OPERATION & STERILIZATION OF AN 8000 TONS PER DAY TOWER DIFFUSER WITH COUNTER-CURRENT MIXER

THE AMALGAMATED SUGAR CO.
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USE OF LIQUID SO_2 FOR BACTERIAL CONTROL

Formaldehyde has been a standard bactericide for use in sugar factories. There have been several attempts made to find a suitable substitute for formaldehyde.

Application of formaldehyde has to be discontinued for one or more of the following reasons:

-Safety in handling and application

-Toxicity (Proven damage to respiratory & nervous system)

-Contributes to high lime salts

-Contributes to high ash in white sugar

-Interferes with pulp pressing (excessive formaldehyde usage will decrease and pressed pulp dry substance)

-Environmental impacts

-Cost

During 1989-90 Campaign, three most commonly used sterilants were tried at the Nyssa Factory of Amalgamated Sugar Company.

Formaldehyde was tried in small doses and frequently, (approximately 60 gallons every two hours) for the first few days of campaign. Then liquid Sulfur dioxide was started to the cossette mixer and the press water system at the rate of 300 PPM. This was continued until day number 43 while the formaldehyde dosage stayed the same but less frequent, (once every four hours).

From day 43 to day 70, liquid sulfur dioxide was used at the rate of 250 PPM with no formaldehyde. Initially, liquid sulfur dioxide was introduced at the top of mixer and near the center. Later, the point of injection was moved to the hot end of the mixer, (below juice level). The test results indicated the mid-tower and bottom of the tower were infection free, but the raw juice counts were high. The point of injection was then moved to the cold side of the mixer, (between where the cossettes enter and middle of the mixer and below juice level).

From day 70 to day 87, chlorine dioxide was tried. Chlorine dioxide was locally generated and introduced in the cossette chute at the rate of 250 lbs/day, (15 PPM on juice) and press water system at the rate of 125 lbs/day, (7.5 PPM on juice).

The raw juice lactic acid, raw juice invert, and cossette invert and the difference between raw juice invert and cossette invert are in tables 1 and 2 and the trends are charted in figures 1 and 2.

Results of bacteria counts of mid-tower, raw juice and comparison of raw juice bacteria counts and unaccountable loss are graphed in figures 3 through 6.

All results indicated the effectiveness of liquid SO_2 as a bactericide and the decision was made to install a permanent liquid sulfur dioxide station.

Installation and Safety:

Liquid sulfur dioxide was made available to Nyssa either in 50 ton or 90 ton rail cars. There are four valves on top of the liquid SO_2 rail car. Two are extended with a pipe to the bottom of the car and two are open to the top. Since liquid SO_2 is needed for our application the connection was made to the valve extending to the bottom of the rail car.

An air compressor was used to pressurize the car, (about 60 psig) and the connection was made to the valve which is open to the top.

The tubing to carry liquid SO_2 along the pulp conveyor to the main building was 1/2 inch and made out of 316 S.S. The compression type fittings were used to connect these 20 foot sections of this tubing.

There is an electrically actuated valve installed in this tubing just outside of the mixer building and the switch is located on the carbonation control panel. This valve is being shut if an SO_2 leak is suspected in the main building.

Liquid SO_2 is metered into the mixer, (injected below juice level in the cold side) through a specially made flow meter. The calibration is for material of 1.4 specific gravity and the tube and the float is made from such material that is not easily discolored or damaged.

Usage and Cost:

At 300 PPM, (on juice) and slice rate of 385 tons/hour the flowmeter was set at 0.32 GPM which is about 230 lbs/hr. The cost at this rate was about $700/day.

When the dosage was lowered to 250 PPM at the same slice rate, the meter had to be set at 0.27 GPM and the cost was about $580/day.

During 1990-91 campaign the rate of usage was dropped to 0.10 GPM in the cossette mixer and 0.03 GPM in the press water system. At the slice rate of 400 tons/hr and 121 draft the liquid sulfur dioxide dosage is about 100 PPM. The total cost for the liquid sulfur dioxide added to the mixer and the press water system was approximately $300/day. The test comparisons at this lower rate are shown in figure 7.

