Techno Evaluation of Various Existing Steps in India : A Case Study

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ABSTRACT

Technology evaluation depends upon wastewater characteristics and on the treatment objectives as translated into desired effluent quality. Effluent quality control is aimed at public health protection, preservation of the oxygen content in the water, prevention of eutrophication, prevention of sedimentation, preventing toxic compounds from entering the water and food chains and promotion of water reuse. The selection technologies should be environmentally sustainable, appropriate to the local conditions, acceptable to the user, and affordable to those who have to pay for them. Simple solution that are easily replicable, that allow further upgrading with subsequent development, and that can be operated and maintained by the local community.

The Sequencing Batch Reactor (SBR) is a most preferred technology, as treated effluent was found to be of excellent quality & can be reused for non-potable purpose like, gardening, car washing, toilet flushing. The treated effluent from WSP, UASB and ASP is the most appropriate for irrigation as it conserve the N, P and K during treatment process. UASB with FPP is suitable when temperature inside the reactor is above 18 - 20°C and in India temperature is not a problem. The treated effluent from ASP, WSP and UASB is suitable for irrigation, while that of from FAB and SBR can be directly discharged into waterbodies / streams or can be reused.

INTRODUCTION

The selection technologies should be environmentally sustainable, appropriate to the local conditions, acceptable to the user, and affordable to those who have to pay for them. Simple solution that are easily replicable, that allow further upgrading with subsequent development, and that can be operated and maintained by the local community, are often considered the most appropriate.

Wastewater needs to be adequately treated prior to disposal or reuse in order to:

(a) Protect receiving waters from gross fecal contamination as they are often used as a source of untreated drinking water by downstream communities..

(b) Protect receiving waters from deleterious oxygen depletion and ecological damage;
(c) Produce microbiologically safe effluents for agricultural and aquacultural reuse.

SEWAGE TREATMENT TECHNOLOGY SELECTED FOR STUDY

In this regard existing STPs of various technology were visited and based on the observations on the status of O&M of individual STPs on the basis of physical inspection, and information given at site by operating staff/officers, techno evaluation have been prepared. As treatment methods range from the physico-chemical to the biological, from the aerobic to anaerobic and accordingly the following treatment plants based on different technologies were studied, as shown in Table 1.

Table 1: Various treatment plants selected for performance study

Sl. No.	Sewage Treatment Technologies	Location of Site
1.	Activated Sludge Process (ASP)	Haridwar (Uttarakhand)
2.	Upflow Anaerobic Sludge Bed with Final Polishing Pond (UASB + FPP)	Karnal, Haryana.
3.	Fluidized Aerobic Bed (FAB) Reactor	Lucknow, Uttar Pradesh.
4.	Sequencing Batch Reactor (SBR)	Panjim, Goa.
5.	Waste Stabilization Pond (WSP)	Titagarh, West Bengal.

PERFORMANCE EVALUTION OF ASP, HARIDWAR (UTTARAKHAND)

Details of ASP

The plant is using Activated Sludge process (ASP) and was commissioned in the year 1993 with a capacity of 18 MLD spread over an area of 2.9 hectare, and of initial project cost of Rs.15.00 crores. The current sewage generation is approximately 25-30 MLD but during festive season it goes even higher upto 45MLD (Peak designed capacity) and beyond 18MLD sewage is being bypassed and is mixed with treated effluent, used for irrigation purpose.

Design parameter		Influent	Effluent
BOD_5 (in mg/l)	:	250-300	< 30
TSS (in mg/l)	:	450-600	< 50
MPN No. / 100ml	:	10^6 - 10^9	< 10^3
Annual maintenance cost	:	Rs. 79.00 lacs in the year 2006.	

