

1914

The determination of the critical sizes in table concentration

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John N. Webster

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THE DETERMINATION OF THE CRITICAL SIZES IN TABLE
CONCENTRATION

by

Julius C. Miller & John N. Webster.

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A

T H E S I S

submitted to the Faculty of the

SCHOOL OF MINES AND METALLURGY OF THE UNIVERSITY OF MISSOURI

in partial fulfillment of the work required for the

D E G R E E O F

BACHELOR OF SCIENCE IN GENERAL SCIENCE

Rolla, Mo.

1914.

—

Approved by

Horace T. Mann

Professor of Ore Dressing.

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OBJECT OF EXPERIMENT.

It has been observed in table concentration that the ore band consists of the coarsest particles of ore on the bottom or low side. Further up on this ore band the coarse particles grade into finer particles, until a certain marked degree of fineness is reached by which the mineral can no longer adhere to the table top, but must be carried over by the wash water as slimes. To determine the critical size of ore of practical value which will remain in the concentrates band, under certain variable conditions, is the purport of this thesis.

STEPS IN CARRYING OUT EXPERIMENT.

The material used in the test was prepared by crushing pure Carthage limestone, and a Galena ore, crystalline, and practically free from impurities. These natural products were crushed so as to pass thru a 12 mesh screen (1.75 M.M.). then an intimate mixture of 10% Galena and 90% Limestone was made by Coning. This feeder was adjusted so as to produce the proper constant feed for table concentration. The table used was a "Wilfley" "tacked-on riffles" type, 48" in length by 24" wide. The riffle cleats are tacked on the wooden table top,

parallel to each other, and are tapered, so that at the discharge end they are nearly flush with the table top proper. Their tip ends (i.e., discharge ends) are in a diagonal line, with the longest cleat on the tailings or lower side of the table, which latter extending the whole length of the table. The shaking motion was produced by a reciprocating machine and a spring.

In order to determine the critical sizes of ore which will remain in the concentrates band, the following variable conditions were subjected to the operation of the table. Throughout the entire test a constant feed was delivered to the table by a suitable amount of feed water.

DESCRIPTION OF TESTS.

TEST No. 1.

The table was adjusted to the best operating conditions. by small trial runs. Upon obtaining a standard of separation, samples were taken of the concentrates, tails and slimes, for a period of two minutes. with the feed and slope of the table remaining constant, and the amount of the wash water being increased from time to time. A two minute sample was taken after this alteration and then

more wash water was used. Samples were taken after each increase of wash water until a set of five tests was complete.

TEST No. 2.

After re-adjusting the table for a standard of separation, the feed and wash water were allowed to remain constant while the slope was made to vary for each test. The first and second slopes were made less than the original, while the last two were made of a larger angle than that to which the table was set for the standard original run. Two minutes samples were taken of the table products after each alteration of slope. Screen analyses were made of each two minute sample collected, and a definite idea was obtained as to the location of the finer particles of ore, upon being concentrated under the said conditions.

The following tables give the necessary data for (1st) determining the critical size in table concentration, and (2nd) the results of accurate screen analysis made upon the table products of the two minute samples.

DETAILS AND OPERATING CONDITIONS OF TESTS.

---0---

| | Test No. 1. | Test No. 2. |
|----------------------------------|--------------------------------|--------------------------------|
| Size of Feed. | 1.75 mm to 0 | 1.75 mm to 0 |
| Composition of Ore Fed, Percent. | 10%PbS 90%CaCO ₃ | 10%PbS 90%CaCO ₃ |
| Rate of Feeding, Kgs. per min. | 2 appr. | 2 appr. |
| Feed Water, " " " | 6 | 6 |
| Wash Water, " " " | Variable | 30 |
| Slope of Table. | 4° 2' | Variable |
| Number of Strokes per Minute. | 220 | 220 |
| Length of Stroke, Inches. | 7/8" | 7/8" |
| Sample of Two Minutes. | 5 | 5 |

TEST No. 1.
 SLOPE CONSTANT (4° 02'); FEED CONSTANT (6 L./Min.)
 VARYING AMOUNT OF WASH WATER.

