International Journal for Research in Engineering Application & Management (IJREAM)
ISSN : 2454-9150 Vol-06, Issue-03, June 2020

Sustainable management of water & wastewater in food industry for ZLD system

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Abstract - In India Thousands of villages which are comes under the water scarcity and it's having the significant impact on human life well as the ground water and the water which have use for the industrial process that can be utilized by the combination process of the rain water harvesting and ZLD System.

During the recycling process of waste water, it is practiced to various type of degrees within clear of industrial area, Other industrial reprocess and recycling of water a chance to save and preserve huge capacities of treated water. Groundwater recharge system of reuse of Potable water are practiced to some extent in extremely dry area in the Globe.

Keywords – Rainwater harvesting, STP, Zero liquid discharge system, Sustainable of water management by rainwater and zero liquid discharge, Design of Storage water tank.

I. INTRODUCTION

With the system developed by the Rain water harvesting, it is the main system which were developed for the operation of plant, compare the PH value of the rain water and ground water, according to the water the PH effect on the pipe and machinery and forming scaling, which result the maintenance of plant as well as cost optimization is low, rain water is maintain pH and soft and if the ground water is hard by this comparison it is easy to find the cost optimization of the machine maintenance.

In water scarcity area, it is very useful to rain water harvest and used that water for the industrial operational process, to calculate and design of the capacity of the water tank for the water storage system, to use this storage rain water for the stippling and process.

Main cost optimization of the machine with the rain water. With the help of the zero liquid system the rain water which may use and produce outcome for the better benefit in future to avoid the water loss in low rainfall industrial area.

II. STUDY AREA

As observed there has been a highly demand of water for the different industry and small sources of water the highly provision, with the different season but the monsoon season the use of collection system of rain water that can to fulfill these water demands ground water is being utilized at an exponential rate. To tackle this problem, it is important for people to implement the use of (RWHS- rain water harvesting system) sand help in replenishing the decreasing ground water levels.

The main aim to minimize the scarcity of water in food industry and other manufacturing plant by using collection of rain water & Recycling of effluent by rain water collecting different catchment area.

Due to the large amount of water scarcity by rapid growth of industry, plant cutting, high rise concrete building and the high population. demand of sources is high and resources is less, due to that the global warming effect, the water table it's goes decreasing which has been found in the report of geological survey of India.

Fig No. 1 – Geographical Location of Plant

 DOI : 10.35291/2454-9150.2020.0443

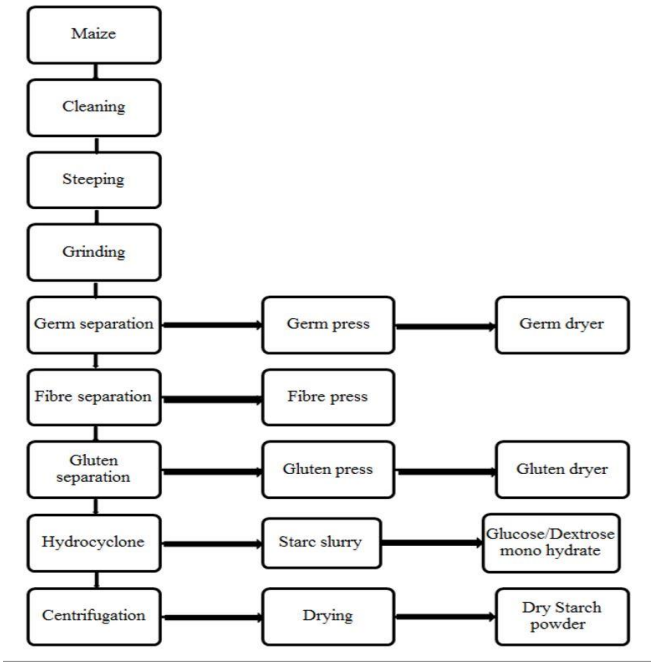


Fig No. 2 – Flow diagram of starch process plant.

