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A REVIEW PAPER ON PROCESS SELECTION OF EFFLUENT TREATMENT PLANT FOR DAIRY INDUSTRY

Meet S Chokshi[1], Deep K Modi[2], Dhwani Joshi Patel[3],
Vaibhavi Purani[4], Beena Patel[5]
Department of Environment Engineering, Venus International College of technology Kalol

Abstract: ETP Treatment Process Selection while construction of a wastewater treatment plant is planned in food processing factories as well as in other industries, the wastewater properties, site conditions of the wastewater treatment plant, and economical efficiency of the treatment shall be considered for selecting the treatment process. The basic flow in food processing factories is the regulation, aeration, and settling tanks. Although activated sludge and the lagoon were the most widely used processes before the beginning of the 1990s, new processes offering improved capability, lower cost performance, and better care for the environment have taken their places in recent years. A representative type is anaerobic treatment, which has enabled economically stable treatment, owing to the development of technology for drastically upgrading the anaerobic microorganism holding density. As the result, direct discharge of effluent from the process to the sewer has been permitted where sewerage systems are available. As wastewater from food processing factories contains a high portion of organic matter, a hybrid system combining an aerobic and aerobic processes with an aerobicpre-treatment can contribute to substance

Key Words: Dairy Waste water, Effluent Treatment process, Reverse osmosis, Waste treatment, Membrane process, Design, Water reuse.

I. INTRODUCTION

The characteristics and volume of wastewater discharged from food processing factories vary with the products and production procedures. In factories like accompanying dishes makers and beverage makers, due to changes of products and/or production the wastewater fluctuates in characteristics and volume of waste water. Almost all the wastewater in food processing factories is treated using a biological treatment process. The wastewater qualities and treatment methods are summarized in Table: 1 The characteristicsofwastewaterfromfoodprocessingfactoriesarech aracterizedbyhighBOD,SS, and oil concentrations as well as emitting smells from acidification. When aerobic or anaerobic biological processes are applied to wastewater treatment in food processing factories, removing oils and solids prior to the biological process is important for preventing them from disturbing thetreatment.energy savings by producing methane gas. One defect in the activated sludge process is sludge bulking. New technologies, however, such as the floating media biofilm activated sludge process and the activated sludge process equipped with UF membrane instead of the settling tank, have been developed to prevent bulking problems. The effluent standards have lately become more stringent, and the nitrogen removal requirement is being specially strengthened. Denitrification processes have been dramatically improved by developing the technology of the single-phase sludge circulating denitrification process and equipment like floating medias holding high-density anaerobic microorganisms. Advanced treatment including coagulation-sedimentation, high-rate sand filtration, and dissolved air floatation is used for removing BOD, COD, and SS. For removing color, coagulation-sedimentation, ozonation

II. TREATMENT METHODS

Table: 1 Typical industrial wastewater characteristics and treatment methods

Industries	Wastewater	Major pollutants								Typical treatment methods
		pH	BOD	COD	SS	Oil	N	P	Color	Others	
	Brewery		o	o	o						AS, AD
	Beverage		o	o							AS, AD
	Vegetable oil		o	o		◎					OS, AS, AD,
	Milk/daily product		o	o							AS
Food					◎						
	Starch		o	o							AS
	Daily dishes		o	o							AS
	Confectionary		o	o							AS
Petroleum	Refinery			o		◎				Smell	OS, AS, AD,
Refinery	Deforming										
	Petrochemistry	o	o	o							N, FL, AS, AD
	Chemical fertilizer	o	o	o	o		◎	◎			N, AS, DN, PR
Chemistry	Polymer chemistry	o	o	o							N, AS, AD
	Organic chemistry	o	o	o		o					N, FL, AS, AD
	Oil/fat			o	o	o					OS, FL, AS
	Pharmaceuticals		o	o	o						AS
	Blast furnace			o	o						CS, FI
Steel	Steel, hot mill			o	o	o					OS, FI,CS, FI
	Col mill	o				o					N, FI
	Cokes		o	o		o	◎		o	phenols	N, OS, AS, FI
	SKP		o	o	o				o	smell	IC, AS
Paper/pulp	KP	o		o	o				o	smell	CS, FL, BL
	SCP, CGP		o	o	o				o	smell	CS, FL, AS, IC
	Washing/screening				o						FL, AS
	Desizing		◎	o	o						CS, FL, AS
Dyeing	Scouring			o							CS, FL, CH
	Bleaching			o							CS, FL, CH
	Dyeing			o					o		N, CS, FL, O3
	Semiconductor	o	o	o						fluoride	N, AS, CS, FI, MF, O3
Machinery	Automobile					o					FL, FI, MF
	Plating	o								cyanide	N, FL, CS, CH, O3
Fiber	Wool		o	o	o						CS, AD, IC
	Synthetic fiber	o	o	o							N, CS, FL, AS

