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Reclaim, reuse and recycle (3 Rs) of waste water and go green strategy by ESSAR pelletization plant in Visakhapatnam (India) - A case study

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ABSTRACT

Growing population, industries, agricultural practices, and urbanization have increased the water demand. Availability of drinking water is becoming a serious issue to manage. To fight the growing water stress, reclaiming and reusing of treated waste water for various day-to-day activities except for drinking purpose is necessary. A serious thinking and strong commitment of reuse of waste water may bridge the gap between supply and demand of water in the future. Waste water produced from residential area is collected through under ground drainages system and treated at waste water treatment plants located at 3 locations of Visakhapatnam. The Total waste water (W.W) produced is 140 MLD and if at least 25% is reused by power & steel industries around the city, there would be great saving of about 20% on daily drawl on the surface fresh water sources. ESSAR Pelletization plant is the pioneer industry that is using water for cooling towers, coke ovens, air stabilization units. Fresh water usage by ESSAR Pelletization plant is 8.4 MLD and to reduce expenditure on fresh water purchase, it is using 3.6 MLD of treated waste water of GVMC for last 8 months. The capital cost for developing W.W System is realized in less them 30 months. Monthly expenditure on the purchase of fresh water has drastically reduced from Rs. 70.00 lakhs per month to Rs 44.00 lakhs due to utilization of treated W.W for 42% of its daily usage. After recycle the same water is reused for gardening, vegetation, washing the roads, plant washings etc., By conservation & optimum utility of water and waste water., Go Green Strategy is followed by the industry.

KEYWORDS

Rapid urbanization;
Fresh water sources;
Waste water;
Reuse;
Environmental pollution of receiving waters;
Industrial use;
Go green strategy;
ESSAR pelletistion plant.

INTRODUCTION

Water is needed for the biological survival. such as drinking water cooking, washing, and is vital for our developmental needs, like agriculture and industry.

Unfortunately, the available fresh water supplies are not evenly distributed in time and space. Historically, water management has focused on building dams, reservoirs, and diversion canals etc., to make available water wherever needed and to an amount desired. Soaring demands due to rapidly expanding population, industrial expansion, and expanded agriculture, are met by larger dams and diversion projects. Natural surface water resources, impounding structures are major sources of water supply after necessary treatment. The increasing water demand will lead to a clear stress on these water bodies. Inadequate water management is accelerating the depletion of surface water and groundwater resources. In addition to that water quality has been degraded by domestic and industrial pollution sources as well as non-point sources.

The term "Waste Water" means any water that is no longer wanted, as no further benefits can be derived out of it. Reuse of waste water for domestic and agricultural purposes has been occurring since historical times. However, planned reuse is gained importance only two or three decades back. But in future waste water would play an important role for some of steel, Alloy making, power producing industries.

Due to daily human activity and also various agricultural and industrial operations waste water is produced in enormous quantity. Due to lack of management and treatment facilities and most of the municipal waste water generated in Indian cities is discharged into aquatic systems,(River / Seas) without proper treatment. Inadequate treatment facilities for sewage would deteriorate the water quality of aquatic resources. Thus, the safe discharge of wastes to the environment is increasingly recognized, both in terms of implications for public health, and for the environment.

The benefits of promoting wastewater reuse as means of supplementing water resources and avoidance of environmental degradation have been recognized by national governments. The value of wastewater is becoming increasingly understood in arid and semi-arid countries and many countries are now looking forward to the ways of improving and expanding wastewater reuse practices.

Conventional wastewater treatment consists of the following stages: preliminary, primary, secondary, and tertiary. Municipal wastewater treatment facilities use combinations of physical, biological, and chemical treatment technologies. Preliminary and primary treatments are usually physical process.

Processing Stage	Preliminary	Primary	Secondary	Tertiary and advanced
Purpose	Removal of large solids and grit particles	Removal of suspended solids.	Biological treatment and removal of common biodegradable organic pollutants	Removal of specific pollutants such as nitrogen or phosphorous, color, odor etc.,
Sample Technologies	Screening, Setting.	Screening, Sedimentation.	Percolating/trickling filter activated sludge, anaerobic treatment, waste stabilization ponds.	Sand filtration, membrane bioreactor reverse osmosis, ozone treatment, chemical coagulation.

Wastewater can be recycled/reused as a source of water for a multitude of water demanding activities such as agriculture, aquifer recharge, aquaculture, fire fighting, flushing of toilets, snow melting, industrial cooling, parks and golf course watering, formation of wetlands for wildlife habitats, recreational impoundments, and essentially for several other non-potable requirements. Potential reuses of wastewater depends on the hydraulic and biochemical characteristics of wastewater, which determine the methods and degree of treatment required. For Agriculture and Irrigation reuses, in general, lower quality levels of treatment of waste water is sufficient. The following table explains in the various uses and applications of waste water.

