Biofilm innovations crown US trickling filter revival

The use of trickling filters in the USA is increasing after a period of decline. This article, based on the conference paper [illegible] D S Parker, [illegible] of the Brown & Caldwell [illegible], describes recent developments.

After falling into disfavour in the USA in the 1970s, trickling filters are now enjoying a revival, reappearing in new applications. The trickling filter/solids contact (TF/SC) process uses physical and biological flocculation features to transform the poor quality of the trickling filter effluent into something comparable to the best activated sludge system.

Over 50 TF/SC plants have been built since the process was introduced in 1979. Last year's developments of the biofilm-controlled nitrifying trickling filter (BCNTF) has permitted higher rate operation and made the process cheaper than the activated sludge system for nitrification. Three BCNTF projects are now under way in the US.

Trickling filters used for carbonaceous BOD removal gained a poor reputation because they typically could not meet USA federal requirements except at low loadings. Poor effluent quality was due to the high level of dispersed solids in the trickling filter underflow. The introduction of aerated solids contact (ASC) tanks and the flocculator-clarifier in the TF/SC ensures that finely dispersed solids are removed in the secondary clarifier.

A suspended growth culture develops by return of sloughed trickling filter solids to the ASC. This encourages and provides for physical contact of the finely divided solids with recirculated floc.

Even the mild turbulence generated by fine bubble aeration does not optimise flocculation. An enlarged centrewell is provided for additional flocculation in the secondary clarifier.

The provision of the ASC and flocculator-clarifier has allowed trickling filter total organic loadings to be raised to high levels ($2kg/BOD_5/m^3d$) without impairing effluent quality. Part of the increased loading capability can be attributed to the development of the more efficient cross flow plastic media by the Munters Corporation. This has been shown to permit a 40% reduction in trickling filter size when compared to the older vertical media.

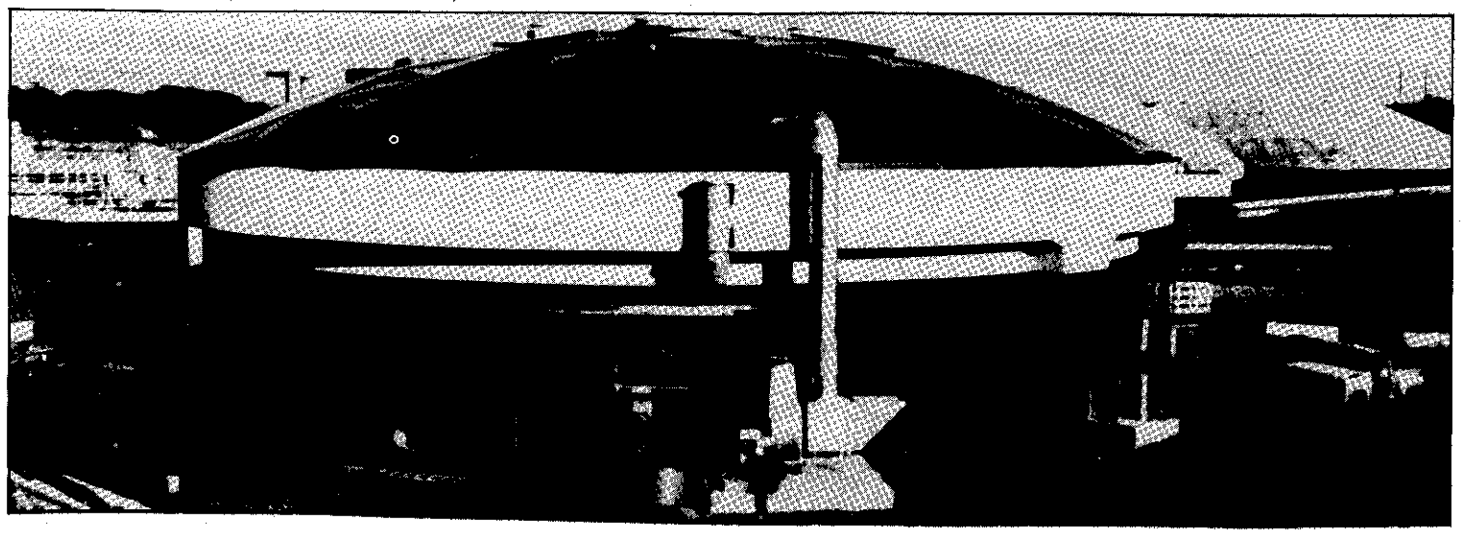
ASC tanks are small with typical residence times ranging from 10 to 60 minutes. Solids residence times vary with the extent of bioflocculation needed and are generally one day or less. The flocculator-clarifier has been equipped with several features to improve its hydraulic efficiency, including inboard weirs and deep side-water depths of 5m.

