

1.0 INTRODUCTION

This City of Los Angeles Pretreatment Program Compliance Guide is meant to provide you with general information that can help in your efforts to identify and eliminate common causes of noncompliance. Starting upstream, the topics of pollution prevention and recycling, preliminary pretreatment (e.g., stream segregation, flow equalization, and screening), and alternatives to pretreatment are presented. These upstream activities can often eliminate or substantially reduce the hydraulic and/or pollutant load placed on the pretreatment system. With reduced load, the potential for having a noncompliant event is also reduced.

This discussion of upstream activities is followed by the presentation of information for eight common pretreatment technologies. For each technology, a process overview is provided followed by information regarding the specific design and operating factors that make a system successful. This information will be of most use to industrial users looking to either upgrade or replace their existing system. Each section concludes with a listing of common causes of noncompliance and potential corrective actions.

Final topics include the tracking down of incidental pollutants, the emerging role of environmental management systems, and additional sources of information and help. It is the hope of the IWMD that most industrial users will find this guide helpful and that it will serve as a ready reference for solving noncompliance problems as they occur.

2.0 RESPONSIBILITIES OF THE INDUSTRIAL USER

Compliance management begins with the Industrial User (IU) filing an application for an industrial wastewater discharge permit with the IWMD. Once the permit is issued, it is the responsibility of the IU to operate the pretreatment system in an efficient manner and to ensure that all discharges comply with permit limits. The IU that is subject to monitoring is required to periodically collect effluent samples from their system, send the samples to a certified laboratory for analysis, and file self-monitoring reports.



The IU is also responsible for notifying the IWMD whenever certain operating, process, flow, or pretreatment changes are made and whenever an upset occurs that causes the discharge to be noncompliant. Extensive monitoring and effluent sampling following the upset may be imposed to confirm the effectiveness of corrective action. By knowing one's responsibility, taking a proactive approach, and knowing what to do when upsets occur, the potential for noncompliance can be

greatly reduced.

2.1 KNOW YOUR DISCHARGE PROHIBITIONS AND LIMITS

All industrial facilities that discharge wastewater to the environment, either directly or indirectly, must comply with general discharge prohibitions and limits. In the City of Los Angeles, most industrial facilities discharge their pretreated wastewater to a Publicly Owned Treatment Works (POTW) for further treatment prior to release. Wastewater pretreatment is often required to ensure compliance with federal discharge limits and with local limits set by the Industrial Waste Control Ordinance.

The USEPA General Pretreatment Regulations (40 CFR 403) establishes two sets of standards: Prohibited Discharge and Industrial Categorical Discharge. The Prohibited Discharge Standards include two general prohibitions and eight specific prohibitions as listed below:

General Prohibition

Industrial wastewater is prohibited from being discharged to a POTW if it may:

- 1) Pass through the POTW untreated.
- 2) Interfere with the operation or performance of the POTW.

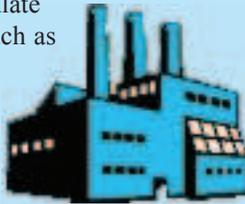
Specific Prohibition

Industrial wastewater is prohibited from being discharged to a POTW if it contains:

- 1) Pollutants that may create a fire or explosion hazard in the sewer system or at the POTW.
- 2) Pollutants that are corrosive, including any discharge with a pH of less than five.
- 3) Solid or viscous pollutants, in sufficient amounts, that will cause obstruction or blockage of flow.
- 4) Any pollutants discharged in sufficient quantity to interfere with the operation of the POTW.
- 5) Discharge temperature greater than 104 °F at the POTW or is hot enough to interfere with biological treatment processes.
- 6) Petroleum oil, non-biodegradable cutting oil, or other products of mineral oil origin in amounts sufficient to cause interference or pass-through.
- 7) Pollutants that result in the presence of toxic gases, vapors, or fumes at the POTW in sufficient amounts that may cause acute worker health and safety problems.

- 8) Any trucked or hauled pollutants, except at discharge points designated by the POTW.

In addition to prohibited discharges, 40 CFR 403 established Industrial Categorical Discharge Standards for more than 50 industrial categories. These standards regulate the discharge of conventional pollutants such as pH, oil and grease, biochemical oxygen demand (BOD), and suspended solids. Subsequent legal action forced the USEPA to study and promulgate technology-based standards for the control of priority toxic pollutants. This effort is still ongoing with industrial categories being added and deleted. The following categories are currently regulated:



Industrial Category	40 CFR
Aluminum Forming	467
Builder's Paper and Board Mills	431
Battery Manufacturing	461
Carbon Black Manufacturing	458
Centralized Waste Treatment	437
Coil Coating and Can Making	465
Copper Forming	468
Electrical & Electronic Comp.	469
Electroplating	413
Fertilizer Manufacturing	418
Glass Manufacturing	426
Ink Formulating	447
Inorganic Chem. Manufacturing	415
Iron and Steel	420
Leather Tanning and Finishing	425
Metal Finishing	433
Metal Molding and Casting	464
Nonferrous Metal Forming	471
Nonferrous Metals Manufacturing	421
Org. Chem., Plastic & Syn. Fiber	414
Paint Formulating	446
Paving and Roofing Materials	443
Pesticide Chem. Manufacturing	455
Petroleum Refining	419
Pharmaceutical Manufacturing	439
Porcelain Enameling	466
Pulp, Paper, and Paperboard	430
Rubber Manufacturing	428
Soap & Detergent Manufacturing	417
Steam Electric Power Generation	423
Textile Mills	410
Timber Products	429

The City of Los Angeles has established local limits to protect its sewer system and treatment plants. These local limits impose instantaneous maximum values that may not be exceeded at any time. The table below shows the local limits that are currently in force.

Pollutant	Maximum Limit (mg/l)
Arsenic	3
Cadmium	15
Chromium (Total)	10
Copper	15
Lead	5
Nickel	12
Silver	5
Zinc	25
Cyanide (Total)	10
Cyanide (Free)	2
Dissolved Sulfide	0.1
pH Range	5.5 - 11

These local limits are reviewed regularly to determine if revisions are necessary to meet all local, state and federal regulations. Additional limits may be applied on a case-by-case basis. Examples of such added limits include, but are not restricted to, BOD and total dissolved solids (TDS), high pH, ammonia, benzene, thiosulfate, mercaptans, fluoride, selenium, toxic organic, and oil and grease.

2.2 TAKE A PROACTIVE APPROACH

The best way to minimize or avoid the impacts associated with noncompliance is to take a proactive approach. Facilities that actively seek out and correct the potential causes of upset seldom find themselves operating in "panic mode." Such reactive maintenance and repair can be quite costly when one considers the overall cost. Worker overtime, the need to rent emergency response equipment, production downtime, and possible fines can far out-weigh the costs associated with taking a proactive approach.