Approach-

- The aim of this research project to reduce water consumption in industry.
- The need to capture and determine the sustainable use of water by maintaining the balance between it's water demand and water sources to the water of minimize the charge of the production and earning the profit without loss of any natural property.
- To management the sustainability of water for avoid the ground water at low rain fall area.
- Cost optimized of the production by using the rain water due to less amount of pH.
- This is the ideal tool which were beneficial for the environment and avoid the hazard result associated from the dangerous occurrence.
- It is the main system which were developed for the operation of plant, compare the pH value of the rain water and ground water,

III. LITERATURE REVIEW

Literature review was done to study the Artificial recharge with the help of the rain water harvesting systems, methods of rainwater harvesting, components of rainwater harvesting systems, need for rainwater harvesting, its advantages and disadvantages.

And zero liquid discharge system and it's treatment for the industrial use.

IV. METHODOLOGY

- To find out the geographical location.
- To make a data collection of that area by resource mapping, forecast average area of the industry.
- To collect the rainfall data collection.
- Estimate the catchment area
- To carry out the hydrological analysis.
- To Analysis on the factor of the Physical and chemical characteristic of the rain water in laboratory.
- To analysis on calculate on various factor on the Physical and chemical characteristic of ground water use for the process in plant.
- Compare between both rain water and ground water test report of the result to pH, BOD, COD, Chlorine contain, TSS, TDS.
- To design the industrial rainwater-harvesting module to the plant, how much capacity of rainwater required for annual water demand.
- To use this rainwater for operational process by pretreatment.
- To find out the effluent characteristic result by ETP plant in test laboratory.
- To make this treatment by zero liquid discharge technique.
- Find out the final parameter of the effluent generated by using Rainwater.
- To find out the parameter of the effluent generated by using ground water.
- By this result to evaluate the maximum load and its effect on the treatment plant & process plant.
- To calculate the maintenance cost, Direct & Indirect Cost, that can be using for the rainwater process and ground

V. GROUND WATER USED FOR THE INDUSTRIAL PROCESS

The basic purpose of important of the water is the food manifacturing industry, reason it is available in all nutrients.

This is elaborately secondhand in highly in food unit as a progressively for housekeeping and hygiene process. Maintenance, maintain of hugeness in the plant and industry activities in the food process industry include the practice of water handling system solving agent, dispersant, flush and diluent.

VI. WATER REQUIREMENT FOR PLANT PROCESS

Table Chart Treatment of Ground Water Cycle wise.

Water requirement & recycling process:

SR NO	GROUND WATER IN LITRE	WATER LOSE IN 10 %	WATER TREATEMENT IN CYCLE
1 Cycle	65000	6500	58500
2 Cycle	58500	5850	52650
3 Cycle	52650	5265	47385
4 Cycle	47385	4738.5	42646.5

 DOI : 10.35291/2454-9150.2020.0443

5 Cycle	42646.5	4264.65	38381.85
6 Cycle	38381.85	3838.185	34543.665
7 Cycle	34543.665	3454.3665	31089.2985
8 Cycle	31089.2985	3108.92985	27980.36865
9 Cycle	27980.3686	2798.03686	25182.33179
10 Cycle	25182.3317	2518.23317	22664.09861
11 Cycle	22664.0986	2266.40986	20397.68875
12 Cycle	20397.6887	2039.76887	18357.91987
13 Cycle	18357.9198	1835.79198	16522.12788
14 Cycle	16522.1278	1652.21278	14869.9151
15 Cycle	14869.9151	1486.99151	13382.92359
16 Cycle	13382.9235	1338.29235	12044.63123
17 Cycle	12044.6312	1204.46312	10840.1681
18 Cycle	10840.1681	1084.01681	9756.151294
19 Cycle	9756.15129	975.615129	8780.536165
20 Cycle	8780.53616	878.053616	7902.482548
21 Cycle	7902.48254	790.248254	7112.234294
22 Cycle	7112.23429	711.223429	6401.010864
23 Cycle	6401.01086	640.101086	5760.909778
24 Cycle	5760.90977	576.090977	5184.8188
25 Cycle	5184.8188	518.48188	4666.33692
26 Cycle	4666.33692	466.633692	4199.703228
27 Cycle	4199.70322	419.970322	3779.732905
28 Cycle	3779.73290	377.973290	3401.759615
29 Cycle	3401.75961	340.1759615	3061.583653

Requirement of water for industrial process per day.=65KLD=65000 Litre.