Category of Reuse	Examples of applications
Urban use unrestricted	Landscape, irrigation of parks, play grounds, school yards, golf courses, cemeteries, residential, green belts, snow melting.
Restricted Other purposes	controlled access fire protection, disaster preparedness, construction.
Agricultural Food crops, Non-food crops and crops consumed after processing.	Irrigation for fodder, fibre, flowers, seed crops, pastures, commercial nurseries, sod farms.
Recreational use unrestricted	lakes and ponds used for swimming, snowmaking, boating.
Environmental enhancement	Artificial wetlands creation, natural wetland enhancement, stream flow.
Ground water recharge	Ground water replenishment for potable water, salt water intrusion control, subsidence control.
Industrial reuse	Cooling system water, process water, boiler feed water, toilets, laundry, air conditioning.
Residential use	Cleaning, laundry, toilet, air conditioning.

Industrial use of reclaimed wastewater represents major reuse next to irrigation in both developed and developing countries. Reclaimed wastewater is ideal for many industrial purposes, which does not require water of high quality. Often industries are located near populated area where centralized treatment facilities generate reclaimed water. Depending on the type of industry, reclaimed water can be utilized for cooling, boiler feed, process etc., Cooling water make-up in a majority of industrial operations represent the single largest water usage. The water quality requirement of industrial cooling is not generally high. Consequently, cooling water make-up presents a single largest opportunity for reuse.

Electrical power generation industries, by the nature of their activities, are normally located close to large urban settlements, where domestic wastewater is generated in large quantities. Since power-generating stations have a huge cooling water requirement, they provide potential reuse locations for reclaimed sewage. It is possible economically to treat the domestic waste water to achieve adequate quality for reuse as cooling water. The membrane filtration system could remove all suspended solids, fecal coli-forms and gradia cysts. There is a great potentiality for reuse of waste water in power generation and other industrial manufacturing facilities such as iron and steel industry.

Industrial water reuse has the following specific benefits, in addition to the general environmental benefits.

1. Potential reduction in production costs from the recovery of raw materials in the wastewater and reduced water usage.
2. Heat recovery.
3. Potential reduction in costs associated with wastewater treatment and discharge mechanism.

CASE STUDY

Waste water re-use to cope with water shortage in Visakhapatnam

Visakhapatnam sometimes referred as Goa of the East coast. The city is nestled among the hills of Eastern Ghats and faces the Bay of Bengal to the East. It has got virgin beaches, laterite hill rocks and stunning landscape. Visakhaptnam is variously referred to as jewel on the coromondal coast or steel city.

Visakhapatnam is second largest city in Andhra Pradesh and has 18 lakhs population. Major industries like BPPV, NTPC, Visakhapatnam Steel Plant (RINL), HPCL, BPCL, HSC (Hindustan ship yard), L.G Polymers, Hindustan Zinc, GAIL, Pharamacity and many more industries were established. The reason is that the city is well connected with road, rail, sea and air transport network. A part from these industries. Visakhapatnam port, MES, ENC (Eastern Naval Command), Special Economic Zones (SEZ’s), Gangavaram port are the other establishments that consume bulk water.

Water supply service is provided by GVMC from the surface water sources. The water supplied 180 MLD, thus supplying at the rate of 100 lpcd and the residents have good ground water potentiality. About 80% of Visakhaptnam area is covered with tap water and intermittent supply is made for an hour a day, so most families have to store water in tanks and/or supplement water from private wells.

Apart from the above, around 50 MLD of water is being supplied by the GVMC to industries like., HPCL, BPCL, Coromandal Fertilizers, BHPV, Hindustan Zinc, Hindustan Shipyard Ltd, MES, Naval Command, Visakhapatnam Port Trust, Indian Railways.

In Visakhapatnam the total water supply is about 230 MLD. There are 700 unauthorized colonies (Slums) and 32 villages panchayats where sewerage systems are not operating due to a lack of adequate water supply and lack of drainages infrastructures. With the population of Visakhapatnam increasing from 0.04 million in 1911 to 1.8 million in 2011, there is an ever-increasing pressure on the water resources.

TABLE 1 Explains the present population in the water supply zones and TABLE 2 shows actual water supply. The water shortfall will still increase and there is a little hope that the water supply will never match the water demand in Visakhapatnam. Because of the drinking water shortfall, water related conflicts occur in several localities where water lines run dry; for example alternate day supply was made during the summer 2010 for a period of 3 months, with ground water completely dried up in many parts of Visakhapatnam This calls for a need to a improve water supply resources and search for alternative sources.

