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Study on Cost Effective Treatment System in Food Processing Industry

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Abstract

It is noticed that the spent concentrated brine constituted a considerable volume of strong waste with an objectionable odor. Spent brine is a strong pollutant and creates serious disposal problems, because of the large quantities of organic matter and salt contained therein. The operational cost goes high due to high installation cost and skilled operational requirements for the available best treatment for the concentrated brine is Nano-filtration followed by the Evaporation. In this paper the study of the pilot plant comprises of Pretreatment with PAC & Polyelectrolyte followed by the Sand filter and three Activated carbon filters in series, study shows that concentrated brine is treated satisfactory and reducing the COD & BOD from the Brine. Further this treatment is not achieving the disposable standards as it is having considerable BOD as well as COD but we can reuse this water in the process as it is having large salt concentration and by this way we will recycle the salt which will reduce our consumption on Water as well as Salt. Also groundwater water pollution problems will be minimized due to this project. Therefore, further experiment should be carried out for large - scale operations for recycling potential of Concentrated brine.

Keywords: Brine, Food Industry, pH, BOD, COD.

Introduction

Water conservation seems a good topic to explore the records and in present condition of proportional research as it has previous history of agricultural soil and management of water, multi-purpose storage projects and expanding scenario of urban development[1]. Food processing industries are now have increased pressure to ensure that company's activities should be environmentally sustainable, and also having internal pressure to increase their profitability and economical viability in current sever competition[2]. Also in the food processing industries more focus should be give on the consumer's health and safety. Traditionally, the food processing industry has requiring huge water. In food processing industries water is used for different purposes such as; ingredient, initial and intermediate cleaning source, efficient transportation or convey of raw materials, washing activities, and the in large contest for sanitizing plant machinery and areas[3].

Brine water used in the Food processing Industries for Preservation is needed to treat properly. The most important regarding the treatment is its environmental damage and particularly the concentrated brine discharges. Overall trends used for these types of industries for disposal of the brine are; 1. Discharge in to the sewer drains, 2. Injected in to the Deep well, 3. Zero liquid discharge (ZLD) systems mainly included evaporation-crystallization technologies, 4. Dilution and mixing with other discharges (e.g. wastewater), 5. In coastal area mostly direct discharge in to the Sea. At present it seems that the R&D related to desalination is focusing on the energy consumption and reduction of impact of brine[4]. The present study is focused on developing a system having fewer impacts on environment and technologies which will recover or reuse salts from the concentrated brines. The objectives of the present study are to study the present water & Salt consumption and production ratio (m3/MT), to identify the present recycle streams and their disposal practices, to segregate the concentrated stream from the processing area and to develop pilot plant for treatment of concentration brine stream based on the recycling of the brine in the process by using sand filter & series of Activated carbon filters as Activated Carbone is very good adsorbent for reduction of COD & BOD[5], to minimize the water and Salt consumption ratio of the Food processing industries especially Papaya Fruit processing units.

Methodology

Pilot Plant Set-up: Pilot plant was set-up for the study comprising Sand Filter & Series of Activated Carbone to treat the segregated concentrated brine effluent from the process[6,7]. Specially designed Glass columns are used having dimensions of the 76.2 CM length & 38 CM diameter with inlet and outlet nozzles also a porcelain plate with holes is fixed at the bottom of the Glass column for media resting. 'T' shaped outlet provided with control valves at both the ends. Treatment grade sand having mesh size of 1 to 2 mm was used as a media in sand filter and granular Activated Carbone having mesh size of 2 to 3

mm was used as a media in sand filter. The arrangement is as shown in Figure-1 and 2.

