FS-PRE-002

TECHNOLOGY FACT SHEETS
FOR EFFLUENT TREATMENT PLANTS
ON TEXTILE INDUSTRY

EQUALIZATION TANK / HOMOGENIZATION TANK

SERIES: PRETREATMENTS

TITLE	**EQUALIZATION TANK / HOMOGENIZATION TANK (FS-PRE-002)**
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INDITEX

EQUALIZATION TANK / HOMOGENIZATION TANK (FS-PRE-002)

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1.- INTRODUCTION

A large number of industries have wastewater with very important flow and/or composition variations throughout the day, due to batch processes, operation hours, type of production, etc. These variations may produce malfunction of process steps or, in the design of the treatment plant, they may lead to oversizing.

In the case of a system with continuous treatment, if the variation of inlet flowrates is very pronounced, any subsequent transfer process is difficult whether it is biological, physical or chemical. Something similar happens with the pollutant load.

In order to avoid these difficulties, chambers (tanks, basins or ponds) which can act as water "lungs" are designed.

Wastewater flows can be accumulated in these chambers, and then may be dosed (usually by pumping) to the rest of the system with a relatively constant flow rate, thereby avoiding the peaks of flow and load.

The equalization tank can achieve two objectives: flow control (equalization) and/or homogenization of contaminated flows

The main advantages of having an equalization tank are:

- It improves overall processes yields, working with more homogeneous flows and loads.
- Biological treatment is enhanced, because shock loadings are eliminated or can be minimized, inhibiting substances can be diluted, and pH can be stabilized.
- It is possible to keep a constant water supply even during phases of process production stop in the industry, ensuring treatment stability.
- The effluent quality and thickening performance of secondary sedimentation tanks following biological treatment is improved through improved consistency in solids loading;
- Effluent filtration surface area requirements are reduced, filter performance is improved, and more uniform filter-backwash cycles are possible by lower hydraulic loading.
- In chemical treatment, damping of mass loading improves chemical feed control and process reliability. It minimizes neutralizing agents for reactives dosing in pH control.
- Installation control is facilitated
- It helps operation and maintenance activities scheduling.
- The life of the facilities is increased by working under constant conditions.
- It optimizes the size of the installation and avoids over-sizing of the treatment plant as it should be dimensioned, for example, at maximum flow conditions.
- The size and cost of processing units located downstream are reduced.

2.- FLOW CONTROL STRATEGIES

The regulation of the treatment plant inlet water flow consists of flow peaks and valleys mitigation, so that the treatment plant works with a constant flow rate, leading to an increase of different processes and unit operations efficiency

Basically, the process flow control consists of a basin or a tank with appropriate volume. When the inflow is higher than the average flow (or ETP design flow) in the tank, flow accumulation of excess water occurs (level in the tank rises). When inflow is smaller than average, accumulated water is extracted with the unit outflow (tank water level decreases)

The two basic modes of operation of the ponds or tanks flow control are:

- Online/In-line: The tank of regulation is in line with the feed to the treatment plant and consequently, all wastewater passes through the tank or the regulation basin.
- Parallel or off-line: Only the water exceeding the average flow rate is derived to the equalization tank, and is forwarded to the treatment when the arrival rate is below average.