OPERATIONAL PERFORMANCE

The performance of STP is being studied for various parameters such as pH, TSS, BOD, COD etc. the test result are well within norms. In the STP, the domestic sewage with BOD and SS characteristics of about 150 mg per liter and 350 mg per liter respectively, is treated and these parameters are brought down to less than 20 mg per liter (as shown in Table 1a and in Figure 1), respectively, which is better than the norms laid down for pollution control standards.

Table 1a : Performance of ASP#

Parameters →	pH	BOD_5 in (mg/l)	COD in (mg/l)	TSS in (mg/l)	Total Coliform (MPN/100ml)
Influent	7.3	150	300-350	300-350	$1.2x10^9$
Effluent	7.5	10-15	20-30	15-20	$7x10^4$
Standards for discharge in streams	5.5-9	30	250	100	
Efficiency in %		90 - 93.33	91.43 - 93.33	94.30 - 95	99

Data collected at site in Dec'2007.

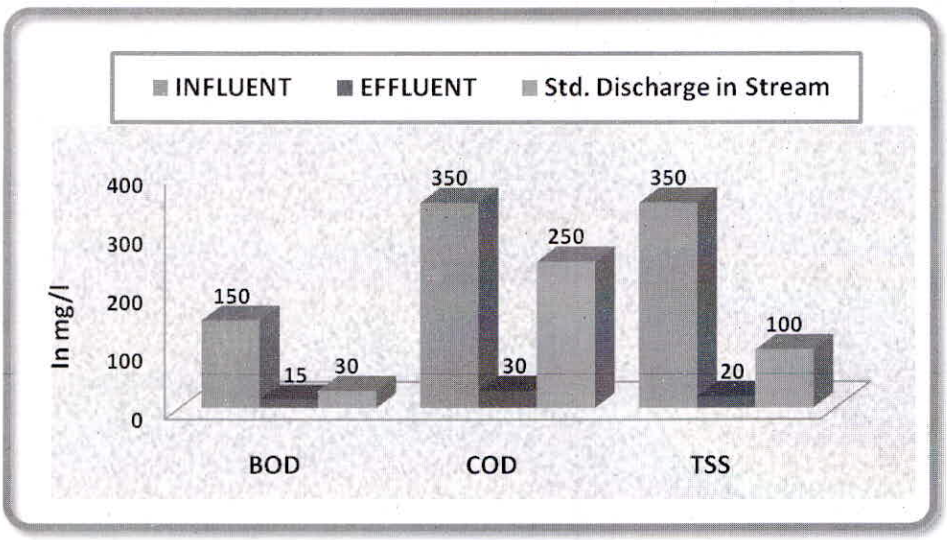

Fig. 1: Performance evaluation of ASP, Haridwar

OBSERVATIONS

1) Plant receives 30 MLD sewage out of which 18 MLD sewage is treated in the plant, and the rest is bypassed.
2) ASP unit is being fed with low organic loading and it is performing well.
3) Gas generated in anaerobic sludge reactor is not being utilized fully.
4) Plant is able to comply with the discharge standards.
5) One out of three nos. of mechanical screens is under repair.
6) No facility is provided to measure the quantity of bio-gas being produced daily.
7) Lot of greenery/plants has been grown inside the STP campus.
8) Treated effluent is meeting the design standards for BOD & TSS.

PERFORMANCE EVALUTION OF (UASB+FPP), KARNAL (HARYANA)

Details of UASB + FPP

The STP is using Upflow Anaerobic Sludge Blanket Process with Final Polishing Pond (UASB + FPP) and was commissioned in the year 2000 with a capacity of 40MLD (Zone-I) and 8MLD (Zone-II) of project cost of Rs.12.71 crores spread in an area of 25 acres under Yamuna action plan. Against a design capacity of 40 MLD, flow varying from 30-38 MLD (average 35 MLD) is being received at the STP. The effluent from the system is being used for irrigation.

Design parameter		Influent	Effluent
BOD_5 (in mg/l)	:	150	< 30
TSS (in mg/l)	:	275	< 50
Sewage temp (°C)	:	20	
Annual maintenance cost	:	54.00lacs. in the year 2003.	

