbs total solids or 0.0059 lbs/head dipped (2.7 gm/head). The low flowrate resulted in an average solids removal of 61.2 lbs or 0.0066 lbs/head (3.0 gm/head). Increasing the mean detention time by 160%

TABLE 5

SUMMARY OF SOLIDS REMOVAL FROM
975-GALLON SEDIMENTATION TANK, EXPERIMENT III,
CACTUS FEEDYARDS
(8433-9440 HD.)

Date	Flowrate gpm	Flow Duration min.	Wet Material lbs	Settled Solids Removal					Volatile Solids lbs
				Dry Solids		Ash		Volatile Solids lbs	
				%w.b.	lbs	lbs/hr	%w.b.		lbs
6/25/80	125	48	415.8	14.4	59.9	74.9	47.2	28.3	31.6
"	115	44	303.6	13.8	41.9	57.1	46.4	19.4	22.5
6/26/80	45	105	551.1	13.3	73.3	41.9	41.1	30.1	43.2
"	44	92	563.0	8.7	49.0	32.0	36.8	18.0	31.0

with the 45 gpm flowrate produced only a 20% increase in solids removed.

The rate of solids removal (weight per unit time) was much greater for the high flowrate (66 lbs/hr) than for the low flowrate (average of 37 lbs/hour). These solids removal rates were below those previously achieved with the Hydrasieve (Sweeten, 1980), but were higher than the solids removal rates achieved with the Vat Clean system (Tables 1 and 2).

Over all flowrate and time combinations, the settleable solids concentrations were reduced from an average of 13.7% by volume at the inflow to 11.6% at the outflow. This difference was highly significant ($\alpha = 1\%$ level). There was also a significant difference between the inflow and outflow concentrations of settleable solids within the two flowrates ($\alpha = 5\%$). There was no significant difference between inflow and outflow concentrations of total solids, volatile solids, total suspended solids, volatile suspended solids, COD, or BOD.

The second experiment with the TAEX sedimentation chamber (Experiment IV) occurred on September 23, 1980. It consisted of a 5.55 hour continuous run at a flowrate of 120 gpm. This flow duration was equivalent to 1.47 hours per 1,000 head dipped and 7.9 vat turnovers. At the start of this test, 3,291 head had been dipped since the vat was recharged six days previously. The Hydrasieve had been run throughout dipping but the sedimentation tank had not been used. Some 458 head of cattle were dipped intermittently during the sedimentation chamber test at a average dipping rate of 140 head/hour.

Sediment in the first settling chamber contained 9.9% total solids concentration. Sediment removed from the first chamber weighed 799.4 lbs (wet basis) which yielded 79.4 lbs dry solids. The second chamber contained 356.1 lbs wet sediment with 11.8% dry matter content or 41.9 lbs dry solids. The amount of sediment trapped behind the inflow baffle was insignificant (0.75 lbs dry solids). Total sediment removed in this experiment therefore

was 121.7 lbs dry matter or 15 grams per head dipped. Ash content of the sediment averaged 49% of dry solids. The solids removal rate was 21.9 lbs/hour.

For comparison, the amount of wet solids removed from vat solution by the adjacent Hydrasieve in the same time interval was measured at 502.9 lbs. The solids content ranged from 9.8 to 12.1% (w.b.) so that the calculated amount of dry solids removed with the Hydrasieve was 59.7 lbs or 59 grams/head average for the day's dipping. Almost 90% of this Hydrasieve residue was removed in the first 85 minutes with the remaining 10% in last 248 minutes. The dry solids removal rate ranged from 38.4 lbs/hour initially to only 1.3 lbs/hour for the last 4.1 hours. The ash content of Hydrasieve residue was fairly low (37% d.b.) and the nitrogen content was high (3.6% d.b.), reflecting the large amount of cattle hair captured with this device.