After 29 Cycle the water recycle finaly =3061 Ltr.

A. Improving of water used efficiency for industry sector According to CWC - (Central Water Commission.)

By the record of need of the industrial water and it's demand .in the present sitution constitutes it's only 10% of whole demand of water, its praposed of water consumption is growing rapidly of the year 2050 that anticipated to growth to around 15% of the total predictable water use at that time.

At current scenario the manufacturing plants in different fatherlands consumenear about 2 to 3.5 periods additional water per as compare unit of production compared to similar industry operating in diffrent countries. There is imperative requirement and need to scope to make the systems more efficient and operate with reduced to qualityof magnitude of water.

Another things to nothing like in agricultural used in company need of water requirement on contenious basis throug all year. That's why,to ensure reasonable present avaialability of water for industries even during the spare time, the industrial demand the and make contenious practice for the efficient requirement use of the water for process.Apart that the industry water management has approches, the compnies will have to calculate the tradition of effective use of water. Apart from this, waste water management need to report a main matter of quality of water effluents which can also managed with some extends in the use of the water.

B. Improving of major efficiencies:

The proficiency to use of waste water that can be expanded by embracing appropriate water protection methodology including limiting of water misfortunes, avaoid any wastage of water etc.There is requirement to the importnace of for compulsory sustainable of waste water in certain required sectors comprising for measures like industrial effluent treatment.

Sl. No	Category of Industry	Water Requirement per tonne in m^3	Year 2000		Year 2010		Year 2025		Year 2050	
			Production	Water Req.	Production	Water Req.	Production	Water Req.	Production	Water Req.
1	2	3	4	5	6	7	8	9	10	11
1	Iron & Steel	22	174050	3829.1	265350	5837.7	273300	6013	547050	12035
2	Smelters	82.5	203.6	16.76	292.6	24.14	391.6	32.31	537.6	44.35
3	Textiles & Jute	200	51193	8153.7	95094	19019	183507	36701	234618	46924
4	Leather Products	30	1277.5	1244.7	2191.3	65.74	3102.5	93.08	4927.5	147.83
5	Inorganic Chemicals	200	3730	165	8000	1600	16730	3346	30076	615
6	Pharmaceuticals	25	4960	124	8370	209.25	11046	276.2	17170	429.15
7	Distillery	22	1790.8	6357.2	3059.6	66.31	4454.6	318	6020	5203.9
8	Paper & Pulp	200	4950	1260	10350	207	51200	10240	97450	19490

Fig No. 3. WATER REQUIREMENT OF VERIOUS SECTORS OF INDIAN INDUSTRY.

C. By Different Methods Measures for improving efficiencies.

I. **Water Audit**
II. **Benchmarking for industries**
III. **Technological improvements**
IV. **Reuse of waste water**
V. **Regulatory measures**
VI. **Training & Awareness program and Individual contribution of workers in industries**

A. Water Audit
a. Survey in the Plant

 DOI : 10.35291/2454-9150.2020.0443

- In industry the area of assessment identifies where water is maxiumum wasted or water could be reusing for induadual purpose.
- Examine all points location of where water is found hose links include, and analysis the amount of water required to every point.
- Analyse on the ability of whole water-catchment element and it's rate of recurrence .
- Analysis the water quality,water quantity, and required high temperature of water carried by all maximum water line.

b. Evaluate Survey Results

- Datermine the maxiumum water-using process.
- Analysis on the water reuse practices that currently employed.
- Evaluate the feasibility of installing cooling towers (as applicable).

B. Waste water Reuse.

- The process recycling and again use of the water should it should be made compulsory to minimise the pressure on requirement of recycling water.
- Contenious recycle and reuse of effluent from that thoes happenings and production the retrieved water present for use in the other activities within or outdoor the industry will conserve huge ammount of water.
- The bonus and other pearks from government of like as tax consumed and excise release, etc. can also be provided for outproduct industries and domastic setting up to encourage recycling and by the Stateand central Governments / with the afraid of local authorities.
- The industrial water recycling cost change from area to arae and it is depends on cost comparision of waste water treatment before to throwing away of that of waste water treatment of waste water for again use in the Plants.The water recycling cost it's may effort out less-in upcoming cost of water supply may goincreasing.