The calculations of water requirement and short-

TABLE 1 : Domestic water usage:

S. No	Locality / Zone	Population (Millions)	Water Required (MLD)@150 Lpcd
1	Central Visakhapatnam	1.130	169.50
2	Gajuwaka area	0.345	51.80
3	32 Villages Peripherals now under GVMC	0.325	48.7
	Total	1.800	270.0

TABLE 2 : Water budget of 2011

User Section	Population	Total Demand	Quantity of water supply	Deficit
Domestic	1.800 Millions	270 MLD	180 MLD	90 MLD
Industries	89 Nos	70 MLD	50 MLD	20 MLD
Total		340 MLD	230 MLD	110 MLD

age with respect to GVMC is tabulated in TABLE 1 and 2 to understand the need for new sources or alternate sources of water. Reuse of waste water to the industries and gardening is better alternative instead of fully depending on fresh water sources.

TABLE 3 expresses the actual requirement of water for Visakhapatnam city for different years. The sources of water to supply to meet the needs of domestic as well as industrial is surface impounding reservoirs which are located about 156 km to 25 km away from the city.

TABLE 3 : Present & future water requirement

S. No	Year	Population	Demand of water in MLD		
			Domestic@ 150 Lpcd	Industrial	Total
1	2011	18,00,000	270	70	340
2	2015	20,96,960	315	77	392
3	2020	23,28,240	349	91	440
4	2040	35,19,930	474	136	610

The following TABLE 4 shows the actual realization of the water for the year 2011. There are no new sources in and around the city, except Godavari River near Rajahmundry (in AP) about 200 Kms away from town All ensuing sources are rain dependent . But water has to be pumped from Godavari river and this leads to heavy expenditure. From polavaram project about 24 TMC (1850 MLD) of water was allocated to meet the requirements for both industrial and domestic consumption, But the project was stopped half way after spending about nearly 6000 crores for construction of dam and formation of canals due to some reasons. Even if all permission and funds are arranged for the completion of Polavaram project it would take many years to complete the project, possibly by the year 2020.

TABLE 4 : Water resources available for 2011

S. No	Source	Distance from city (km)	Water realized at present (MLD)
1	Thatipudi	65	27
2	Raiwada	70	73
3	Yeleru/Godavari (VIWSCO)	160/200	73
4	MGR	25	27
5	Gostani	32	14
6	KBR-2MGD Gajuwaka	25	9
7	MGR Filtration well	25	7
	Total		230

As seen from TABLES 2 and 4 there is a gap between demand and supply. The gap is going to be widened considerably by the year 2020. since no new sources are expected in near future the option is to go for the treated waste water utilization by the potential industries. Thereby considerable amount of that water would be saved and the water saved would be served for domestic purpose.

WASTE WATER COLLECTION AND TREATMENT

Waste water is collected through under ground drainage system collected at a STP and it flows to the Bay of Bengal after treatment. There is a program under JNNURM to construct underground drains to collect sewerage all over Visakhapatnam city leading to the existing three sewage treatment plants and one more new treatment plant is under construction. The coverage of the underground drains will be 40% of Visakhapatnam (area) – close to 60% of the population at present and in the next phase, that is by 2017, it is planned to cover total city area (533 Sq.km) with under ground sewerage system.

The TABLE 5 shows the details of the waste water treatment plants' in GVMC. Domestic sewage is treated in the STP and can be supplied to industries.

The sewage treatment plant at Appurghar is a 10 year old, biological treatment plant using an activated sludge process followed by chlorination. The incoming water 25 MLD, is pretreated in a fast sedimentation tank and then led to the aeration tanks,. The aeration is performed with surface aerators/mixers risking spreading aerosols in the surroundings.

The aeration is followed by one big round sedimentation tank and then chlorination. The effluent from the plant is let out in a pipe to the sea.

TABLE 5 : Particulars of swage treatment plant (STP) in GVMC

S. No	Location	Capacity (MLD)	Functioning year
1	Appughar, MVP Colony	25	2011
2	Old Town	38	2010
3	Arilova	13	2011
4	Sheela nagar	150	2012
5	Gajuwaka & 32 Panchayats	150	Under Planning
	Total	226	

Figure 1 : 38 MLD sewage treatment plant at old city

One more 38 mld plant was commissioned recently near port harbor area (Figure 1) and the case study relates to that STP and is similar to the treatment plant at Appughar. Calculating of domestic sewage is done based on the 80% of water supplied and the quantity of domestic sewage is shown in TABLE 5. Two more treatment plants are under construction and are basically of the same standard. The plant operation is for biological treatment of waste water with limited reduction of nutrients. Simultaneously sludge produced is dried in filter beds. The sludge is used as a fertilizer in a greening project.

Waste water from domestic use contains a broad spectrum of contaminations and these are measured by oxidizable Biochemical reactions and is measured in the laboratory as Biochemical oxygen demand (BOD). Chemicals are also liable to be broken down using strong oxidizing agents and these chemical reactions are measure in the laboratory as chemical oxygen demand (COD). Both The BOD and COD tests are a measure of the relative oxygen –depletion effect of a waste contaminant. Both have been widely adopted as a measure of pollution effect. The BOD test measures the oxygen demand of biodegradable pollutants whereas the COD test measure the oxygen demand of utilizable pollutants.