Ways to be Proactive

- ✓ Routinely evaluate P2 and recycling opportunities to reduce or eliminate the load placed on the pretreatment system. Once an option is implemented, monitor and track its performance. If you do not get the results expected, investigate why and take additional corrective action.
- ✓ Recognize that eventually all equipment becomes worn-out or obsolete and must be replaced. Some factors to consider include efficiency, physical integrity, safety, and replacement part cost/availability. The replacement of old equipment with new is often justified if one considers the total life-cycle cost.
- ✓ Adopt a Reliability Centered Maintenance approach. This approach seeks out the root cause of equipment

failure so that corrective measures can be enacted to prevent reoccurrence. Equipment is monitored so that maintenance is based on actual need rather than a routine schedule.

2.3 WHEN NONCOMPLIANCE OCCURS

Upsets are bound to occur and when they do, the severity of penalty or sanction that may be imposed will greatly depend on your response and the effect the upset has on the POTW. Most industrial users will have several opportunities to resolve an issue of noncompliance before any escalated administrative enforcement action is taken.

The first level of enforcement action regarding a noncompliance problem taken by IWMD is the issuance of a Notice of Violation (NOV). If the proper corrective action to achieve compliance is taken by the IU, no further action will occur. If continued noncompliance persists beyond the NOV stage, then IWMD will escalate the enforcement action through issuance of an administrative order (Cease and Desist or Compliance Order). If noncompliance continues to persist, IWMD will escalate the enforcement action and may suspend or revoke one's industrial wastewater discharge permit, levy administrative fines and penalties, and apply cost recovery.



In severe cases of willful noncompliance and repeat offense, civil penalties and criminal prosecution may result. Such penalties and prosecution may also result from failure to respond to an upset in a responsible way. In the event you experience a sudden upset or noncompliance problem, the following steps should be enacted to correct the problem in a safe and timely manner.

Steps to Take in Response to an Upset Condition

- ✓ Immediately stop the noncompliant discharge. If the cause of the noncompliant discharge cannot be identified and controlled immediately, it may be necessary to temporarily shut down production.
- ✓ Notify all appropriate agencies. It is the responsibility of the IU to immediately telephone and notify the IWMD. This notification should include the location of the upset, the type, concentration, and volume of waste discharged (if known), and the corrective actions taken to stop or contain the discharge.
- ✓ Identify and correct the problem. This step can be as easy as replacing a failed sensor or it can be a complex task, requiring much detective work. This Guide should provide a good start in identifying and correcting some of

the most common noncompliance problems. Other actions may include:

- Interview the line operators and identify any unusual operating conditions. Poor treatment performance is frequently traceable to system operation at a higher than design flow or loading rate. A simple change in operating procedure may correct the problem.
 - Perform a treatability study. A noncompliance problem may be due to an incorrect operational setting or treatment chemical dosage rate. A treatability study can help establish the proper settings and rates.
 - Discharge effluent to a portable storage tank for batch testing and release (if compliant). Noncompliant effluent should be taken offsite for treatment. This option is expensive but it allows production to continue while the corrective actions are underway.
 - Bring in a Transportable Treatment Unit (TTU). A TTU may be more practical than offsite treatment if the volume of effluent is large.
- ✓ Monitor and report progress. Within five days of the upset, the IU must submit a detailed written report that describes the cause of the upset and the corrective actions taken. A compliance schedule, including progress milestones, must be submitted if the problem cannot be resolved immediately.

2.4 EFFECTIVE COMPLIANCE IS A TEAM EFFORT

Effective compliance requires the involvement of not only the industrial user, but of all regulatory agencies, chemical suppliers, and outside consultants. A cooperative approach is always the best way to achieve the greatest degree of compliance at the lowest cost.

One essential role of the IWMD is to enforce the regulations that are intended to protect the POTW and the environment. The IWMD must also be capable of explaining the ordinance requirements and federal and state regulations to the IU. Thus, the IWMD must walk a fine line between enforcer and advisor.

For the IU, the ability of the IWMD to walk this fine line can often mean the difference between cost-effective compliance or a series of restrictive mandates. One way the IU can help the IWMD walk the line between enforcer and advisor is by keeping everyone informed when a problem occurs. This action ensures that the IWMD knows what actions the IU is taking to correct the problem and it demonstrates to the IWMD that the IU is taking the situation seriously.

This action may also save the IU considerable time and expense because the IWMD might be able to direct the IU to

the appropriate resources for solving their problem. One such source might be another IU that was faced with a similar problem. Additional sources of help for resolving a noncompliance problem include chemical suppliers and outside consultants.

Chemical suppliers often provide advice as to how their products can be effectively used in the process and how the resulting wastes should be treated. The major suppliers of wastewater treatment chemicals all offer extensive advice and assistance as to how to set up a proper monitoring program. They may also provide testing services to help optimize the treatment process. When the need for assistance is great, an outside consultant may be hired to investigate the problem and identify corrective actions.

3.0 THE ROLE OF POLLUTION PREVENTION AND RECYCLING

It is important to keep in mind that the source of a noncompliance problem can be located upstream of the pretreatment system. The sudden discharge of concentrated solution to the pretreatment system can result in upset. Depending on the extent of the upset, a wastewater compliance problem may occur. The implementation of pollution prevention (P2) and recycling practices in upstream operations can help reduce the potential for upset.

The Pollution Prevention Act of 1990 clearly established pollution prevention (P2) as the Nation's preferred approach to environmental protection and waste management. While prior protection and management regulations focused on hazardous waste (i.e., waste minimization), the Act applies to all forms of pollution. As stated:



“The Congress hereby declares it to be the national policy of the United States that pollution should be prevented or reduced at the source whenever feasible; pollution that cannot be prevented should be recycled in an environmentally safe manner whenever feasible; pollution that cannot be prevented or recycled should be treated in an environmentally safe manner whenever feasible; and disposal or other release into the environment should be employed only as a last resort and should be conducted in an environmentally safe manner.”

In addition to protecting the environment and helping a facility remain within compliance, P2 can help facilities operate safer and at less expense. Both direct and indirect cost savings can be achieved through P2. Indirect cost savings are often overlooked because they are difficult to quantify. However, indirect costs often represent a large percentage of the “hidden” cost of doing business. Examples of direct costs and indirect costs include:

Direct Costs

- ✓ Raw material purchases
- ✓ Waste treatment and disposal
- ✓ Labor for waste management
- ✓ Operation and maintenance
- ✓ Water and energy

Indirect (or Hidden) Costs

- ✓ Liability, onsite and offsite
- ✓ Insurance
- ✓ Workman' compensation
- ✓ Regulatory compliance
- ✓ Future pollution control needs

With the practice of P2 and recycling reducing the amount of waste generated by a given production activity, the load discharged to the wastewater pretreatment system is also reduced. This can help a facility maintain compliance by reducing the potential for system upset that often occur due to hydraulic and/or pollutant overload.

For a wastewater pretreatment system in the planning stage, the adoption of P2 and recycling practices beforehand can save substantial capital. A 50 percent reduction in the total volume of wastewater requiring pretreatment can yield a 35 to 40 percent reduction in capital cost. Future operating costs and waste disposal fees will also be less because these costs are directly related to the amount of wastewater. Many shops have been able to reduce their wastewater flows by 50 percent or more through simple changes in operator practice and by making minor modifications to their equipment.