Dip vat solution was sampled at the inflow and outflow sections of the sedimentation chamber after elapsed times of 10, 60, 120, 200, 240, and 333 minutes. Total solids concentration in the pesticide solution decreased from 2.75% in the inflow after 10 minutes to 2.21% in the outflow after 333 minutes of operating time. Paired statistical analysis of inflow versus outflow concentrations revealed significant differences ($\alpha = 5\%$) in concentrations of total solids, total suspended solids, and volatile suspended solids across the sedimentation tank. Outflow samples contained an average of 0.1, 0.3, and 0.2% lower concentrations of these respective parameters than the corresponding inflow samples. The reduction in TSS and VSS concentrations with time is shown in Figure 5.

There was also a significant reduction in settleable solids content as measured with a 2-hour settling test. Outflow samples contained an average of 1.0% less settleable solids than the simultaneous inflow samples. The

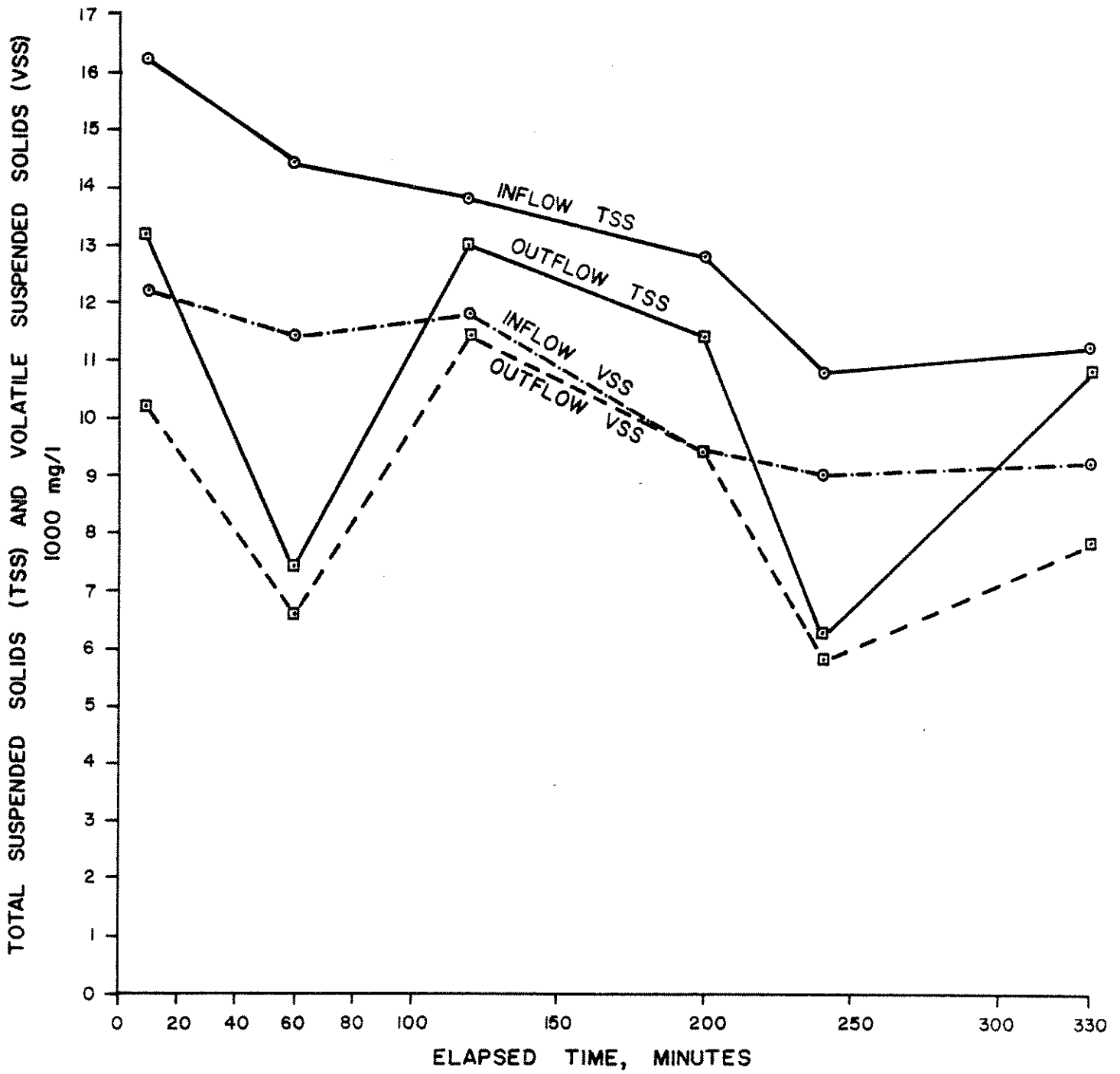


Figure 5. Concentrations of total and volatile suspended solids decreased during 5 ½ hours flow through 975 gallon TAEX sedimentation tank at Cactus Feedyards in Experiment IV.