OPERATIONAL PERFORMANCE

The Govt. of India, MOEF (NRCD), have appointed BHEL (Pollution Control Research Institute) as a third party evaluator, who regularly collects samples of STP. The test result indicate that the value of BOD, COD, TSS, pH are well within prescribed limit i.e. BOD_5 < 30mg/l, TSS < 100mg/l, shown in Table 2.

Table 2: Performance of (UASB +FPU)[1]

Parameters ⇒	pH	BOD in mg/l	COD in mg/l	TSS in mg/l	Total Coliform (MPN/100ml)
Raw sewage	7.35	172.30	430.30	219	$1.3x10^7$
UASB reactors effluent	7.23	53	182.69	54.36	
Final effluent	7.41	25.38	75.30	29.90	$4x10^5$
Standards for discharge in streams	*5.5-9*	*30*	*250*	*100*	
Efficiency in %	O.K.	82.59	82.50	86.35	96

OBSERVATIONS

1) Treated effluent is meeting the design standards for BOD and SS and there is lot of greenery/plantation inside the STP.
2) The bio-gas produced is mostly, being flared up.
3) Unequal flow is observed through V-notch/weir along with closing of feed inlet pipes which need to be more regularly cleaned.
4) Growth of weeds/plants at some places at the water surface on the embankments and scum/algae accumulation on the corners/sides of ponds is observed.

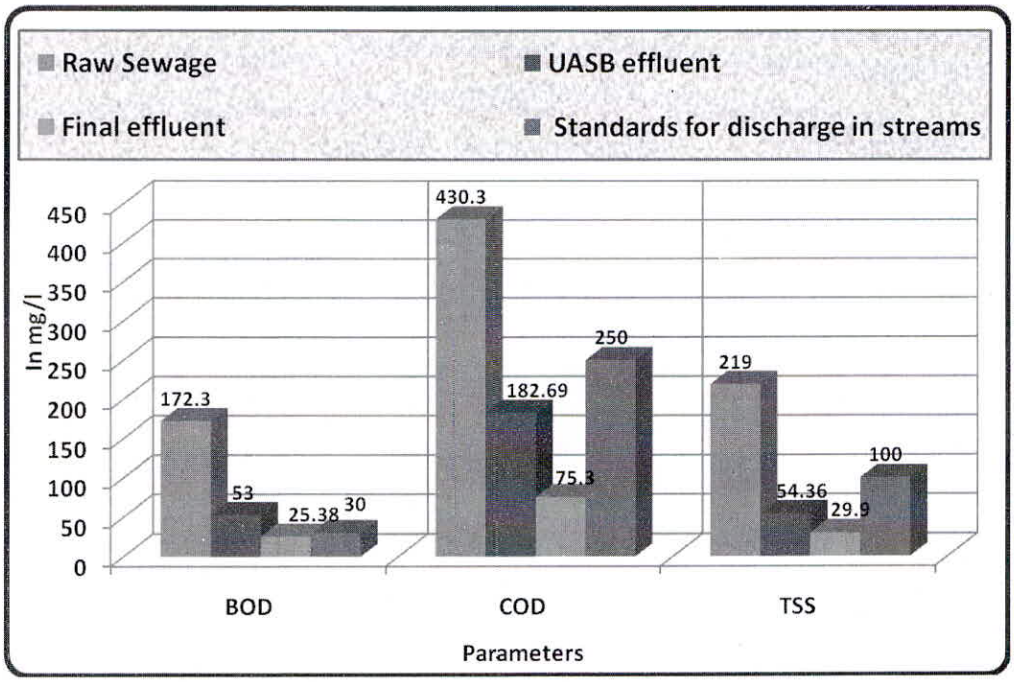

Fig. 2: Performance evaluation of (UASB+ASP)

