# Master Plan 2025 of Pune Municipal Corporation for Sewage Treatment and Disposal

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## ABSTRACT

About eighty percent of the water supplied to consumers in Indian cities gets converted into sewage. According to an estimate, the major cities and towns in our country together generate about 20,000 million litres of wastewater (sewage) per day. It is reported from different parts of the country that about 50 to 70 percent of the pollution load of rivers and streams is from domestic sewage. Sources of fresh water are getting exhausted and development of new water resources is cost intensive and time consuming. Since surface water is the main source of water for urban population, it is to be conserved, treated and discharged in nature after its use. To prevent the degradation and to maintain the quality of water in the rivers, the sewage generated from cities is to be treated before its disposal into the nearby water bodies. The treated sewage can also be used for secondary purposes like gardening, agriculture and even for recreational purposes in rowing channel. This paper outlines the integrated approach in decentralised planning, designing, and execution of master plan 2025 for the treatment and disposal of sewage of Pune city.

***Key words***: Master plan 2025, Decentralisation, Sewage, Effluent, BOD,TSS

## INTRODUCTION

The Pune city, with 18° 31' N latitude and 73° 51' E longitude, is situated on the western margin of the Deccan Plateau at the confluence of Mutha and Mula rivers. Pune is second largest city of Maharashtra state and lies on the leeward side of the Western Ghats, at a height of about 560 Mts above mean sea level. The mean daily maximum and the minimum temperatures for the hottest month i.e. May are 38°C and 23°C respectively. The same for the coldest month of December are 30°C and 12°C respectively. The annual rainfall is about 70 cm. The cumulative storage of 28 TMC in Panshet, Varasgaon, Temghar, Khadakwasala, and some other small dams within Mutha river catchment is the source of water to Pune city. This total storage capacity also, includes the agricultural requirements. Mula and Mutha are the two major rivers, which pass through and converge within Pune city. A large population is dependent on Mula-Mutha river water flow down to Pune city and these rivers finally discharge into Ujani dam. As per census of 2001 the city population is 25,40,069 souls. The forecasted population of Pune city for the year 2011 and 2025 are 4300000 and 6500000 souls respectively. At present the annual requirement of raw water is around 9.5 TMC.

On an average Pune Municipal Corporation is supplying water at the rate of 200 litres per head per day to the citizens of Pune. The city generates around 451 MLD of sewage. With the enforcement of pollution control norms, the municipal authorities are allowed to dispose the treated sewage into the rivers after reducing its pollutional strength below acceptable limit. Up to year 1997, in old Pune city limit Dr.Naidu Sewage Treatment Plant with full-fledged primary and secondary treatment facility was treating 90 MLD sewage and Bhairoba Nala sewage treatment plant with primary treatment facility was treating 32 MLD sewage (**Table a**). Due to merger of 23 villages from the outskirts in year 1997, the area under jurisdiction of Pune Municipal Corporation (PMC) has gone up to 243 Sq.Kms. PMC anticipated sudden load on municipal services like water supply and sanitation due to merger of nearby villages and initiated formulation of the Master Plan of these services up to year 2025. The approximate total budget of Master plan 2025 for sewerage and sewage treatment is 523 Cores. This master plan is being executed in three phases. Phase I is completed in year 2005 and Phase II is likely to be completed by end of 2008. Early execution of Phase III is in thought process and is likely to be completed by 2015 instead of earlier plan of 2025. At present, 65 % (305 MLD) of the total sewage is treated before discharge in to the rivers and remaining 35 % (165 MLD) untreated sewage reaches the rivers through drains and Nallas due to inadequate conveyance system. This is leading to an adverse impact on the environment in the surrounding areas through which they flow. A large number of housing schemes in the outer areas still depend on the on site sanitation in the form of septic tanks. Massive program to augment the sewage treatment capacity was undertaken in 2001 and it is one of the most important aspects to reduce Mula-Mutha river pollution and make the city clean and