progressive reduction in settleable solids concentration with sufficient sedimentation tank operating time is vividly shown in Figure 6. There was little or no change in solids concentration for the first 60 minutes. However, a dramatic decrease took place between 60 and 200 minutes of system operation, and further reductions occurred throughout the remainder of the experiment. The largest decrease occurred for particles that had settling times of 7 to 25 minutes, after which the curves are nearly parallel, indicating little removal of solids with longer settling times.

The geometric mean particle size diameter for vat solution was reduced from 23.4 microns for the inflow at 10 minutes of chamber operation to 18.9 microns after an operating time of 333 minutes (Figure 7). Overall, the median particle diameter for the inflow samples was 0.9 microns greater than for the simultaneous outflow samples, indicating a slight reduction in particle size through the chamber.

Sedimentation tank operation was continued during cattle dipping until October 2, at which time an additional 4,871 head of cattle had been dipped (8,620 head total). Assuming a dipping rate of 140 head per hour, it is estimated that an additional 35 hours of sedimentation tank and Hydrasieve operation were incurred. As shown in Figure 6, the settleable solids concentration had been reduced to only 6.4%. Much of this reduction occurred with solid particles that had settling times of 75 to 240 minutes. The removal of these fine, buoyant particles from a sedimentation chamber that had only 8 minutes detention time is believed attributable to flocculation.

Solids collected in the sedimentation tank between September 23 and October 2 occupied 720 gallons or 73% of the total tank capacity. The sediment contained from 12.8 to 21.9% solids concentration (16.6% average) and averaged 39% ash. The calculated weight of total solids was 994 lbs dry