---0---

| Run: | Wash | :Weight | : Weight | : Weight | : Slope | : Feed |
|------|-----------|-------------|----------|----------|---------|------------|
| | : Water | :Conc. Gms: | : Gangue | : Slimes | | : Water |
| | :Liters.: | : Gms. | : Gms. | : Gms. | | : Liters.: |

| | | | | | | |
|---|-------|-------|--------|-------|--------|---|
| 1 | 13.5 | 192.0 | 1401.0 | 296.2 | 4° 02' | 6 |
| 2 | 17.5 | 137.1 | 1272.0 | 437.5 | " | " |
| 3 | 19.0 | 172.5 | 1394.0 | 417.0 | " | " |
| 4 | 25.0 | 129.2 | 1324.0 | 421.5 | " | " |
| 5 | 33.00 | 154.2 | 993.0 | 252.2 | " | " |

TEST No. 2.

WASH WATER CONSTANT; FEED CONSTANT.

SLOPE VARYING.

---O---

| Run: | Wash | :Weight | : Weight | : Weight | : Slope | : Feed |
|------|----------|-------------|----------|----------|---------|---------|
| : | : Water | :Conc.Gms.: | : Gangue | : Slimes | : | : Water |
| : | : Liters | : | : Gms. | : Gms. | : | :Liters |

| | | | | | | |
|---|----|--------|--------|-------|-------|---|
| 1 | 30 | 124.5 | 1033.0 | 245.9 | 4°18' | 6 |
| 2 | 30 | 100.00 | 871.5 | 237.0 | 3°54' | 6 |
| 3 | 30 | 139.2 | 633.5 | 140.0 | 3°25' | 6 |
| 4 | 30 | 143.7 | 999.0 | 202.3 | 4°49' | 6 |
| 5 | 30 | 186.9 | 796.8 | 178.7 | 5°10' | 6 |

SCREEN ANALYSIS TEST No. 1.....RUN No. 1.....

| | | CONCENTRATES. | | GANGUE | | SLIME. | |
|------|-----|-------------------|----------|-------------------|----------|-------------------|----------|
| THRU | ON | WEIGHT (GRAMS) | PER CENT | WEIGHT (GRAMS) | PER CENT | WEIGHT (GRAMS) | PER CENT |
| 12 | 14 | 11.45 | 5.97 | 176 | 12.56 | | |
| 14 | 16 | 5.60 | 2.92 | 145 | 10.35 | | |
| 16 | 20 | 18.65 | 9.72 | 205 | 14.60 | | |
| 20 | 40 | 42.25 | 22.00 | 439 | 31.30 | | |
| 40 | 60 | 34.50 | 17.50 | 141.5 | 10.10 | | |
| 60 | 80 | 30.25 | 15.77 | 172.50 | 12.30 | | |
| 80 | 100 | 25.70 | 13.40 | 49.7 | 3.55 | 0.40 | .13 |
| 100 | 120 | 10.15 | 5.29 | 30.40 | 2.16 | .56 | .18 |
| 120 | 150 | 5.15 | 2.53 | 9.95 | .71 | 7.28 | 2.46 |
| 150 | 200 | 1.59 | .83 | 17.27 | 1.23 | 1.09 | .37 |
| 200 | | 6.40 | 3.34 | 13.86 | .98 | 286.50 | 96.70 |

SCREEN ANALYSIS TEST No. **1**....RUN No. **2**....

| | | CONCENTRATES. | | GANGUE | | SLIME. | |
|------|-----|-------------------|----------|-------------------|----------|-------------------|----------|
| THRU | ON | WEIGHT (GRAMS) | PER CENT | WEIGHT (GRAMS) | PER CENT | WEIGHT (GRAMS) | PER CENT |
| 12 | 14 | 8.55 | 6.24 | 207 | 16.2 | | |
| 14 | 16 | 4.53 | 3.23 | 138 | 10.8 | | |
| 16 | 20 | 9.88 | 7.21 | 234 | 18.4 | | |
| 20 | 40 | 33.51 | 24.4 | 397 | 31.2 | | |
| 40 | 60 | 19.09 | 13.9 | 159 | 12.5 | | |
| 60 | 80 | 17.65 | 12.8 | 61 | 4.8 | | |
| 80 | 100 | 25.43 | 18.5 | 38.5 | 3.02 | .29 | .006 |
| 100 | 120 | 9.41 | 6.87 | 18.7 | 1.41 | 4.18 | .9 |
| 120 | 150 | 2.48 | 1.81 | 12.15 | .95 | 4.75 | 1.08 |
| 150 | 200 | 3.22 | 2.35 | 5.75 | .45 | 27.95 | 6.4 |
| 200 | | 3.15 | 2.30 | 10.06 | .81 | 400.00 | 91.2 |