5) Excess sludge is removed from time to time and sent to a simple sand bed drying.
6) The nutrients, nitrogen and phosphorous are not removed, but are conserved to make the irrigational use of the effluent more valuable.
7) Performance of demonstration scale DHS bio-tower of 1MLD shows, as promising post treatment alternative for UASB treating municipal wastewater. Needlessness of aeration, negligible excess sludge, tolerance to temperature variance, low maintenance and consistency in performance makes it a low cost and ideal wastewater treatment system.
8) The corrosion potential of anaerobic system is a major weak point which can ruin a UASB in no time and it needs special attention for better upkeepment of plant.

PERFORMANCE EVALUTION OF FAB, LUCKNOW (UTTAR PRADESH)

Details of FAB

This Sewage Treatment Plant is based on the Fluidized Aerobic Bed (FAB) technology. It works on the principles of attached growth process where Media supports the biomass. Media is in suspension has Specific gravity < water and fluidization takes place by virtue of hydraulic currents set by aeration. The STP was commissioned in the year 2003 with a capacity of 42MLD of project cost of Rs.14.36 crores spread in an area of 4.60 hectare.

Design parameter		Influent	Effluent
BOD_5 (in mg/l)	:	100-250	< 30
TSS (in mg/l)	:	200-250	< 30
MPN No. / 100ml	:	10^6 - 10^9	< 10^3
Annual maintenance cost	:	Rs.198.00 lacs in the year 2006.	

OPERATIONAL PERFORMANCE

It reduces the E-Coli in the wastewater with a very nominal chlorination and is the most successful and cost effective technology which reduces the E-coli count from an inlet level of $10^6 - 10^7$ MPN to less than 10^3 MPN at the outlet, (as seen from Table 3 & Figure 3). Due to fixed film nature these plants can accept shock loads much better than those employed for suspended growth process.

Table 3: Performance of FAB[2]

Parameters ⇒	BOD in mg/l	COD in mg/l	TSS in mg/l	Total Coliform (MPN/100ml)
Raw sewage	180	342.6	306	9000000000
Final effluent	22.5	119.5	98	1400
Standards for discharge in streams	30	250	100	
Efficiency in %	87.50	65.12	68.00	99.99