The following listings present P2 options and ideas for a number of industrial and waste generating activities. Some of these ideas are universal in that they apply to most production facilities. An example would be practices that avoid the generation of waste associated with material storage and handling. Practices that apply to maintaining the process bath or reducing drag-out are specific to a given industry (i.e., metal finishing). Both the USEPA and the State of California have published numerous industry-specific guides that should be consulted for additional information.

GOOD HOUSEKEEPING AND SPILL MANAGEMENT

- ✓ Conduct periodic inventories and use materials on a first-in first-out basis. The use of off-spec material can result in poor product quality and reduced bath life.
- ✓ Conduct periodic sampling of supplies held in bulk storage to confirm that they still meet specification. Potential contaminants include water due to atmospheric moisture or rain and iron due to storage tank/bin corrosion.

✓ Improve storage facilities by converting fixed roof tanks to floating roof (less product loss due to evaporation and less potential for contamination by rain or moisture) and by replacing rusted storage units with plastic or lined containers.

✓ Store materials inside the shop or provide outdoor covered storage. Area should be well lit and secure. Provide dikes and berms to contain material in the event of a spill. A concrete pad is better than asphalt and both are better than bare soil.



✓ In the event of a spill, avoid the urge to grab a hose and flush it away (unless there are safety reasons to do so). After containment, try to recover as much of the material for reuse as practical and then use dry absorbents.

REACTION AND MIXING PROCESSES

✓ In a chemical reaction process, improve physical mixing by installing baffles, multiple impellers, or in-line mixers. Good mixing reduces the generation of unwanted byproducts that must later be removed.

✓ Eliminate the use of steam eductors for vacuum production. Steam eductors allow direct contact of vapors with steam, resulting in contaminated condensate.

✓ Use Clean-In-Place systems for the cleaning of reaction vessels and mixing tanks. A high-pressure spray reduces the total volume of cleaner required.

✓ Improve the heating system to avoid localized hot spots. Overheating can lead to the formation of degradation products and an increase in equipment fouling.

✓ Periodically check the heating and cooling system for leaks. Process chemicals may enter the steam condensate or cooling water return lines during shutdown, resulting in contamination of the blowdown.

HEAVY METAL (PROCESS BATH MAINTENANCE)

✓ Use demineralized water to replenish the bath. Hardness salts, sulfates, and chlorides can increase over time and lead to rejects. For a heated tank, the use of tap water can increase hardness levels by 100 percent every 3 to 5 days.

✓ Routinely test bath to ensure that all constituents are within their proper operating range. For facilities without a lab, the solution supplier may offer testing.

✓ To prevent overfilling a process tank with makeup water, automatic control valves and high/low level alarms should be installed. Solid-state sensors are preferable to float valves because they are less prone to fouling.

✓ In a process bath, agitation prevents temperature and concentration gradients from setting up, which can result in rejects. In a cleaning bath, agitation is needed to keep soils in suspension and prevent their deposition onto the parts.

✓ Air agitation is widely used but it has severe limitations. Compressed air seldom provides adequate agitation, it increases the rate of heat loss, and it increases the evaporative loss. Newer systems favor mechanical agitation.

✓ Some shops tolerate high drag-out rates as a means of controlling the build-up of bath impurities. This is poor practice because it results in excessive solution loss and it places a large load on the pretreatment system.

✓ To control impurity build-up, continuous or periodic bath treatment/filtration should be employed. Common bath contaminants and the chemicals used to precipitate them out of solution include the following:

Bath	Contaminant	Chemical
Cyanide	Carbonates	Calcium Oxide
	Zn and Pb	Sodium Sulfide
Zinc	Fe	Potassium Permanganate
	Pb and Cd	Zinc Sulfide
Nickel	Fe and Al	Nickel Hydrate
Nickel (Acid)	Fe and Cr	Hydrogen Peroxide

✓ Allowing the solution to cool down and remain inactive overnight can often result in the separation of oil from an aqueous cleaning bath. A skimmer may then be used to remove the oil that separates out. Membrane systems are available to remove emulsified oils.

HEAVY METAL (DRAG-OUT REDUCTION)

✓ Favor slower withdrawal speed over longer drainage time. For a fixed time cycle, spend two-thirds of the time withdrawing the part from the bath and one-third of the time draining over the bath.

✓ Drain parts over the tank or use drainage boards to extend the effective length of the tank. Boards must slope back towards the tank so that liquid is returned.

✓ Do not rack parts directly over one another. The upper parts will drip and may dirty the parts below resulting in spotting or staining.

✓ Orient part surfaces as close to vertical as possible. Rack parts with their lower edge tilted from the horizontal. Run-off should be from a corner rather than an entire edge. Burp bars may help to knock solution off the part after removal.

- ✓ Cavities and recessed pockets should be oriented downward. Rotation of parts during withdrawal and drainage may help.
- ✓ Use the correct size and type of basket to minimize wetted surface area. A wire mesh basket can retain much liquid if the mesh is too tight. Never use porous materials such as ropes or cloth bags to hold parts.

HEAVY METAL (WATER CONSERVATION)

- ✓ Select the minimum size tank in which the parts can be rinsed and use the same size tank for the entire process line, where practical.
- ✓ Locate the clean water inlet below the surface and at the opposite side of the rinse tank away from the outlet to avoid short-circuiting.
- ✓ Use multiple rinse tanks in a counter-flow configuration. Compared to a single rinse, a counter-flow rinse can reduce water use by 90 percent. Using the spent rinse water for process bath makeup reduces the pretreatment load.
- ✓ Install flow-restrictors on water supply lines. Stop water flow during idle periods by means of production-activated controls, conductivity probes, and timers.

4.0 ALTERNATIVES TO PRETREATMENT

The practices of P2 and recycling have been identified as viable ways to reduce the hydraulic and pollutant loads placed on a pretreatment system.

This reduction in loading is based on the position that these practices improve the overall efficiency of a given process (i.e., the more effectively raw materials are used, the less waste generated). Countless studies have shown that the opportunity for hydraulic and pollutant load reduction is present at most facilities.



On a more limited scale, some P2 and recycling practices can eliminate certain pollutants from the wastewater stream. One example is the replacement of a cleaner that contains chromium-based corrosion inhibitors with a non-chromate version. Since chromium compounds are no longer used, the need for hexavalent chromium reduction prior to heavy metal precipitation is eliminated (assuming that the cleaner was the only source of chromium in the shop).

The following listing presents some P2 and recycling practices

that have successfully eliminated the discharge of certain pollutants. Concerns over worker health and safety, treatment costs, regulatory compliance costs, and potential liability are prompting many to investigate these practices. Major limitations include the need for tighter process control, worker retraining, and issues of product quality. However, with management commitment, many limitations of the past have been successfully overcome and the development of new practices is expected to continue.