| SCREEN ANALYSIS TEST No. 1.... | | | | | | | |
|--------------------------------|-----|-------------------|----------|-------------------|----------|-------------------|----------|
| RUN No. 3.... | | | | | | | |
| | | CONCENTRATES. | | GANGUE | | SLIME. | |
| THRU | ON | WEIGHT (GRAMS) | PER CENT | WEIGHT (GRAMS) | PER CENT | WEIGHT (GRAMS) | PER CENT |
| 12 | 14 | 16.50 | 9.58 | 204 | 14.64 | | |
| 14 | 16 | 7.71 | 4.47 | 146 | 10.48 | | |
| 16 | 20 | 22.48 | 13.05 | 168 | 12.05 | | |
| 20 | 40 | 46.15 | 26.79 | 486 | 34.90 | | |
| 40 | 60 | 24.4 | 14.16 | 172 | 12.34 | | |
| 60 | 80 | 22.10 | 12.83 | 86.50 | 6.21 | | |
| 80 | 100 | 17.85 | 10.36 | 59.7 | 4.28 | .54 | .13 |
| 100 | 120 | 6.41 | 3.72 | 33.71 | 2.43 | 2.9 | .69 |
| 120 | 150 | 3.51 | 2.03 | 12.18 | .88 | 18.21 | 4.39 |
| 150 | 200 | 1.12 | 6.50 | 11.9 | .85 | 13.62 | 3.27 |
| 200 | | 4.02 | 2.33 | 13.66 | .98 | 381.50 | 91.53 |

SCREEN ANALYSIS TEST No. 1.....

RUN No. 4.....

| | | CONCENTRATES. | | GANGUE | | SLIME. | |
|------|-----|-------------------|----------|-------------------|----------|-------------------|----------|
| THRU | ON | WEIGHT (GRAMS) | PER CENT | WEIGHT (GRAMS) | PER CENT | WEIGHT (GRAMS) | PER CENT |
| 12 | 14 | 6.45 | 4.99 | 200 | 15.1 | | |
| 14 | 16 | 4.06 | 3.14 | 128 | 9.67 | | |
| 16 | 20 | 10.72 | 8.30 | 219 | 16.6 | | |
| 20 | 40 | 32.60 | 25.2 | 388 | 29.3 | | |
| 40 | 60 | 30.10 | 23.3 | 197 | 14.8 | | |
| 60 | 80 | 22.29 | 18.04 | 87 | 6.57 | | |
| 80 | 100 | 13.15 | 10.1 | 54 | 4.7 | 3.65 | .86 |
| 100 | 120 | 4.41 | 3.4 | 21.4 | 1.6 | 14.45 | 3.4 |
| 120 | 150 | 1.97 | 1.5 | 12.37 | .93 | 13.5 | 3.2 |
| 150 | 200 | .64 | .49 | 4.30 | .32 | 38.7 | 9.18 |
| 200 | | 2.68 | 2.06 | 12.55 | .94 | 351.0 | 83.3 |

SCREEN ANALYSIS TEST No. 1

RUN No. 5

| THRU | ON | CONCENTRATES. | | GANGUE | | SLIME. | |
|------|-----|-------------------|----------|-------------------|----------|-------------------|----------|
| | | WEIGHT (GRAMS) | PER CENT | WEIGHT (GRAMS) | PER CENT | WEIGHT (GRAMS) | PER CENT |
| 12 | 14 | 10.45 | 6.77 | 135 | 13.61 | | |
| 14 | 16 | 6.35 | 4.12 | 86 | 8.66 | | |
| 16 | 20 | 18.75 | 12.11 | 136 | 13.61 | | |
| 20 | 40 | 13.4 | 24.92 | 351 | 13.38 | | |
| 40 | 60 | 42.1 | 27.32 | 115 | 11.59 | | |
| 60 | 80 | 18.8 | 12.20 | 63.5 | 6.40 | .3 | .11 |
| 80 | 100 | 9.70 | 6.94 | 47.7 | 4.8 | 4.57 | 1.81 |
| 100 | 120 | 3.4 | 2.21 | 24.0 | 2.32 | 11.51 | 4.57 |
| 120 | 150 | 1.8 | 1.17 | 10.5 | 1.06 | 18.18 | 7.21 |
| 150 | 200 | .95 | .61 | 11.0 | 1.10 | 217.5 | 86.28 |
| 200 | | 3.4 | 2.21 | 12.4 | 1.27 | . | |