Figure-1
Photograph of Pilot plant

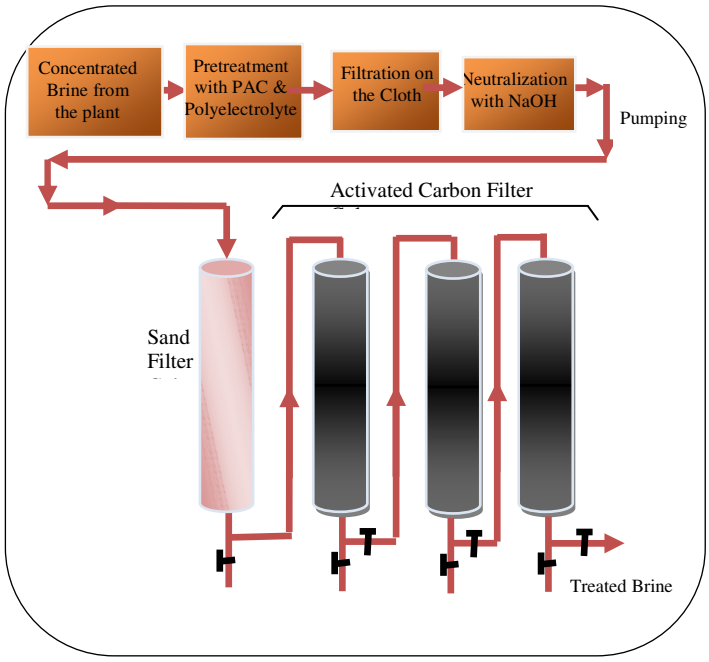

Figure-2
Flow chart of Pilot plant

Pretreatment of the Concentrated Brine: Concentrated brine was pre-treated with PAC & Polyelectrolyte to have better results and doses of the PAC &Polyelectrolyte was obtained by performing Jar test. Jar Test was performed with the set of Six beakers of 100 ml having 100 ml sample (Concentrated Brine) and gradual addition of PAC (Ploy Aluminum Chloride) (30 % Powder form suitable for acidic effluents) as 1.0, 1.5, 2.0, 2.5, 3.0 & 3.5 grams and Polyelectrolyte (Cationic base, 1 gram/Liter solution) 2, 4, 6, 8, 10 & 12 ml (1 ml of polyelectrolyte = 1 ppm) and visual observations were noted.

Optimization of the pH on pilot scale: After pretreatment of concentrated brine with PAC & Polyelectrolyte said sample was filtered by using cloth having mesh size 100 micron and the sample was feed to the pilot plant as the pH of the feed was in between 3 to 4. Optimization of the pilot plant for pH has been carried out and for that 1 N NaOH was used to adjust the Inlet pH as 3.5, 4.5, 7.0, &8.0. Pilot plant was run for all the inlets having different pH and further outlet pilot plant was analyzed for pH, BOD, COD, SS, TDS, Salt % as NaCL.

Sample Analysis: Concentrated brine and the pilot plant treated effluents were collected for analysis and all the samples were analyzed by using standard procedures as per the APHA & AWWA for water and wastewater analysis.

Results and Discussions

Operation of Pilot Plant: Using materials as described in the methodology chapter pilot plant was set up with sand filter followed by series of three Activated Carbone filters and said plant was run for the concentrated brine (Spent brine) collected freshly from the Plant. Initially it was getting only slight colour reduction from the Inlet to outlet. After that before giving feed to the Pilot plant arrangement of addition of PAC (Ploy Aluminum Chloride) (30 % Powder form suitable for acidic effluents) & Polyelectrolyte (Cationic base, 1 gram/Liter solution) for the pretreatment was done. As PAC is a inexpensive material, requires minimal capital expenditure. also, PAC is easy to apply where needed[8]. To have actual proper dose Jar test was performed (Figure No. 3) and has obtained proper dosing as 2.5 mg of PAC & 6 ml (i.e. 6 ppm) of Polyelectrolyte for 1 liter sample(Photograph).This pretreated sample sludge generation and this brine was filtered through the cloth having 100 micron size.

Figure-3
Jar Test Performance

Pretreated concentrated brine was obtained good results (Range of Analysis Results for Raw Concentrated Brine and Pretreated brine with PAC &Polyelectrolyte was tabulated in the Table-1.

Table-1
Range of Analysis Results for Raw Concentrated Brine and Pretreated brine with PAC & Polyelectrolyte

Parameter	Raw Concentrated Brine	Pretreated brine with PAC & Polyelectrolyte
pH	3 to 4	3 to 4
BOD mg/Ltr	15000 to 20000	10000 to 12000
COD mg/Ltr	40000 to 50000	28000 to 32000
TSS mg/Ltr	2000 to 3000	150 to 250
TDS mg/Ltr	80000 to 95000	85000 to 105000
% Salt (NACL)	9 to 11	10 to 12

Results of Optimization of the pH: Pretreated Concentrated Brine was used for further studies in the pilot plant and pilot plant was optimized for the pH by using 1 N NaOH for pH adjustment and at different pH such as 3.5, 4.5, 7.0, & 8.0. Pilot plant was run for all the inlets having different pH and samples for the outlet of pilot plant was collected and analyzed for parameters such as pH, BOD, COD, SS, TDS, Salt % as NaCL, average analysis results of Inlet & Outlet were tabulated in Table-2 and 3 respectively.

Graphical presentation of the Percentage removal of the BOD & COD was shown in the Figure-4.

The average analysis data was used for % removal of the BOD & COD and same was tabulated in the Table-4.

Pilot plant was getting satisfactory results at pH neutral i.e. 7. The results are getting good at normal pH and decrease with Acidic as well as Basic pH range this trend is also observed by the Ladhe U.V. et all[9-12]. As at low pH it is getting average 3.63 getting BOD & COD removal up to 12.27 % & 16.14 % respectively, at average pH 4.58 getting BOD & COD removal up to 26.63 % & 24.94 % respectively. At Normal average pH 6.95 getting BOD & COD removal up to 52.85% & 53.58 % respectively which was better removal percentage and as pH increases from normal to alkaline again percentage of removal of BOD & COD were decreased as average pH 7.93 getting BOD & COD removal up to 30.90 % & 38.44 % respectively.