MATERIAL SUBSTITUTION AND RECYCLING

- ✓ Non-cyanide-based copper plating solutions are commercially available for steel, brass, lead-tin alloy, zinc die cast, and zincated aluminum. By eliminating the use of cyanide, the need for two-stage chlorination during pretreatment is avoided.
- ✓ Cyanide-based solutions are used to strip valuable metal from rejected parts and remove metal buildup from racks and holders. Non-cyanide-based solutions for nickel, silver, and other metals are available.
- ✓ Cadmium can be replaced in a variety of applications by electroplating with zinc alloy or by the ion vapor deposition of aluminum. Since cadmium solutions contain cyanide, conversion eliminates two undesirable pollutants.
- ✓ Hexavalent chromium is widely used in hard chrome and decorative chrome plating. The use of trivalent chromium in some decorative applications has been successful. One issue is color matching with existing fixtures. The performance requirement for hard chrome makes substitution difficult.
- ✓ Chromium conversion coatings are widely applied to magnesium, aluminum, and zinc. Sulfuric acid anodizing has been used as a substitute, but the resulting coating is more brittle and thicker. Zirconium oxide and molybdate conversion coatings are under development.
- ✓ Many vendors offer non-chromate versions of their cleaners and degreasers that contain chromium-based corrosion inhibitors. Many MIL-Specs have been revised to allow for the use of these non-chromate cleaners.
- ✓ All of the chlorinated solvents that are widely used for cleaning and degreasing are listed as Toxic Organics (TO). To eliminate their use, many facilities have converted to aqueous cleaners. Product data is available from the SCAQMD Clean Air Solvent program.
- ✓ Small-scale electro dialysis systems are commercially available for regenerating spent hexavalent chromium solutions. Other regeneration techniques include reverse osmosis, ion exchange, and electrolytic metal recovery. These systems are finding increased use for cyanide, nickel, copper, and zinc solutions.

5.0 SOLVING COMPLIANCE PROBLEMS

The following sections provide help in troubleshooting and correcting many common wastewater compliance problems. As stated in the introduction, this help is meant to provide you with general information that can be used in your troubleshooting effort. Most compliance problems can be solved by following the listed actions, but not all. For such “unsolvable” problems, outside assistance may be required.

5.1 PRELIMINARY PRETREATMENT

Proper wastewater pretreatment should always begin ahead of, or upstream of, the pretreatment process. Most pretreatment processes are highly sensitive to flow and load variations and the presence of solids. Efforts to eliminate or reduce variations can mean the difference between compliance and non-compliance. Preliminary methods include stream segregation, flow equalization, and screening.

5.1.1 Stream Segregation

Stream segregation is important because most pretreatment systems operate best when handling a limited range of pollutants. The mixing of some streams, such as those containing heavy metals with those containing chelating compounds can make effective pretreatment difficult. Such mixtures require additional treatment steps that add complexity and cost to the overall system.

In addition to easing the complexity of pretreatment, stream segregation allows streams to be pretreated individually. The pretreatment of an individual stream often results in better compliance because less pollutant is present in the overall effluent. This effect is illustrated by the example below.

Rinse water containing 100 parts per million by weight (ppmw) copper is discharged to a 500 gpm pretreatment system. Assuming rinse water flow to be 5 gpm and no other sources of copper, the total influent of 500 gpm will contain 1 ppmw copper. Pretreatment via pH adjustment and precipitation will reduce this level to 0.4 ppmw copper (the minimum solubility limit at a pH of 8 to 11). By pretreating the 5 gpm of rinse water first and then combining it with the 495 gpm of other influent, the resulting level of copper is 0.004 ppmw (4 ppbw).

Points to Remember about Stream Segregation

- ✓ Concentrated metal-bearing solutions should be batch-treated and the effluent bled into the existing wastewater pretreatment system. Large and sudden bath dumps are sure to result in upsets and noncompliance.
- ✓ Acidic and alkaline streams should not be discharged to the pretreatment system in the same piping. The mixing of these streams can result in the formation of solids that can foul pumps and plug lines. The exothermic reaction that occurs can also damage the piping and in extreme cases, cause an explosion.
- ✓ Waste streams containing cyanide must be piped separately to the pretreatment system and not be allowed to mix with other streams. Mixing with low pH streams can result in the release of toxic hydrogen cyanide gas.
- ✓ Solvents used for equipment cleaning may be reusable as part of the next product batch if they are kept segregated from other cleaning wastes. This practice is common with solvent-based paints, inks, and pesticide formulations.
- ✓ Manual pre-cleaning is an effective way to minimize the amount of oil and grease discharged to an interceptor. Dirty cooking oil and grease should be collected in buckets and drums for subsequent pickup by a licensed hauler.

5.1.2 Flow Equalization

After segregation and screening (if needed), some means of flow equalization should be provided. Biological processes are very sensitive to changes in flow and pollutant load because they are slow to react. A sudden increase in the influent flow or load may pass through the system untreated. Particularly for physical-chemical treatment, variations in flow can result in the under or over use of chemical additives. This occurs because the addition of the chemical is most often based on flow while the actual need is based on load.

The equalization of incoming wastewater flow is an economical way to improve the performance of your treatment system. Flow equalization reduces the variation in hydraulic and pollutant loads that can result in upset and pass-through. With flow equalization, downstream equipment operates more efficiently and with less stress. This can result in power savings and reduced maintenance costs. For a planned system, the inclusion of equalization can help reduce the peak design load. This, in turn, reduces the need for over-sizing the system and saves capital expense.

There are two common methods used to provide flow equalization: in-line and sideline. In-line equalization takes all incoming flow and passes it through a large holding tank. This tank provides sufficient surge capacity so that the wastewater can be discharged to the treatment system at a constant rate. In sideline equalization, flows that exceed the average rate or

pollutant load are diverted into a holding tank for eventual return to the system. While both methods are effective in equalizing hydraulic load, the in-line method is best for equalizing pollutant load.

Will Flow Equalization Benefit Your System?

Follow these steps to determine if flow equalization will help you in your efforts to maintain wastewater pretreatment compliance:

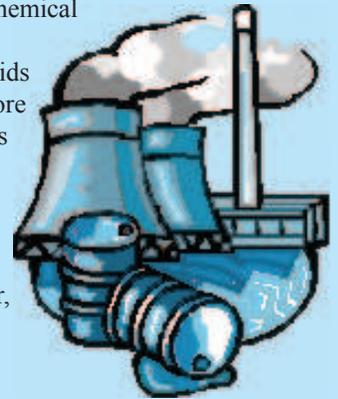
- 1) Monitor the flow of wastewater into your pretreatment system for one or more cycles of operation. One cycle of operation may be an 8-hour shift or a 24-hour day depending on your operation.
- 2) From the monitoring data, calculate the average flow rate and the standard deviation of flow. Divide the standard deviation by the average flow rate and multiply by 100. This term is your coefficient of variability in percent.
- 3) If your coefficient of variability is greater than 25 percent, then you may want to consider installing in-line or sideline flow equalization. Don't overlook good operating practices as a way to lower your coefficient of variability.
- 4) Repeat steps 1 through 3 using monitoring data for a critical pollutant or a representative parameter (e.g., pH, conductivity, TDS). If the coefficient of variability exceeds 25 percent, consider in-line flow equalization.