**Table a. DETAILS OF VARIOUS SEWAGE TREATMENT PLANTS OF PUNE MUNICIPAL CORPORATION, PUNE**

| Sr. No | Description | MASTER PLAN 2025 | | | | | | | | | Old STP's till Year 1997 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Future Plants | | | | |
| | | Bopodi | Tanajiwadi | Erandwane | Bhairoba | Vitthalwadi (under construction) | Existing premises of Dr.Naidu Hospital (Proposed) | Baner | Kharadi | Mundhawa | Dr.Naidu Hospital | Bhairoba Nala |
| 1 | **Plant Capacity** | 18 MLD | 17 MLD | 50 MLD | 130 MLD | 32 MLD | 115 MLD | 30 MLD | 40 MLD | 45 MLD | 90 MLD | 32 MLD |
| 2 | Treatment Process | Extended Aeration | Bio Tower and Diffused Aeration | Modified Activated Sludge P[illegible]s | Activated Sludge Process | - | | | | | Carrousel Process(AST) | - |
| 3 | Year of Commissioning | May 2003 | April 2004 | December 2004 | July 2003 | Expected by July 2008 | | | | | 1988 | 1928 |
| 4 | Plant Area | 1.5 Hectare | 0.72 Hectare | 0.8 Hectare | 8 Hectare | | | | | | 4.26 Hectare | |
| 5 | Catchment Area | 15 Sq.Kms | 18.20 Sq.Kms | 26.15 Sq.Kms | 56.65 Sq.Kms | | | | | | 40 Sq.Kms | |
| 6 | Population | 1,25,150 | 1,29,000 | 3,46,000 | 7,41,000 | | | | | | | |
| 7 | Project Cost | 5.69 Crores | 6.75 Crores | 11.12 Crores | 37.54 Crores | | | | | | 2 Crores | |
| 8 | Power Consumption per Day | 2300 kWh | 4050 kWh | 11000 kWh | 24000 kWh | | | | | | 15700 kWh | - |
| 9 | Design Parameters | BOD: 250, < 20 mg/l; COD:350 mg/l; TSS: 300, < 30 mg/l; pH : 6 to 8 ; Oil and grease: 30, < 10 mg/l; Residual Chlorine < 1 ppm | | | | | | | | | | |
| 10 | **Treatment Scheme** | | | | | | | | | | | |
| (a) | Preliminary / Primary Treatment | | | | | | | | | | | |
| | (i) Coarse Screen | 75 mm | 50 mm | 40 mm | 40 mm | | | | | | | Screening |
| | (ii) Raw Sewage Pumping | - | - | - | - | | | | | | - | - |
| | (iii) Fine Screen | 25 mm | 20 mm | 20 mm | 25 mm | | | | | | | |
| | (iv) Degritting Unit | Yes | Yes | Yes | Yes | | | | | | Yes | Degritting |
| | (v) Parshall Flume (Digital flow meter) | Yes | Yes | Yes | Yes | | | | | | Yes | Yes |
| | (vi) Primary Clarifier | - | - | 1 No- 27 m dia Tube settler tank | 4 Nos circular 37.9 m dia | | | | | | 2 Nos Circular | - |
| (b) | **Secondary Treatment** | | | | | | | | | | | |
| | (i) Aeration Tank | 2-Circular Channels 124m x 9.6m | Bio-Tower, and 2 Nos-Aeration Tanks 67mx28m | 2 Nos circular – 25.7 m dia Diffused Aeration | 4 Nos –Tanks Rectangular 67m x 27.5 m | | | | | | 2 Nos Channel | - |
| | (ii) Secondary Clarifiers | 2 Nos 31 m. dia | 1 No 35 m. dia | Tube settler- 1396 $m^2$, Hopper type | 4 Nos circular 45.5 m dia | | | | | | 2 Nos Circular | - |
| | (iii) Thickner | 1 No | 1 No | 1 No, 17 m dia | 2 Nos circular 25 m dia | | | | | | 1- Circular | - |
| | (iv) Centrifuge | 2 Nos 7 cu.m/hr | 2 Nos 7 cu.m/hr | 1+1 Nos. 10 cu.m/hr | 3(2 W+1S) 20 cu.m/hr | | | | | | - | - |
| (c) | Tertiary Treatment Chlorine Contact Tank | Applied dose of chlorine in all STPS is in the range of 3 to 5 ppm | | | | | | | | | 3 to 5 ppm | - |
| 11 | Disposal of Treated Sewage | Treated sewage is discharged into the Mula-Mutha river | | | | | | | | | | Reuse for Irrigation till 1980 |

healthy in every possible way. Pune Municipal Corporation under this master plan will treat 100 % of its sewage generated by the end of 2025.