These features permit the use of higher than normal hydraulic loadings. For example, tank size in municipal plants is determined at peak hydraulic loadings during wet weather. Depending on the duration of the peak, design overflow rates range from 2.5m/h-3.4m/h. Flocculator-clarifier technology permits the use of smaller, less costly tanks.

A new decade of development

The success of the TF/SC process at a plant in Corvallis, Oregon, USA 10 years ago led to early repetition at a number of other sites. These experiences showed that the process consistently led to high effluent qualities. Operating and capital costs have been significantly less than for the activated sludge process.

A nitrifying trickling filter with biofilm control at the 75th Street treatment plant in Boulder, Colorado (Brown and Caldwell).



The modern nitrifying trickling filter (NTF), designed to oxidize ammonia in secondary effluents, was introduced as a process concept by the Dow Chemical Company in the early 1970s. The first demonstration of the system was at pilot scale at Midland, Michigan, where highly efficient and stable operation was demonstrated. A second pilot study soon followed at Lima, Ohio and led to the design and construction of a new, full scale facility.

So far 22 NTF facilities have been built in the USA, a relatively small number compared with the hundreds of nitrifying activated sludge plants built in the same period. Half of the existing facilities examined in a survey provided detailed operating data. Only five of these data sets were deemed suitable for evaluating the technology.

The survey also showed that NTF facilities in the USA operate under conservative loading conditions, with low average ammonia removal rates of $0.2gN/m^2/d$-$0.39gN/m^2/d$. Another conservative design practice has been to follow the NTFs with either effluent filtration or clarification.

