
The Effects of Volume and Surface Area on the Rate of Accumulation of Solids in Indoor Manure Digestion Tanks¹

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In 1960, Owings and Adams (1961) initiated experiments involving the use of “indoor lagoons” or digestion tanks for collecting and storing poultry manure. This work was apparently the first report by an experiment station where poultry manure was collected and held under liquid. Their tank allowances were 2.5 cu. ft. and 288 sq. in. of surface per bird. It is conceivable that several physical conditions, heat, aeration, surface area and cubage, might affect the rate of dry matter accumulation. Since most pumping arrangements can handle only up to 20% solids, the rate of dry matter accumulation is closely associated with time between cleanouts. Some of the above factors (heating and aeration) have been studied by Al-Timimi et al. (1964), but only one cubage (3.5 cu. ft./bird) and one surface allowance (256 sq. in./bird) were reported. The present report investigates the effects of several cubage and surface allowances (Table 1).

EXPERIMENTAL PROCEDURES

Since Al-Timimi (1963) showed that the hen weight, egg weight, and feed consumption affect dry matter (D. M.) accumulation rate, data on these factors were recorded and the same techniques of D. M. determination and statistical adjustment were used. Ten stainless steel
TABLE 1.—Cubages, and surface areas used in the stainless steel tanks

<table>
<thead>
<tr>
<th>Tank No.</th>
<th>Volume (H₂O) cu. ft.</th>
<th>No. of birds</th>
<th>Surface (sq. in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Per tank</td>
<td>Per bird</td>
<td>Per tank</td>
</tr>
<tr>
<td>1</td>
<td>0.89</td>
<td>0.89</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>0.89</td>
<td>0.89</td>
<td>1</td>
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<tr>
<td>3</td>
<td>1.78</td>
<td>1.78</td>
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<tr>
<td>5</td>
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<td>10</td>
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<td>1</td>
</tr>
</tbody>
</table>

VOLUME AND SURFACE EFFECTS IN INDOOR LAGOONS

The percent D. M. accumulation, based on a 3.5 cu. ft. of H₂O per bird, is presented in Table 2. The change in the percent D. M. from one period to another was used for the least-squares method of analysis and the results are shown in Table 3. Cubage and surface area per bird seemed to have no significant effects on the digestion of the solids in the tanks.

RESULTS AND DISCUSSION

The percent D. M. accumulation, based on a 3.5 cu. ft. of H₂O per bird, is presented in Table 2. The change in the percent D. M. from one period to another was used for the least-squares method of analysis and the results are shown in Table 3. Cubage and surface area per bird seemed to have no significant effects on the digestion of the solids in the tanks.
Periods and the interaction between treatments and periods were highly significant. The period effect indicates that the build up of solids was faster than digestion. The interaction was attributed to the treatment differences that changed through time. Hen weight, egg weight, and feed consumption effects did not tend to be significant even when their combined effects were taken into consideration, apparently because the variation in hens assigned to the treatments was not great.

Surface area allowance may be important in balancing evaporation with accumulation of solids to hold a constant level in the tank; where a small amount of surface is available and air flow is low, excessive overflow will occur. Conversely, where surface and/or air flow is excessive, water will have to be added. The overflow in some of the tanks was due to the smaller surface areas (128 sq. in. per bird). Fifteen liters of the supernatant was removed from each of tanks 5 and 6 (7.0 cu. ft. tanks with 3.5 cu. ft. H₂O and 128 sq. in. per bird). This rise in liquid level suggests that the surface area of 128 sq. in./bird could occasion an overflow problem in large systems. Five liters of liquid were removed from each of tanks 1 and 2 over the ten periods. Larger surfaces, tested here (256 sq. in.), showed only a very minor imbalance of deposition with evaporation.

From the above and other work by the authors, it appears that at least 3.5 cu. ft. of space per bird should be provided when biennial cleaning is desired. Aeration and heating (Al-Timimi, 1963) have not been indicated as substitutes for cubage as the best way to attain long tank "life." Obviously, several gases (CO₂, methane, perhaps others) are produced by the bacteria. The study of the quantitative and qualitative aspects of these gases might be an excellent way to characterize the rate of activity of the bacteria and as an indication of the types of bacteria operative. Gas chromatograph studies and the effects of the isolated gases on birds are planned as future phases of the indoor liquid manure storage problem.

SUMMARY

Ten stainless steel tanks were utilized to form four volume and two surface area allowances. Leghorn type pullets were placed in eight inch cages over the tanks and their manure was allowed to accumulate in liquid for 20 weeks. At the end of each period (2 weeks), dry matter determinations were made and hen weight, feed weight and egg production were recorded. The dry matter percentages were put on a 3.5 cu. ft./bird basis and the changes in percent dry matter from one period to another were calculated. The least-squares method of analysis was used in the analysis of the data.

Cubage and surface area per bird seemed to have no significant effects on the rate of digestion of the solids in the tanks. Periods and the interaction between treatments and periods were highly significant. Although the manure output is influenced by factors such as hen weight, feed consumption and egg weight, none of
the uniform distribution of the hens assigned to the treatments. Liquid overflow was inversely related to the surface area per bird.

At this point, the authors feel that at least 3.5 cu. ft. of H₂O per bird is needed to provide for biennial cleaning.

ACKNOWLEDGMENTS

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REFERENCES


The Influence of Comb Genotype on Mating Behavior in the Domestic Fowl

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Although there are many reports in the literature concerning the genetic basis for differences in behavior in the domestic fowl, relatively few cases have been described in which single pairs of alleles have been found to be associated with these differences. Siegel and Dudley (1963) reported that in intermingled flocks of chicks from the same strain, males with pea combs were socially subordinate to those with single combs. Marked differences in social and sexual behavior associated with plumage pattern have been described by Crawford and Smyth (1964c) in a segregating strain of Fayoumis. In a study concerning behavior of turkeys, Hale and Buss (1960) found significant differences in social rank between black and bronze sisters, and between white and bronze sisters, in populations designed to segregate for these plumage color genes.

In the present report, data are presented concerning differences in mating behavior between rose and single comb birds of the same strain. These data were obtained as part of a study of the relationship between fertility and the gene for rose comb (Crawford and Smyth, 1964a). It was not considered likely that aberrant sexual activity would explain the low fertility characteristic of homozygous rose comb males, since it was known that these males gave poor fertility under conditions of artificial insemination (Crawford and Merritt, 1963). However, it was considered desirable to obtain direct evidence of involvement of behavior in the fertility problem.

MATERIALS AND METHODS

The birds used in this study were derived from mass matings of rose comb in-