Engineering Ecological Security

CHEMICALLY ENHANCED PRIMARY TREATMENT – AN ALTERNATE PARADIGM FOR BASIN-WIDE RIVER WATER QUALITY IMPROVEMENT

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ABSTRACT

In view of limited resources available for water pollution control from rapidly growing urban centres, an alternate paradigm of covering wider geographical areas in a river basin through provision of a basic or curtailed treatment scheme comprising enhanced primary treatment is proposed. This paradigm deviates from the conventional approach wherein complete treatment upto secondary level is provided only at selected large cities while the rest of the smaller towns get left out and; wherein discharge standards for these large cities are attempted to be complied with while at the rest of the places in the same river basin, raw sewage continues to get drained. The new paradigm is based on the premise that discharge standards at each of the new treatment plants can be attained in phased manner over a reasonable period of time rather than in one go. The curtailed treatment scheme entails limited upfront capital investment at a particular location and allows the available budget to be spread over a larger number of cities and towns in a river basin. As additional budget is made available, secondary level treatment units can be appended to the curtailed treatment schemes, starting from larger installation and gradually covering the smaller installations. This strategy is known to have yielded rapid gains elsewhere in terms of water quality improvement in a river basin and deserves considerations in the Indian context.

Key words: Chemically enhanced primary treatment, CEPT,

INTRODUCTION

The Indian sewage treatment sector witnessed action in mid eighties when the centrally sponsored Ganga Action Plan (GAP) was launched in the northern and eastern states of UP, Bihar and West Bengal. Prior to that, only selected metropolitan cities e.g., Delhi, Mumbai and Chennai had sewage treatment plants. The first generation plants were typically based on conventional activated sludge process, extended aeration or trickling filter technology. While they are proven and have given satisfactory results, their energy consumption and therefore the operating and life cycle costs were found to be the major constraints. Subsequently in early nineties the Yamuna Action Plan was launched which attempted to explore the paradigm of resource recovery from sewage in the form of biogas/energy and manure while at the same time limiting operating expenses. This was attempted through the UASB technology which is an improved anaerobic reactor. As of now more than 30 UASB based plants have been set up across the country, however with over 10-12 years of experience it has been found that none of them is working satisfactorily with regard to final effluent quality

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or energy recovery. Several inherent limitations of the UASB technology have become evident which make the effluent more complex and difficult to render secondary or polishing treatment. In principle, the paradigm of attempting recovery of energy (biogas) directly from sewage appears to be in violation of the fundamental second law of thermodynamics. This law states that if the entropy (disorder) of the feedstock (sewage) is high, then it requires commensurately higher input of energy for producing viable outputs. In this context it is understandable that the UASB plants for sewage treatment have not been able to deliver the desired effluent quality.

During the GAP and YAP concurrently with the above initiatives, the 'low cost' system of waste stabilization ponds was also tried out successfully. While a WSP has lower capital expenditure for plant and equipment and has lower operating costs, it has a very large foot print which is generally in the range of 1-2 ha/mld. In fast growing urban centres, large tracts of land at affordable price are not available and therefore in totality such a system may not offer an affordable option. Moreover the lagoon type treatment systems have certain limitations e.g., potential for ground water pollution, odour nuisance in case of overloading, mosquito breeding, disruption of process due to toxicity or overloading, etc.

In view of the above limitations of the UASB and the WSP type of treatment systems, in the recent past a renewed interest in aerobic processes and high end treatment technologies has been shown from the point of view of recycling of treated effluent for industrial applications or horticulture, etc. These technologies are capable of producing effluent with BOD:SS under 10:20 mg/l respectively. However, their high life cycle costs are a deterrent for wide scale application.

Over last two decades large resources have been deployed in wastewater management including centralized treatment facilities, however this has not translated into commensurate improvements in the quality of receiving water bodies – lakes and rives across the country. As a matter of fact, there is growing realization that the rate of population growth and industrial discharges is overtaking the rate at which the sewage collection and treatment infrastructure is being created and as a result the pollution load on the receiving water bodies is not showing signs of decline. In view of this, there is a need for exploring an alternate paradigm which considers rapidly deployable, scalable and affordable treatment systems over the large part of a river basin rather than focusing on large urban centers alone.