| SCREEN ANALYSIS TEST No... <u>2</u> | | | | | | | |
|--|-----|-------------------|----------|-------------------|----------|-------------------|----------|
| RUN No... <u>1</u> | | | | | | | |
| | | CONCENTRATES. | | GANGUE | | SLIME. | |
| THRU | ON | WEIGHT (GRAMS) | PER CENT | WEIGHT (GRAMS) | PER CENT | WEIGHT (GRAMS) | PER CENT |
| 12 | 14 | 8.0 | 6.43 | 143 | 13.7 | | |
| 14 | 16 | 7.7 | 6.18 | 77. | 7.46 | | |
| 16 | 20 | 14.7 | 11.8 | 97 | 19.1 | | |
| 20 | 40 | 35.5 | 28.5 | 304 | 29.4 | | |
| 40 | 60 | 16.0 | 12.8 | 150 | 14.5 | | |
| 60 | 80 | 14.3 | 11.4 | 64 | 6.2 | | |
| 80 | 100 | 16.1 | 12.9 | 43.2 | 4.1 | 2.25 | .91 |
| 100 | 120 | 7.55 | 6.06 | 21.9 | 2.1 | 3.25 | 1.3 |
| 120 | 150 | 2.15 | 1.72 | 16.5 | 1.5 | 3.65 | 1.8 |
| 150 | 200 | 2.3 | 1.8 | 5.65 | .59 | 16.45 | 6.7 |
| 200 | | 2.3 | 1.8 | 9.95 | .96 | 219 | 89.5 |

| SCREEN ANALYSIS TEST No. 2..... | | | | | | | |
|---------------------------------|-----|-------------------|----------|-------------------|----------|-------------------|----------|
| RUN No. 2..... | | | | | | | |
| | | CONCENTRATES. | | GANGUE | | SLIME. | |
| THRU | ON | WEIGHT (GRAMS) | PER CENT | WEIGHT (GRAMS) | PER CENT | WEIGHT (GRAMS) | PER CENT |
| 12 | 14 | 3.7 | 3.71 | 181 | 21.9 | | |
| 14 | 16 | 2.6 | 2.61 | 67 | 7.69 | | |
| 16 | 20 | 6.1 | 6.13 | 148 | 16.98 | | |
| 20 | 40 | 21.5 | 21.59 | 304 | 34.89 | | |
| 40 | 60 | 17.0 | 17.07 | 77 | 8.83 | | |
| 60 | 80 | 17.2 | 17.29 | 36.5 | 4.19 | | |
| 80 | 100 | 15.2 | 15.27 | 23.8 | 2.73 | .32 | .13 |
| 100 | 120 | 9.4 | 9.44 | 14.3 | 1.64 | .75 | .31 |
| 120 | 150 | 2.2 | 2.21 | 5.8 | .66 | 4.25 | 1.36 |
| 150 | 200 | 2.16 | 2.61 | 8.6 | .98 | 5.18 | 2.10 |
| 200 | | 2.05 | 2.06 | 5.2 | .59 | 226.50 | 95.5 |