C. Technological improvements:

a. .Use of water for better efficiency and productivity in indian industry sector is sligltly not much good as comparise between with other industry in Different country.

b. Use of the recycling of water It can be produced and gain by all so with the help of water saving technology and ideas,Treatement process that can be reused of wastewater,The water conservation technique that can adopt by process of water conservation it's approaches are evaporative cooling, ionisation process, Zero liquid discharge system and air heat exchange.

c. The ZLD Process of industrial waste water it can
It can be toward by the result obtained by the five-Fold reduction systemwhen it all so compare with the chemichal treatement process it all so consider for the option for the increasing and saving of the water.

VII. BENEFIT OF RAIN WATER USE FOR THE INDUSTRIAL PROCESS:

A. Average 5 Year Weather Forecast of -GUJRAT State.:

For calculation of average rainfall in Gujarat location to the purpose of amount of consumption of rain water in 1 year to the use of this water in industrial purpose by rain water harvesting.

To the calculation of this water consumption in different catchment area to design the water tank for the collection system to use this water after primary and secondary treatment by contentious recycling process in ZERO LIQUID DISCHARGE SYSTEM.

Conclusion of the collection of Rain water to find out the How much amount of water storage by different catchment area and that collected water used for industrial process to help optimization of cost of output and avoid any water losses in low water laying area.

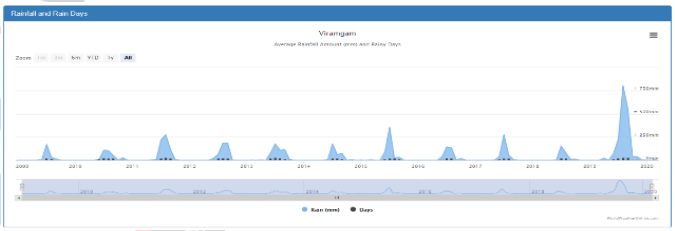


Fig No. 4. Average Rainfall data from-2009 to 2020

(190+130+251+249+249+248+300+247+253+230+750)

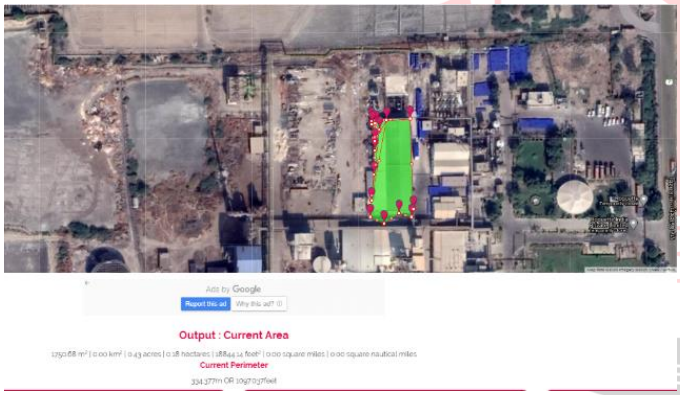
11

=258.91 mm/Hr Average Year rain fall.

"**1mm rainfall means** every **one** square meter area is filled with the water of height **1mm**. **1** square meter = 1000mm length ×1000mm breath. So **1mm rain means** 1000mm length × 1000mm breath × **1mm** height = 1litre of water. Every square meter has **one** litre of water."

 DOI : 10.35291/2454-9150.2020.0443

Fig No. 5. TOPOGRAPHICAL VIEW OF THE INDUSTRY.