Sewage Treatment Plants (STPs) which may include physical, chemical and biological treatment processes. The most important aerobic treatment system is the activated sludge process, based on the maintenance and recirculation of a complex biomass composed by micro-organisms able to absorb and adsorb the organism matter carried in the waste water.

Andhra Pradesh pollution control board (APPCB) issued certain guidelines on allowable pollution levels. The allowable limits of water quantity parameters as per the sewerage Manual of CPHEEO and APPCB Guide lines are given in the table below.

TABLE 7 : Allowable water quantity parameters

S.No	Water Quantity Parameters	CPHEEO	APPCB
1	pH	8.5	5.5 – 9.0
2	Suspended Solids	30 mg/L	-
3	Total Dissolved Solids	2100 mg	1800 mg
4	BOD	30 mg/L	100 mg/L
5	COD	250 mg/L	250 mg/L
6	Oil & Grease	10 mg/L	-
7	Chloride	1000 mg/L	-
8	Sulphate	600 mg/L	600 mg/L

The tests on the effluent samples were conducted on 25.9.2010 and the values of parameters are compared with the marine standard effluents as shown in TABLE 8. All the parameters specified are found with in the permissible limits of APPCB.

The quality of water can be estimated by assessing the wastewater characteristics. The Colour, generally, within the collection tank is brown in color. Upon addition of the activated sludge (sent back from settling tank), it gets to a thicker texture. And the Odor, Foul-smelling upon prolonged stay, the odour gets stronger.

The performance of all STPs is good and effluent quality is within permissible limits for the aquatic body disposal. With the above effluent quality it may not be necessary to impart further treatment so as to make it fit for reuse.

Greater Visakhapatnam Municipal Corporation has received –Rs. 350 crores from Government of India & Government of Andhra Pradesh under JNNURM for implementation of underground drainage system including sewage treatment plants. Around 80 MLD capacity sewage treatment plants are already commissioned and another 150 MLD plant is under construction and would be commissioned by the year 2012.

TABLE 8 : Effluent standards after treatment:-

S. No	Parameters	APPCB Norms	Quantity of waste water before Treatment (ltrs)	After Treatment (ltrs)
1	Ph	5.5 - 9.0	6.94	7.7
2	Ammonical Nitrogen	50	21	6.8
3	BOD	100	160	30
4	COD	250	290	50
5	Total Solids Suspended	10%	1800	0
6	Sulphide	5	-	2
7	Phenolic compounds	20	100	2

Assessment of wastewater generation management patterns

The total waste water generated in 300 cities of India is about 60% that is generated in to be defined the four major cities of Mumbai, Kolkata, Delhi and Chennai. In the metropolitan cities, only 30% of waste water is treated before disposal. Visakhapatnam is one among 65 cities included in JNNURM programme where in it was strongly suggested by the Government of India to taken up underground drainage system & STP for entire city.

Wastewater characteristics

The projected waste water generation (assuming 80% of the demand) in Visakhapatnam is 140 MLD by 2011 and 270 MLD by 2020 with an estimation that 360 MLD out of 470 MLD will reach the sewage treatment plants by the year 2040. The short fall in the water supply may be reduced by reusing the waste water and supplying it to the city by imparting necessary treatment. Even 20-40% reuse of treated waste water may reduce the shortfall in the city water supply substantially.

ESSAR was using the water separated from ore slurry which was received through ore slurry pipeline for cooling other purpose. Since slurry pipe line is not functioning and water seperated from slurry is not available. Therefore ESSAR approached GVMC for additional quantity of water.

Therefore ESSAR has wholly depended on GVMC for supply of water. The consumption was increased from agreed quantity of 5 MLD to 8.4 MLD with in a short span of time. For the extra quantity of consumption ESSAR is paying 100% extra amount to GVMC for consumption of water by ESSAR.

TABLE 9 : Water requirement by (ESSAR plant):

No	Plants	Capacity MTY/MW	Water requirement
1	Pelletization Plant.1	4MTPY	1850cum/day
2	Pelletization Plant.2	4MTPY	3000 cum/day
3	Beneficiation plant	8MTPY	-
4	CPP	25 MW	3600 cum/day
	Total		8450 $m^{3/}$ day

Water requirement of ESSAR pelletization plant

Water requirement of plant has been shown TABLE 9 generally water is obtained from the GVMC at the rate of Rs.30/- per M^3. Data is obtained from the GVMC on the quantity and amount paid by ESSAR for a period of last two years. The average consumption of water per month. The average consumption of water per month is 260 ML and average amount paid is around Rs.70 lakhs.

