

MANURE HOLDING PONDS FOUND SELF-SEALING

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Waste ponds can be utilized to economically handle dairy and poultry waste waters. Usually the effluent from the ponds is used later for irrigation. Sometimes the effluent is recycled by reusing it for subsequent flushing. Whatever the mode of operation of the ponds, it is important to know how much, if any, deep percolation occurs; what is the fate of nitrogenous substances; what are the changes in other chemical constituents; and what bacterial processes occur in the ponds. This report outlines some preliminary findings in a study of operation of waste ponds, and delineates subsequent necessary research to evaluate their total impact on the environment. The most significant of these preliminary findings was that there was hardly any seepage of water from manure-laden ponds in this study, and that artificial seals were not needed under these soil conditions.

THE PORTER COLOGNE WATER quality Control Act charges the State Water Resources Control Board with the responsibility of regulating waste water quality from agricultural operations. Included among these waste waters are those which arise from poultry and dairy

husbandry. In the past, some waste waters from the poultry and dairy operations flowed to nearby stream beds where they either became part of the surface stream or percolated into gravelly stream beds and comingled with percolating ground water.

High B.O.D. compounds

Such waste waters are often high in biological oxygen demand (B.O.D.), nitrates and related compounds, total dissolved solids, various esthetically offensive constituents and miscellaneous organisms, such as bacteria. For the protection of nearly every beneficial use, therefore, it is imperative that improved practices be adopted. The use of manure waste ponds is one of a number of alternatives available to handle animal wastes. Other alternatives are combustion, spreading, composting, and feeding.

Waste ponds have a number of useful attributes. They are inoffensive to work around because they have very little odor. Fly and mosquito production can be minimized. The manure wastes can be readily applied to surrounding crop land by blending with irrigation water. Overflow of manure to adjacent water courses is eliminated. Solutions leaving the ponds through leakage into the soil contain low concentrations of nitrate-nitrogen. In addition, technology is currently available to effectively monitor the performance of ponds and to evaluate the ef-

ficiency of operating techniques used.

Seventeen manure holding ponds in the San Joaquin Valley were selected in this study. The ponds were located in Merced, Stanislaus, and San Joaquin counties. These ponds were selected because they represented a wide range of soil textures (from sands to clay loams), varying water table depths, and ages of ponds generally found in the area. Nine of these ponds were instrumented with porous ceramic cups for measuring the rate of water leakage and the concentration of nutrients moving through the soil beneath the ponds. The remaining eight were not instrumented but were used for determining other changes in the pond water during use.

Nitrogen and salt content

Cows excrete 0.4 lb and chickens excrete 0.0003 lb of nitrogen per day in the form of nitrogenous materials. These nitrogenous materials are oxidized, under aerobic conditions, to nitrates — the most soluble form of nitrogen, which moves readily through the soil with water. In an anaerobic aquatic environment, nitrates are converted to nitrogen gas, a process commonly known as denitrification. Periodically analyzing samples of water from the ponds for nitrates and comparing this with the amount of nitrogen entering the ponds from manure provides a good measure of the rate of denitrification.

The total dissolved nitrogen content of a manure pond was determined at the end of a 10-1/2 month period. During this period the pond had received the waste from 43,000 chickens. This loading rate corresponds with total nitrogen additions equivalent to 800 ppm nitrogen, but only 250 ppm nitrogen was found. The gross difference of 550 ppm indicates apparent anaerobic nitrogen losses of considerable magnitude occur under normal pond operation. Additionally, it should be recognized that the average nitrate-nitrogen content of the same pond after 10-1/2 months was about 5 ppm (equivalent to approximately 13 lbs of nitrate-nitrogen per acre foot of water).

Cows excrete about 20 lbs of total dry solids per day and chickens excrete about 0.06 lb of total dry solids per day. Much of these manure dry solids are salt. These salts will continue to increase in concentration within a pond in direct proportion to the amount of manure added. To reduce the chance of problems related to salts and precipitation of magnesium ammonium phosphate, the ponds should be emptied frequently and certainly when the salt content reaches 2,900 ppm (Ec — 4-5 mmho). If ponds are not emptied at that time, the magnesium ammonium phosphate may precipitate on the inside of pipes and on pump impellers, eventually ruining them.

Soil nitrate and salt

Recordings of nitrate-nitrogen and salt content of the soil beneath the ponds before filling showed values were representative of soil solutions found in most of the agricultural areas in which waste ponds are located. After several months of use, levels of nitrate and salt in soil solutions from below the ponds showed very small changes. These results were obtained from analyses of solutions extracted by vacuum through ceramic cups and from soil auger sampling. A comparison of results from both types of sampling measurements indicates both methods give comparative results and the choice of method of sampling can be based on experimental requirements. It was not

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possible to extract solutions at 1- to 2-ft. depths below the pond bottoms with the porous cups. This failure resulted from the extremely low water-conducting properties of the soil. This very reduced water-conduction ability confirmed that the basins were sealed. Moreover, auger samples indicated that the soils were blue-black, dense and not saturated at the times of sampling.

A comparison of the nitrate-nitrogen beneath the manure ponds and the nitrate-nitrogen content of the soil beneath a nearby agricultural area is revealing (see table). The nitrate-nitrogen content in and below the pond was much less than that beneath the adjoining almond orchard.

Tests with both the modified suction cup technique and the reference stake technique indicated that there is a very low rate of water loss from manure ponds. The stake data indicated higher rates of water loss than the suction cups, until water loss from the pond was corrected for evaporation. These findings applied to both sand and clay soils.

Stratification

All ponds developed a layer of sludge on the soil bottom. This sludge had very low nitrate-nitrogen contents and very high B.O.D. values. This mat or very high B.O.D. material acted as a nitrate filter or an energy source for denitrification, and removed much of the nitrate. The small amount of water that did enter the soil contained about 2 ppm nitrate-nitrogen or 12 lbs of nitrate-nitrogen per acre foot.

Conclusions

Seepage of water from manure-laden ponds under the soil conditions studied amounted to only about one mm per day. Lateral movement seemed not to exist. The maximum movement found was one

mm per day under the coarsest soil conditions, and appeared to decrease with time. The quantities of salt and nitrate-nitrogen that moved through the soil profile were extremely low.

Fifteen months after the start of this study, the soil solutions below the ponds had a lower concentration of all nutrients than adjacent well waters. No observable alterations occurred in nearby well and ground waters.

Significant stratification of the waste ponds appeared to exist, with considerable anaerobic activity and lowering of nitrates with depth near the reservoir bottoms.

Salinity

Total salinity (T.D.S.) within the ponds increased fairly rapidly and linearly according to loading. Because of salt increases at present recommended loadings (15,000 chickens, or 100 dairy cows per acre of surface) it was necessary that the ponds be emptied at least every 4 to 6 months. Irrigation blending and disposal to croplands is one use for the effluent.

From the results of this continuing research it does not appear necessary, under the soil conditions of this study, to recommend any artificial seal inside manure-laden reservoirs.

Further research is needed to integrate pond performance with other environmental criteria commensurate with water quality standards.

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