Comparison:

Formaldehyde is used in shock doses and it controls infections, but the micro-organisms population rapidly reappears.

Sulfur dioxide is used continuously, it does not kill the micro organisms completely, but it controls it.

Sulfur dioxide is added to the press water after the presses and before it is pumped through the press water heaters.

The advantages are:

- Sterilizing the long pipe line of press water to the main factory building.
- Sterilizing the tailings recovery mix tank since a large portion of this press water goes to the mix tank to slurry the tailings.
- Sulfur dioxide is a weak acid and tends to act as a buffer where sulfuric acid is used to control diffuser supply pH.
- Press water which is used to flush out the press spindles is taken after SO_2 is added and it has a bacteria controlling effect in the presses, and press water screens.

Observations:

1. Liquid SO_2 can safely be handled.
2. Liquid SO_2 is effective in controlling micro-organisms.
3. Exceptional settling rate and clear over flow in the Dorr clarifier can be contributed to lack of micro-organism activity.
4. Long service cycle for vacuum drum filters, Kelly filters and candle filters can be contributed to lack of by-products of micro-organism activities.
5. If raw juice lactic acid and the difference between raw juice invert and cossette invert can be used as an indication of micro-organism activities. The attached table clearly indicates the advantages of liquid Sulfur Dioxide.
6. Use of liquid sulfur dioxide had a positive impact on unaccountable loss.

DAILY VALUES FROM LEDGER OR KEYED

Values for 1989 beet campaign for day 1 to 97.

Value 1.	Corr Lactic Acid in Raw Juice	High:	195.0	Low:	12.0	High day:	94	Low day:	20
Value 2.	% Invert in DS in Raw Juice	High:	1.900	Low:	1.370	High day:	4	Low day:	18
Value 3.	% Invert in DS in Cossettes	High:	1.820	Low:	0.320	High day:	4	Low day:	19
Value 4.	Raw Juice Invert minus Cossette Inve	High:	0.800	Low:	-0.870	High day:	75	Low day:	3

DAY	1	2	3	4
1	0.0	0.000	0.000	0.000
2	42.0	1.250	1.200	0.150
3	67.0	0.940	1.510	-0.570
4	84.0	1.900	1.820	0.080
5	97.0	0.820	0.400	0.220
6	46.0	0.580	0.640	-0.060
7	76.0	0.620	0.500	0.120
8	54.0	0.650	0.380	0.250
9	58.0	0.580	0.570	0.010
10	80.0	0.660	0.460	0.220
11	115.0	0.670	0.450	0.240
12	39.0	0.700	0.430	0.270
13	76.0	0.650	0.440	0.210
14	57.0	0.630	0.560	0.070
15	50.0	0.670	0.550	0.140
16	54.0	0.750	0.580	0.170
17	41.0	0.630	0.810	-0.180
18	51.0	0.570	0.370	0.200
19	65.0	0.650	0.320	0.330
20	16.0	0.620	0.560	0.060
21	64.0	0.610	0.620	-0.010
22	38.0	0.650	0.570	0.080
23	70.0	0.600	0.000	0.000
24	54.0	0.800	0.490	0.310
25	63.0	0.690	0.480	0.210
26	53.0	0.740	0.470	0.270
27	45.0	0.770	0.690	0.080
28	57.0	0.910	0.730	0.180
29	44.0	0.740	0.700	0.040
30	20.0	0.900	0.630	0.270
31	47.0	0.820	0.590	0.230
32	76.0	0.730	0.470	0.260
33	62.0	0.720	0.610	0.110
34	49.0	0.890	0.400	0.490
35	45.0	0.750	0.630	0.120
36	51.0	0.780	0.530	0.250
37	34.0	0.810	0.610	0.200
38	34.0	0.680	0.530	0.150
39	62.0	0.620	0.470	0.150
40	33.0	0.690	0.440	0.250
41	37.0	0.680	0.570	0.110
42	30.0	0.630	0.400	0.230
43	46.0	0.690	0.500	0.190
44	42.0	0.740	0.500	0.240
45	64.0	0.730	0.480	0.250
46	41.0	0.780	0.550	0.230
47	46.0	0.850	0.430	0.420
48	46.0	0.780	0.680	0.100

TABLE 1

Values for 1989 beet campaign for day 1 to 97.