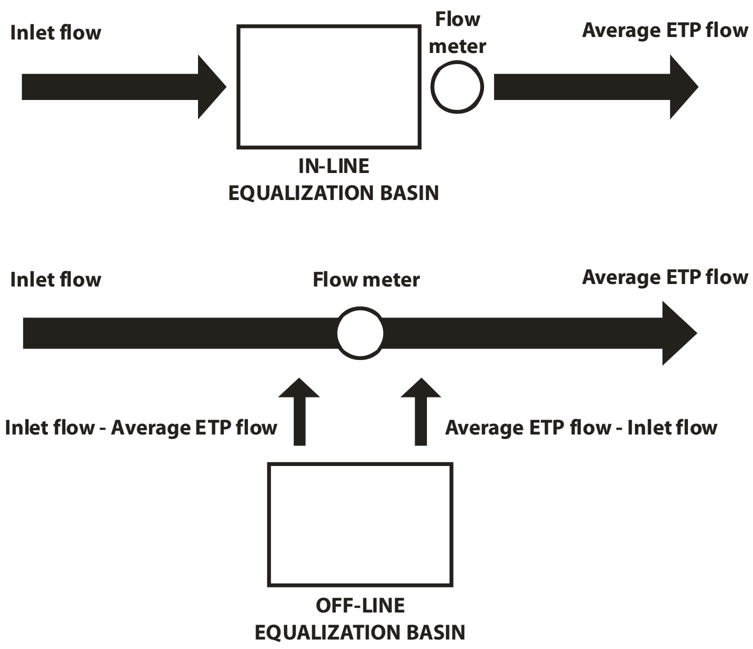

Figure 1.- Basic operation schemes for equalization tanks.

If wastewater has suspended solids regulation tanks implement agitation in order to prevent settling.

Design basis are defined by installation water feed rates variation along a period of time. The volume required for the flow regulation tank can be determined either by graphical representations of flow changes throughout the day or by mass balances over time, which can be translated in tables inside the calculation sheet.

a) <u>Graphical method</u>

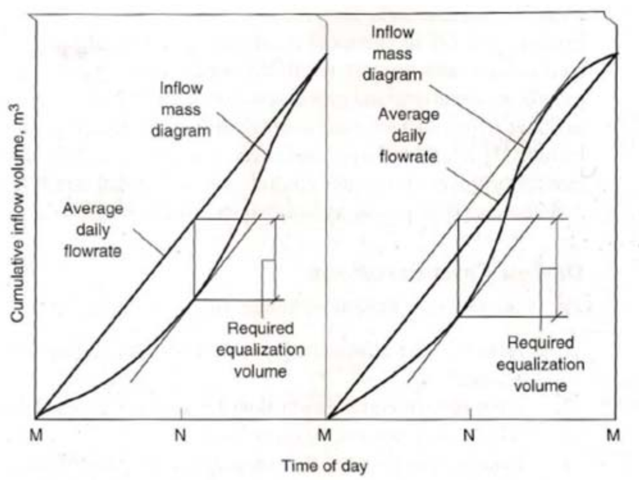

Figure 2.- Schematic mass diagrams for the determination of the required equalization basin storage volume for two typical flowrate patterns.

The volume required for flowrate equalization is determined by using an inflow cumulative volume diagram in which the cumulative inflow volume is plotted versus the time of day. The average daily flowrate, also plotted on the same diagram, is the straight line drawn from the origin to the endpoint of the diagram. Diagrams for two typical flowrate patterns are shown on Fig. 2. (Metcalf-Eddy, 2003)

To determine the required volume, a line parallel to the coordinate axis, defined by the average daily flowrate, is drawn tangent to the mass inflow curve. The required volume is then equal to the vertical distance from the point of tangency to the straight line representing the average flowrate (see Fig. 2). If the inflow mass curve goes above the line representing the average flowrate (see Fig. 2), the inflow mass diagram must be bounded with two lines that are parallel to the average flowrate line and tangent to extremities of the inflow mass diagram. The required volume is then equal to the vertical distance between the two lines. The procedure is exactly the same as if the average hourly volumes were subtracted from the volume flow occurring each hour, and the resulting cumulative volumes were plotted. In this case, the low and high points of the curve would be determined using a horizontal line.

The physical interpretation of the diagrams shown on Figure 2 is as follows. At the low point of tangency (flowrate pattern A) the storage basin is empty. Beyond this point, the basin begins to fill because the slope of the inflow mass diagram is greater than that of the average daily flowrate. The basin continues to fill until it becomes full at midnight. For flowrate pattern B, the basin is filled at the upper point of tangency.

In practice, the volume of the equalization basin will be larger than that theoretically determined to account for the following factors:

- Continuous operation of aeration and mixing equipment will not allow complete drawdown, although special structures can be built.
- Volume must be provided to accommodate the concentrated plant recycle streams that are expected, if such flows are returned to the equalization basin (a practice that is not recommended unless the basin is covered because of the potential to create odors).
- Some contingency should be provided for unforeseen changes in diurnal flow.

