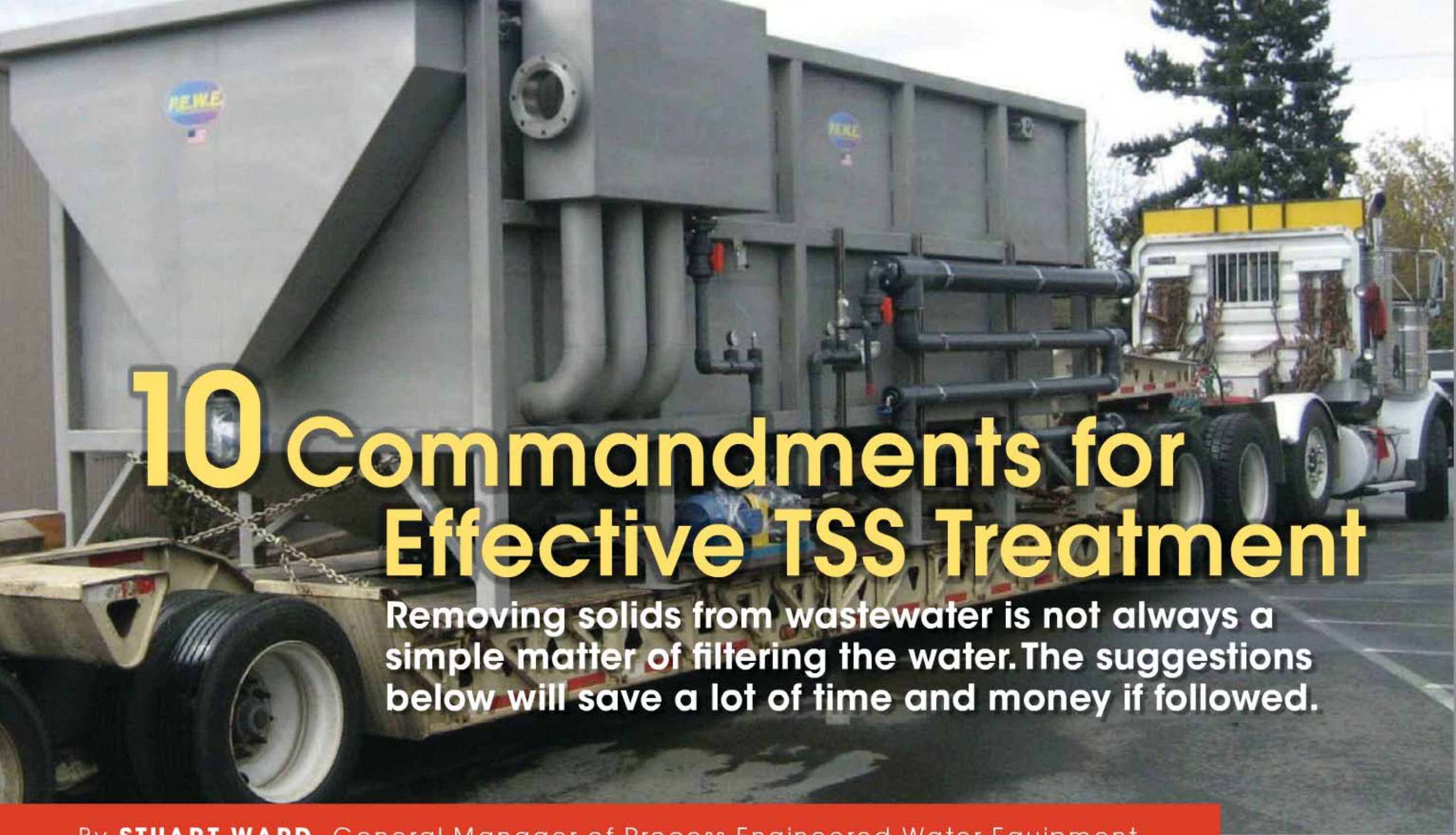


10 Commandments for Effective TSS Treatment

Removing solids from wastewater is not always a simple matter of filtering the water. The suggestions below will save a lot of time and money if followed.

By **STUART WARD,** General Manager of Process Engineered Water Equipment

Water treatment professionals, whether they are operators, vendor representatives or managers, are often tasked with the removal of total suspended solids (TSS) from a waste-stream. This removal may be necessary in order to meet regulatory permit requirements or simply as cost avoidance. Universally the goal is to remove as many solids as possible at the lowest cost.