Value 1.	ppm Lactic Acid in Raw Juice	High:	193.0	Low:	16.0	High day:	94	Low day:	20
Value 2.	% Invert on DS in Raw Juice	High:	1.900	Low:	0.570	High day:	4	Low day:	18
Value 3.	% Invert on DS in Cossettes	High:	1.820	Low:	0.320	High day:	4	Low day:	19
Value 4.	Raw Juice invert minus Cossette Inve	High:	1.500	Low:	-0.870	High day:	75	Low day:	3

Day	1	2	3	4
1	59.0	0.940	0.650	0.290
2	46.0	0.860	0.650	0.210
3	38.0	0.850	0.610	0.240
4	42.0	0.900	0.990	-0.090
5	35.0	0.820	0.520	0.300
6	33.0	0.930	0.640	0.290
7	37.0	0.860	0.650	0.210
8	29.0	0.880	0.650	0.230
9	28.0	0.880	0.650	0.230
10	38.0	0.800	0.600	0.200
11	41.0	0.810	0.650	0.160
12	37.0	0.790	0.430	0.360
13	31.0	0.850	0.570	0.280
14	37.0	0.890	0.620	0.270
15	28.0	0.870	0.720	0.150
16	38.0	0.860	0.510	0.350
17	25.0	0.730	0.420	0.280
18	34.0	0.810	0.580	0.230
19	27.0	0.810	0.810	0.000
20	26.0	1.000	0.530	0.470
21	49.0	0.870	0.620	0.250
22	52.0	0.810	0.500	0.310
23	37.0	0.830	0.700	0.130
24	54.0	0.740	0.470	0.270
25	106.0	0.850	0.660	0.190
26	101.0	0.950	0.660	0.290
27	122.0	1.070	0.570	0.500
28	117.0	0.930	0.750	0.180
29	109.0	0.930	0.620	0.310
30	109.0	0.980	0.620	0.360
31	78.0	0.960	0.700	0.260
32	74.0	0.970	0.710	0.260
33	107.0	1.000	0.750	0.240
34	127.0	1.000	0.900	0.100
35	122.0	1.120	0.710	0.410
36	113.0	1.010	0.920	0.090
37	125.0	1.020	0.550	0.470
38	116.0	0.780	0.590	0.190
39	96.0	0.840	0.490	0.350
40	76.0	1.120	0.670	0.450
41	105.0	1.040	0.550	0.490
42	72.0	0.830	0.660	0.150
43	122.0	1.370	0.520	0.370
44	92.0	0.840	0.650	0.190
45	87.0	0.980	0.840	0.140
46	193.0	0.000	0.000	0.000
47	0.0	0.000	0.000	0.000
48	0.0	0.000	0.000	0.000

TABLE 2

GRAPHS OF DAILY VALUES

Values for 1989 beet campaign for day 1 to 97
x = value beyond graph limits. m = missing value.