Although no fixed value can be given, the additional volume will vary from 10 to 20 percent of the theoretical value, depending on the specific conditions.

<u>b) Mass balance method:</u>

To carry out the second method, more accurate and easier to perform than the first, a spreadsheet with the following columns has to be prepared:

- Time (e.g. hour by hour).
- Volume of water entering the treatment plant in the referred period (m^3).
- Cumulative water volume starting from time zero (m^3). The daily accumulated volume divided into 24 h is the average flow (m^3/h).
- Volume of water extracted from the regulation tank since zero time, which corresponds to the average flow rate multiplied by the number of elapsed hours.
- Difference between the two previous columns. This last column is set of positive and negative values.
- Positive values correspond to the amount of water needed to store, as extracted water flows are less than the amount of water arrivals.
- Negative values represent the water needed to have stored for those periods of time when withdrawals are greater than the inlet flow.

The volume of the regulation basin is the sum of the maximum positive value and negative minimum value in absolute value. If there are no positive or negative values, this term will be zero.

3.- POLLUTANTS CONCENTRATION HOMOGENIZATION STRATEGIES

In certain industrial plants the composition of the wastewater that reaches the treatment plant varies considerably throughout the day, or point source discharges occur with high concentrations of pollutants. If these variations are important it is necessary to carry out a water stream homogenization so that the treatment plant can operate under the best possible conditions.

Homogenization of the influent composition of a treatment plant for industrial water is the mitigation of peaks and valleys of contamination loads which are entering to the installation, so that water inlet can be as homogeneous as possible. The homogenization process basically consists of a deposit or tank of suitable capacity, which normally works full, serving as "lung", where homogenization of the residual water takes place.

According to the above, the optimum working state of a homogenization tank is always full, so that the volume of water in the same buffer serves as mitigation for variable contamination levels.

Moreover, in order to achieve a proper homogenization between the affluent and the water in the tank it is necessary to install an agitation system (a soft agitation is usually enough).

The volume of the homogenization tank will be defined in terms of changes in influent quality caused by production processes.

Besides, the way how to determine the volume of a homogenization basin may be performed as in the case of equalization tanks; by graphical representation, or by performing a mass balance which can be transferred into a calculation sheet, but in this case using contaminant kilograms rather than water volumes of regulation tank case.

It is important to note that when regulating tanks are set online, during most of the time are partially filled with water, where a certain degree of homogenization is achieved, considering that a proper agitation extists.

In the design of such equipment the following must be taken into account:

- Tanks work at a variable level, and do not require agitation unless the water contains suspended solids so as to prevent their decantation or intend to achieve a certain degree of homogenization.
- The homogenization basins work optimally at a fixed level and always full, needing agitation

If homogenization facilities are ahead of the primary sedimentation and biological treatment, the project should consider providing a degree of mixing in the homogenization tank sufficient to prevent sedimentation of solids and concentration variations; and aeration devices sufficient to avoid odor problems.

Sometimes it can be more interesting to place homogenization after primary treatment and before biological treatment.

Adopting an online homogenization system allows to considerably mitigate constituent loads on the treatment processes which occur downstream, while in offline systems homogenization effectiveness is rather lower.

4.- SPECIFIC TECHNICAL CONSIDERATIONS

The two basic mixing systems are:

- Mechanical agitation. The mixing power should be about 15 to 25 W/m^3 of water (3 to 4 W/m^3 in some references). In the case of a regulation tank always working with variable levels, keep in mind that the agitators cannot stay in the air.
- Air agitation by injection through diffusers. The amount of air should be between 0.4 and 0.6 m^3 air/m^3.hour. The type of diffusers to use are medium or coarse bubble.

In practice, the volume of the equalizing tank, or the regulation tank, must be bigger than that of theoretical calculations, in order to take into account the following factors:

- Continuous operation of stirring and mixing equipment in the homogenization and regulation tanks, if needed, will not allow complete emptying.
- Return flows to treatment plant entry and filtered supernatants require an additional storage volume
- Please note an additional volume to meet contingencies that may arise from unexpected changes daily flow or composition.
- The retention time in these units is estimated in the range from 12 to 24 hours for a defined volume based on the daily flow
- Maintaining aerobic conditions requires having an air supply of 9 to 15 L/m^3. Storage retention (min).