Due to huge expenditure on the use of water it was proposed by ESSAR Plant to use treated waste water in certain operations on the plant such as cooling towers, gas chambers, road washing, gardening dust reductions etc., 38 MLD Waste STP of GVMC Old Town is about 3 km away (Figure 2) from the ESSAR Plant. The plant was very recently commissioned. The effluents are in with in standards specified by APPCB as discussed earlier.

Figure 2 : Image showing the location of 38 MLD STP of GVMC and the ESSR pellitisation plant

ESSAR GROUP (BSE: 500630, BSE: 500134) is a multi national corporation in the sections of steel, energy, power, communications, shipping ports and logistics as well as construction. It's head quarters is located in Mumbai, India. The group's annual turn over is about Rs. 18 billions in financial year 2009-10.

Essar has set up a 4.0 MTPA pelletisation plant, (Figure 3) at Visakhapatnam to supply high quality iron ore pellets at competitive prices to its hot briquetted iron (HBI) plant. After meeting the pellet requirement of Essar Steel, the balance production is sold in the domestic and international market.

Figure 3 : ESSAR pelletization plant

To convey raw material from Iron ore mines through closed system, Essar steel, has commissioned its 267 km, pipeline connecting Bailadilla Mines and its polarization plant here to transport iron ore from the mine head in the form of slurry (Figure 4)

The slurry pipeline is the second in the country after Kudremukh Iron and Steel Limited's 67 km, pipeline. The world's longest slurry pipeline, which is 396 km long, is located at the Germano Mines in Brazil.

Elaborating the slurry process, from the Kirandul mines of National Mineral Development Corporation would be fed into the nearby 8 mtpa capacity or beneficiation plant, which would enhance the quality of the ore fines by eliminating impurities and increasing the Fe(iron) content by over four percentage points to 68, thus making it suitable for pelletisation. The beneficiated ore is suitable for producing direct reduction (DR) grade pellets, which contribute to improve the yield while making steel.

8 million tonne of slurry per annum and is expected to reduce Essar Steel's transportation cost from Rs.550 per tonne to about Rs.80 per tonne.

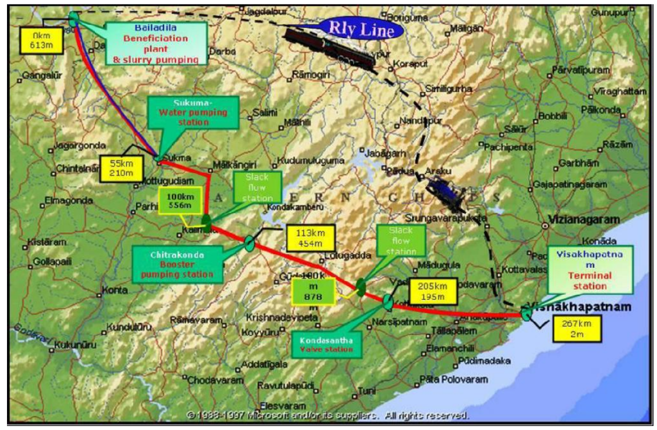

Figure 4 : Map of slurry pipeline of ESSAR steel:

The pipeline will help the company save at least Rs.200 crore every year, thus the capital cost is recovered with in 6 years. "It is the most environment-friendly way of transporting iron ore fines."

Maoists blasted a pump house attached to the pipeline on the Andhra Pradesh-Orissa border at Chitrakonda on several times in the past, and during march 2009 and due to another blast, the damage was heavy and the pump house is beyond repairable condition.

If there is any short fall in supply of water to the industry it will face a threat in the productions as the water storage capacity with in the firm is very small. Therefore ESSAR Plant depended on GVMC supply for its day to day activities. GVMC produces about 38 MLD treated waste water through its S.T.P very close to ESSAR plant.

As 50% of the water requirement in the plant is used for gas stabilization and for cooling towers and water quantity need not be of potable water quantity. Therefore the plant is inclined to use treated waste water supplied by GVMC.

Cost recovery for new pipelines for drawing treated waste water

TABLE 10 : Redemption of water cost due to waste water utilization

S.No	Month	Reading of meter		Quantity in M3	Cost of reused water @2/ /KL	Cost of potable water @30/- /KL	Amount saved per month (Rs.Thosands)
		Initial	Final				
1	24.9.10	0	2148	21480	42.960	1289	1246
2	24.10.10	2148	3619	14710	29.420	882	853
3	24.11.10	3619	5809	21900	43.800	1284	1235
4	24.12.10	5809	8518	27090	54.180	1625	1571
5	24.1.11	8518	11302	27840	55.680	1670	1614
6	24.2.11	11302	14109	28070	56.140	1684	1628
Total							8147

Reuse of treated water by the plant has been studied for a period of six months and quality and pattern of use has been studied. The actual quantity consumption of treated water has been shown in TABLE 10

The rate per m^3 of treated waste water is Rs. 2/- and it is very nominal and capital contribution towards supply of Waste Water is also very nominal.