B. Rooftop Dimensions

Runoff Coefficient

Runoff coefficient at different area. Roof top area wise.	
Type Of Catchment.	**Runoff Coefficient.**
Starch Dryer	**0.65-0.95**
Gluten Area	**0.55-0.95**
Water Tank Area	**0.35-0.75**
STP Area.	**0.29-0.65**

SR NO.	DISCRIPTION	COLLECTION RAIN WATER IN LITRE
01	Starch Dryer Area	1750 Sqr/mtr
02	Gluten Area	1230 Sqr/mtr
03	Water Tank Area	1840 Sqr/mtr
04	STP Area	1500 Sqr/mtr
Total Roof Catchment area of rain water.		6320 Sqr/mtr
Average year Rainfall		258.91 mm/Hr
Collection of rain water per Hour.		(6320*0.258=1630 Litre/Hr)
Collection of rain water per Day/10 Hour.		1630*10=16300 Litre/Day
Collection of rain water per month.		(16300*30)=4,89,600 Litre/Month.

Result =

1. For total collection of rain water in 10 Hour/Day by different catchment area in Plant is = 16300 Liter/Day.
2. For total collection of rain water in 10 Hour/Day by different catchment area in Plant is = 4,89,600 Liter/Month
3. Collect all rain water in monthly basis from catchment area and use this rain water by cycling process 1 to 30 Ultimately save the consumption of water that can be used to industry process from the rain water.

Table Chart Treatment of Rain Water Cycle wise.

SR NO	RAIN WATER IN LITRE	WATER LOSE IN 10 %	WATER TREATEMENT IN CYCLE
1 Cycle	489600	48960	440640
2 Cycle	440640	44064	396576
3 Cycle	396576	39657.6	356918.4
4 Cycle	356918.4	35691.84	321226.56
5 Cycle	321226.5	32122.656	289103.904
6 Cycle	289103.9	28910.3904	260193.5136
7 Cycle	260193.5	26019.35136	234174.1622
8 Cycle	234174.1	23417.41622	210756.746
9 Cycle	210756.7	21075.6746	189681.0714
10 Cycle	189681.0	18968.10714	170712.9643
11 Cycle	170712.9	17071.29643	153641.6678
12 Cycle	153641.6	15364.16678	138277.5011
13 Cycle	138277.5	13827.75011	124449.751
14 Cycle	124449.7	12444.9751	112004.7759
15 Cycle	112004.7	11200.47759	100804.2983
16 Cycle	100804.2	10080.42983	90723.86845
17 Cycle	90723.8	9072.386845	81651.4816
18 Cycle	81651.48	8165.14816	73486.33344
19 Cycle	73486.33	7348.633344	66137.7001
20 Cycle	66137.70	6613.77001	59523.93009
21 Cycle	59523.93	5952.393009	53571.53708
22 Cycle	53571.53	5357.153708	48214.38337
23 Cycle	48214.38	4821.438337	43392.94503
24 Cycle	43392.94	4339.294503	39053.65053
25 Cycle	39053.65	3905.365053	35148.28548
26 Cycle	35148.28	3514.828548	31633.45693

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27 Cycle	31633.45	3163.345693	28470.11124
28 Cycle	28470.11	2847.011124	25623.10011
29 Cycle	25623.10	2562.310011	23060.7901
30 Cycle	23060.79	2306.07901	20754.71109

VIII. COMPARISON BETWEEN RAIN WATER AND GROUND WATER.

1. Ground Water requirement for operational process per day = 65000 Litre.
2. Collection from rain water in month =489600 Litre
3. 29Th Cycle Water treatement from rain water is =23060 Litre.
4. 29Th Cycle Treatment from Ground water =3061Litre.

23,061Litre > 3061Litre

1. Hence The rain water is all so sufficient use for industrial process.
2. Dimensions of the roof of the building were obtained by measuring and were plotted as below-
3. According to the collected data catchment area of the rooftop of the building is found out to be 6320m^2.

IX. Calculation

This is the volume of water that can be harvested from the roof of the building throughout the year. The required volume of the storage tank is the volume of harvestable rainwater in peak rainfall season (June to August) minus the volume of water consumed in these months. The required volume of the tank comes out to be about 4,89,640 liters/Month.