Although it cannot be any fixed value, the additional volume can vary between 10% and 20% of the calculated value.

5.- SPECIFICATIONS IN THE TREATMENT OF WASTEWATER OF TEXTILE INDUSTRY

Different tables with ranges of pollutant concentrations present in textile industry wastewater are presented below. These pollutant levels can be homogenized in the tanks.

Table 1.- Parameters concentrations of water pollutants generated in the textile sector in terms of treatment and finishing of yarn, wool, cotton or knit (Cámara Valencia, 2000).

Parameter	Yarn	Cotton fabric	Wool fabric	Knitted cotton
pH	8 -12	8 – 13	5,5 – 8	5,5 – 9
COD (mg/L)	600 – 1000	1000 – 3000	1000 – 1800	800 – 1300
BOD_5 (mg/L)	200 – 350	300 – 1100	250 – 600	200 – 450
SS (mg/L)	50 - 150	50 – 200	50 – 200	50 – 150
Colour (Pt-Co)	100 - 1000	300 - 3000	200 – 1500	1000 - 1000
Water consumption (L/kg)	***60 – 125***	***100 - 400***	***100 – 300***	***100 – 200***

Table 2.- Categories and characteristics of textile process effluents (Jefferson S. & B. Judd, 2003).

Parameters	**Categories**						
	Raw wool scouring	**Yarn and fabric manufacturing**	**Wool finishing**	**Woven fabric finishing**	**Knitted fabric finishing**	**Carpet finishing**	**Stock and yarn dyeing and finishing**
BOD/COD	0,2	0,29	0,35	0,54	0,35	0,3	0,31
BOD_5 (mg/L)	6000	300	350	650	350	300	250
TSS (mg/L)	8000	130	200	300	300	120	75
COD (mg/L)	30000	1040	1000	1200	1000	1000	800
Oil and grease (mg/L)	5500	-	-	14	53	-	-
Total chrome (mg/L)	0,05	4		0,04	0,05	0,42	0,27
Phenol (mg/L)	1,5	0,5	0,014	0,04	0,24	0,13	0,12
Sulphide (mg/L)	0,2	0,1	-	3	0,2	0,14	0,09
Colour (ADMI)[a]	2000	1000	8	325	400	600	600
pH	8,0	7,0	10	10	8	8	11
Temperature (ºC)	28	62	21	37	39	20	38

[a] ADMI ("American Dye Manufacturers Institute") lcolour values result from a special procedure for determination of colur in dyeing wastewaters (Allen et al., 1972; Little. 1978).

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Table 1
Major characteristics of real textile wastewater studied by various researchers.

pH	COD (mg/L)	BOD_5 (mg/L)	TSS (mg/L)	TDS (mg/L)	Colour	Turbidity (NTU)	References
8.8–9.4	595 ± 131	379 ± 110	276 ± 76	–	–	–	El-Gohary and Tawfik, 2009
11.2	2276	660[a]	–	47.9	–	–	Golob et al., 2005
5–10	1100–4600	110–180	–	50	1450–1475(ADMI)	–	Dos Santos et al., 2007
6.5–8.5	550–1000	–	100–400	–	7.50–25.50[b]	15–200	Ciabatti et al., 2010
2.7	7000	–	440	930		2140	Al-Malack et al., 1999
13.56	2968	–	–	–	3586 (C.U)	120	Joo et al., 2007
12–14	1500–2000	–	–	–	Dark blue	–	Gozalvez-Zafrilla et al., 2008
10	1150	170	150	–	1.24^{436nm}	–	Selcuk, 2005
9	750	160	–	–	–	–	Schrank et al., 2007
2–10	50–5000	200–300	50–500	–	>300 (C. U)	–	Lau and Ismail, 2009
8.32–9.50	278–736	137	85–354	1715–6106	–	–	Phalakornkule et al., 2010
8.7 ± 0.2	17900 ± 100	5500 ± 100	23900 ± 50	1200 ± 50	–	–	Rodrıguez et al., 2008
9.30	3900	–	–	–	–	240	Paschoal et al., 2009
7.8	810 ± 50.4	188 ± 15.2	64 ± 8.5	–	0.15^{659nm}	–	Haroun and Idris, 2009
13 ± 1	2300 ± 400	–	300 ± 100	–	–	–	Debik et al., 2010
6.95	3422		1112	–	–	5700	Bayramoglu et al., 2004
7.86	340	210	300	–	>200 (Pt-Co)	130	Merzouk, 2010
7.5 ± 0.3	131 ± 18	–	75 ± 13	1885 ± 80	–	–	Ustun et al., 2007