Remarks: (1) treatment methods, N: neutralization, FI: Filtration, OS: oil separation, CS: coagulation-settling FL: dissolved air floatation, AS: aerobic biological treatment, AD: CH: chemical treatment, O3: ozonation, chlorination, IC: incineration DM: denitrification, PR: phosphorous removal, BL: black liquor recovery anaerobic biological treatment, MF: membrane separation,(2) specifically heavily polluted items are marked by ◎ in case of advanced treatment, filtration, activated carbon absorber and membrane separation are provided in addition to above unit

operations

III. MILK AND DAIRY PRODUCTS

Wastewater Volume and Qualities: The production lines of milk and dairy products are shown in Figure 2. In the milk and dairy product processing factories, water is used for washing, cooling, air conditioning, boilers, sanitation, etc. The waste water originates from washing equipment, machines, floor, etc.; accidental leakage of raw materials and products; and dumping off-spec products and contaminated raw materials and products. Figure 2 shows, in percentages, the water consumption by various processes. About 60% of wastewater comes from washing. After production works terminate, the equipment used is cleaned by chemicals and, before and after the cleaning, washed and rinsed with water. Thus, the wastewater is generated. Table 3shows the properties of wastewater and the generated volume per unit of product, classified by the products. As production of milk and dairy products peaks in the summer, so does the wastewatervolume.Dependingonthedegreeofproductionactivities,thevolumeandpollutant concentration of wastewater fluctuates within a 3 to 1 range by the hour and 2 to 1 by the day. The pollution load is especially high on the weekends.

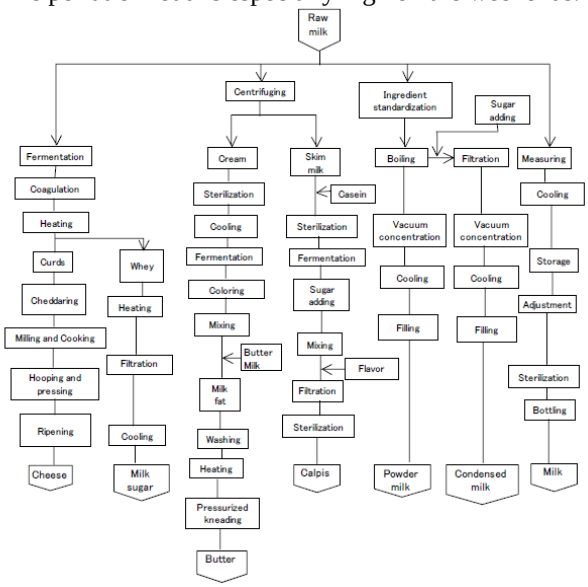


Figure 3 Schematic flow of milk and dairy products

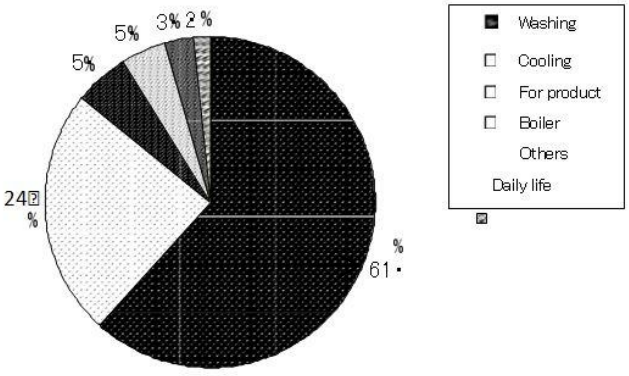


Figure 4 Water consumption rate by various processes

Table 2: Wastewater volume and qualities in milk and dairy product processing factory

Product	pH	BOD mg/A	COD mg/A	SS mg/A	Oil※ mg/A	Water/product m^3/ton
Milk, milk drink	11	750	400	150	90	10
Dairy products	10	600	300	100	60	3
Desserts	11	750	350	250	130	13
Cold cakes	11	800	400	200	200	20

※ N-hexane extract

IV. EXAMPLE OF ACTUAL TREATMENT

A conventional activated sludge process in milk and dairy product processing factories is applied to this factory2）.