(489640 liter*3mnth) =14,68,920 Approximate = 1.47 MLD water storage in one Manson season. (June, July, August)

Therefore, the storage tank has to be designed for 440m^3 of harvested rainwater. Assuming the depth of the tank to be 4m, the dimensions for a rectangular storage tank is

11m x 4m x 10m.=440m^{3,} 4,40,640 Litre

Fig No. 5-Design Tank for collection of rain water.

X. DATA COLLECTION & CALCULATION

A. Physical & Chemical Parameters:

1. On Below References of physiochemical characteristic of industrial waste water that mention in Literature review.

The detail of quality of water it having for the process of the industry, it should must remember and consider when the to develop strategy use of municipal wastewater to reclamation facility of the industry, Second thing the application of integrated process of reuse object.

To identify the parameter of water to primary concern to the makeup of cooling system. Including hardness, Silica, and total suspended solid.

The chemical substance. i.e. the ammonia is the gas which can extremely effecting on the surface of the metal part for corrosively to alloys resulting iron deterioration and losses and due to stress and the process. The term nitrification this process are required for the to do away for ammonia to industrial use disciplined water.

The corrosion reaction all so affecting due to the water, that all so present in dissolved chloride that causing increasing with the corrosion of the maximum metal parts of the industry and the mostly metal parts corroded with by erosion high phosphate Ph and temperature for calcium phosphate.

The formation of scaling, while some chemicals it can be an operatively on carbon steel corrosion for that on the controlled levels.

Physical & Chemical parameter of the industrial waste water ground water & rain water, studied and summarized below-

Table No. 1– Collection of different type sample & It's Result.

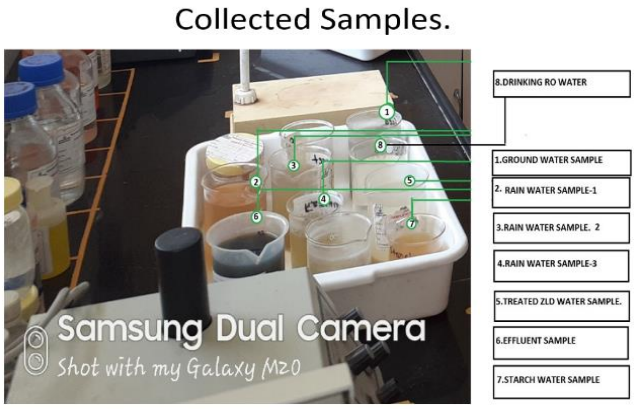


Fig No. 6-Collected Water Sample

According to the collection rainfall data at Food manifacturing Plant to different catchment point, the to collect the different water sample,Gry water sample to result find out pH and acidic and alkaly charactorstic that highly affected on the plant to avoid the corrosivness for maintanance,According to the different Sample.

1.Ground Water Sample- 15 Days Different Sample.

2.Rain Water Sample - 15 Days Different Sample and 4 Different catchment area.

 DOI : 10.35291/2454-9150.2020.0443

3.Trated ZLD Water Sample- 3 Location Sample of ZLD Water.

4.Effluent Sample-2 Different Sample.

5.Starch Water Sample- 3 Starch water sample of Glutain & Starch Glucose-HMCS.

Parameters	BIS 2490 (1974) of industrial wastewater standards	Sample I (Ground Water Sample)	Sample II (Rain Water Sample)	Sample III (Rainwater Sample)	Sample IV (Rainwater Sample)	Sample V (Treated ZLD Water sample.)	Sample VI (Effluent water sample.)	Sample VII (Starch Water Sample)
pH	5.5-9	7.5	6.5	5.9	6.5	5.1	4.9	5.2
Color	colorless	Yellow white	Yellow white	Milky white	Milky white	Milky white	Black Grey	Milky white
Odor	odorless	Offensive Odor	Odorless	Odorless	Odorless	Offensive Odor	Foul Odor	Offensive Odor
TSS (Total Suspended Solids) mg/l	100mg/l	50630	68346	72964	82240	51226	73294	45834
TDS (Total Dissolve Solids) mg/l	2100mg/l	28890	39470	47960	38480	27830	38425	26250
BOD(Biological Oxygen Demand) mg/l	<30 mg/l	1560	1480	1460	1520	1540	1720	1390
COD(Chemical Oxygen Demand) mg/l	<250 mg/l	4200	4020	4080	4270	4240	5860	3980

Fig No. 7– Type of different sample & It's Result.

