International Journal For Technological Research In Engineering
Volume 3, Issue 10, June-2016 *ISSN (Online): 2347 - 4718*

INTEGRATION OF SEWAGE TREATMENT PLANT (S.T.P) WITH THE CONCEPT OF CIRCULAR ECONOMY

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Abstract: The generation of Energy from waste is a challenging task. Metropolitan cities in India produce 15644 MLD of waste, out of which only 8040 waste is treated in Sewage Treatment Plants i.e. nearly 51% of the waste. Nearly 80% of total sewage generated in urban India flows untreated into its rivers, lakes and ponds, making the water sources too polluted to use, and contaminating of fresh water resources. The rapid population growth and Urbanization is increasing the waste generation and energy consumption, leading to difficulties in waste treatment and energy crisis respectively. The current "take-make-dispose" linear economy approach has resulted in massive waste which has to be treated effectively and efficiently. Thus, the necessity to treat the waste, generate energy and utilities, is the demand of present. The concept of CIRCULAR ECONOMY refers to that industrial economy, which would not only dispose the waste but utilize it to give a practical solution to plant's emerging resource problems. With the SWACCH BHARAT ABHIYAN initiative in action, the government has invested 9.4 billion USD to make use of modern scientific technologies for a CLEANER INDIA. Thus Integration with the CIRCULAR ECONOMY will not only provide a Clean India but also Energized India.

I. INTRODUCTION

Rapid urbanization and industrialization have led to the severe contamination of most of the fresh water resources with untreated industrial and municipal wastes. Treatment and reuse of wastewaters have become absolute necessity to avoid pollution of fresh water bodies. Hence, the purification of waste water, with utilization of Waste, is not only the demand but also an absolute necessity of the present. In the following layout, the sewage water was treated to: provide clean drinking water, as per the WHO norms; generate natural gas from the sludge and produce ALGAL BIO DIESEL, A CARBON NEUTRAL FUEL.

II. TREATMENT METHODS

The sewage waste water for first analyzed for its properties. The properties are shown in Table 1. The sewage waste was first passed through a series of bar screens in bar chambers to remove large sized waste products like poly-bags, cloths etc. The above screened water was sent to a CLARIFLOOCULATOR, for the removal of TOTAL SUSPENDED SOLIDS, where the coagulant agent, ALUM, was added to form a thick floc of the suspended solids which would settle down at the bottom and can be scraped off. Here, the suspended solids are given a retention time of 30 minutes. The Settled suspended solids are collected and sent to ACTIVATED SLUDGE DISGESTOR. TSS removal with 70 % efficiency can be obtained with this. The amount of TSS before treatment was 200Kg/MLD and after Treatment it was found to be 60 Kg/MLD, which would be further treated. The settled 140Kg/MLD of TSS were collected in ACTIVATED SLUDGE DIGESTOR.

The overflow from the above unit was sent to COD removal unit, where it was stored and Fenton's Reagent i.e. H2O2/Fe+2, was added to remove the COD.

The COD removal mechanism is as follows:

Step1: COD + H2O2 ---> Partially oxidized species

Step2: Partially oxidized species + H2O2 ---> CO2 + H2O + inorganic salts

The COD was reduced from 250 Kg/MLD to 6.25 Kg/MLD, giving a waste inorganic salt sludge of 243.75 Kg.

The COD treated water is split into
Two streams:-
Stream 1: For further treatment, to give clean drinking water.
Stream 2: For Algal fuel production.

The second stream was sent to MULTI STAGE FLASH DISTILLATION (MSF), where it was flash distilled to remove ions, dissolved solids and a few remaining suspended solids. This technology gives efficiency up to 99.5%. The before and after treatment values are shown in TABLE 2(a) and TABLE 2(b). The solid residue from above two steps is collected and sent to ACTIVATED SLUDGE DIGESTOR unit, where it is an-aerobically digested to produce methane gas. The above MSF distilled water was sent to an MBBR, having an efficiency of 70%, for BOD removal and de-nitrification.

At last, the water was TERTIARY TREATED by REVERSE OSMOSIS (R.O) to provide clean drinking water. Here, the colloidal silica with 70% efficiency was removed. The clean water so obtained complies with WHO drinking water standards. (Shown in Table 3)

Particulars details	(Kg/MLD)
Total suspended Solids(TSS)	200
Total dissolved solids(TDS)	1200
Calcium(as Ca)	78
p Alkalinity	21.2
Total Alkalinity(asCaCO3)	500

