



Low cost water treatment plants

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QUALITY DRINKING WATER is a distant dream for several million people living in rural India. This is basically due to the reluctance of the implementing agencies to invest money for treatment of water in rural areas, largely out of fear of failure of cost-effectiveness and upkeep levels. It has been observed that though many cost reducing innovations have resulted from several research activities in India, the results are seldom translated into practice because of the conservatism of practising Public Health Engineers.

When installed in rural areas and many a time, in urban areas as well, the conventional water treatment plants (WTP) result in operational and maintenance problems because of lack of necessary infrastructure for repairs. Neither are small conventional WTPs cost-effective, with the prevailing cost in India being around Rs. 12.00 lakhs/Mld for plants upto 5 Mld. For smaller capacities ranging from 2-3 Mld, installation, operations and maintenance of conventional plants are also found to be very difficult.

Isolated attempts have been made in the country to design and install cost effective WTPs. However, the practising engineers have been reluctant to spread the philosophy of minimum mechanical sophistication and maximum reduction in construction costs.

It is quite pathetic to see clariflocculators with non-rotating bridges and flocculator paddles, sludge boiling etc. in several plants in the Indian water treatment scene, even though as early as in 1977, the superiority of horizontal flow settling tanks has been studied and reported by Dr. Agarwal, Dr. Patwardhan, Dr. Kardile etc., are also pioneers in the field of cost effective treatment plants. Even the advantage of continuous desludging in circular clariflocculators is nullified in rural India due to non existence of facilities for repair and maintenance of mechanical equipment.

In the paragraphs that follow, an attempt has been made to discuss and promote the prospects of using minimum mechanical equipment, resulting in maximum cost reduction, simple operation and maintenance, leading to optimum efficiency of WTPs of smaller capacities.

Chemical mixing and flocculation

Mechanical flash mixing is the current fashion and standard as it is cheaper for large plants, compared to hydraulic mixing. But for small plants hydraulic mixing is desirable as its superiority over mechanical flash mixing has been shown in studies. The main disadvantage of hydraulic mixing is the unsuitability which arises when the actual

flow varies from the designed flow. But this can be mitigated by using multiple units in an economical way.

In the design example available with the authors, a single 2 Mld flocculator has been adopted, though 2 units of 1 Mld each can be designed without much escalation in costs. The mixing and flocculation is combined in an upflow pebble bed flocculator in the design example. The design—a circular shape adopted to achieve economy in construction—is based on experiments done by Dr. Bhole and S. Vaidyanathan. A tapered flocculation has also been attempted.

The big advantage of this flocculator is the reduction in detention time and elimination of mechanical equipment. The problem of occasional clogging of the flocculation can be overcome at a nominal additional cost by providing arrangements for high velocity upwash using wash water from filter. The cost of structures and equipment for dosing chemicals is not considered here as this forms only a small percentage of the cost of the plant. Moreover, it is possible to fabricate economically simple manually adjustable equipment locally.

Settling tanks

Generally, settling tanks are given large capacities providing longer detention times to avoid disturbances to the settled flocs. Plate and tube settlers overcome this limitation but involve problems of desludging. One way of overcoming this problem is overcome by providing steeply sloping (60° to the horizontal) plate settlers and hopper bottoms to the tanks facilitating continuous desludging. This reduces the detention time to about half an hour and also eliminates the mechanical devices for desludging, thus overcoming operation and maintenance problems.

Tube settlers, which are quite common in western countries, are not in vogue, and are not utilized in an effective way in developing countries such as India, due primarily to the innate conservatism and distrust of innovations by practising engineers. For small plants these settlers are quite handy, effective and economical. Adoption of plate settlers results in a saving of 50 per cent in costs when compared to conventional settlement tanks.

Rapid sand gravity filter

The common practice in advanced countries is to achieve higher filtration rates using coarser sand. But in India we still follow conservatively low filtration rates (80 lpm/m²) necessitating larger filters and consequently, higher costs.

Higher rates of filtration using dual media filters have been successfully demonstrated by Dr. Kardile and S.N. Ranade *et al.* But these have not been widely adopted, perhaps due to operational problems. Since higher rates are possible using coarser sand instead of dual media without much innovation in design excepting higher filterwash rates, we feel that these filters can be made more popular. Constant rate filters with influent flow splitting are proposed because they do not require mechanical equipment like the filter rate controller, loss of head indicator etc. Besides, development of negative head is totally prevented.

Adoption of a circular shape more than compensates for the extra depth of filter box, due to considerable cost reduction in structural works. A circular shape also helps to adopt an inverted conical flow enabling the use of an economical, simple, perforated cast iron bell for the under drainage. Incidentally, this results in low wash heads as well.

A central circular weir is used for washwater collection at the centre of the filter effecting economy and uniform flow of washed water to the drains. V notches are proposed for equal flow splitting to the filter whereas the central circular weir assures even distribution of clarified water over the filters.

High velocity wash without an airwash is proposed to reduce operational and maintenance problems. The filters are not proposed to be covered. The philosophy is to use mechanical equipment to a minimum, effecting considerable savings and avoiding operation and maintenance problems.

Washwater tanks etc.

Generally, capacity to wash 2 filters simultaneously is provided for the wash water tank. In the design example available with the authors, the capacity of wash water tank is limited to wash only one bed; instead, the capacity

of the wash pumps has been increased to fill the tanks within one hour. Circular shape is provided for both the clear water reservoir (CWR) and wash water tank (WWT) and provision of the same diameter for both, helps in considerable cost reduction.

Even the staging required for the WWT has been reduced due to the special nature of the underdrainage system adopted. The mechanical equipment is restricted to a few pipes, valves, 2 wash water pumps and chlorinator equipment.

Conclusion

We are not propounding new theories through this paper. Neither has any original idea developed by us been used in the design of the plant. A large number of experiments are being conducted in several laboratories in India with interesting results. But sadly there is a reluctance on the part of the practising engineers to assimilate the results of these experiments and translate them into practice. What we have attempted, is to draw from the experiences of several such researches and to use them in an innovative way to achieve economy in the design of small water treatment plants.

If one can draw from the results of these studies and put them into practice in an innovative manner, it will definitely lead to cost reduction, a lesser number of breakdowns, better overall efficiency in the water treatment sector and larger consumer and organisational satisfaction in a resource starved country such as India. We appeal to all practising Public Health Engineers to shed their conservatism and experiment with the valuable research findings available in the country. Let more people have access to good quality drinking water. Let us reach the unreached. (*Cost estimates and illustrations of a flocculator, clarifier, filter and general layout and functional design of the 2.0 Mld W.T.P. are available with the authors.*)