

Reclamation of Dairy Wastewater_____ *By Abraham Wubishet*

Urban encroachment onto traditional dairy lands, increased dependence on chemical fertilizers for crop and vegetable production, and continued operation of large dairies has created a tremendous environmental impact on ground water quality. A report by the Regional Water Quality Control Board, Santa Ana Region (1989) attributed 88% of the agricultural waste load in the region due to dairies.

Consequently, the University of California Cooperative Extension Office at San Bernardino and Riverside put together a project that would attempt to partially remove some of the pollutants in dairy wastewater. The main components targeted were biological oxygen demand (BOD), ammonium nitrogen ($\text{NH}_4\text{-N}$) and nitrate nitrogen ($\text{NO}_3\text{-N}$). To achieve these objectives, we enlisted the cooperation of Shady Grove Dairy in Ontario, Schreiber Corporation (Trussville, AL) and Managerial Wastewater and Septage (MWS) Corporation. The project was conducted at Shady Grove Dairy where a solids-liquids separator removed some of the fibrous undissolved organic matter from the dairy effluent. MWS Corporation provided natural zeolite and the labor necessary for the construction of the various settling channels. Schreiber Corporation provided a four-reel Bio-Reel.

Natural zeolites are crystalline hydrated aluminum silicates that contain alkali or alkaline earth elements and loosely bound water molecules. Their molecules carry a negative charge due to a replacement of some of the silica ions by aluminum ions. This negative charge is balanced by cations, such as sodium, calcium, potassium, or magnesium. They are also known to have an affinity for ammonium ion. Natural zeolite can lose most of their loosely bound water molecules without affecting the integrity of their molecular structure. For this reason, they have been used for water treatment, especially for the removal of ammonia in many European and Asian countries, as well as in the US.

The Bio-Reel is a fixed film reactor, which consists of a large number of corrugated tubular spirals located adjacent to each other and coiled in the same direction. These coils are confined in a reel-like rotary cage. The cage is immersed in a wastewater reactor with only the outer turn of the spiral emerging above the water line. During rotation, the emerging end of each tube captures air, which is trapped in the upper bend of the tube as a bubble upon re-immersion. This air bubble displaces the liquid in the tube and thus creates a continuous flow of wastewater through the tubular spiral. The nutrients in the organic matter in the wastewater thus are exposed to millions of microorganisms adhering to the corrugated tubular walls. At the bottom of each cage, air is allowed to bubble through the wastewater. Thus, most of the BOD reduction and nitrification is due to aerobic organisms.

A set of ten trapezoid channels each 8 ft. long, 4 ft. wide, and 4 ft. deep were constructed and lined with plastic. The first four channels served as settling channels. The fifth was filled with gravel. The sixth and seventh were filled with natural zeolites which had a high cation exchange capacity. The eighth and ninth served as anaerobic channels. The final channel was used to temporarily store treated effluent. Dairy wash-water from the solids-liquids separator is stored in an existing pond. From this pond, the effluent was continuously pumped at one gallon per minute into the first

channel and from there through the rest of the settling, gravel and first zeolite channel by gravity flow. The effluent leaving the first zeolite channel is pumped at one-half gallon per minute into the first cell of the Bio-Reel, from there it goes through the other cells by gravity. After it leaves the Bio-Reel, it discharges into the second zeolite channel and finally into the last two anaerobic channels.

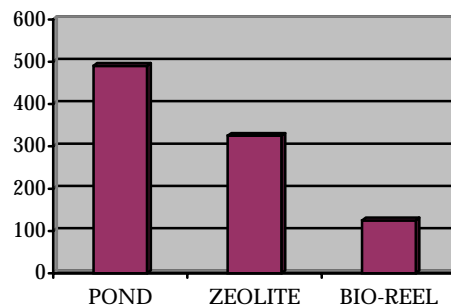
Our observations are that digestion of the organic matter in the effluent takes place in all the channels en route to the anaerobic channels. However, our preliminary data indicates that the zeolites were effective for about the first two weeks in removing the ammonium ions, but soon become overwhelmed and become less effective. The Bio-Reel was very effective in reducing the five-day BOD and was effective in nitrifying. Thus, the effluent leaving the Bio-Reel had only 12% of the BOD, 27% of the ammonium nitrogen, and 226% of the nitrate nitrogen in the original pond effluent (for a removal of 88% of the BOD and 73% of the ammonium nitrogen, but an increase of 226% in nitrate nitrogen). The zeolite removed 32% of the ammonium and 14% of the nitrate nitrogen. The final treated effluent leaving the anaerobic channels had only 5% of the BOD in the original pond effluent (for a removal of 95% of the BOD), the bar graphs in Figures 1, 2, 3 and 4 depict these changes.

Ammonium and nitrate nitrogen data after anaerobic digestion are unavailable at this time. However, from the improved BOD removal due to anaerobic digestion, it is surmised that a similar removal of ammonium and nitrate nitrogen can be achieved. It should also be mentioned that both the aerobic and anaerobic digestions achieved are due to the natural organisms present in the effluent and that no extraneous synthetic material was added to the reaction mixture.

While some progress has been made in reducing some of the pollutants in dairy wastewater, the problem of dissolved salts (TDS) has not been addressed by the system described here. In addition, our system could handle only a small portion of the daily out-put of dairy effluent. Therefore, it is imperative that economically feasible systems that can treat all the wastewater generated at one or more dairies be developed.

AMMONIUM - NITROGEN

Fig. 1 Ammonium-Nitrogen Concentration before Anaerobic Digestion



AMMONIUM - NITROGEN
Fig. 2 Nitrate-Nitrogen Concentration
Before Anaerobic Digestion

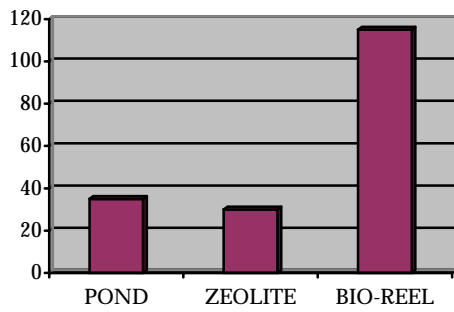


Fig 3 BOD Levels Before Anaerobic Digestion

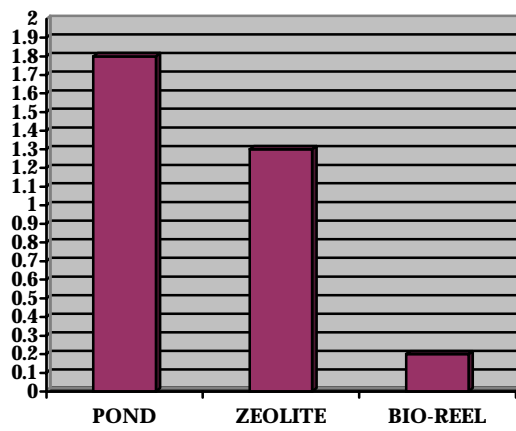


Fig 4 BOD Levels From Anaerobic Digestion