Cost of pipeline: The cost of HDPE pipe line laid from new STP plant to ESSAR Plant premises is about Rs. 3.5 crores for 4.5 km length.

Total amount saved in six months:	Rs. 8,147 thousands	
Amount saved per month	Rs 8,147/6= Rs 1358 Thousands	
	= Rs 13.58 Lakhs	**(A)**
1. Capital Cost:-		
(a) Total amount spent on laying of pipelines	= Rs. 350 lakhs	
(b) Capital cost paid to local body (GVMC)	= Rs. 013 lakhs	
	= Rs 363 Lakhs	**(C)**
2. Operational Cost:-		
Man power for run the pipeline	= Rs 0.30 Lakhs	
Power charges to run the pumps	= Rs.0.36 Lakhs	
Operational cost per month	= Rs 0.66 Lakhs	**(B)**

Net amount saved = (A) –(B) = Cost difference between water and waste water

(–) operational cost = 13.58 – 0.66 = 12.92 lakh/m (D)

Actual recovery period = (C / D) = Rs 363/ 12.92 = 28 month < 2.5 years.

ESSAR Pellitisation plant needs 8.4 MLD of fresh water for its entire operations such as production of pellets, cooling towers, coke oven plant and gas converters. Presently 3.6 MLD of waste water is used for these operations and saves (8.4 - 3.6) = 4.8 MLD of fresh water. There by recurring cost on the purchase of fresh water reduced thus saving an amount of Rs. 26. Lakhs every month

If agreed quantity (with GVMC) of 3.6 MLD of treated W.W is utilized by the plant the capital cost of the pipeline could have been be recovered with in a period of 12 months.

GO GREEN STRATEGY

Some household items can be recycled for go green and stay clean, strategy. Waste water is one among them.

Re use of treated waster water will reduce the pressure on existing raw water sources and bridge the gap between city water supply demand and availability. Pollution due to discharge of waste water effluent will reduce significantly. There is an urgent need to improve the efficiency of water installations, and to augment the existing sources of water with more sustainable alternatives. Among such approaches, wastewater reuse has become increasingly important in water resource management for both environmental and economic reasons.

In many applications, reusing wastewater is less costly than using freshwater, with savings stemming from more efficient water consumption and a reduced volume of additional wastewater treatment, as well as associated compliance cost savings. By reusing treated wastewater for these applications, more freshwater can be allocated for uses that require higher quality, such as for drinking thereby contributing to more substance resource utilization.

A simple calculation would reveal that about 144 MLD of waste water is produced in Visakhapatnam as depicted in TABLE 11 through domestic water supply by the year 2011.

TABLE 11 : Water supply and estimated waste water generation, 2011 in Visakhapatnam

S. No	Population (in lakhs)	Requirement of water mld	Water Supplied mld	Deficit of water mld	Estimate Waste Water	25% W.W Produced mld	Reduction on stress on Natural water source mld
1	18.00	270	180	90	144	35	35

Therefore even if planning is done to utilized at least 25 % of the W.W Produced for gardening, Industries, boating etc., there would be a saving of 35 MLD for fresh water source. Waste water reuse is environmentally responsible wastewater reuse can preserve the health of waterways, wetlands, flora and fauna. It can reduce the level of nutrients and other pollutants entering waterways and sensitive marine environments by reducing wastewater discharges. Waste water reuse makes economic sense. Reclaimed water is available near urban development where water supply reliability is most crucial and water is priced at the highest. Reuse of wastewater can be a supplementary source to existing water sources, especially in arid/semi-arid climatic regions. Costs associated with water supply or wastewater disposal may also make reuse of wastewater an attractive option. Reuse is frequently practiced as method of water resources management.

Grey water recycling along with waste water recycle & reuse is especially important for developing countries, to resolve the uncertain availability & variability of water resources in time and region. Conservation, recycling & reuse & optimum use of water are the most obvious device to respond to the situation as it is done by the environmental policy of ESSAR. A lot of greenery is being developed (Figure 5) by ESSAR Pelletization plant. There by environmental pollution, Air pollution and soil pollution is reduced. Working atmosphere is more comfortable in "Greens" promotion industries and the example is ESSAR Industry and the Motto of ESSAR is

1. Take all the necessary steps to prevent pollution of air, noise, land, and ground water.
2. Minimize fugitive emissions, spillages, and leakages.
3. Conserve resources and optimize utilization of energy.
4. Reduce, re-use, recycle, and dispose waste in an environmentally sound manner.