Factors Which Make Flow Equalization Successful

- ✓ Solids should be removed from the wastewater via screening prior to the flow equalization tank. Solids inside the tank may settle out and reduce the liquid capacity of the tank. Abrasive solids may cause excessive wear.
- ✓ Proper and complete mixing is required for successful flow equalization. Tanks should be provided with internal baffles to promote mixing. Large tanks may require mixers and/or pump operated jets.
- ✓ Tank inlets should be located near the mixers to disperse the flow as soon as possible. The flow outlet should be configured to prevent short-circuiting of the incoming wastewater.
- ✓ Streams containing volatile solvents should be kept segregated from the main wastewater flow. Solvent vapors may create an explosive atmosphere inside the equalization tank or trigger the need for emission controls.
- ✓ For biodegradable wastes, mixing and aeration may be required to prevent septic conditions. Septic conditions can lead to the conversion of benign sulfates into harmful sulfides. Hydrogen sulfide is a highly corrosive and toxic gas.

5.1.3 Screening of Solids

When large solids are present in the influent, they should be screened out prior to the pretreatment step. Failure to remove these solids ahead of the pretreatment step can lead to poor mixing and reaction, increased chemical usage, and higher maintenance costs. The removal of these solids from the effluent may also be more difficult due to physical changes and the potential reuse of these solids may be impossible due to cross contamination. Such solids are often found in the food processing, pulp and paper, textile, and commercial laundry industries.



Screens may be fabricated from bare or coated metal bars, rods, wires, grating, mesh, or perforated plate. Bar (or coarse) screens are often used to remove trash and debris. This solid waste may be present due to the collection of storm and/or process water from large outdoor areas. Fine screens may be used to remove solids such as sand, silt, and fibers that exceed 75 microns in size. Common equipment designs include stationary (i.e., static) screens, vibrating screens, and rotating drum.

The stationary screen features a flat or curved screen panel that fits into a cabinet that consists of overhead influent chamber and bottom effluent chamber. Water passes through the screen while the retained solids cascade down the front of the screen and drop off into a collection bin. Manual cleaning with a hose and brush is periodically required due to fouling (i.e., blinding) of the screen openings. Vibration may be used to help remove solids from the front of the screen and to produce a dryer sludge.

The drum screen consists of a revolving hollow cylinder covered with screen material. Incoming water is distributed along the top of the drum where it flows through the screen. Retained solids are carried along on the rotating drum until a fixed doctor blade removes them. As the drum continues to turn, the screened water from above now passes through the bottom of the drum. This second pass removes any trapped solids from the screen and provides a self-cleaning effect.

Factors Which Make Screening Successful

- ✓ Always use the appropriate type of screen for a given application. Static screens and rotating disc filters are suitable for fibrous and non-greasy waste. Internally fed rotating screens are good for coarse fibrous waste. For fatty and greasy waste, use externally fed rotating screens.
- ✓ Screens should be visually checked for fouling and

blinding at least once per 8-hour shift. Always clean the screen if it is to be shut down for an extended time.

- ✓ To manually clean a screen, use a portable pressure spray cleaner or hard bristle brush. Never use a metallic brush other than stainless steel. The iron from a metal brush can result in rusting and pit formation.
- ✓ Regular maintenance ensures peak performance, reduces the potential for upset or equipment breakdown, and maximizes the life of the screen.

Common Causes of Solids Noncompliance

Cause	Corrective Action
Influent overflows static screen due to solids buildup.	Shut off influent and clean the top surface of the screen. Remove the screen panel and clean the underside. Cleaning should be performed with a high-pressure sprayer or with a water hose and non-metallic hard bristle brush.
Solids pass through static screen.	Check the screen for visible signs of damage. Inspect the seal between the edge of the screen and the screen cabinet. Replace screen, if necessary.
Influent overflows externally fed rotating screen.	Inadequate spray cleaning may require a change in the cleaning cycle. Check the spray nozzles for a buildup of solids and clean if necessary. The effectiveness of on-line cleaning may be improved by installing a set of spray bars inside the rotating screen.
Solids bypass the rotating screen and are present in the effluent.	Inspect and replace seals, as needed. Adjust the doctor blade so that there are no gaps and it makes contact with the entire length of the screen. Damaged or warped blades should be replaced.

5.2 PRETREATMENT TECHNOLOGIES

The following sections provide help in troubleshooting and correcting many common wastewater compliance problems. Each section presents a brief introduction to a given pretreatment technology, a listing of factors that make a given operation successful, and a listing of corrective actions for each cause of noncompliance. Pretreatment technologies discussed in this guide include the following:

- ✓ pH Adjustment
- ✓ Heavy Metal Precipitation
- ✓ Hexavalent Chromium Reduction
- ✓ Cyanide Destruction
- ✓ Physical Oil and Grease Separation
- ✓ Biochemical Oxygen Demand Reduction
- ✓ Toxic Organic Pretreatment
- ✓ Suspended Solids Removal

Except for oil and grease separation, few of these pretreatment technologies are employed on a stand-alone basis. Some of these technologies must be used to alter or condition the waste so that it is amenable to further treatment. Examples include the destruction of cyanide prior to heavy metal precipitation and the removal of toxic organics prior to biochemical oxygen demand reduction. The table presented below lists the pretreatment technologies that are often employed at a given type of facility.



Type of Facility	pH Adjustment	Heavy Metal Precipitation	Hex. Chromium Reduction	Cyanide Destruction	Physical O&G Separation	BOD Reduction	Toxic Organic Pretreatment	Suspended Solids Removal
Automotive Repair					X			
Chemicals, Inorganic	X	X	X					X
Chemicals, Organic	X			X		X	X	X
Electrical Component Manf.	X	X	X	X	X			X
Food Production	X				X	X		X
Groundwater Remediation	X	X					X	X
Laundries	X				X			X
Metal Plating and Finishing	X	X	X	X	X			X
Petroleum Refining	X				X	X		X
Pharmaceuticals	X					X	X	X
Restaurants					X			

5.2.1 pH Adjustment

The most common method of adjusting pH is by the addition of an acid or base to the wastewater. To raise pH, basic compounds such as sodium hydroxide (caustic soda), calcium oxide (lime), calcium hydroxide (hydrated lime), or sodium carbonate (soda ash) are used. To lower pH, sulfuric or hydrochloric acid may be used. For ease of ordering, handling, and safety, some facilities use their existing process chemicals for pH adjustment.

The pH value of neutral water is seven, with a value less than 2 representing a very acidic condition and a value greater than 12 being very basic. The pH value is derived from the negative logarithm of the hydrogen ion concentration.

To measure pH, a specially designed meter employing a glass bulb sensor is used. The sensor is placed in the sample and the meter compares the signal from the sensor to the signal from an internal reference cell. Common sources of error include improper calibration, failure to adjust for temperature effects, bulb damage or fouling, the presence of interfering ions, and lack of a representative sample.