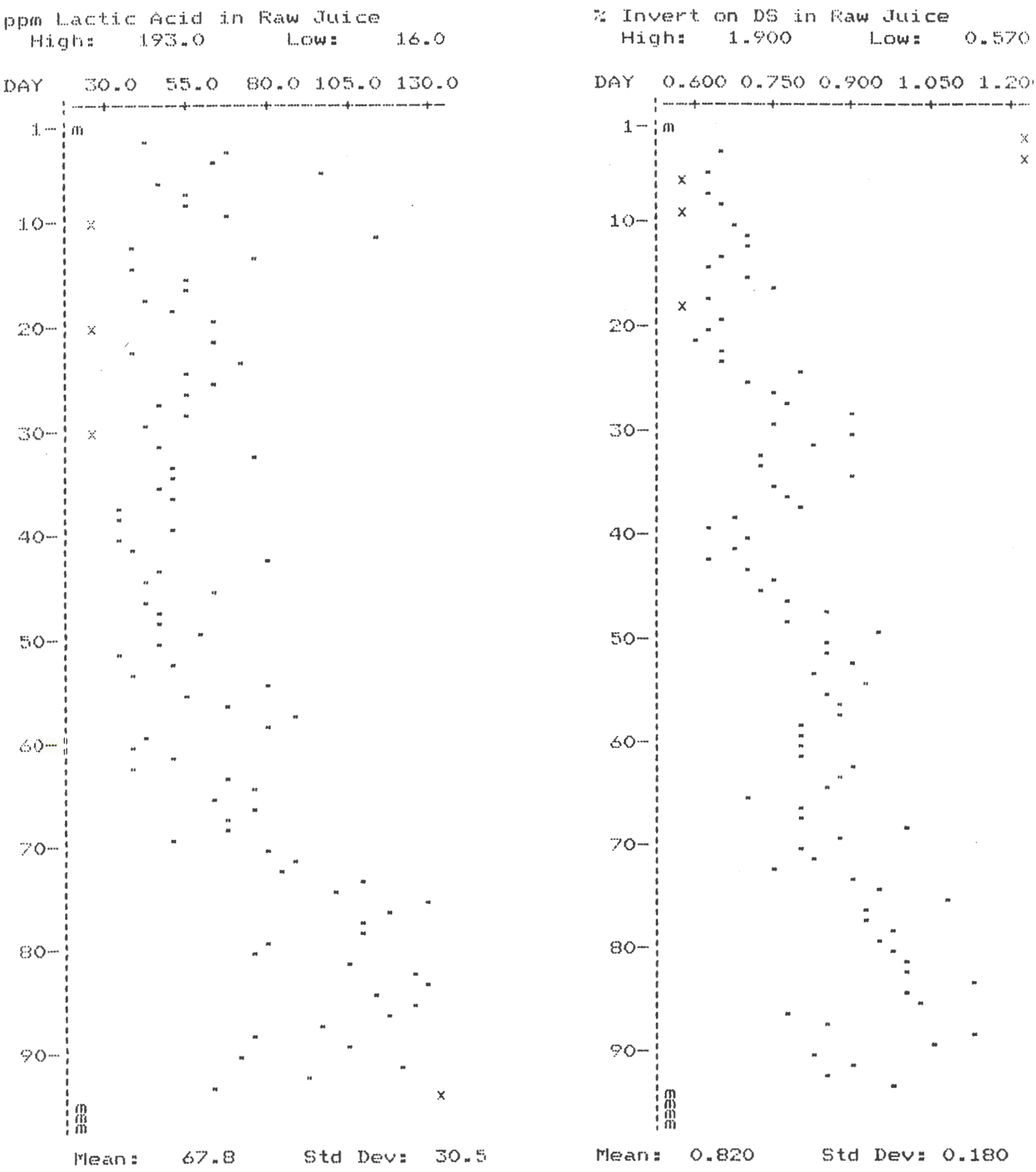

FIGURE 1

GRAPHS OF DAILY VALUES

Values for 1989 beet campaign for day 1 to 97
x = value beyond graph limits. m = missing value.