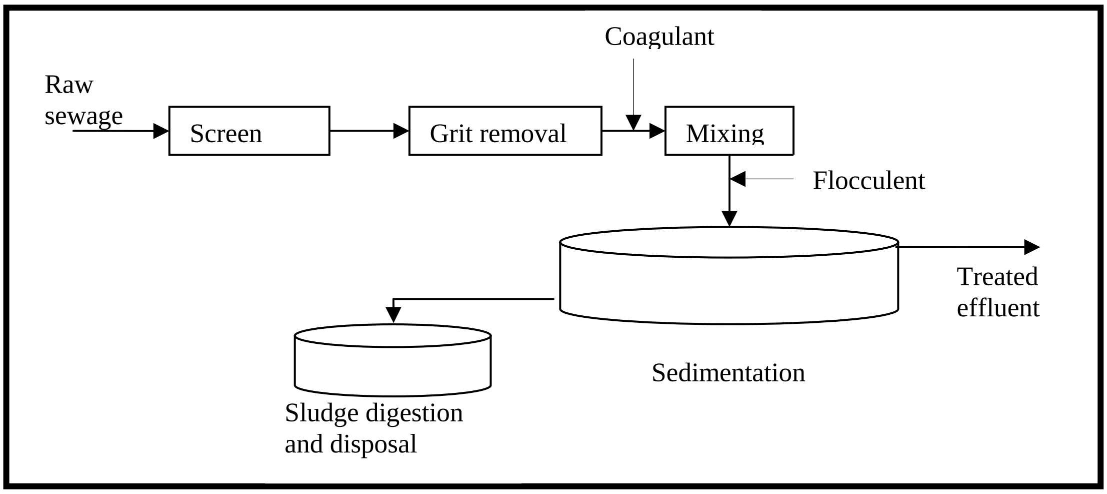
CHEMICALLY ENHANCED PRIMARY TREATMENT

In the above context, it is interesting to learn about two pilots based on an innovative combination of treatment process and technology which have been constructed in Delhi during the YAP extended phase in 2002-03 at the 'Dr. Sen Nursing Home Nalla' and 'Delhi

Gate Nalla' STPs. The focus of this paper is the primary treatment section of these two pilots which is technically termed as 'Chemically Enhanced Primary Treatment' (CEPT). It essentially comprises addition of chemicals for coagulation and flocculation followed by sedimentation whereby in a short period of time one can achieve significantly higher reduction in TSS (total suspended solids) and BOD (biological oxygen demand).

As shown in Exhibit 1, a stand alone CEPT plant would typically comprise screening, grit chamber, chemical addition followed by coagulation & flocculation, settling and sludge management (thickening, drying and disposal). Innovative technology features have been incorporated in the pilots at Delhi wherein the coagulation, flocculation and settling operations have been combined in a single reactor, thereby further limiting the footprint of the plant. A 60 mld tertiary plant has been constructed in Bangalore based on the same technology which treats effluent from an activated sludge process plant. The treated effluent from this plant is being sold for industrial usage at a rate of Rs. 16/m^3.

EXHIBIT 1: SIMPLE FLOW DIAGRAM OF A CEPT PROCESS



A comparison of treatment efficiency and sludge production rates of conventional primary treatment, CEPT and conventional primary and secondary level treatment plant is presented in Exhibit 2. It is found that in terms of TSS removal, performance of CEPT is comparable to secondary treatment plant while BOD removal is almost 60%. In terms of Phosphorus removal it is 3 and 4 times higher compared to a secondary and primary level treatment respectively. In terms of sludge production, it is about 25% lower than the conventional combined primary and secondary level treatment process.