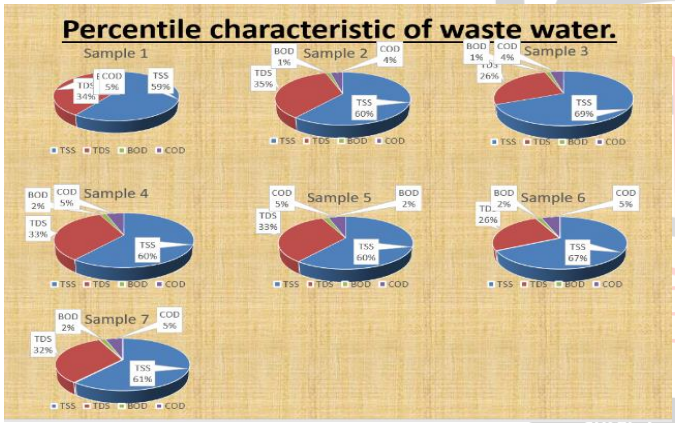
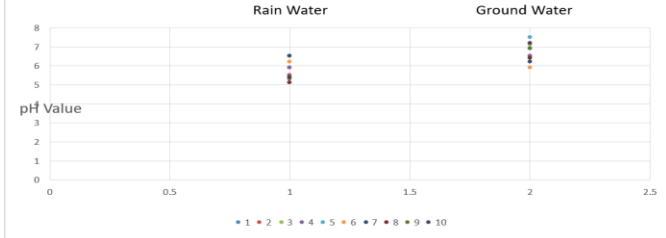


Fig No. 7– Percentile Characteristic of waste water.

Electrometric(Digital pH Method)

	pH value of ground water & Rain water.									
pH Value	1	2	3	4	5	6	7	8	9	10
Rain Water	5.9	5.5	6.5	5.9	5.4	6.2	6.5	5.1	5.3	5.4
Ground Water	6.9	6.5	7.1	6.5	7.5	5.9	6.2	6.4	6.9	7.2



	pH value of ground water & Rain water.									
pH Value	1	2	3	4	5	6	7	8	9	10
Rain Water	5.9	5.5	6.5	5.9	5.4	6.2	6.5	5.1	5.3	5.4
Ground Water	6.9	6.5	7.1	6.5	7.5	5.9	6.2	6.4	6.9	7.2

Rain Water = **6.5**

Ground Water = **7.5**

1.The Peak pH Value of the Rain Water = 6.5

2.The Peak pH Value of Ground water = 7.5

Conclusion .

Rain Water = Slightly Acidic with soft rainy color.
physical characteristic of the rain water is found Soft by test.

Ground Water=Found normal with slightly Alkaline
physical characteristic of the rain water is found Hard by test.

Fig No. 8– pH Value of Different Rain water & Ground water Sample.

XII. ZERO LIQUID DISCHARGE SYSTEM:

Zero Liquid Discharge system is it is the basically treatment process and design to removal of the all liquid waste that present in water that is used in industry for different purpose to decrease of Raw water sparingly and Produce fresh water that is appropriate for recycle it is beneficial for economy and produce cost and good to environment.

In the Zero Liquid Discharge system there is different functional operational for treatment process for better result to consumption and conservation of the water to industrial purpose to avoid any water scarcity in feature.

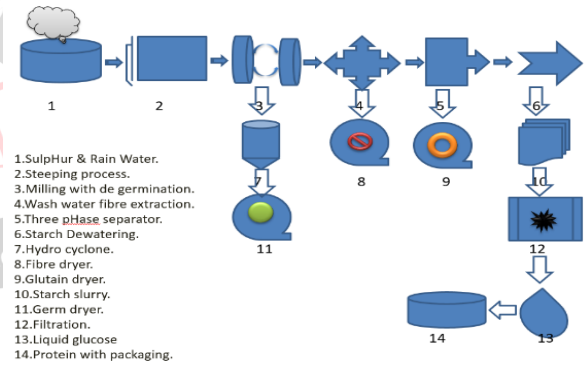


Fig No. 9 OPERATIONAL PROCESS IN FOOD MANIFACTURING PLANT.