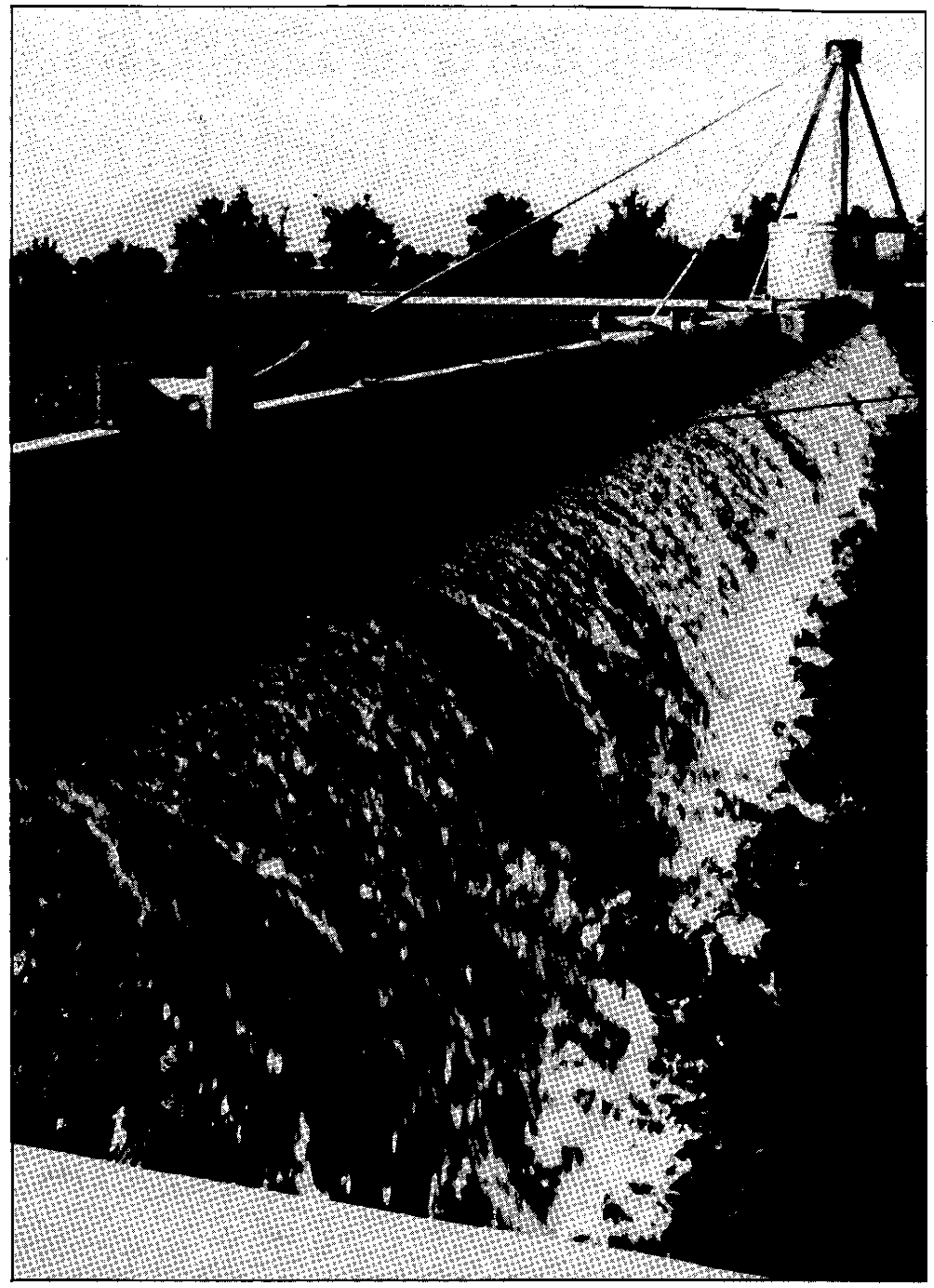
Of the 19 USA NTF operators reporting details of their process flowsheets, 17 followed their NTFs with some form of tertiary solids separation. In nine of the 17 cases, carbonaceous removal occurred in an upstream activated sludge step where it should have been possible to eliminate any necessity for a tertiary solids removal step.

Recognising operation and maintenance cost advantages of NTF technology, studies have been undertaken to assess factors limiting nitrification rates and to modify the process. A pilot investigation was undertaken in Utah where conditions controlling biofilm activity would be optimised. If biofilm control could be demonstrated capital costs could be lowered and the process made more competitive. The successful application of various control features in producing higher nitrification rates led to the newly named biofilm-controlled nitrifying trickling filter (BCNTF) process.

Activated sludge is by far the most common nitrification system used in the USA. Studies show that when a secondary treatment plant must be upgraded for nitrification, the BCNTF addition often proves less costly than activated sludge. Where the secondary plant already provides a high degree of treatment the BCNTF is significantly cheaper.

Considering that BCNTFs were introduced only last year, the new process has gained rapid acceptance. The company Brown and Caldwell is now involved in three BCNTF projects. One, being built in Boulder, Colorado, is a $0.7m^3/s$ plant. Another system, under design for the joint Littleton/Englewood plant, will have a capacity of $1.7m^3/s$. The firm is also about to design a $1.1m^3/s$ BCNTF downstream of an activated sludge plant in Georgia.

Additional advantages of BCNTFs in these situations have been the use of less land, the fact that they can be built without disrupting secondary treatment operations, and their ease in producing partially nitrified effluents by side-stream treatment. Seasonal requirements requiring a partial degree of nitrification are becoming increasingly common in the USA. Operational control is also simpler than in the activated sludge process.



Rock and plastic media at the Tolleson, Arizona, plant (Brown and Caldwell).