Factors Which Make pH Control Successful

- ✓ Provide adequate hydraulic capacity and mixing for a complete and homogeneous reaction. The minimum residence time for batch adjustment should be 3 to 10 minutes; continuous adjustment should be 5 to 7 minutes. Chromium reduction and cyanide treatment require longer residence times.
- ✓ The interval between chemical addition and the first detected change in effluent pH (i.e., dead time) should be about 5 percent of residence time. The agitator should be sized to provide a pumping capacity of 20 times the influent flow.
- ✓ Automate pH monitoring and chemical feed control. Automated systems provide a greater degree of control than manual systems. Advanced systems can account for response times, reducing the potential for over or under adjustment.
- ✓ Maintain pH monitoring and control equipment in good working order. Sensor cells should be routinely cleaned and inspected for damage. Meters should be routinely calibrated or checked against a standard.
- ✓ Provide redundant pH sensors. The accurate measurement of pH can be difficult. Some operators have found it best to use three sensors and base control on the middle value. When values differ by more than a set amount (about 0.15 pH units), it is an indication of a malfunctioning probe.
- ✓ Provide effluent pH alarm and a flow diversion system. If the effluent pH exceeds permit limits, the discharge should be

held for batch treatment or recycled to the inlet of the pH adjustment stage. Alarms should be located at the treatment plant and at the production area so that noncompliant discharges can be curtailed.

Common Causes of pH Noncompliance

Cause	Corrective Action
Reliance on litmus paper to monitor pH.	The use of litmus paper to monitor pH is acceptable for spot checks, but is not suitable for a pretreatment control system. Reliable control requires continuous monitoring. Install automated pH controls to maintain accurate chemical feed and reaction conditions.
Incorrect chemical usage.	For a manual feed system, the operator should not rely on pH readings alone. Buffering effects, poor mixing, and slow meter response time can result in overdosing. Routine lab tests should be run to confirm that the proper amount of chemical is being added.
	Better pH control is achieved via automated monitoring and chemical feed control. Occasional lab tests are used to set maximum dosage rates.
	Chemical weigh feeders should be routinely inspected and calibrated. Use of liquid chemicals provides better dosage control and mixing than the use of dry powders.
Incomplete mixing.	Check the concentration of reagents, especially if diluted prior to use. Too strong a reagent makes control difficult and unstable. If too dilute, feed pumps may not be able to supply sufficient reagent.
	Systems should be sized to provide sufficient residence time for reaction. The installation of baffles, agitators, or eductor jets may be required to ensure proper mixing and improve pH sensor response.

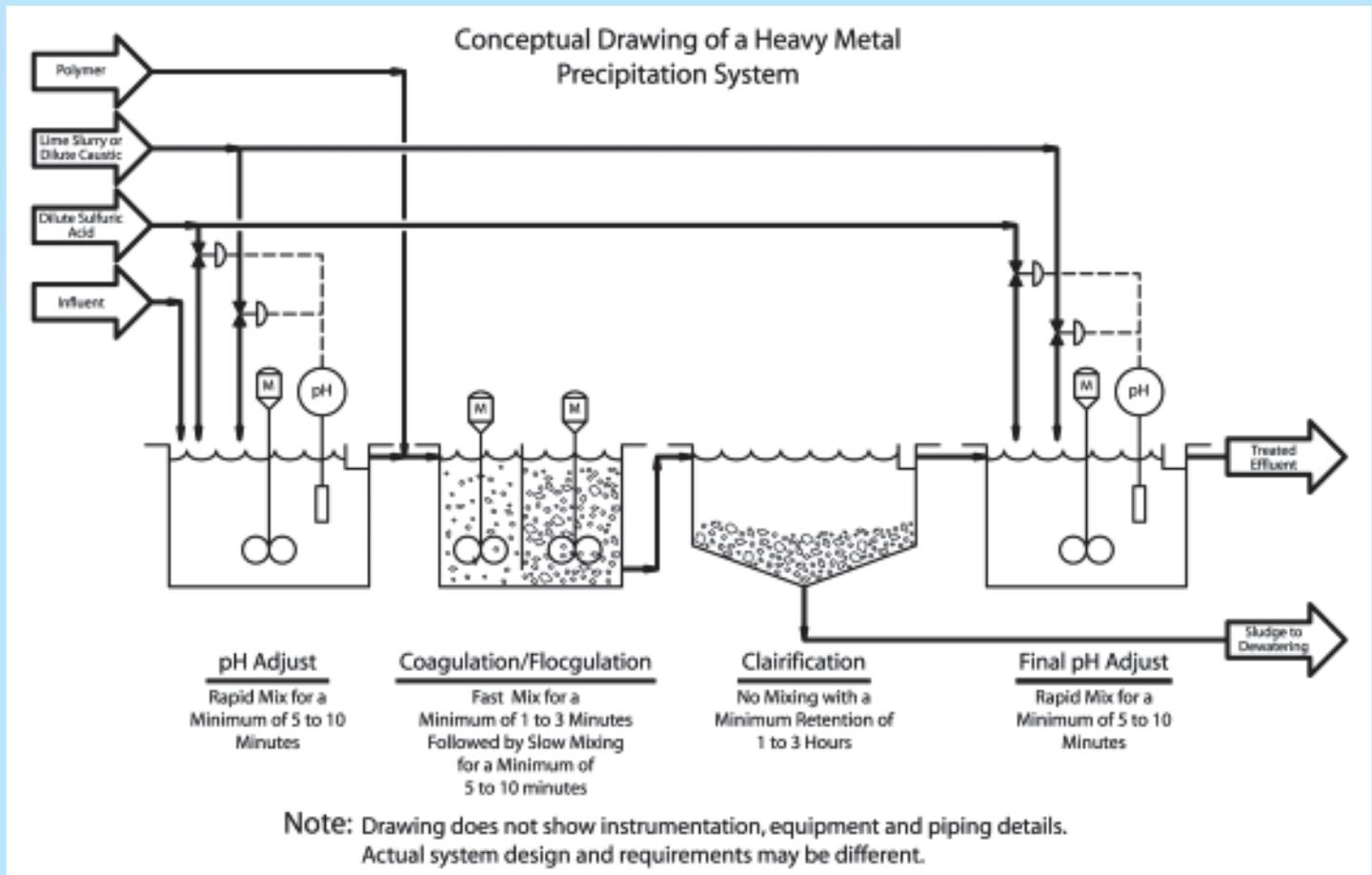
5.2.2 Heavy Metal Precipitation

Heavy metals tend to be most soluble at acidic or low pH conditions. By raising pH via the addition of caustic or lime, solubility is reduced and the metals precipitate out of solution as insoluble hydroxides. Under most conditions, hydroxide precipitation is consistently capable of meeting the parts per million discharge limits set by local ordinance.

The overall process consists of adjusting the pH to an optimum value to precipitate the metals of concern followed by multi-stage coagulation and flocculation, and then clarification. Additional operations include effluent polishing and sludge dewatering. If the wastewater contains hexavalent chromium or cyanide, specialized pretreatment is required prior to

Factors Which Make Precipitation Successful

✓ Provide the optimum precipitation pH for the metals present. The optimum pH for chromium, copper, and zinc is 8.5 to 9.5 while higher pH values are optimum for cadmium and nickel. Effective removal may require multiple stages.



precipitation.

After precipitation, the charge that is present on the formed particles must be neutralized so that coagulation and flocculation can occur. Charge neutralization may require the use of aluminum sulfate, ferric chloride, or calcium hydroxide. Rapid mixing is important to ensure complete mixing and intimate contact between particles.