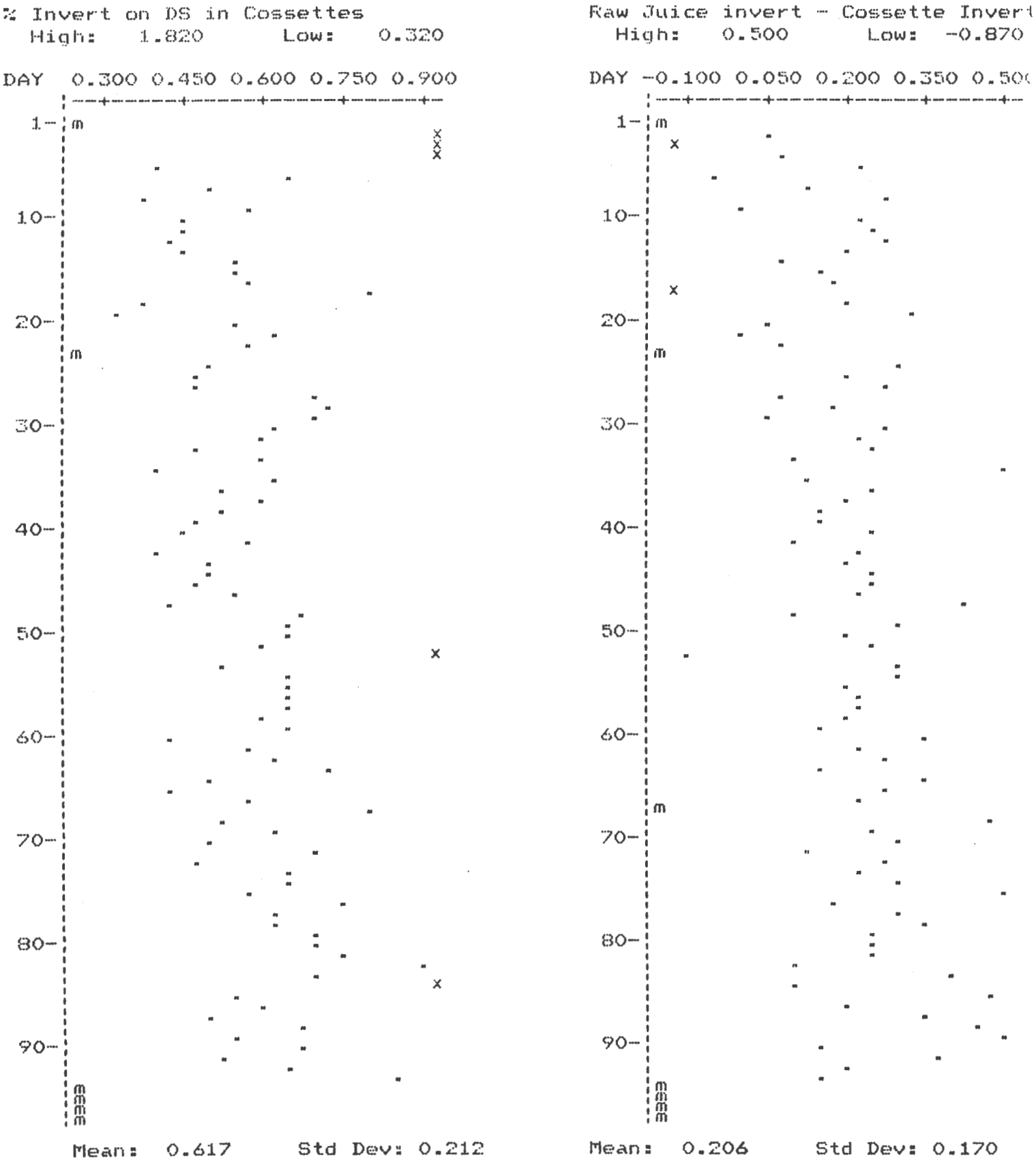

FIGURE 2

NYSSA 89 Raw Juice
250 ppm SO2