## OBLIGATORY CONDITION OF IRRIGATION DEPT OF STATE AND NORMS OF POLLUTION CONTROL BOARD (20/30)

Originally, Kamshet and Warasgaon dams within the Mutha river basins were constructed for agricultural water requirements. In 1960 the water supplied to Pune city was 5 % of cumulative storage capacity of these dams and now the demand has gone up to 25%. The water to Pune city is supplied at the cost of partial cut down of agricultural requirements. The right bank canal of Khadakwasla dam passes through Pune city and at Hadapsar the shortest distance between Mula-Mutha river and canal is hardly 1-1.5 Kms. All these old and newly constructed sewage treatment plants are located on or near the banks of Mula-Mutha rivers flowing through Pune city **(fig 1)**. In developing countries and especially in the areas of water scarcity greater compatibility between water, wastewater and agriculture is necessary for the sake of sustainability. There are several villages and towns (riparian) on the downstream who are dependent on the river flow for their agricultural and drinking water requirements. In view of their dependency and as a matter of long term policy, the Irrigation Department of Govt of Maharashtra (Krishna Water Dispute Tribunal) in a year 1997 has put a condition to PMC while granting the increased demand of water to Pune city to 11.5 TMC, that the Pune Municipal Corporation at its own cost will pump 6.5 TMC mixture of Mula-Mutha river flow and treated sewage from suitable downstream point of Pune city and deliver into Khadakwasla right bank irrigation canal at sadesatranali (17½ nali) near Hadapsar for agricultural reuse.

With the increased pollutional load on the rivers in our country their environment has deterioted. To prevent the river water degradation and to maintain clean river water, the Maharashtra state pollution control board stated the discharge norms on the sewage effluents. Part of the mixture of Mula-mutha river flow and treated sewage is proposed to be pumped back to Mutha river/