The following rules may be utilized in a wide variety of industrial wastewater applications. And I admit to a bias toward dissolved air flotation (DAF) over a traditional clarifier for solids removal. Why? Because a DAF is easier and quicker to trouble-shoot and it is often the nature of solids that they can be made to readily float. To a degree, these rules may be applied to the municipal field. However, the focus within is industrial applications as that is where my expertise is. Industrial wastewater comes in many forms from the simple to the complex; by boiling TSS down to these 10 commandments, better treatment results can be achieved.

These basic principals were learned through many years of personal experience first as a "water-treater," selling coagulants and flocculants and later as a wastewater systems solution engineer. During a stint peddling chemistry, I often found wastewater treatment systems either missing critical pieces of equipment or equipment that was not up to the job at hand. The latter may have been due to poor quality out-dated equipment, or simply equipment being misapplied. Unfortunately, it was often operator neglect or even incompetence. A key point about these rules is that they are cumulative. That is, the rules stack efficiency in layers and each layer brings with it increased opportunity for cleaner water.

Thou shalt prescreen thy water

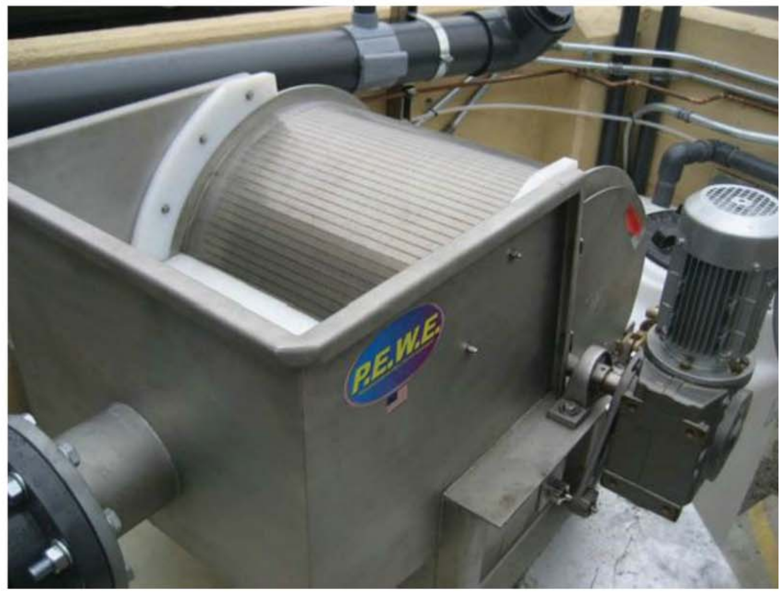
The first order of business is removing large solids or foreign matter from the wastewater. A screen mechanically removes solids, helps reduce chemical usage and protects downstream equipment from plugging or damage. Plugged and damaged valves, pipes or DAFs do not efficiently remove TSS. Wastewater screens come in a number of designs such as bar or in-channel, side-hill, externally fed and internally fed. Some incorporate shaker mechanisms or self cleaning spray bars. It is important to select the correct screen for a particular application by consulting with vendors and manufacturers.

Above is a DAF designed and built by P.E.W.E.

Provideth adequate flow and load equalization

There are two major reasons for adequately controlling the flow and load coming out of a plant. The flow needs to be controlled so that all downstream equipment can be sized such that it consistently operates within an optimal range. In order to do so, an equalization tank (EQ) or basin must be used. This tank will balance a varying discharge flow rate. The tank should be sized at a proportion to the daily plant flow. The more the flow rate varies, the larger the percentage of the daily flow the tank should be designed to handle. As a general rule of thumb, start with 25 percent. If there are wide swings, such as a high flow during nightly clean-up, the percentage might creep to 50 percent. Keep in mind, EQ sizing depends upon other factors to be taken into account, including available space, odor concerns, containment requirements and budget.

The second reason adequate EQ should be used is that industrial flows often vary in TSS loading. Some rinse waters during production are relatively clean while others are heavily laden with solids. These must be blended so that chemical usage is minimized and efficiency is maximized. The downstream chemistry is designed to be fed at a consistent rate given a flow and TSS loading level. The purpose of the chemical additions is to aid formation of floc. That is, a large semi-solid particle of DAF can be efficiently dealt with using aeration and floating it to the surface for removal by skimming. More solids requires high chemical doses – but there is a limit as too much chemistry will have the opposite effect so you cannot just over feed it. If the chemical feed is set to high solids conditions and conditions change, too much can be added causing other problems. Have an EQ tank that effectively blends the variable TSS loads and the operator can better dial in the chemistry on that particular average TSS level. The EQ is the cheapest piece of equipment that can reduce overall wastewater treatment costs.