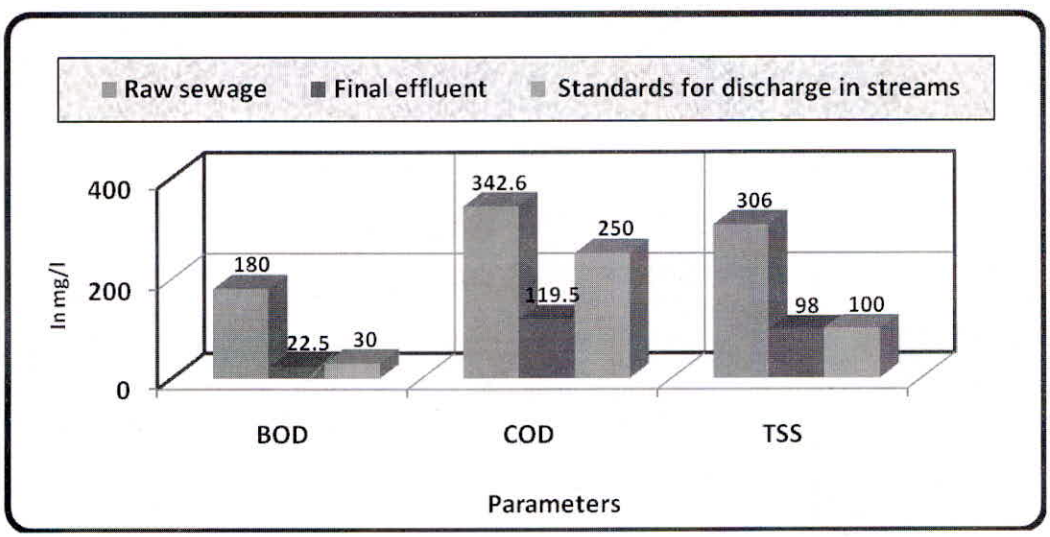

Fig. 3: Performance evaluation FAB

OBSERVATIONS

1) Treated effluent does conform to the standards for discharge in streams, as per the data received from Industrial Toxicology Research Centre, (constituent lab of C.S.I.R.) Lucknow which indicates the excellent performance of the plants.
2) Treated effluent is discharged into the river Gomati and the digested sludge is used for dumping in low-lying areas as there is no scope for sale of sludge as manure.
3) No test results are available after November, 06.
4) Chlorination is provided for coliform removal but has not been working for want of chlorine gas.
5) Sprayers / sprinklers have been installed to arrest the foam formation but these are mostly out of order.
6) The plant has not been running since Dec, 06.

PERFORMANCE EVALUTION OF SBR, PANJIM (GOA)

Details of SBR

The STP is using Sequencing Batch Reactor (SBR / C-Tech), and was commissioned in the year 2005 with a capacity of 12.50MLD of project cost of Rs.15.00 crores spread in an area of 4.00 hectare.

Annual maintenance cost	:	Rs. 48.00 lacs in the year 2007.
Cycle completion period	:	180 minutes (90+45+45).

A typical process flow schematic for a municipal wastewater treatment plant using an SBR is shown in Figure 4. Influent wastewater generally passes through screens and grit removal prior to the SBR. The wastewater then enters a partially filled reactor, containing biomass, which is acclimated to the wastewater constituents during preceding cycles.

OPERATIONAL PERFORMANCE

Depending on their mode of operation, SBRs can achieve good BOD and nutrient removal. For SBRs, the BOD removal efficiency is generally 85 to 95 percent. SBR produces an effluent of less than, as seen from Table 4 & Figure 4 :

OBSERVATIONS

1) Complete plant operation is controlled automatically through a PLC system, where all key functions like RAS, Sludge wasting, Aeration intensity, Cycle time control, Decanting rate etc. are automatically controlled as well as data logged, which is a major factor in reducing operating cost.

2) Complete system is capable of handling variable flow and load conditions by automatically adjusting to the new feed condition by changing cycle times, aeration intensity etc.
3) Chlorination is being done for coliform removal and treated effluent is being discharged into Mandavi river.
4) Sludge from drying beds is being used for filling low-lying areas as there is no demand for its use as manure.
5) Equalization, primary clarification (in most cases), biological treatment, and secondary clarification is being achieved in a single reactor vessel.

Table 4: Performance of SBR[3]

Parameters ⇒	BOD in mg/l	COD in mg/l	TSS in mg/l	Total Coliform (MPN/100ml)
Raw sewage	480	940	340	$46x10^8$ - $21x10^6$
Final effluent	2.6	37.6	24	2400 - 21
Standards for discharge in streams	30	250	100	
Efficiency in %	99.50	96	93	99.99