Figure 5 : Greens by ESSAR pelletization plant

COMMENTS

It is common practice to discharge treated sewage directly into bodies of water or put into agricultural land. In developing countries, application on land has always been the predominant means of disposing municipal wastewater as well as meeting irrigation needs.

Application of reclaimed wastewater for landscape irrigation include use in public parks, golf courses, urban green belts, freeway medians, cemeteries, and residential lawns. This type of application is one of the most common applications of wastewater.

Feature of water reuse

As of now, major emphasis of wastewater reuse has been for non-potable applications; in spite of developing sound technological approaches for producing water of any desired quality from reclaimed wastewater. It has generally been too expensive to be taken seriously as a potable supply option. Application of membrane treatment process in production of high quality reclaimed water, is not cost-effective.

Wastewater reuse in industries is depended mainly on the water and wastewater costs and penalties on pollution levels. As the cost goes-up, industries try to scale-up recycling and reuse. The role of government assistance, especially economic incentives and non-commercial credit for obtaining appropriate technology, shown good success.

Factors driving further implementation of wastewater:-

1. **Proximity:** Reclaimed water is readily available in the vicinity of the urban environment, where water resources are most needed and are highly priced.
2. **Dependability:** Reclaimed water provides a reliable water source, even in drought years, as production of urban wastewater remains nearly constant.
3. **Versatility:** Technically and economically proven wastewater treatment processes are available now that can provide water for non-potable use.
4. **Safety:** Non-potable water reuse systems have been in operation for over four decades with no documented adverse public health impacts in developed countries.
5. **Demand on water resources:** Increasing pressure on existing water resources due to population growth and increased agricultural demand.

Concerns of waste water use

Potential concerns for industrial water reuse include scaling, corrosion, biological growth, and fouling, which may have impact on industrial process, as well as product quality. A major problem associated with reuse of wastewater will be biofilm growth in the recirculation system. Presence of microorganisms (pathogens or otherwise) with nutrients such as nitrogen and phosphorus, in warm and well-crated conditions, as found in cooling water towers, create ideal environments for biological growth.

One reason the industries have responded so favorably is that reused waste water is billed on a flat rate not on consumption. Using potable water would cost between five to ten times more than reused waste water. But the main constraint in the usage of waste water is principal cost that is involved in the laying of trunk main from WWTP to the steel of power industry.

In order to achieve ecological waste water treatment, a closed-loop treatment system is recommended. Many present day systems are a " disposal-based linear system". The traditional linear treatment systems must be transformed into the cyclical treatment to promote the conservation of water rand nutrient resources as shown in Figure 6

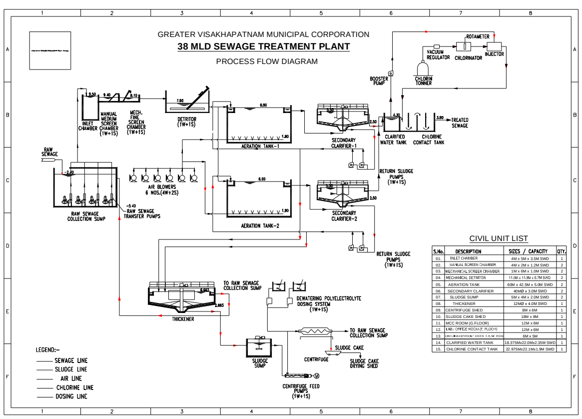

Figure 6 : Liner flow disposal pattern of WWTP

By adopting closed loop treatment system the waste water generated can be reclaimed, reused and recycled. Thus reducing environment pollution of sewerage receiving water bodies as well as saving water in fresh water resources.

CONCLUSION

In Visakhapatnam the sustainability in wastewater management includes minimization of wastewater production, maximization of reuse and recycling in terms of a clean and healthy environment. Waste water is used for the irrigation of public parks, school yards, highway medians, and residential landscapes, as well as for fire protection and toilet flushing in commercial and industrial buildings in visakhapatnam is highly recommended.

The requirement of fresh water is 8.4 MLD for ESSAR plants' operation. About 8 Months back a separate pipeline was drawn from GVMC's Sewerage treatment plant to use 3.6 MLD of treated waste water there by 42% fresh water is saved. Expenditure on buying fresh water is also saved considering duly paying Rs .2 per KL instead of Rs. 30 per KL for fresh water. The ESSAR Pelletization plant is saving Rs 26 lakhs by using treated waste water sufficient reusable water is available for gardening & lawn maintenance dust quenching, plant washing etc., for its environmentally go green strategy.

Visakhapatnam Steel plant (VSP) and NTPC are two major industries situated in the peripheral of Visakhapatnam city as shown in figure 7. VSP consumes about 130 MLD and NTPC about 32 MLD of fresh water for its production, usage and domestic population. These are the two potential users of raw water for their coke over plants, cooling towers, gas converters etc., Present water consumption of these two plants is 162 MLD and water need would rise to 250 MLD by the year 2013 due to expansions of VSP & NTPC. Even if 50%of domestic treated waste water is used the water saved at fresh water source would be 80 MLD by year 2011 and 125 MLD by the year 2013.