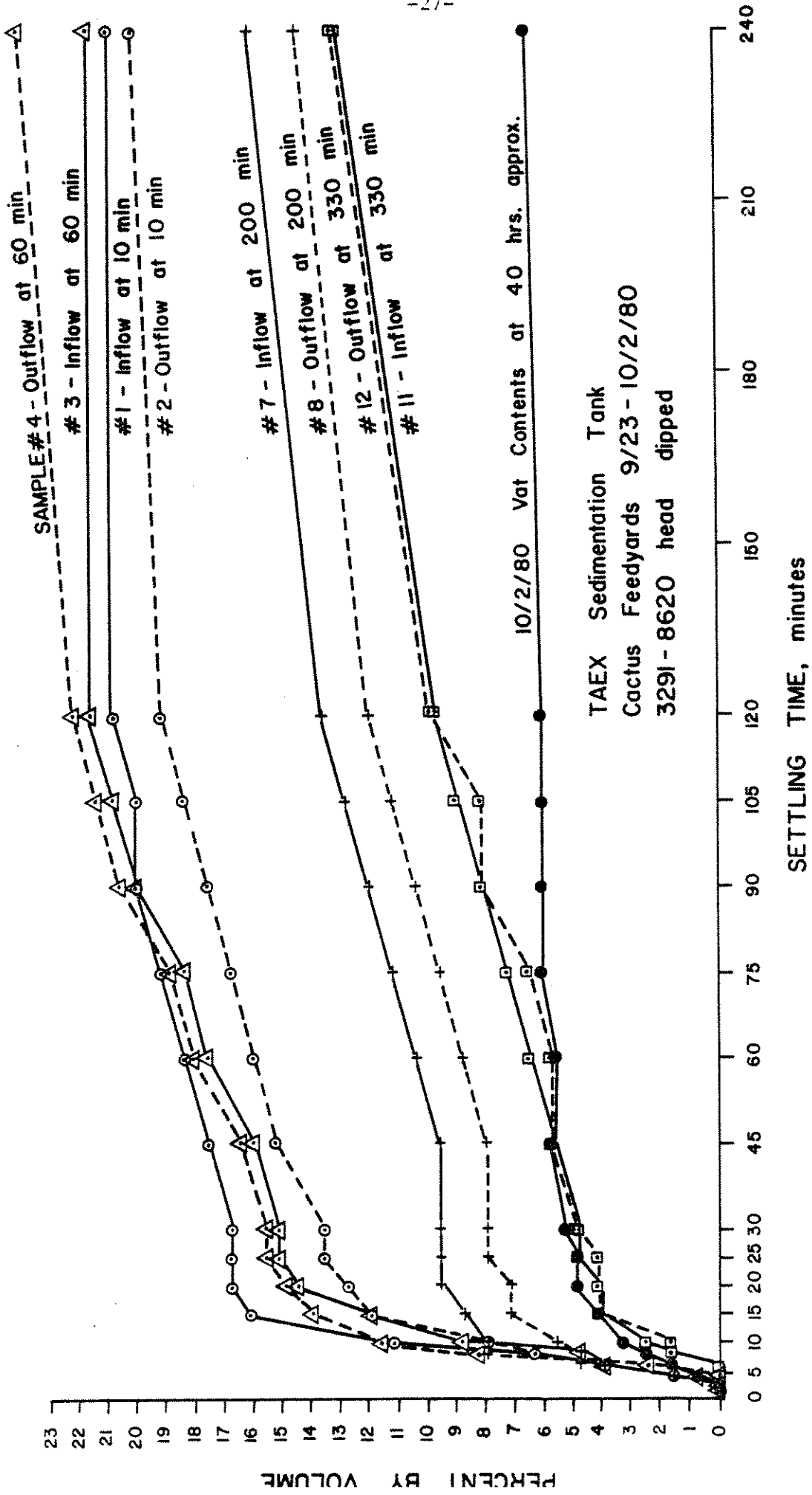


Figure 6. In vitro settling characteristics of cattle dip solution were drastically altered after operation of the 975 gallon sedimentation tank for various flow durations in Experiment IV.