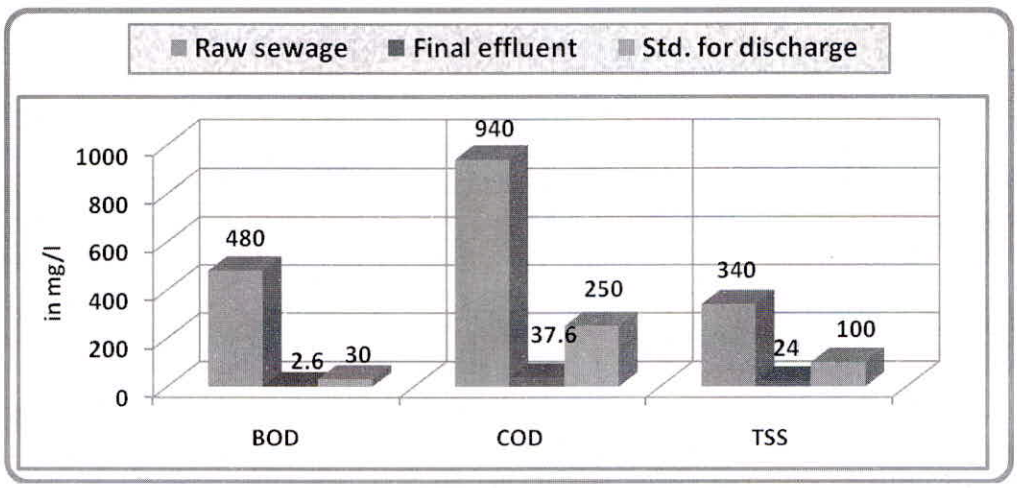

Fig. 4: Performance evaluation SBR(C-Tech)

PERFORMANCE EVALUTION OF WSP, TITAGARH (WEST BENGAL)

Details of WSP

The STP is using Waste Stabilization Pond (WSP) process, and was commissioned

in the year 1993 with a capacity of 14.10MLD of project cost of Rs.1.571 crores spread in an area of 10.8 hectare.

Design parameter		Influent	Effluent
BOD_5 (in mg/l)	:	200	< 30
TSS (in mg/l)	:	400	< 100
MPN No. / 100ml	:	$10^5 - 10^7$	$< 10^4$

The system is for treatment of raw sewage discharged by the people of Titagarh and parts (50%) of Barrackpore municipality, the sewage available being mainly from commercial and domestic sources. It is designed for the waste water treatment and reuse for aquaculture, which is termed as the "Resource Efficient Stabilization Tank System", based on the past ten years experience with the sewage fed fisheries in east Calcutta. Fish culture is currently practiced in both the facultative and maturation ponds. It comprises two series of anaerobic, facultative and a single maturation pond.
Technical features:

Design capacity of STP : 14.1 MLD;
Average flow reaching STP : 12 MLD Technology adopted.

OPERATIONAL PERFORMANCE

It is seen from performance report in Table 5, that the treated effluent is meeting the discharge standards in streams for BOD and SS and there is lot of greenery/plantation inside the STP, graphical representation is being done in Figure 6.

Observations

1. Plant receives very low strength sewage and treated sewage quality is meeting the discharge standards, about 90% of the treated sewage is used for irrigation and reuse for aquaculture.
2. Accumulated sludge from the ponds has never been cleaned since the plant was established in 1993. Anaerobic ponds were filled with accumulated sludge.

Table 5: Performance of WSP[4]

Parameters ⟹	pH	BOD in mg/l	COD in mg/l	TSS in mg/l
Influent	7.37	94	303	284
Final effluent	7.40	15	57	57
Efficiency in %	o.k.	84.04	82.7	91.55
Standards for discharge in streams	5.5-9	30	250	100