Figure 7 : Location of WWTP & industries in Visakhapatnam

A Model PPP Project can be worked out, for laying of trunk mains to these industries and development of other infra such as pumping stations, storage etc., from upcoming 150 mld Waster water Treatment plant. Re use & re circulating the treated waste water not only saves fresh water resources but also reduces pollution levels of waste water receiving bodies and ground water.

There is an urgent need to plan strategies and give thrust to policies with equal importance for waste water reuse. The future of urban water supplies for potable uses will grossly depend on efficient waste water treatment systems and reuse. Therefore a ray of hope is treated waste water. But the constraint in the supply of treated waste water is development of infrastructure and motivating the industries to use treated waste water.

The case study that is use of treated waste water by ESSAR Pellitisation plant and saving enough money is an eye opener to the other industries in and around the Visakahapatnam city. The amount spent on capital cost and maintenance cost was just recovered in short span of time by ESSAR Plant. Domestic treated waste water is plenty and industries are plenty in and around Visakahpatnam, such as Thermal Power Plants, Iron and Steel, Petro-Chemicals. Ore conveyers, fertilizer manufacturers etc.,

All these industries definitely do not need potable water or fresh water for every need and a part of potable water can be replaced by treated waste water which is very cheap.

GLOSSARY

Black water	:	Household wastewater containing toilet wastes.
Dual system	:	Water distribution system having two separate networks to Supply potable water and treated reclaimed water.
Reticulation system	:	Water for potable and non-potable uses respectively
Gray water	:	Household wastewater after exclusion of toilet wastes.
Pathogens	:	Disease-causing microorganisms.
Sludge	:	The concentrated form organic and inorganic pollutants removed from wastewater as result of treatment.

ABBREVIATIONS

APPCB	-	Andhra Pradesh Pollution Control Board
BOD	-	Biological oxygen demand
COD	-	Chemical oxygen demand
CPHEEO	-	Central Public Health & Environmental Engineering organization.
GVMC	-	Greater Visakhapatnam Municipal Corporation
JNNURM	-	Jawaharlal Nehru National Urban Renewal Mission
LPCD	-	Liters per capita per day
MLD (mld)	-	Million liters a day
PPP	-	Private Public Partnership
STP	-	Sewage treatment plant
WWTP	-	Waste water treatment plant

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REFERENCES

[1] D.D.Benmann, D.M.Dwarkin; Planning for Water Re-Use, Marcoufla Press, USA, **(1978)**.

[2] S.Khanna, M.Krishna; Wealth from Waste. Tata Energy Research Institute, New Delhi, India, **(1995)**.

[3] S.K.Shukla; Management of Urban Water Supply and Sanitation-Challenges and Strategies. Integrated Water Resource Society, New Delhi, India, **(2002)**.

[4] S.N.Kaul, Kumar Arvind; Estimation of Water Demand and Wastewater Flow, Perliminary Treatment in: Wastewater Engineering, 1st Edition. APH Publishing Corporation, New Delhi, India, **1-38**, 319-400, **3**, **(2006)**.

[5] Matealf, Eddy; Wastewater Engineering: Treatment and Reuse, Metealf & Eddy. Inc., 4th Edition, G.Techobanglous, F.Burton, H.Stensel, (Eds); McGraw Hill.

[6] SIDA: Water and Wastewater Management in Large to Medium-sized Urban Centres, **(2000)**.

[7] UNEP: Guidance on Municipal Wastewater: Practical Guidance for Implanting the Global Programme of Action for the Portion of the Marine Environment form Land based Activities.

[8] R.C.Cooper; Water Science and Technology, **24(9)**, 55-65 **(1991)**.

[9] K.K.Mathan; Bioresource Technology, **48(3)**, 275-276 **(1994)**.

[10] Chennai Metropolitan Water Supply and Sewer Service Board (CMWSSB) (nd); Rainwater Harvesting.

[11] J.Crrok, R.Y.Surampali; Water Reclamation and Resue Criteria, Water Secience and Technology, **(1996)**.

[12] World Health Organization (WHO); Health Guide Line for the Use of Wastwater in Agriculture and Aquaculture, (WHO Technical Report Series, No.778) Geneva, Switzerland, **(1989)**.

[13] World Health Organization (WHO) and United Nations Chindren's Fund (UNICEF); Global Water Supply and Sanitation Assessment 2000, USA, **(2000)**.

[14] World Health Organization (WHO); Guidelines for the Safe Use of Waste Water Excreta and Grey Water, Water Water Use in Agriculture, Geneva, Switzerland, **2**, **(2006)**.