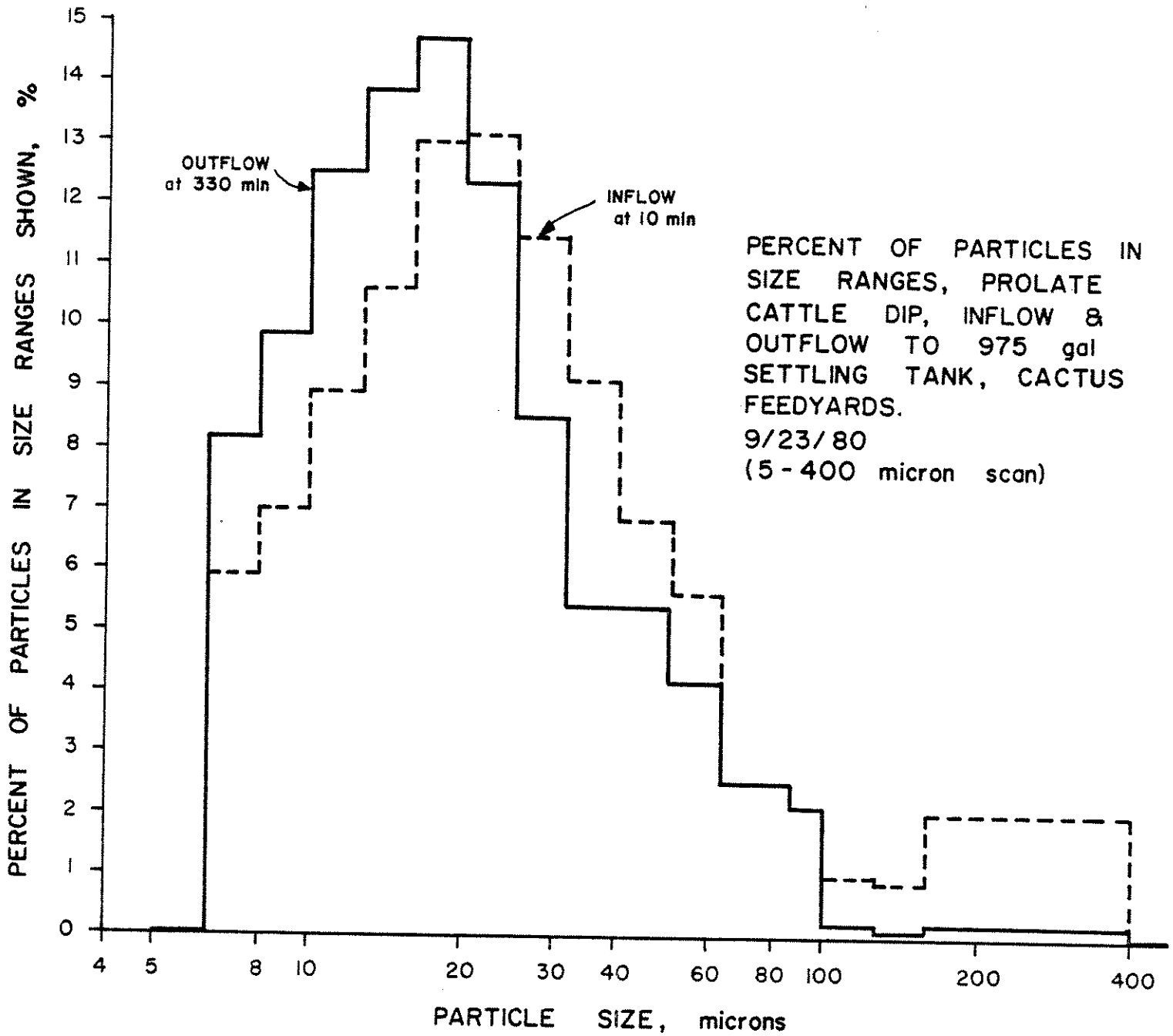


Figure 7. Particle size distribution was altered by operation of sedimentation tank in Experiment IV, with the geometric mean particle diameter reduced from 23.4 μm to 18.9 μm .

matter which amounted to 93 grams/head removed. Thus the total solids removed on this vat cycle was increased to 108 grams/head.

The geometric mean particle size of sediment within the 5 to 400 micron range was 31 microns for chamber 1 and 29 microns for chamber 2. The particle size distributions for the sediment and vat solution are shown in Figure 8.

On the October 2 sampling date, the vat solution had a total solids concentration of 3.1%, pH of 6.9, and prolacte concentration of 0.16%. After an additional 597 head of cattle were dipped later that day (9,217 head total), the vat was recharged even though settleable solids were still below 10%.

A statistical summary of solids concentrations, oxygen demand, pH, and prolacte concentrations for all the Cactus Feedyards experiments is provided in Table 6.

Extended Evaluation and Economic Benefits

Eleven months after the Vat Clean system was placed in operation at Sugarland Feedyards, its effectiveness in increasing the number of cattle dipped per vat recharge was determined by comparing feedlot dipping records before and after installation of the unit. As shown in Table 7, the vat recharging interval was increased from 17 days to 33 days average. The average number of cattle dipped per vat charge was increased from 2,446 head without the sedimentation tank to 4,856 head with the unit (98.5% increase). As a result, the estimated amount of pesticide discarded (assuming 3,300 gallons per recharge event) was reduced from 1.35 gallons per head originally to an average of 0.68 gallons per head with the Vat Clean system in operation. With prolacte vat solution worth \$0.32 per gallon, this indicates a savings of \$0.21 per head dipped. Thus, the total indicated savings for the 48,560 cattle dipped in the first 11 months of Vat Clean operation was \$10,200. This is almost a 400% return on the initial investment in the system, which presently costs \$2,700.