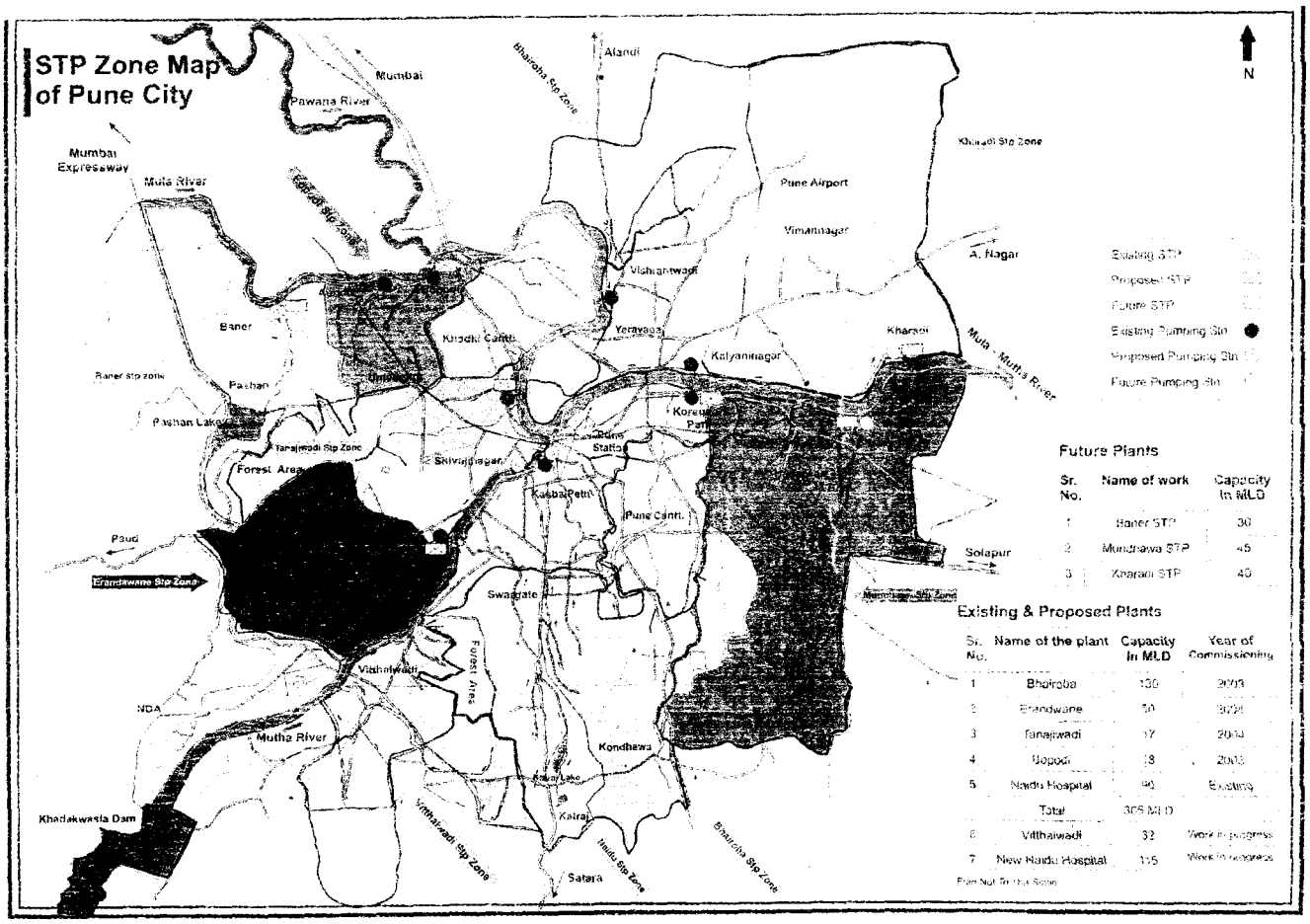


**Fig 1. Location of existing and proposed STPs on Mula-Mutha river**

and to prevent its accumulation in digestion tank. Screw conveyors withdraw the grit accumulated in grit chamber. The details of the units at different STPs are given in table a. The primary treatment at all treatment plants except Bopodi (extended aeration process) consists of primary clarifiers. In general the suspended solids removal efficiency of primary clarifiers is about 60 % at all plants

**(b) Secondary treatment**

The secondary treatment adopted at various plants are aerobic based, where the aeration is done either by surface mechanical aerators or by diffused aeration system. The suspended and colloidal organic matter from sewage gets oxidised in aeration tank, tends to coagulate, form a precipitate and settle down readily in secondary settling tank. The dimensions and number of aeration tanks, power consumption per day and number of secondary clarifiers at different STPs are given in table a.

**(c) Tertiary treatment / chlorine contact tank**

The chlorination of treated sewage is very much essential to prevent the growth of pathogenic bacteria and for its safe disposal into the rivers or nearby water bodies. In all these plants the clarified sewage from secondary settling tanks is disinfected in baffled chlorine contact tanks (CCT). The applied dose is in the range of 3 to 5 ppm to have the residual chlorine less than 0.5 ppm at the outlet of CCT. The chlorine contact time i.e. flow detention in CCT is 30 min.

**(d) Centrifuge**

The surplus sludge produced in sewage treatment is to be dewatered and disposed off hygienically and economically. At all sewage treatment plants the sludge produced is aerobically digested, thickened and then centrifuged with the help of mechanical device after addition of a dose of polylectrolyte and converted into cake. The final disposal of manure cake is application to gardens of Municipal Corporation and agriculture use as organic manure. The effluent of centrifuge is taken to the aeration tank and allowed to mix with aeration liquor. The centrifuge capacity and their numbers at different STPs are as mentioned in table a.

## LAND UTILISATION AND POWER CONSUMPTION

**(a) Land utilisation**

Availability of a suitable land in cities is a major constraint for the construction of sewage treatment plants. To minimize land requirement the sewage collection system must be decentralized as much as possible consistent with the topography of the area and its population disposition. The total area utilised at different sewage treatment plants is as given in table a. The per person land required ($m^2$/ person) in warm climates for conventional activated sludge treatment process and extended aeration is to be within the range of 0.20–0.25 and 0.15–0.20 $m^2$/person. The land utilised at Bopodi,(including its future expansion), Tanajiwadi , Erandwane, Bhairoba are 0.12, 0.055, 0.023, 0.083 $m^2$ per person respectively ( Ref table b).

The 50 MLD sewage treatment plant at Erandwane is an activated sludge process with diffused aeration. The total plant is planned and constructed in a very small area of 0.8 hectare.

