"The Solids Loading on Final Tanks Should Not Exceed 20 lb/sqft/day"

A recent addition to the folklore of final settling tank analysis is the inclusion of consideration of the solids loading on the tank. Use of the solids loading parameter is, of course, appropriate because it relates to the thickening function of final sedimentation basins (6). In cases in which maximum solids loadings are suggested, values in the order of 20 lb/sq ft/day (98 kg/sq m/day) are typical. The ASCE-WPCF Manual of Practice on Sewage Treatment Plant Design (15) indicates that "available data show plants operating successfully with loadings of 12 to 18 psf/day with sludge volume indices under 100." In the same manual it is concluded that "in general, with mixed liquor concentrations of 3,000 mg/l or less, with a sludge index of 100 or less, and a tank underflow of not more than 1 percent solids, the area determined by the overflow rate is adequate for the solids." This condition "including recycle" corresponds to a solids loading of about 28 lb/sq ft/day (237 kg/sq m/day). Whereas adoption of solids loading as a parameter related to the thickening performance of final settling tanks is logical, the danger of the approach would seem to be in specifying the permissible magnitude of the solids loading. As illustrated in the following paragraph, the solids load which successfully can be handled by a final sedimentation tank is a function both of the settling characteristics of the sludge and of the mode of operation of the final sedimentation tank, and successful performance may he achieved over a wide range of solids loading values. The reason for restricting the applied solids load on final settling tanks is that each layer of a sludge which might exist in the tank has some definite capacity for transmitting solids to the bottom of the tank (27). This capacity is determined both by the settling characteristics of the sludge and by the rate of removal of return sludge, it is essential that the capacity of any layer which might exist in the tank for transmitting solids not be exceeded or else solids in excess of those which can pass through the limiting layer will accumulate and, in time, move into the clarification portion of the tank (and "bulking" might be said to occur). The capacity, G_i, of a sludge layer of suspended solids concentration, c_i, for transmitting solids to the bottom of a final sedimentation tank is:

$$G_i = c_i v_i + c_i \frac{rQ}{A} \tag{4}$$

where v_i is the gravity settling velocity of the sludge at concentration C_i, Q is the waste throughput rate, r is the recycle fraction and A is the cross-sectional area of the final sedimentation tank. The influence of sludge wastage on the solids transport due to sludge removal has been omitted from the second term on the right side of Equation 4, but readily could be added.

As described in a later section, rational design of final sedimentation tanks requires that the minimum value of G_i for all possible concentrations which could occur in the final settling be identified. Then, the average applied solids flux, G_a, must not be allowed to exceed this limiting value for G_i. The applied solids flux may be computed from:

$$G_a = \frac{(1+r)Q\, c_{MLSS}}{A} \tag{5}$$

where C_{MLSS} is the mixed liquor suspended solids concentration.

It is noted that for sludge of some concentration, c_i, the magnitude of the first term on the right side of Equation 4 depends only on the settling characteristics of the sludge, whereas the magnitude of the second term depends only on the way in which the final settling tank is

operated; that is, on the rate of recycle, r. It is for this reason that it is inappropriate to attempt to designate proper solids loading on final sedimentation tanks.

The magnitude of the first term in Equation 4 varies widely depending on the particular nature of the waste being treated and the mode of operation of the biological phase of the process. The magnitude of the second term is controlled by the way in which the final settling tank is operated, and can be varied over wide limits. There are activated sludge plants operating at solids loadings far less than 20 lb/sq ft/day (98 kg/sq m/day) which have difficulty in thickening solids and, conversely, plants are in operation with solids loadings of 80 lb/sq ft/day (390 kg/sq m/day) or more with good performance. Thus, it seems undesirable to attempt to specify a loading to represent a "typical" design value.

REFERENCES (in this section)

6. Dick, R.I., "Role of Activated Sludge Final Settling Tanks," Journal Sanitary Engineering Division American Society of Civil Engineers, 96, SA2, 423, (1970).
15. "Sewage Treatment Plant Design," ASCE WPCF Manual of Engineering Practice, Water Pollution Control Federation, Washington, D. C. 375 pp., (1959).
27. Dick, R.I., "Gravity Thickening of Sewage Sludges," Water Pollution Control. 71, 4, 368, (1972).