| SCREEN ANALYSIS TEST No. 2.... | | | | | | | |
|--------------------------------|-----|-------------------|----------|-------------------|----------|-------------------|----------|
| RUN No. 3..... | | | | | | | |
| | | CONCENTRATES. | | GANGUE | | SLIME. | |
| THRU | ON | WEIGHT (GRAMS) | PER CENT | WEIGHT (GRAMS) | PER CENT | WEIGHT (GRAMS) | PER CENT |
| 12 | 14 | 6.45 | 4.64 | 105.2 | 26.6 | | |
| 14 | 16 | 5.95 | 4.28 | 59.4 | 8.22 | | |
| 16 | 20 | 15.2 | 10.9 | 91.7 | 14.4 | | |
| 20 | 40 | 29.75 | 21.4 | 192 | 30.3 | | |
| 40 | 60 | 24.7 | 17.7 | 94.1 | 14.8 | | |
| 60 | 80 | 20.7 | 14.8 | 33.6 | 5.3 | | |
| 80 | 100 | 20.0 | 14.3 | 21.7 | 3.4 | 4.44 | 1.02 |
| 100 | 120 | 80.1 | 5.8 | 12.7 | 2.0 | .32 | .2 |
| 120 | 150 | 4.15 | 2.9 | 11.3 | 1.7 | 1.17 | .8 |
| 150 | 200 | 1.35 | .97 | 5.2 | .8 | 5.0 | 3.5 |
| 200 | | 2.7 | 1.95 | 6.3 | .9 | 132.0 | 94.3 |

| SCREEN ANALYSIS TEST No. 2..... | | | | | | | |
|---------------------------------|-----|-------------------|----------|-------------------|----------|-------------------|----------|
| RUN No...4.... | | | | | | | |
| | | CONCENTRATES. | | GANGUE | | SLIME. | |
| THRU | ON | WEIGHT (GRAMS) | PER CENT | WEIGHT (GRAMS) | PER CENT | WEIGHT (GRAMS) | PER CENT |
| 12 | 14 | 15.2 | 10.6 | 137 | 15.4 | | |
| 14 | 16 | 7.0 | 4.88 | 88 | 9.88 | | |
| 16 | 20 | 20.0 | 13.93 | 135 | 15.3 | | |
| 20 | 40 | 36.5 | 25.43 | 297 | 33.3 | | |
| 40 | 60 | 21.3 | 14.84 | 96 | 10.7 | | |
| 60 | 80 | 15.7 | 10.93 | 52.6 | 5.9 | | |
| 80 | 100 | 12.5 | 8.71 | 40.3 | 4.52 | 1.1 | .54 |
| 100 | 120 | 5.2 | 3.62 | 25.8 | 3.0 | 1.1 | .54 |
| 120 | 150 | 3.0 | 2.16 | 5.7 | .64 | 1.87 | .93 |
| 150 | 200 | 1.62 | 1.13 | 8.8 | .10 | 15.07 | 7.95 |
| 200 | | 5.4 | 3.76 | 5.3 | .63 | 182.0 | 90.03 |