[a] BOD_7 and effluent is from reactive dye bath.
[b] Integral of the absorbance curve in the whole visible range (400–800 nm), ADMI : American dye manufacturer institute, C.U: Colour Unit.

6.- PARAMETERS AND CONTROL STRATEGIES

- Hydraulic retention time.
- Establishing bypass systems to perform maintenance emptying and solids and accumulated debris extraction.

7.- OPERATING PROBLEMS

Operational problems:

- Lack of ventilation when much organic matter arrives.
- Accumulation of sediment and sand in the bottom of the tank (lack of energy).
- Extraction problems in the extraction of thick or settled materials.

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ANNEX 1
GRAPHIC DESCRIPTION OF PROCESS UNITS

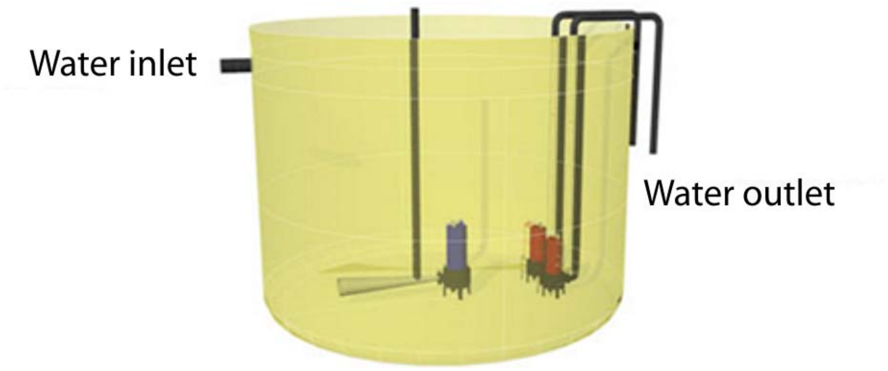

Figure 1
Basic sketch of a flow regulation system.

Figure 2
General image of a equalization tank with surface agitation (Cumberland County, USA).

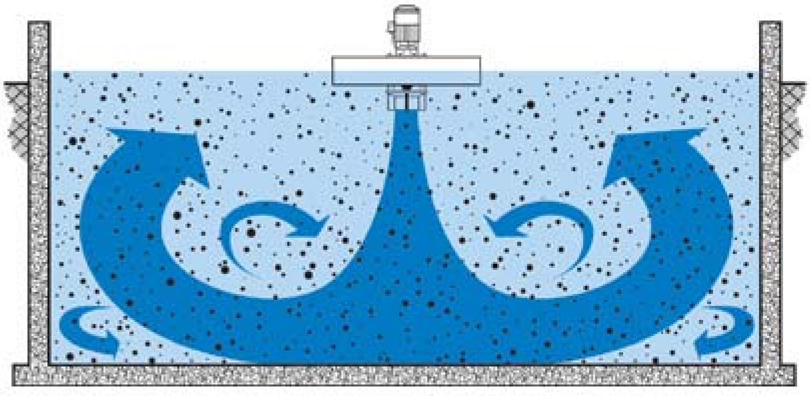

Figure 3
Sketch of the effect of surface agitation system.

Figure 4
Agitation system ejector example

Figure 5
Bottom agitation system

Figure 6
Vertical axis floating agitation/aeration system

Figure 7
Oblique axis floating agitation/aeration system

Figure 8
Details of bottom impeller agitation equipment

Figure 9.
General image of a regulation-homogenization tank.

Figure 10
General image of a regulation-homogenization tank.