**(b) Energy consumption**

The continual increased demand of energy of urban population is alarming and has always been a problem of developing countries like India. While designing the sewage treatment plant two aspects of power are to be kept in mind (1) minimum power / energy requirements (2) effect of its dependability

***Table-b : Land & Energy requirement and cost of treatment***

| Sr No | Description | Bopodi (18 MLD) | Tanajiwadi (17 MLD) | Erandwane (50MLD) | Bhairoba 130MLD) |
|---|---|---|---|---|---|
| 1 | Land Utilisation $m^2$/person | 0.12 | 0.055 | 0.023 | 0.083 |
| 2 | Energy consumption kWh/person/year | 6.71 | 11.45 | 11.66 | 9.09 |
| 3 | O & M cost per year ( in lakhs) | 81.42 | 118 | 240 | 381.8 |
| 4 | Cost of treatment per MLD in lakhs (annualised) | 4.52 | 6.92 | 4.8 | 2.93 |

on the process. As far as possible the least energy intensive processes capable of meeting effluent quality requirements should be selected. This requires judicious selection of equipment and processes. Generally, aerobic digestion needs more power than anaerobic digestion. A more energy intensive process is selected only for very high BOD removal efficiency as a need for nitrification or as a need for reliability in operation. Combining two processes having different requirements and power can be able to optimize the overall cost. As far as possible benefits of natural land contours must be used to avoid pumping. The adoption of advanced resources recovery process such as methane from digestion gas for heat or power generation is added advantage.

For conventional activated sludge process and extended aeration the process power required in kWh/person-year is in the range of 12-15 and 16-19 kWh/person-year respectively. The sewage treatment plants at Bopodi, Tanajiwadi, Erandwane, and Bhairoba has power consumption of 6.7, 11.45, 11.66, and 9.09 kWh/person-year respectively.

## PERFORMANCE OF SEWAGE TREATMENT PLANTS

The design parameters limit for BOD, TSS, Oil and grease, and residual chlorine are < 20 mg/l, < 30 mg/l, < 10 mg/l and < 1 mg/l respectively. The MLSS, MLVSS, SVI values of aeration tanks of all plants are in the range of 3000-3510 mg/l, 2480-2750 mg/l and 44-96 ml/gm respectively. SVI value of aerated liquor of Bopodi STP is about 45 ml/gm (much lesser than 80 to 100 ml/gm, which is normally expected for extended aeration process), indicating its good settling ability. The BOD values of effluent at all plants consistently are in the range of 10-16 mg/l, whereas total suspended solids values are in a range of 15- 18 mg/l. The oil and grease amount is not detectable in effluent from STPs. The residual chlorine at the outlet of CCT is less than 0.5 mg/l. The typical performance parameter values of different sewage treatment plants are given in table c.

## CLEANLINESS IN THE AREAS OF STPs

The annual operation and maintenance (O & M) contract of these STPs is given to private agencies. The operation and maintenance contract includes monitoring the performance of STP, major and minor break down services, security, maintenance of hygienicity and cleanliness within the STP premises. The cleanliness in the premises is noticeable in the sense that utmost care is taken in removing and disposal of the debris, solid waste separated at different stages and garden waste. The absence of foul smell in the premises of STPs is the indication of their excellent performance. These sewage treatment premises are absolutely free from foul smell and odour.

## TOTAL RECURRING EXPENSES PER MONTH

The total expenses per month towards operation and maintenance(O&M) contract, chlorine and

**Table-C : Quality of Raw and Treated Sewage**

| Sr. No. | Parameter | Bopodi | | Tanajiwadi | | Erandwane | | Bhairoba | | MPCB norms |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Raw Sewage, mg/l | Treated Sewage, mg/l | Raw Sewage, mg/l | Treated Sewage, mg/l | Raw Sewage, mg/l | Treated Sewage, mg/l | Raw Sewage, mg/l | Treated Sewage, mg/l | |
| 1 | BOD | 145 | 16 | 180 | 12 | 175 | 14 | 110 | 12 | < 20 mg/l |
| 2 | COD | 296 | — | 235 | 28 | 252 | 20 | 238 | 32 | < 250 mg/l |
| 3 | TSS | 138 | 17 | 140 | 15 | 150 | 10 | 114 | 18 | < 30 mg/l |
| 4 | pH | 6.9 | — | 6.8 | 7.1 | 6.8 | 7.2 | 6.9 | 7.3 | 6-8 |
| 5 | Residual Chlorine | — | < 0.5 | — | < 0.5 | — | < 0.5 | — | < 0.5 | < 0.5 mg/l |
| 6 | Oil and Grease | ND | ND | 3.0 | ND | 2.5 | ND | 2.5 | ND | — |

Note: All values except pH are in mg/l

electricity, polyelectrolyte, laboratory chemicals, oil and grease charges of STPs at Bopodi,Tanajiwadi, Erandwane and Bhairoba are 6.10, 8.49, 17.72 and 23.81 lakhs respectively. The approximate cost of treatment of sewage per MLD/year for comparison can be worked by adding annualised capital cost and operation and maintenance cost of a particular year. The cost of treatment per MLD per year of various treatment plants is as mentioned in table b.