SCREEN ANALYSIS TEST No. 2

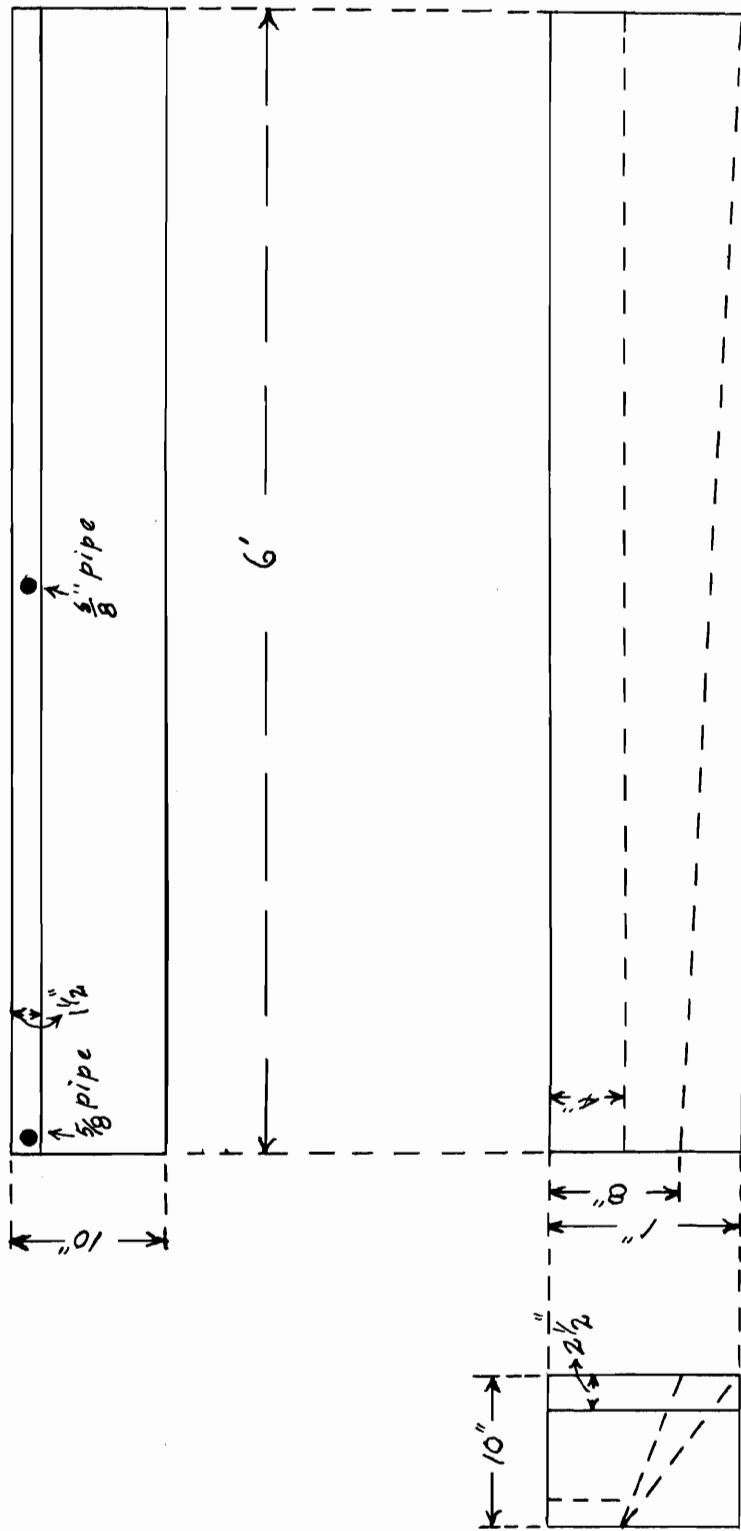
RUN No. 5

| | | CONCENTRATES. | | GANGUE | | SLIME. | |
|------|-----|-------------------|----------|-------------------|----------|-------------------|----------|
| THRU | ON | WEIGHT (GRAMS) | PER CENT | WEIGHT (GRAMS) | PER CENT | WEIGHT (GRAMS) | PER CENT |
| 12 | 14 | 16.75 | 8.86 | 122 | 15.3 | | |
| 14 | 16 | 13.28 | 7.1 | 71 | 8.9 | | |
| 16 | 20 | 29.5 | 15.8 | 11.8 | 14.8 | | |
| 20 | 40 | 58.65 | 31.4 | 224 | 28.1 | | |
| 40 | 60 | 30.25 | 16.2 | 129 | 16.1 | | |
| 60 | 80 | 14.75 | 7.9 | 58 | 7.28 | .46 | .25 |
| 80 | 100 | 11.24 | 6.02 | 38.5 | 4.84 | 1.35 | .75 |
| 100 | 120 | 4.25 | 2.2 | 16.05 | 2.01 | 3.73 | 2.09 |
| 120 | 150 | 2.24 | 1.2 | 9.94 | 1.24 | 10.86 | 6.0 |
| 150 | 200 | 1.3 | .69 | 3.2 | .4 | 12.62 | 7.0 |
| 200 | | 4.43 | 2.3 | 6.65 | .83 | 149.5 | 83.7 |

CONCLUSION.

From the results of the two runs, it is evident that a decided break in the percent of fine particles of ore remaining in the concentrates band, occurs in the neighborhood of the 120 mesh material, (1/240".) Although material of much finer grain exists in the feed we assume immediately that is carried away with the tailing product. By subjecting the concentration to variable conditions we find that an increase of wash water lowers the percent of fine ore that will remain on the 120 mesh, or, increases the amount of fine concentrate in the tails. That increase of slope of the table produces the same results at about the same rate; while a decrease of slope from the standard condition increases the percentage of fine ore particles remaining on the 120 mesh.

From the above it is evident that sizes smaller than 1/240" are not suitable for concentration on a Wilfley table, also minimum slope and water will give best results in table concentration.



FEEDER