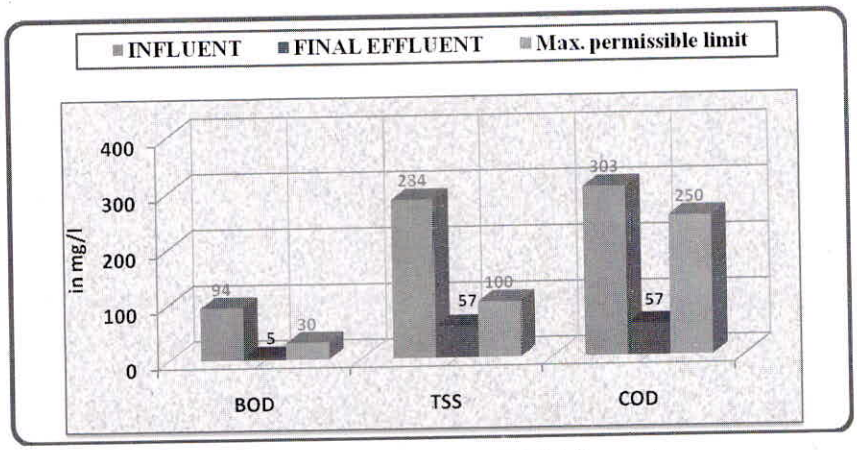

Fig. 5: Performance of WSP, Titagarh

DISCUSSION AND CONCLUSIONS

From the present study the following conclusions are drawn in terms of performance basis, useful for selection of appropriate technology. The effluents of various STPs are shown in Figure 6.

1. The Sequencing Batch Reactor (SBR) is a most preferred technology, as treated effluent can be reused for non-potable purpose like, gardening, car washing, toilet flushing, as effective option to conserve the potable water.
2. The revenue generation potential from UASB with FPP is the highest, as the treated effluent preserving N, K, & P, is suitable for irrigation, use of dry sludge as manure, utilization of bio-gas generated for power saving and encouraging aquaculture in FPP.

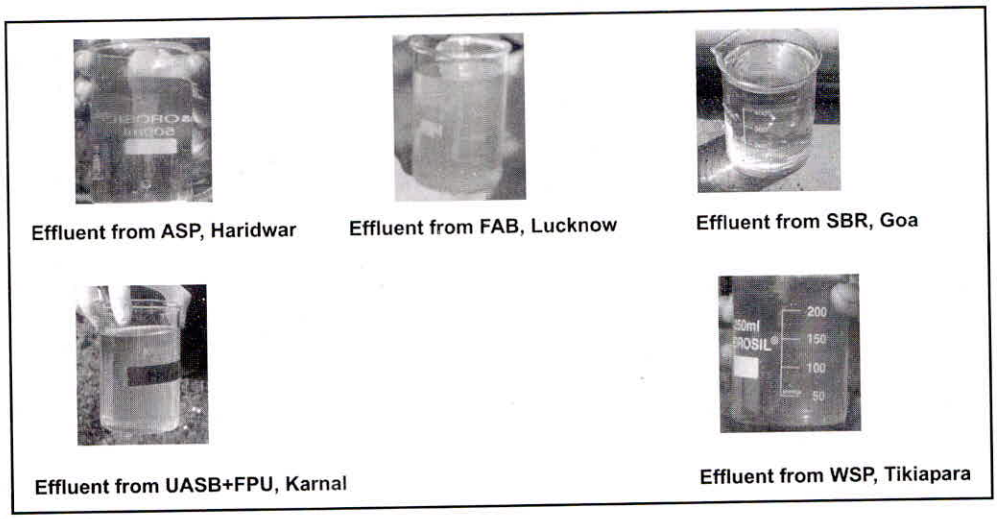

Fig. 6: Effluents of various STPs

3. The treated effluent from ASP, WSP and UASB is suitable for irrigation, while that of from FAB and SBR can directly be discharged into waterbodies / streams or can be reused.

The performance characteristics for the technologies considered are given in the following Table 6.

Table: 6: Performance characteristics of the technologies

Item	WSP	UASB+FPP	ASP	FAB	SBR
BOD Removal, %	77-85	79-86	85-93	65-88	98-99
COD Removal, %	63-83	72-83	90-93	55-75	94-97
TSS Removal, %	78-92	80-87	90-95	55-91	87-93
Coliform Removal, %	60-99.99	99.99	99.99 after chlorination	99.99 after chlorinatio n	99.99 after chlorination
Helminth Removal, %	Yes	Yes	-	-	-
Sludge handling	Manual desilting once in 5 - 10 years	Directly dry on sludge drying beds or mechanical devices	First digest then dry on sludge drying beds or mechanical devices	Mechanic al devices	Mechanical devices
Operational characteristics	Simplest	Simpler than ASP	Skilled operation is required	Skilled operation is required	More skilled personnel required

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