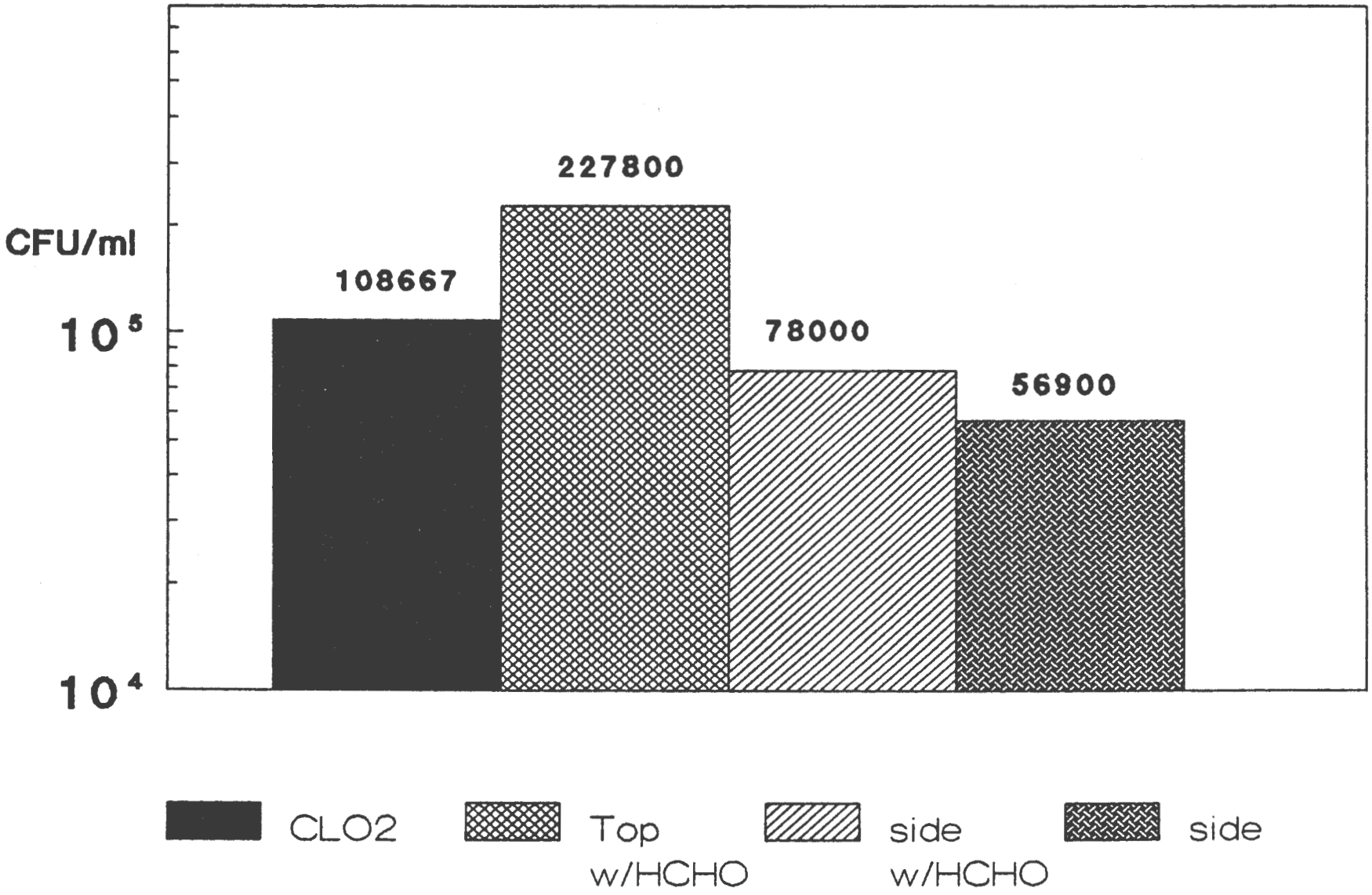

FIGURE 4

Nyssa 89 Mid-tower