## DISCUSSION

The availability of suitable sites for construction of new and proposed STPs along rivers and near the outlets of drainage districts has favoured the decentralization of sewerage and sewage treatment under master plan 2025. At present 65 % of total sewage generated by Pune city is being treated in the treatment plants. Some treatment plants are receiving the raw sewage of lesser BOD value than designed value of 250 mg/l, may be due to improved living standard or high usage of water. The continuous operation and maintenance of coarse and fine screens, and grit chamber are removing almost all large and small debris and grit from sewage. The suspended solids removal efficiency of primary clarifiers of all plants is around 50-60 %. The MLSS, MLVSS, SVI values of aeration tanks of all plants are in the range of 3000-3510 mg/l, 2480-2750 mg/l and 44-96 ml/gm respectively. The processes are completely stable and consistent in their performance parameters. The SVI value of aerated liquor is about 80 to 100 ml/gm indicating its good settling ability. The values of BOD, TSS of treated sewage over a period of three months are in the range of 10-16 and 15-18 mg/l respectively. The BOD and TSS removal efficiency is above 90 % and 85 to 90 %. The sludge produced in secondary clarifiers is completely stabilized. The waste centrifuged sludge has no odour and is fit to use as organic manure. The effluent quality parameters like BOD, SS are well within the limits laid down by Maharashtra Pollution Control Board (MPCB) norms and permits the disposal of treated sewage in Mula-Mutha river. The satisfactory performance of new STPs is reducing the pollutional load on rivers where treated sewage is discharged safely.

## SUMMARY

Day by day the water resources are getting exhausted. Reclamation and reuse of sewage/ wastewater is not an option. It is a grim necessity. Proven technologies for the treatment of sewage wastewater are Activated Sludge Treatment Process and its modifications, or its combination with Bio-towers. The BOD reduction efficiency of all these processes used is above 90 %. Close operational control and maintenance is certainly ensuring the desired efficiency of the STPs. The effluent from these sewage treatment plants is meeting the limits of Maharashtra pollution control board. The quality of effluent from STP has a near sparkling appearance and can be reused for secondary purposes like gardening, agriculture and even for recreational purpose in rowing channel. By 2025,the remaining 30-35 % uncollected sewage reaching the rivers will get reduced. There will be a gradual and total improvement in quality of river water as PMC is aiming for 100 % treatment of generated sewage. Due to reduction in pollution load on river water, there is a reappearance of flora and fauna and fish in the river water. The improvement in river water quality and its environment will secure the dependency and right of riparian (downstream population).

## BIBLIOGRAPHY


1. Duncan Mara, Michael Mc Garry and Richard Feachem, " Water, Wastes and Health in Hot Climates" A Wiley- Interscience Publication, John Wiley and Sons, New York, 1977.
2. Logsheet of test results of Pune Municipal Corporation, on newly constructed sewerage projects. Year 2007-08
3. Metcalf & Eddy, Inc. Revised by George Tchobanoglous, "Wastewater Engineering - Treatment, Disposal and Reuse" Second Edition, Tata Mc Graw-Hill.
4. Patwardhan A D, "Decentralisation of Wastewater handling Facilities". Two day seminar Management of Wastewater and solid wastes in urban Areas, Institution of Engineers(I), Pune local center, 15, 16 Oct 2004.
5. Sakai Y, Fukase T, Yasui H, Shibata M(1997), " An activated sludge process without excess sludge production". Water Science and Technology, Vol 36,pp 163-170.
6. Soli J Arceivala, "Wastewater Treatment for Pollution Control" second edition. 1998. TATA McGraw Hill, New Delhi.
7. Manual on "Sewerage and sewage treatment". Central Public Health and Environmental Engineering Organisation. Ministry of Urban Development, New Delhi.