Table-2
Average results for Pilot Plant inlet while optimization of pH

Sample	Pilot Plant Inlet					
Parameter	**pH**	**BOD (mg/L)**	**COD (mg/L)**	**TSS (mg/L)**	**TDS (mg/L)**	**% Salt (NACL)**
1	3.63	10850	30200	198	95632	10.72
2	4.58	11400	29600	236	95638	10.63
3	6.95	11800	29933	273	97106	11.19
4	7.93	11467	29800	306	100699	10.89

Table-3
Average results for Pilot Plant outlet while optimization of pH

Sample	Pilot Plant Outlet					
Parameter	**pH**	**BOD (mg/L)**	**COD (mg/L)**	**TSS (mg/L)**	**TDS (mg/L)**	**% Salt (NACL)**
1	4.19	9517	25333	89	80840	10.79
2	4.62	8350	22200	106	96045	10.85
3	6.98	5567	13867	117	98064	11.33

4	7.97	7917	18333	144	101161	10.92

Table-4
% Removal of BOD & COD with pH variation

Sr. No.	Average pH	Average % BOD Removal	Average % COD Removal
1	3.63	12.27	16.14
2	4.58	26.63	24.94
3	6.95	52.85	53.58
4	7.93	30.90	38.44

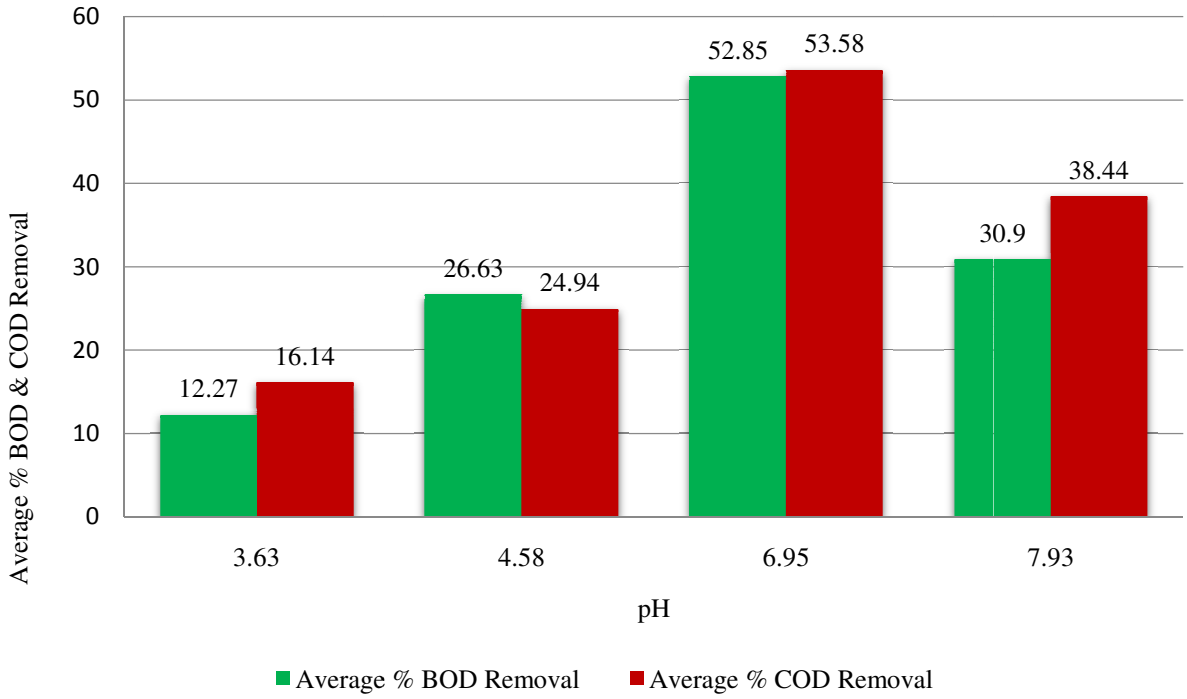

Figure-4
Graphical presentation of Percentage removal of BOD & COD with pH variation

Conclusion

It is observed that the concentrated effluent stream of Papaya Tooty Fruity preservation process is Brine having high NACL percentage and very difficult to treat it but this project is getting satisfactory results for polishing of the said stream which can be reused in the process and it will get benefited for water conservation as well as reduction in the salt consumption. It is recommended to have treatment to concentrated brine as pretreatment with PAC & Polyelectrolyte and after neutralization said will be treated in the Sand Filter & Activated Carbone filters. Though treatment is not achieving the disposable standards with respect to BOD as well as COD; we can still reuse the effluent in the process as it is having large salt concentration and by this way we will recycle the salt which will reduce our consumption on Water as well as Salt. These results are obtained on pilot scale large scale operations has to be assessed and further other additional disposal methods such as Evaporation has to study further.

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