Design Condition

Waste water volume 540 m3/12 hr. /d (factory; 12 hours operation) Waste water qualities pH 8.4

BOD 200 mg/ℓ

Effluent qualities pH 6~8

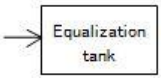
BOD 20mg/ℓ

SS 20mg/ℓ

COD 20 mg/ℓ Coli No.＜330/mℓ

Process

As the hourly and daily fluctuations of volume and pollutant loads of wastewater are large, it is desirable for the conventional activated sludge process that the waste water be sent to the aeration tank after equalization of the fluctuating quantity and quality in the equalization tank. Although an extended aeration process is sometimes adopted for stability against load fluctuations and easy operations, it needs more space than the activated sludge process. In this example, the activated sludge process was adopted. Nutrient supplements are not needed because the wastewater contains BOD, nitrogen, and phosphorous in a well-balanced ratio. Although excess sludge generation in the activated sludge process is generally higher than in the extended aeration process, the excess sludge in this plant was reduced to the same volume as in the extended aeration process by aerobic digestion of thickened sludge. The schematic flow of this plant is shown in Figure 3-5-3. The raw wastewater is screened for floating solids,



equalized in the equalization tank, and fed to the aeration tank. After separating the sludge in the settling tank, it is sterilized by chlorine, and then discharged. Excess sludge is oxidized, and the volume is reduced in the aerobic digestion tank.

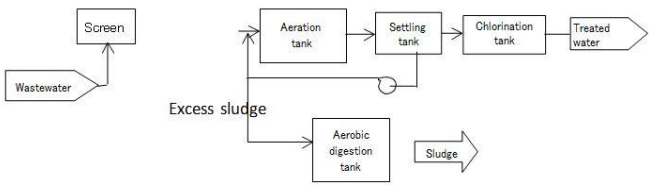


Figure: Schematic flow of wastewater treatment of milk and dairy product factory

V. PERFORMANCE RESULTS

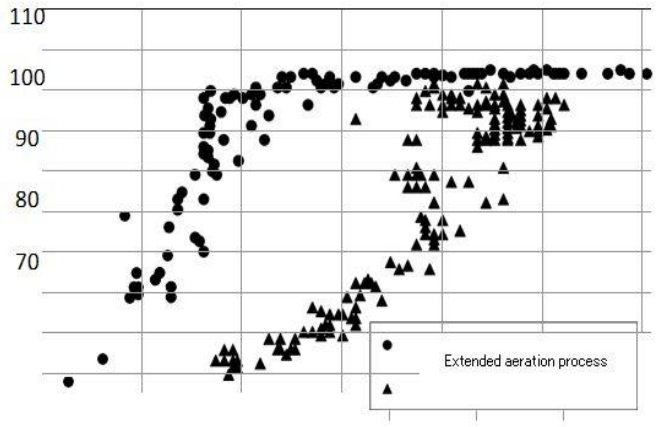
The operation results in this plant are shown in. In spite of the pollutant concentrations in the raw wastewater being lower than the design figure, the BOD in the effluent sometimes exceeded 20 mg/ℓ of the design figure during the period just after start-off when the MLSS concentration is low. BOD in the effluent, however, has decreased responding to the increase of MLSS. Excess sludge is aerated for 10~20 days in the aerobic digestion tank, oxidized, reduced in volume, and then returned to the aeration tank. By this operation, the processed excess sludge balances, in weight, the SS carried out into the effluent, and eliminates the need for sludge transportation to the outside

Table Milk and dairy wastewater treatment result by activated sludge process

Date	Raw wastewater				Aeration tank		Treated water			
	pH	BOD (mg/A)	COD (mg/A)	SS (mg/A)	MLSS (mg/A)	DO (mg/A)	pH	BOD (mg/A)	COD (mg/A)	SS (mg/A)
1-May	7.6	121	41	6	1,200	4.2	7.1	19	7	22
5-May	7.3	134	46	17	1,110	4.6	7.1	22	7.4	16
10-May	7.4	110	36	8	1,308	3.2	7.2	16	5.1	18
10-Jul	7.1	140	47	5	2,100	3.6	7	11	3.4	8
10-Sep	6.8	96	31	3	1,860	2.8	7	14	5.2	6
10-Oct	7.4	126	40	6	2,460	3.2	7.1	18	6.1	10
10-Nov	7.6	118	40	4	3,120	3.8	7.2	12	4.2	8
10-Dec	7.2	180	58	9	3,080	3.8	7	12	4.8	20

VI. CONCLUSION

In wastewater treatment of milk and dairy products, sludge satiability sometimes becomes poor and accordingly SS concentration in the effluent rises. It is caused by the over-aeration of activated sludge. Over-aerated sludge floc becomes less coagulable, disperses in water, and does not settle. Relations between the MLSS concentrations and SV30, an indicator of sludge satiability(height of the settled sludge blanket after 30 minutes settling, %) for both the activated sludge process and extended aeration process are shown in Figure 3-5-41）. When the MLSS concentration rises, the DO concentration falls, and the treatment performance deteriorates. In this case, MLSS shall belowered by extracting sludge to resume the DO levelat 1~2mg/ℓ.



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