Nitrate(as NO3)	12
Sulphate (as SO4)	124
Sodium as Na	174
Iron(as Fe)	1.76
Zinc(as Zn)	0.05
Coliform organisms 100ml at 37°C	90000
Chloride(as Cl)	250
Chemical Oxygen Demand(COD)	250
Biological Oxygen Demand(BOD)	50
Dissolved Oxygen	5.9
Nickel(as Ni)	0.05
Residual FREE Chlorine	0
Dissolved Phosphate(as PO4)	21.4
Magnesium	41
Colloidal Silica as SiO2	2
Reactive silica as SiO2	25
Arsenic(as As)	0.01
Cadmium(Cd)	0.01
Copper(as Cu)	0.01
Boron(as B)	0.2
Cyanide(as CN)	0.01
Fluoride(as F)	0.05
Phenolic compounds	0.001
Carbonate alkalinity(as CaCO3)	120
Potassium(as K)	16
Aluminium(as Al)	0.03
Manganese	0.01
Total Hardness(as CaCO3)	400
Chromium(as Cr+6)	0.05
Carbonates(as CO3)	384

TABLE 1: Quality of Raw Sewage Water

Cd=	0.01	Cl=	250
Ar=	0.01	Na=	174
Ni	0.05	F=	0.05
Zn=	0.05	Cr=	0.05
Cu=	0.01	Mn=	0.01
$NO_{3=}$	12	K=	16
SO4-	12.4	CN=	0.01
TS=	1260	B=	0.2

TABLE 2(a): Before MSF treatment values

TS=	6.3	B=	0.01
Zn=	0.0025	CN=	0.0005
Cu=	0.0005	K=	0.8
$NO_{3=}$	0.6	Mn=	0.0005
SO4-	0.62	Cr=	0.0025
Ni	0.0025	F=	0.0025
Ar=	0.0005	Na=	8.7
Cd=	0.0005	Cl=	12.5

TABLE 2(b): After MSF treatment values.

Parameter	Treated Water (mg/l)	WHO STANDARD (mg/l)
Total Suspended Solids	6	~0
Total dissolved Solids	4	~0
Nitrates	3.6	50
Sulphates	0.62	50
Sodium	8.7	200
Iron		
Zinc	0.0025	3
Chloride	12.5	250
COD		
BOD		
Nickel	0.0025	0.006
Arsenic	0.0005	0.01
Cadmium	0.0005	3
Copper	0.0005	1.5
Boron	0.01	2.4
Cyanide	0.01	50
Fluoride	0.0025	1.5
Potassium	0.8	
Manganese	0.0005	0.5
Chromium	0.0025	50

TABLE 3: Quality of Treated Water

From the TABLE 2(a) and 2(b), it is evident that MSF can be used as a method to eliminate all ions and Total solids.
The second Stream is taken for ALGAL FUEL PRODUCTION UNIT, where it was stored at pH 8-9, temperature 20°C -24 °C and salinity 20-24gm/l.
Since, Algae is a plant and for its growth CO2 is needed. The waste CO2 generated from industries, vehicles etc. can be used for the algal fuel production.
They were collected in RACEWAY PONDS (10 in numbers,

each of dimension 20 m X 20m). RACEWAY PONDS ARE PREFABRICATED. IN CASE OF AREA CONSTRAINT, WE CAN GO VERTICAL.

The so produced ALGAL SLURRY was separated from the water and chemically treated (and then simple distilled) with hexane to extract oil from it. The extracted oil is TRIGLYCERIDE, which is reacted with METHANOL, to give METHYLE ETHYLE ESTER (ALGAL BIODIESEL). HEXANE is recycled back. The remaining BIOMASS is a protein rich residue and can be used as a FERTILISER/FEED FOR SLUDGE DIGESTOR/ANIMAL FEED. The net growth of algae is estimated to be around 5,000-20,000 gallons oil per acre per year. They can be produced using waste water, are biodegradable and the remaining biomass from algae have no environmental impact. Another massive advantage of algal fuel is the consumption of carbon di oxide, a green house gas responsible for global warming. Production of each gallon of algae consumes 13 to 14 Kg of carbon di oxide. Thus, maintaining the carbon balance of atmosphere. Open pond System of algae production can be replaced by Hi-Tech Photo bioreactors, which would easily control the cultural parameters. Spirulina which is an algae rich in proteins content has been commercially cultivated in India. Algae is used in India for treating the sewage in open/natural oxidation ponds This reduces the Biological Oxygen Demand (BOD) of the sewage and also provides algal biomass which can be converted to fuel.

Therefore, in the above layout no waste was generated. Rather, sewage was treated to generate energy to overcome the growing energy crisis.

III. CONCLUSION

The entire layout satisfies the concept of CIRCULAR ECONOMY by, turning waste into a source of renewable energy. This facility is a prime example of the circular economy that gives value to materials previously considered worthless. By closing the loop in the material, water and energy cycles, this economy provides an effective solution to the growing scarcity of raw materials and fossil fuels, and climate change: all challenges faced by China and Asia–as indeed by all continents.

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