250 ppm SO2

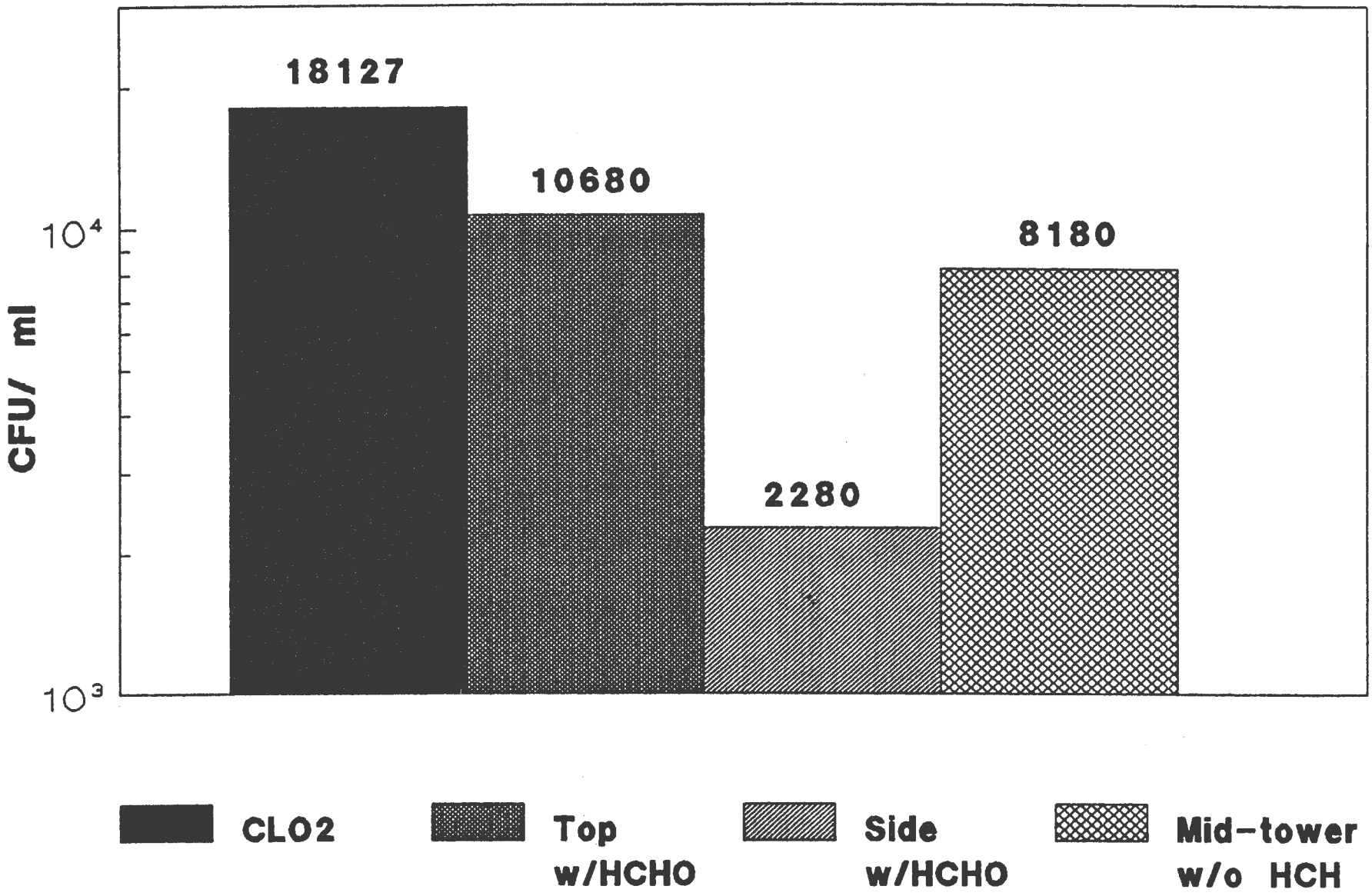

FIGURE 3

Comparison of 