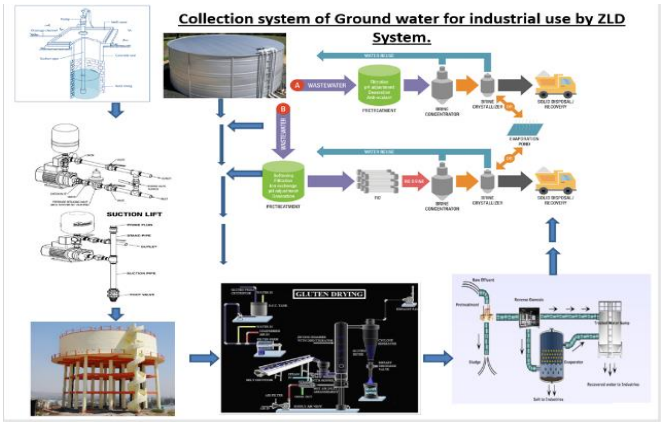


Fig No. 10 FLOW DIAGRAM OF GROUND WATER OF ZLD PROCESS.

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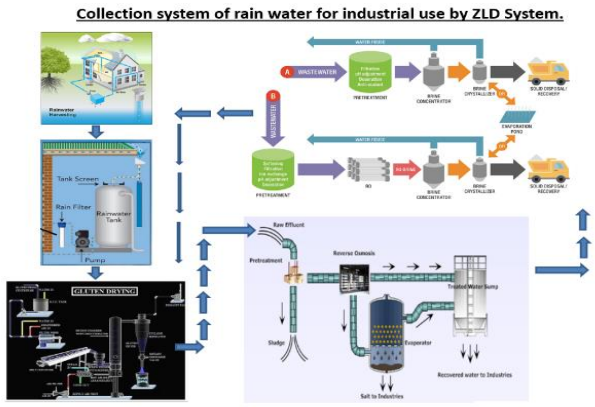

Fig No. 11 FLOW DIAGRAM OF RAIN WATER OF ZLD PROCESS.

XIII. Cost Study.

Rainwater harvesting system is site precise and hereafter it is hard to give a comprehensive cost Some basic rates of activities and materials have been considering which may be helpful in calculating the total cost of a Rain harvesting structure. estimate of the cost.

By the evaluating the all parameter with the help of existing set up of ZERO LIQUID DISCHARGE SYSTEM (ZLD) it is costly but for the plant operational maintenance it is beneficial.

The catchment area in industry for collection of water having maximum, so the initial setup of all structure have must for better result.

The collection of the rain water is high as study on annual rain fall and the requirement of the water for industry is less, so it have a cost saving to consuming maximum collection of water.

The cost of designing of an RWS is negligible for a new construction project, but for developing an RWS for an existing building is considerably high as it requires.

XIV. CONCLUSION

With the help of ZLD system water can be save as in extremely by recycling process So that the demand of water for industry it is very less and the cost optimization maintaining and producing good profit.

The collection of rain water over in one session have maximum and that is very sufficient to the process in industry.

During the water reuse & recycling it is moderately practice in India, experience from other country it can be used to assist for identification of future application.

The reuse of water is basically it has primary used aimed at farming and landscape irrigation in India.it is most spread area on the word, recycling of effluent & rainwater used have most significant for the project and this is the must take in to the amount for use of water.

According to the water the PH effect on the pipe and machinery and forming scaling, which result the maintenance of plant as well as cost optimization is low, rain water is maintain pH and soft and if the ground water is hard by this comparison it is easy to find the cost optimization of the machine maintenance.

Population is increasing rapidly and so are the water demands. To meet these demands, rain water harvesting is an environmentally sound solution. This will not only solve water scarcity problems but also help indirectly such as reduction in water bills, reduction of load on water supply systems and reduction of load on water and storm water treatment systems.

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 DOI : 10.35291/2454-9150.2020.0443