This period of rapid mixing is followed by a period of gentle mixing to allow time for flocculation. An organic polymer may be added during this stage to speed the process. As the insoluble particles flocculate and grow larger, their settling velocity increases and they are more likely to settle.

Solids removal is typically performed by gravity separation in a clarifier. The solids settle out and they are removed via the clarifier underflow as sludge. To minimize the weight of sludge sent offsite for disposal or recovery, the sludge is dewatered and the filtrate is returned to the head of the pretreatment process. Overflow from the clarifier may undergo effluent polishing by passing through a screen or filter prior to discharge.

- ✓ Provide adequate hydraulic capacity and mixing for a complete and homogeneous reaction. The minimum retention time should be:
 - 5 to 10 minutes of rapid mix for pH adjustment
 - 1 to 3 minutes of fast mixing for coagulation
 - 5 to 10 minutes of slow mixing for flocculation
 - 1 hour or more with no mixing for settling and clarification
- ✓ Optimum precipitation pH and minimum reaction time are difficult to predict. Most published solubility curves do not represent the level of solubility achieved in practice. Jar tests should always be conducted to establish the optimum pH and reaction, flocculation, and settling time for a given wastewater stream.
- ✓ Automate pH monitoring and chemical feed control. Automated systems provide a greater degree of control than manual systems. Advanced systems can account for response times, reducing the potential for over or under dosing.

Common Causes of Heavy Metal Noncompliance

Cause	Corrective Action
Reliance on litmus paper to monitor pH.	The use of litmus paper to monitor pH is acceptable for spot checks, but is not suitable for a pretreatment control system. Reliable control requires continuous monitoring. Install automated pH controls to maintain accurate chemical feed and reaction conditions.
Incorrect chemical usage.	For a manual feed system, the operator should not rely on pH readings alone. Buffering effects, poor mixing, and slow meter response time can result in overdosing. Routine lab tests should be run to confirm that the proper amount of chemical is being added.
	Better pH control is achieved via automated monitoring and chemical feed control. Occasional lab tests are used to set maximum dosage rates.
	Chemical weigh feeders should be routinely inspected and calibrated. Use of liquid chemicals provides better dosage control and mixing than the use of dry powders.
	Check the concentration of reagents, especially if diluted prior to use. Too strong a reagent makes control difficult and unstable. If too dilute, feed pumps may not be able to supply sufficient reagent.
Incomplete mixing.	Systems should be sized to provide sufficient residence time for reaction. The installation of baffles, agitators, or eductor jets may be required to ensure proper mixing and improve pH sensor response.
Inaccurate, slow, or erratic pH readings.	A slime layer of 1-millimeter thickness over the sensor bulb can slow response time from a few seconds to several minutes or more. Trapped solution can cause readings to freeze. Routinely clean and check sensors.
	Sensor response time is diffusion limited. Locating the sensor where the flow velocity is 7 feet per second or more improves response time and reduces fouling. A flow velocity of 10 feet per second or more can cause signal noise and excessive wear on the sensor.
	Routinely calibrate the pH meter and use a handheld unit to periodically check the operation of the fixed sensor. For an application prone to fouling, consider the use of multiple sensors.

5.2.3 Hexavalent Chromium Reduction

The conventional approach to pretreatment is to first reduce the hexavalent chromium to its less toxic trivalent form and then precipitate the chromium in its hydroxide form. The first step involving the reduction of chromium takes place at a pH of about 2 with an oxygen reduction potential (ORP) of +250mV. Sulfur dioxide, sodium bisulfite, or sodium metabisulfite are used as reducing agents. Sulfuric acid is used to lower pH.

In the second step, the pH is raised above eight and the trivalent chromium precipitates out of solution. Caustic soda is the preferred reagent for pH adjustment but many facilities use hydrated lime. Chromium precipitation may be conducted in a dedicated system or the reduced stream may be combined with other metal-bearing streams for precipitation in a common system.

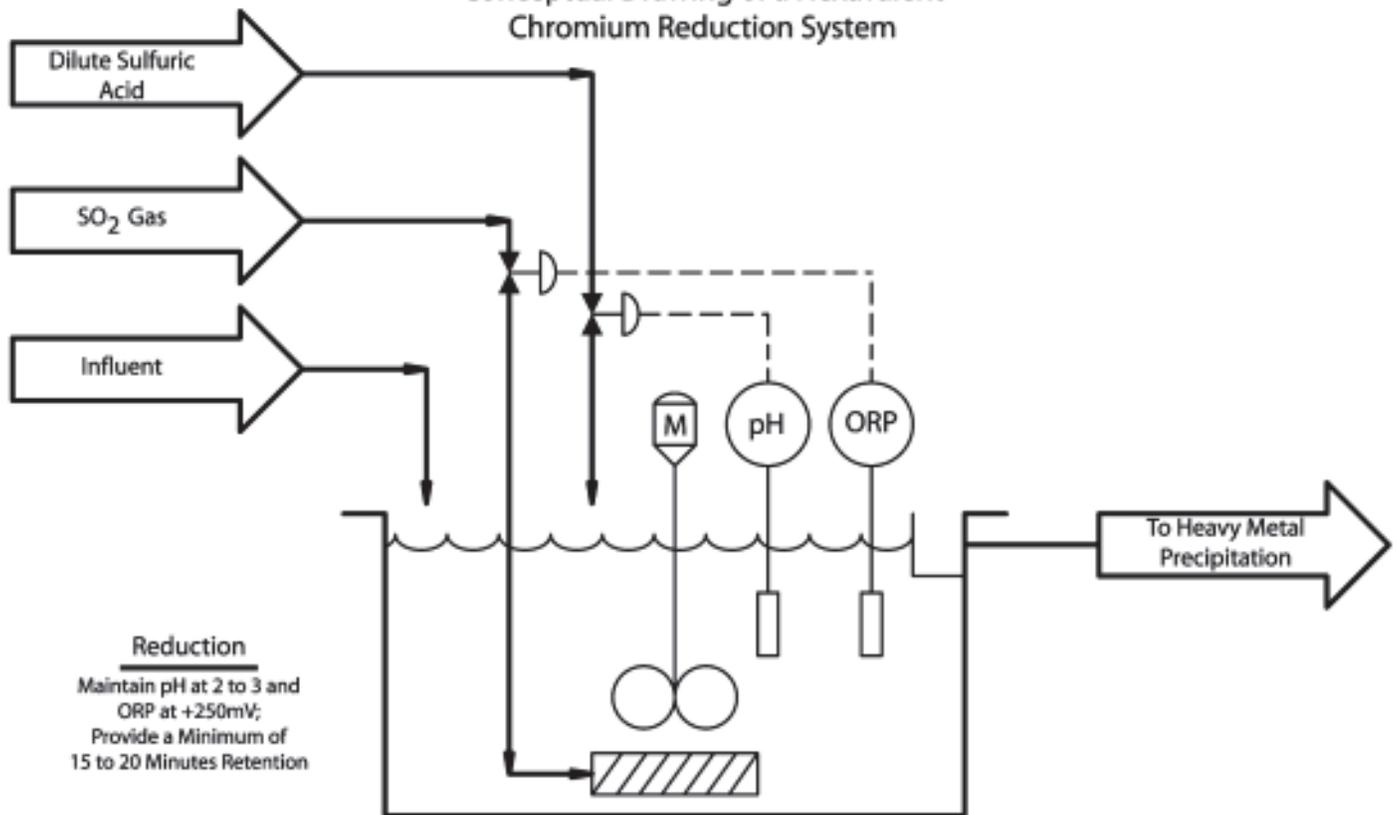


Other chromium reduction methods include batch reduction and the one-step process. Batch reduction is performed by adjusting the water to a pH of four followed by addition of sodium hydrosulfite. In the one-step process, sodium sulfide or ferric sulfide is used under slightly alkaline conditions (i.e., a pH of 8 to 9) to directly precipitate the hexavalent chromium.