EXHIBIT 2: COMPARISON OF REMOVAL RATES AND SLUDGE PRODUCTION

	Removal efficiency			Sludge production		
Treatment Type	TSS	BOD	P	From TSS	From Chemicals/ Biomass	Total
Primary	60%	35%	20%	X	0	X
Chemically Enhanced primary ($FeCl_3$+ anionic polymer)	80%	57%	85%	1.33X	0.12X	1.45X
Primary + Biological Secondary	85%	85%	30%	1.42X	0.48X	1.90X

Advantages of CEPT

A CEPT based plant allows sedimentation basin to operate at higher overflow rates, while still maintaining a high removal rate of TSS and BOD. This offers a great advantage as the treatment infrastructure can be smaller thereby translating into lower land requirement and lower capital costs while giving a fair degree treatment efficiency between 60-70% as compared to a conventional secondary treatment plant. Furthermore, a CEPT based system has minimal energy requirement as there is no need for aeration which otherwise is an intrinsic feature of aerobic processes whereby the biomass growth is facilitated. As it is not a biological process, it is also immune to toxicity in the incoming wastewater which otherwise has the potential to disrupt operations of activated sludge and UASB technology based plants. Because of the simplicity of the process, CEPT does not involve any rigorous monitoring of operating parameters, e.g., DO (dissolved oxygen), sludge age, return sludge ratio, etc., and therefore it also does not require highly skilled manpower.

CEPT can be used at any scale, including for very small towns. Moreover, it allows the flexibility of excluding secondary treatment stage at the outset and adding it at a subsequent stage when additional resources are made available. This feature allows for phase-wise attainment of discharge standards rather than in one shot. Here again CEPT offers an advantage as the size of the required secondary treatment will be smaller compared to that after a simple primary treatment.

Additionally, CEPT also offers an opportunity to increase capacity of existing overloaded conventional treatment plants, such as activated sludge process based plants. The step of dosing of metal salts and/or a polymer only requires provision of storage tanks for the chemicals and injection equipment. Introducing chemical enhanced treatment in an existing primary settling tank will roughly double its treatment capacity.

It is evident that because of reduced reactor requirements e.g., aeration tank and secondary settling tank, a CEPT based plant costs about half of a secondary treatment plant and only minimally more than a primary treatment plant.

Perceived constraints

CEPT technology is confronted with a misconception that it dramatically increases sludge production. However, CEPT is used today with minimal coagulant dosage (10-50 mg/L), and the chemicals themselves make only a slight contribution to the total sludge production. The greatest portion of sludge production is due to the increased TSS removal in the settling tank. And that is precisely CEPT's goal.

Another misconception pertains to higher operating costs on account of chemical usage. However, this gets offset to almost the same or an order of magnitude higher as it does not require energy input for aeration.

THE ALTERNATIVE PARADIGM

The conventional paradigm has involved construction of complete chain of treatment units all the way to secondary or even tertiary level for a few large towns. The latter approach benefits fewer cities and towns, involves higher capital investment at the outset but does not necessarily lead to a commensurate improvement in water quality over a longer stretch of a river or the basin as a whole.

As against this, considering the advantages of a CEPT system, an alternate paradigm is proposed. It essentially stems from the 'expandability' feature of the CEPT system wherein secondary level treatment in the form of biological oxidation, etc., can be added at a later stage when required resources are made available. It is akin to building a basic dwelling unit and constructing additional rooms as one manages additional resources over a period of time. Likewise, this also means that the effluent discharge standards will not be achieved in one go, but will be gradually complied with in phases over a well defined time period.

This paradigm envisages provision of a basic CEPT unit at every urban centre and achieving wider geographical coverage of urban towns rather than concentrating available resources in few a large towns on secondary level treatment plants. At the outset if more number of towns are provided with a basic CEPT unit in a river basin, a longer stretch of the river can experience 60-70% reduction in pollution load. This will also help in regenerating and strengthening the self purification capacity of a river which can then be leveraged for further water quality improvement. This approach will translate into measurable and perceptible improvement in water quality over the entire basin of the river. In the second phase, with budget available, the implementing agencies could provide secondary level treatment at larger installations, thereby consolidating on the improvements made in the previous phase.