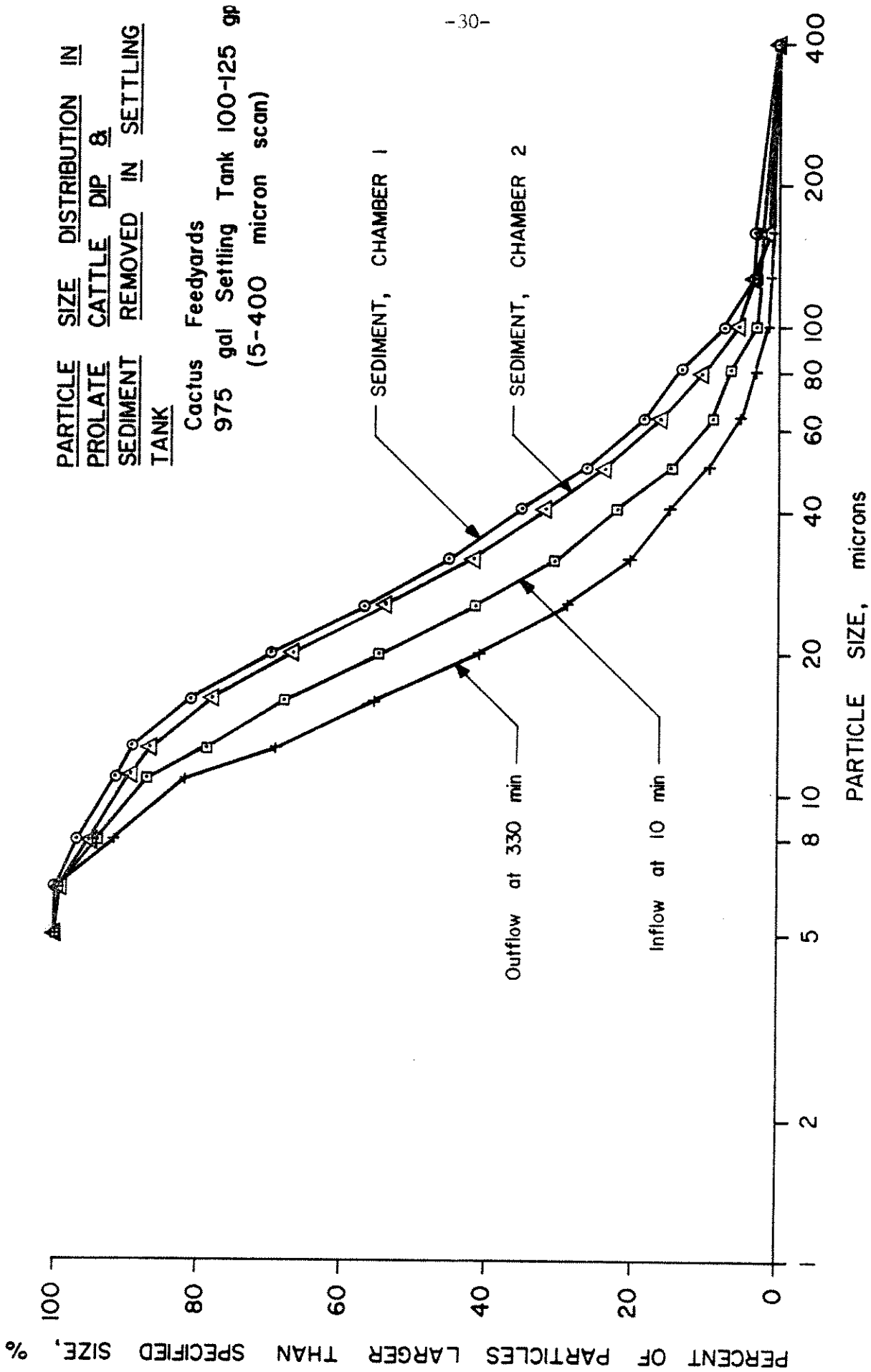


Figure 8. Particle size distribution curves revealed smaller particles in outflow from Experiment IV than in inflow or in sediment collected from extended flow tests.

