

Primary settling

There are many examples of primary settling systems that are ineffective. And limitations are not restricted to small tanneries, as severe problems can be found in some of the largest and most expensive treatment plants.

Many configurations are possible according to the individual situation. For example there are many variables found as pretreatment. Liquors containing sulfides might be oxidised before mixing with the other discharges, and exhaust chrome liquors and drainings may be precipitated. Nevertheless, this does not always take place in practice, so the mixing stage can be in conjunction with aeration, and there may be significant quantities of tanning agents present to precipitate proteins.

In all events, screening of the effluent streams before entering the primary treatment sump or tank is of great benefit. Even if only simple bar screening is used, gross solids can be readily removed. This avoids removal at a more difficult stage, reduces the volume for removal from the settling arrangement, but most importantly, avoids the risk of blockage that might occur within sludge removal.

Thorough mixing of process wastewaters

For the most effective treatment, a comprehensive mixing of all of the wastewater streams from process is required. This is to provide an opportunity for all of the components to inter-react. The soluble components capable of inter-reaction can thus form the maximum amount of precipitates, and reduce the COD accordingly.

In this event the volume must be greater than the daily discharge from the plant, and the "right" working volume is often stated as being 1.3 days effluent discharge. This ensures that the highly contaminated waste streams that are usually discharges in the early parts of the day, can mix with other effluents such as dyestuffs and exhaust fatliquors that are usually received much later. This mixing may be through gradual intermixing of effluent as it gently flows through the system, or

may be by stirring, or blending as a result of aeration. In a system that ensures a thorough mixing, the extra capacity ensures that the system is never completely empty, and that a constant rate of discharge is possible. If a gentle blending takes place then a greater capacity will be needed.

Good settling of solids and precipitates

The system should also ensure that all of the suspended solids discharged from process, and all of the precipitates from inter-reactions have an opportunity to settle. This leaves a relatively clear supernatant for the remaining treatment.

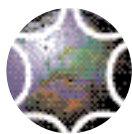
Good settling is often achieved by directing a gentle flow of the mixed effluent towards the base of a separate settling vessel, followed by a very slow upward flow of the effluent. If the upflow rate is slower than the settling rate of the suspended solids, then the solids will be retained in the base area of the settling unit as sludge. If a specialised internal construction is not used, then the containment volume must be increased to allow longer retention time for settling.

Ease of sludge removal

Primary mixing and settling in its simplest form—basically a single sump—will enable some interaction of wastewater streams, and settling of the heavier types of suspended solids. At the other end of the scale, there may be long static retention times, mechanical mixing that can include chemical dosing, and separate settling.

A means to remove the solids that are deposited on the base of the settling vessel is essential, and this requires care in both plant design and management. The design of the settling vessel falls basically into three categories:

- The most basic form where mixing and settling occur in the same vessel, and where essentially the construction has a flat base. Typically used by small tanners, the sludge or solids ►



cannot be discharged from the system, so removal is by pumping off the free effluent, then desludging either using sludge suction pumps—even as a manual operation.

- More complex constructions where mixing first takes place, followed by a separate settling vessel. Usually of intermediate size, the base is ideally formed as an inverted cone. As the sludges generated do not flow easily on opening a discharge valve at the cone base, a high angle to the horizontal is used. The side of this cone is often 65°, so the settling vessel is high but with little volume. Nevertheless, if the sides are not so acute, then the sludges do not flow easily. Either blockages, or “rat hole” effects, occur where a flow of effluent suddenly breaks through the relatively stable sludge layer.

Because of ease of construction, sometimes a square or rectangular vessel is used with a base in the form of an inverted pyramid. There is a problem with this construction, because even if the angle of the sides is acute, the sludges can bunch together in the four converging corners causing blockage.

- Systems where the base of the settling vessel is flat or slightly angled towards the centre, and fitted with a scraper mechanism. This mechanism slowly revolves around the vessel, slowly shifting the solids towards a central discharge point. This is found with larger scale plants. The flow must be slow, and the depth sufficient to allow fines disturbed by the scraper mechanism to resettle.

Common failings

These include:

- Situations where the primary settling capacity has been carefully calculated—but without taking into account the loss of this operational volume as sludge builds up. As a rule of thumb, 1-ton input of hides without the benefit of clean technology can generate between 1-2 m³ of sludge at this stage (dependent upon raw materials and technique), so the available volume can rapidly reduce.
- Pipework used for sludge discharge is often of insufficient diameter. All of this pipework should be generous in size, and curves should be used as opposed to bends to ensure ease of flow. This is especially important where the discharge relies on gravity.
- Lack of accessibility. All of the valves, pumps and pipework for drainage and delivery should be as accessible as possible. If it is possible, the installation of tanks and settling vessels above ground level provides distinct advantages for maintenance.
- Blockages. It is very prudent to set a pair of valves directly below the discharge point. If a “T” junction is included into the pipework between these valves, then with one valve closed, a blockage within the system—either down-flow or in the sludge mass—can be easily blown out using compressed air. This can be invaluable. A most extreme blockage was freed using a combination of water under pressure and compressed air via the described double valve arrangement.
- The inability to stop a discharge. If two valves are built into the system, then if one valve jams open, then the flow can

Simple and effective

One of the most effective, simple, primary settling systems was based on several sumps set in line. Two gullies were formed (A & B), one on each side of the arrangement, with channels leading from both gullies into each sump. The effluent was directed into the first sump by blocking the flow in one channel (A) with bricks and bags of sand. The flow was directed towards the sump base with baffles constructed from wood on a metal frame. This assisted mixing and settling. The outflow was at the opposite side, and the flow directed via the second gully (B) into the second sump using sandbags. The outflow was then similarly directed via channel (A) through the third sump. At each of the outflow points a simple baffle was set on the surface to retain any floating solids.

The system was not ideal as all of the effluent could not mix; however, it was low cost, very effective, and easy to manage.

Constructed of reinforced concrete, any sump could be isolated and thoroughly cleaned out when half filled with sludge. This could take place at any time, and not await holidays, so the system remained fully operative. The capacity was around two days if one pit was taken out for cleaning.

NOTES:

- In this case the gullies were only 0.5 m deep, and about the same width. Essentially they required some holding capacity to cope with periodic discharges and surges, but this is also a function of length of the feed channel.
- If this form of construction is used, the concrete reinforcement must be secure, as there can be considerable pressure on a common wall when one sump is drained. An alternative is to situate each sump individually, so that the surrounding earth supports the walls.
- In the system described the sludge was manually removed using buckets, as a suitable pump was not available. It should, however, always be remembered that there is considerable danger from hydrogen sulfide poisoning.

See “Hydrogen sulfide: danger and detection,” *World Leather*, November 1998, p36.

always be stopped. All valves should be opened and closed daily, and cleaned and lubricated to avoid seizure.

- Failure to address the removal of solids. However good the mixing and settling in a pristine plant, this rapidly diminishes if management is neglected, leading to a gradual increase in sludge. Worse still—if the sludge cannot be removed then the system fails leaving only a simple flow over the top of the sludge mass.

There is a surprising number of settling systems where solids can only be removed when the whole plant is shut down due to oversights in design. And this does not just apply to small tanneries! 🍷

Additional information

For more information into the employment of primary settling plants, general design, and the way that they are used, see “Back to Basics: Environmental”.

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