89 to 90 Microbial titers

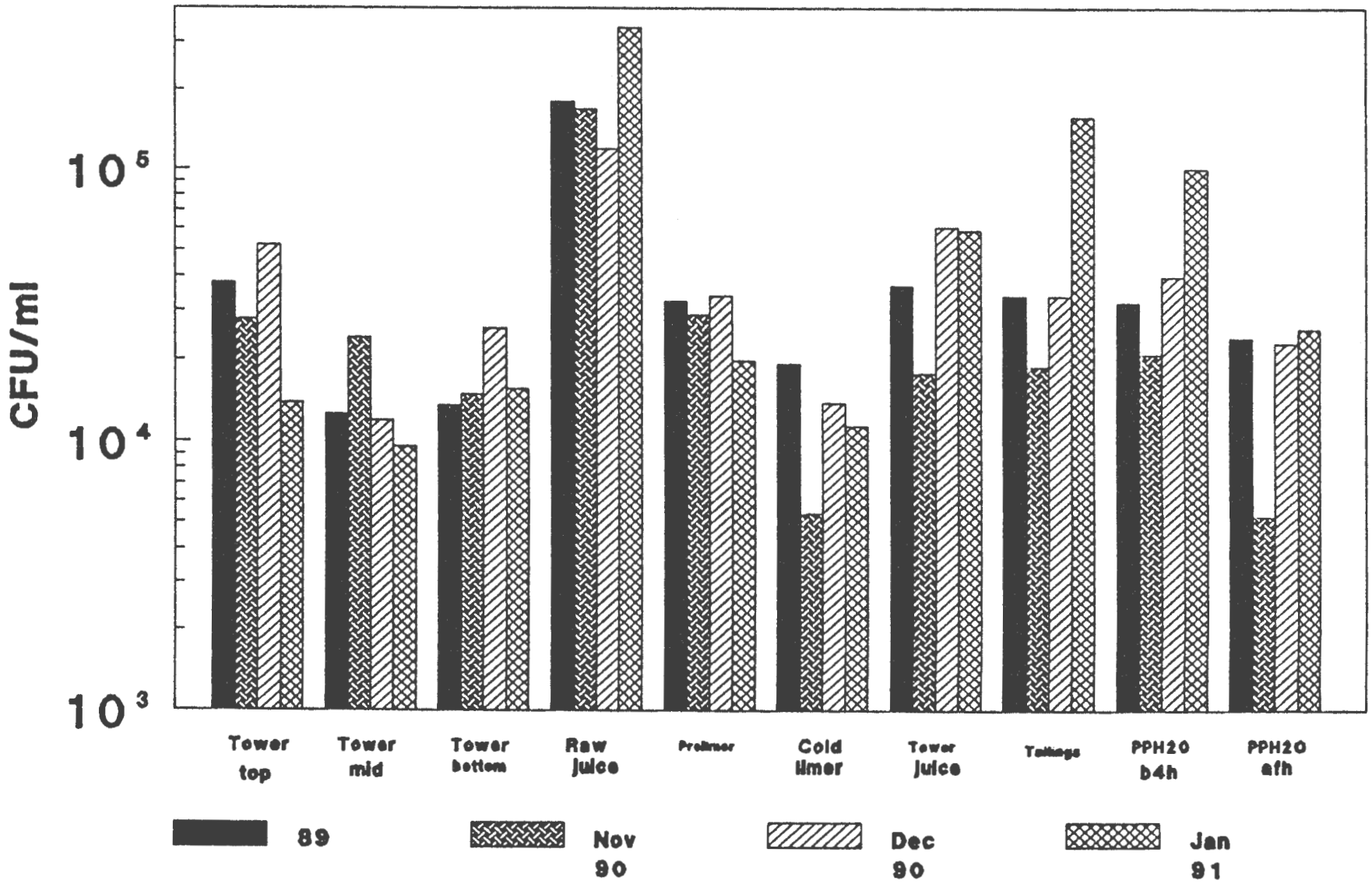

FIGURE 7