TABLE 6

SUMMARY OF CATTLE DIP SOLIDS AND OXYGEN
DEMAND CONCENTRATIONS*, CACTUS FEEDYARDS
June 25 - October 2, 1980

Parameter	Experiment III (June 25-26)	Experiment IV (September 23)
Total Solids, mg/l	36,500±2,600	25,100±550
Volatile Solids, mg/l	12,500±1,200	13,800±580
Total Suspended Solids, mg/l	26,100±1,300	11,800±820
Volatile Suspended Solids, mg/l	17,200±830	9,500±590
Chemical Oxygen Demand, mg/l	76,100±960	--
Biochemical Oxygen Demand, mg/l	6,370±140	11,920±340
Settleable Solids, 2-hr, % (V/V)	12.6±0.4	16.5±1.5
pH	6.6±0.1	5.8
Prolate, ppm	0.184±0.004	0.164

*Average and standard deviation; inflow and outflow samples included.

TABLE 7
SUMMARY OF DIP VAT RECORDS
BEFORE AND AFTER
INSTALLATION OF VAT CLEAN,
Sugarland Feedyards, 1978-81

	Before Vat Clean 5/13/78 - 5/19/80	After Vat Clean 5/19/80 - 4/12/80
No. Cattle Dipped, head	98,831	48,560
Vat Recharging Cycles	40	10
Cattle Dipped Per Vat Charge, Head		
--Average	2,446	4,856
--Std. Deviation	± 93	± 202
--Range	1296-4171	3597-5785
Vat Recharging Interval, Days		
--Average	17.3	32.8
--Std. Deviation	± 1.4	± 2.9
--Range	6-47	21-47

At Cactus Feedyards, the 975-gallon sedimentation tank was placed in operation on a permanent basis on March 24, 1981. Since that time, two vat cycles have been completed with excellent results. The settleable solids content, prolacte concentration, and pH of vat solution were measured two or three times weekly throughout this period. Between March 24 and May 20, 1981, a total of 16,800 cattle were dipped before recharging became necessary. The second vat cycle continued until September 4 at which point 31,988 had been dipped. For these two vat cycles, the average of 24,400 head per vat charge represents an increase of more than 150% over levels achieved using only the Hydrasieve. Furthermore, it represents an increase of 410% more cattle being dipped per vat charge as compared to the period before the Hydrasieve was installed.

Using both the sedimentation tank and the Hydrasieve, the volume of vat solution being disposed of has been decreased dramatically to only 0.20 gallons per head dipped. This is less than one-fifth of the typical disposal volume for most feedyards. The sedimentation tank alone has saved the feedyard an estimated 0.32 gallons of dip vat solution per head, or 9¢ per head. The overall savings of 0.80 gallons of vat solution per head represents a \$0.26 per head savings in pesticide costs alone.

From another standpoint, the theoretical amount of GX-118 formulation it takes to dip cattle according to the label is 0.0367 gallons GX-118 per head. This computation assumes water usage of 1 gal/head for initial charge plus 1 gal/head for replenishment. By contrast, the vat cycle of May 20 - September 4, 1981, required a total of 675 gallons of GX-118 or only 0.0211 gallon GX-118 per head dipped. This represents a 43% reduction in pesticide purchased or a 28.5¢ per head savings as compared to label directions.

For the 5-month period March 24 - September 4 covering the last two vat cycles, it is estimated that Cactus Feedyards saved \$12,500 which is far more than enough to pay for the Hydrasieve, sedimentation tank, and pumping system. Subsequent projected profit to the feedyard could exceed \$30,000.

SUMMARY AND CONCLUSIONS

Two sedimentation tanks (300- and 975-gallon capacity) used for solids removal from GX-118 cattle dipping vat solution were tested at two feedyards on the Texas High Plains in 1980-81. The sedimentation chambers were operated at two flowrates and various operating times. Determinations were made of the amount of solids removed and the reductions in solids concentrations across the sedimentation tanks. The prolacte concentration and pH were also monitored. The number of cattle that could be dipped per dipping-vat charge before and after use of the sedimentation tanks was evaluated as an indicator of pesticide volumes disposed of. Recommendations concerning sedimentation tank design and operating conditions were developed.

From the data collected and analyzed, the following conclusions were drawn:

1. Sedimentation tanks remove solids more slowly than the Hydrasieve initially but are effective in solids removal for a much longer period of operating time.
2. The proper operating time for a sedimentation tank should be at least 4 hours per 1,000 head of cattle dipped. Since this is roughly equal to the time required for cattle processing and dipping, the sedimentation tank should be operated while cattle are being dipped.
3. Most of the experiments were conducted for too short of a time period to adequately realize the full solids-removal potential of the sedimentation tanks.