Water should be prescreened to remove large solids and foreign matter.

Thou shall properly pH control the water

Wastewater must be pH controlled to meet permit requirements. Wastewater must also be pH controlled so that the coagulant and flocculent chemistry may operate effectively. There are many chemical nuances of pH and the available wastewater treatment chemistry. Suffice it to say TSS related removal chemistry has a pH operating "window" where it is most efficient. Stray outside the window and either or both coagulant and polymer will be wasted.

Purchase thine self a plate pack stainless steel DAF

Traditional open style DAF systems still have their place. They function the same as a modern plate pack DAF. They work great as a thickener. They also take up a lot of physical space, which is precisely where the modern DAF comes into its own. The modern plate pack DAF separation area is provided through the use of stacked inclined surfaces (often corrugated for strength). This achieves several things at once:

- It allows the selection of either counter flow or cross flow

From left to right: If space is a premium, Coagulants and floc agents can be added within the piping manifold. Note the sampling ports added in this one. Next, a sloped bottom design makes removing settling solids much easier. The photo on the right shows a liquid solids separation system designed and built by P.E.W.E.

hydraulics.

- It improves laminar flow, aiding particle separation.
- It allows increased separation area in a confined space.
- It dramatically reduces the separation loading rate giving the DAF a wider flow and load tolerance.

As for material, a carbon steel DAF is cheap to build and of limited durability. A plastic DAF has some corrosion resistance advantage but adds bulk due to limited material strength and durability. They are built thick to compensate for this weakness. A stainless steel DAF will handle 99 percent of industrial applications and has the added benefit of being alterable by plant maintenance staff such as attaching brackets, railings, etc. The material is relatively light, has superior strength for its weight and can be welded, attached to and polished at will.

Useth regenerative turbine

OK, if you missed it, there was a cover article published in *Pollution Engineering* magazine October 2011 titled *Regenerative Turbine Aeration* (http://goo.gl/psGu4). The article provides additional information on the topic. In a nut shell, regenerative turbine aeration uses a minimal amount of electrical energy to dissolve air into water. Sounds like electricity turned into air? Not really. It's just the mass transfer of air utilizing electricity creating efficient 20 to 30 micron bubbles that are the work-horse of an effective DAF system.

Useth a self draining/ cleaning DAF

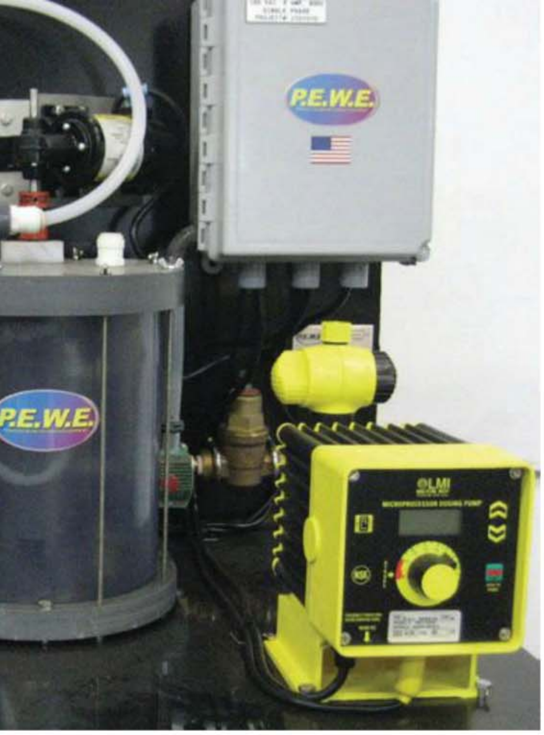
There are two types of DAF with respect to draining flat bottom and not. A flat bottom DAF is less expensive to manufacture and install. It is also much harder to remove solids and keep clean if not all of the solids happen to float. Often a sloped bottom or cone-shaped bottom DAF is the solution to handling settling solids. There are several primary designs. Old school designs use as bottom scraper which are prone to derailing and wear. A better design is the use of a pump to suck the solids out. The

pump is also readily accessed for maintenance purposes as it is located outside the vessel. Some DAF system designs lend themselves to easier cleaning than others. A case in point is the water extraction system. Some DAFs use a simple perforated pipe for extracting water but can also collect and clog with solids. Manufacturers of these system put cleanout plates on their system so that the operator can regularly open and clean them. A more inventive manufacturer uses a self cleaning design saving operators hours of needless work.