4. Dry solids removal rates ranged from 9 to 75 lbs per hour of sedimentation tank operation.
5. The amount of dry solids removed from vat solution with the sedimentation tanks reached peak values of 48 grams per head at a flow duration of 3.77 hours per 1,000 head or 93 grams per head at a flow duration of 7.1 hours per 1,000 head.
6. There was a significant reduction in total solids and settleable solids concentrations between paired samples of inflow and outflow from both sedimentation tanks.
7. Prolate concentration and pH of vat solution were not affected by operation of the sedimentation tanks.
8. The sedimentation tanks do not appear to be sensitive to flowrate fluctuations in terms of solids removal, provided that the average detention time exceeds 5 to 8 minutes.
9. Solids in the outflow from the 975-gallon sedimentation tank had a smaller particle size (geometric mean and median diameter) than for solids in the inflow stream.
10. The volume of vat solution to be disposed of was reduced 50 to 62% by the sedimentation tanks and by 72 to 84% with the sedimentation tank and Hydrasieve together.
11. The sedimentation tanks were cost-effective, with estimated savings of 9 to 21¢ per head dipped. The savings could pay for the system in a few months.
12. The combination of Hydrasieve and sedimentation tank has saved one of the feedlots approximately 26¢ per head.

13. The number of cattle dipped per vat recharge increased by 99 to 220%. The maximum number of cattle dipped on a vat charge with both Hydrasieve and sedimentation tank was 31,988 head.

RECOMMENDATIONS

The following recommendations are provided as guidelines to feedyard managers, based on results and experience gained with this project:

1. Feedyards should install a sedimentation tank and/or static screening device such as a Hydrasieve to remove solids from cattle dipping vat solution.
2. The most critical part of the system is the pump. It should be an electrically-powered self-priming centrifugal trash handling pump, capable of passing solids of 1½-2½" diameter. The pump should be capable of providing the following flowrates at 30 to 50 feet of head at a minimum rated efficiency of 45% (higher if possible):

	<u>Pump Flowrate, gpm</u>	<u>Nominal Pump size, in.</u>
(a) Sedimentation tank only	125 - 150	2 x 2
(b) Both sedimentation tank and static screen	300 - 325	3 x 3

You can expect to pay \$1500 or more for a good pump and motor.

3. The pump intake pipe (3 inch minimum diameter) should be raised 1 to 2 feet off the vat bottom to avoid rocks and other large debris.
4. The sedimentation tank volume should be 10 to 20% of the dipping vat volume.

5. Flowrate through the sedimentation tank should be adjusted to provide an average detention time (volume in gallons ÷ flowrate in gal/min) of 5½ to 8 minutes or more. Some suitable combinations are:

Vat Size Gal	Sedimentation Tank Size Gal	Flowrate, gpm	
		Min	Max
3000	450	36	60
4000	600	48	80
5000	750	60	100

6. In the sedimentation tank, a vertical baffle should be placed near the inflow pipe to dissipate energy and obstruct flow below the top 6" or so of liquid. At least one other overflow baffle should be placed inside the tank.
7. Outlet conditions are important also. Ideally, flow should spread out and decelerate as it exits the tank by passing over a weir plate across the outlet end. The weir plate should be at least as long as the tank width, or longer. The weir crest must be level for this to do any good. (The worst outlet condition is a simple pipe or elbow toward which flow must accelerate to leave.)
8. The sedimentation tank should be operated throughout each cattle dipping event. This will insure good vat agitation and provide sufficient operating time. For convenience, the electric switch for the pump should be placed by the cattle chutes leading into the dipping vat.
9. The sedimentation tank should be cleaned out when it is ¼ to ½ full of sediment. The smaller the tank, the more frequently this will occur. These solids need to be stored in the pesticide evaporation pit awaiting eventual land disposal at very low application rates.

10. Vat solution needs to be tested at least three times per week for active ingredient, pH and sediment. These tests may be furnished by your pesticide supplier. Testing becomes very important as you increase the number of cattle dipped per vat charge.

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