Useth performance tested liquid chemistry

Creating 20 to 30 micron bubbles will aid in making DAF.

First, start with a reputable chemical vendor and a knowledgeable representative as they will save money in the long run. Sure, powder chemical products have their place on a large scale system where they have the pricing edge. However, in regards to industrial wastewater treatment, the added time and expense of manning a powder system is anachronistic. From fish eyes to batch inconsistency, the justification for powder coagulants or polymer is



A properly sized and designed dosing system will quickly pay for itself in chemical savings.

old school thinking. Putting in a liquid system allows for full automation of the process at a low cost, eliminates wetting issues and, more importantly, opens up a range of treatment chemistry. It is much easier to switch to a new product when a drum/tote runs out than to work off a truck load of slowly deteriorating powder.

Useth a flow proportional make-down system

Some wastewater systems are designed to run at a single set flow rate, making injecting chemistry pretty easy. However, most industrial facilities generate wastewater at alarmingly dissimilar rates from day to day, hour to hour and even minute to minute. A good measure of this variability can be controlled through EQ (see Commandment 2). With an EQ tank, one can discharge to a DAF at a steadier rate and inject accordingly. There often still remains a flow cycle and this can be compensated by using a flow-proportional chemical make-down and dosing system. It is not a complex job to install a flow meter and send the 4 to 20 ma output signal to a chemical pump system. The chemical will be dosed more consistently than by manual operation. Such a system will pay for itself through lower chemical usage.

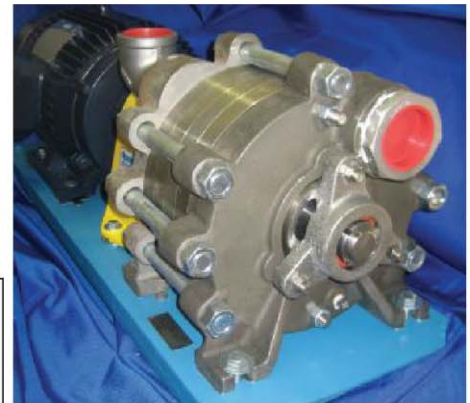
Thou shall properly locate chemical injection points

The preferred chemical vendor should be able to study the wastewater and make recommendations as to optimal application given a particular system setup. Sometimes the preferred location is not available. A good place to start when using a typical two-step coagulant/flocculent treatment scheme is to:

1. Inject the coagulant as far upstream as possible to maximize contact time with the solids, preferably where the wastewater comes out of the EQ tank and ahead of any transfer pump. This also maximizes shear. Given this, a contact tank will likely not be necessary.

2. The polymer should be injected in a pipe flocculator which is also known as a plug flow reactor. It is suggested that a sample port be available ahead of the polymer injection point so the operator can check their coagulant dose for effectiveness at creating a pin-floc.

A sample port after the polymer injection will allow the operator to check the combined effectiveness of the chemical application prior to entering the DAF. Tweaks can then be made on the fly without having to wait and see the water coming out of the back-end of the DAF.



Special pumps such as the Rogue Aeration Pump above create 20 to 30 micron bubbles.

Thou shalt not undersize the system

One of the most often committed sins in system design or purchase is to undersize the equipment. Let's face it, companies have limited budgets and see wastewater treatment as an expense. They are tempted to economize, particularly when business is slow. This happens with pumps, piping, valves, screens, tanks, dewatering equipment, chemical feed and, most often, DAF units. These systems are then pushed beyond their intended design capacity for flow and/or load. The unintended end result is poor quality TSS removal. The plant grows, production changes, output variables change or discharge rules become tighter from the regulatory agencies. Key considerations are average versus maximum flow plus its duration, planned expansion, available space, EQ capacity and discharge limits or goals. A starting point for DAF sizing is 50 to 75 percent of daily gpm flow. The final size can then be adjusted by taking the other factors into account. Remember, better results will not be apparent because inherent equipment system limits can only be marginally improved upon later. As a reformed chemical salesman, I can assure you there are things even the magic of chemistry can't fix. ***PE***

Stuart Ward is the general manager for Process Engineered Water Equipment LLC. For more information, contact him by email at ward@pewe-llc.com.