Factors Which Make Chromium Reduction Successful

- ✓ Design system for adequate hydraulic capacity and chromium load. Provide flow equalization prior to the pretreatment system.
- ✓ Automate pH and ORP monitoring and chemical feed controls. The optimum pH range for hexavalent chromium reduction in a continuous system is 2 to 3. The oxidation-reduction potential (ORP) should be controlled to +250 mv.
- ✓ Provide adequate tank volume for complete mixing and reaction. The optimum retention time for pH adjustment during chromium reduction is 15 to 30 minutes. The optimum retention time for hydroxide precipitation is 10 to 20 minutes.
- ✓ Provide mechanical agitation (mixing) to ensure complete mixing. The feed lines for the reduction chemicals and sulfuric acid should be kept separate.
- ✓ Do not let the pH fall below 8 if sodium sulfide is used because hydrogen sulfide gas may be released. The potential for toxic hydrogen sulfide release is reduced when ferric sulfide is used but the volume of sludge generated is greater.

Conceptual Drawing of a Hexavalent Chromium Reduction System



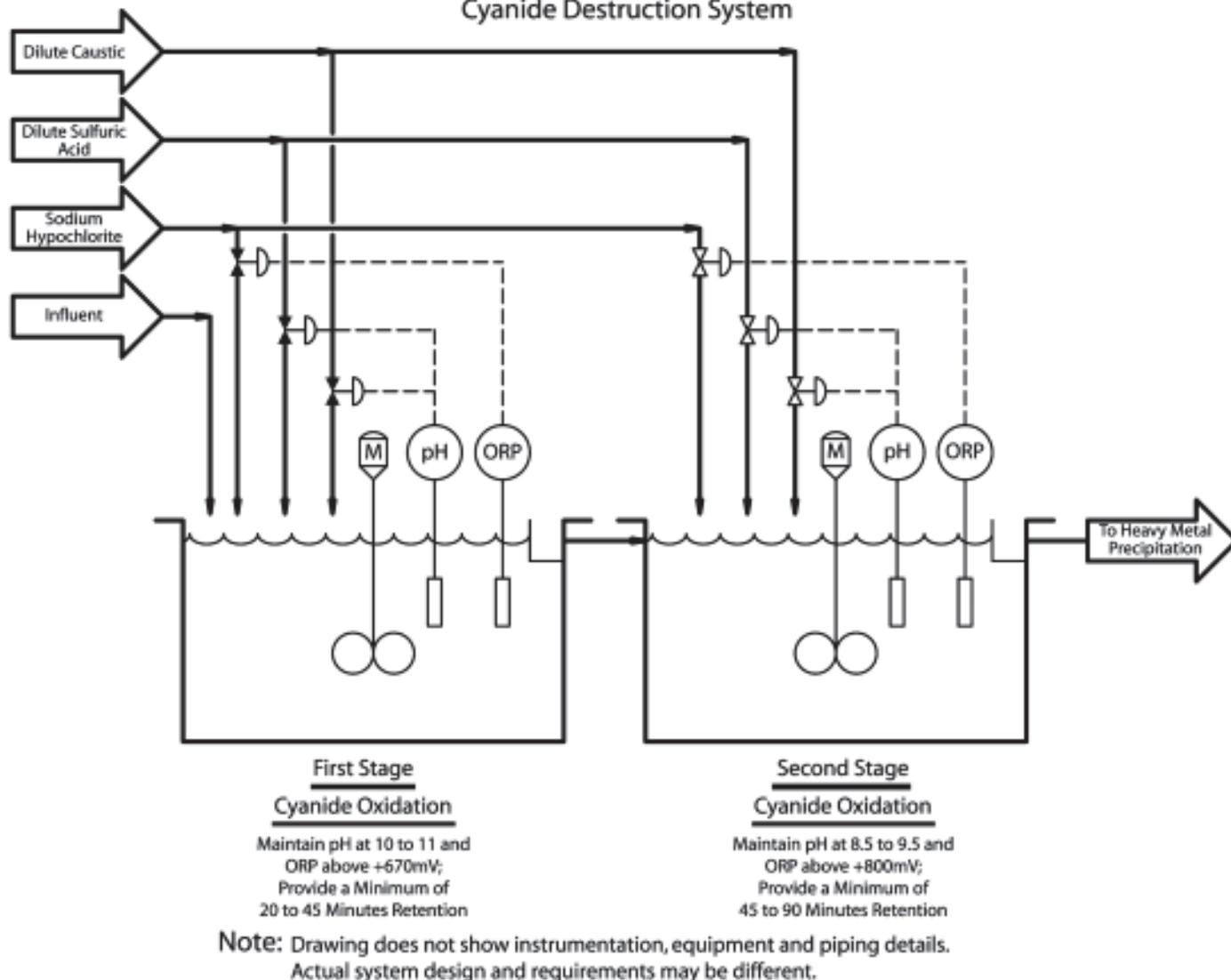
Note: Drawing does not show instrumentation, equipment and piping details. Actual system design and requirements may be different.

Common Causes of Chromium Noncompliance

Cause	Corrective Action
The rate of reduction is too slow; hexavalent chromium is present in first stage effluent.	Check the pH and ORP controls to ensure that they are functioning correctly. If not, repair and recalibrate. Also check the solution strength of the reduction reagent and the sulfuric acid (if diluted before use).
	Add more sulfuric acid to adjust the pH below 2. The rate of reduction increases with a decrease in pH.
	Confirm that there are no chelating agents such as EDTA in the influent. Cross-contamination on the process line can be responsible for causing an upset to the reduction process.

Cause	Corrective Action
Soluble chromium in the second stage effluent.	Maintain the optimum pH for precipitation. See sections 5.2.1 and 5.2.2 for additional help on pH adjustment and metal precipitation.
	At a pH above 9, precipitated chromium will dissolve back into solution. This problem can be avoided by having a dedicated system for chromium precipitation. A multi-stage precipitation system may also be employed.
	Consider the use of sulfide precipitation when discharge limits are very low. Sulfide precipitation can also remove most complexed metals from the wastewater.
Presence of toxic sulfides in the effluent.	The use of sulfide precipitation often requires add-on controls to prevent the discharge of sulfide. Chlorine or peroxide may be used to oxidize residual sulfide.

Conceptual Drawing of a Cyanide Destruction System



4.4.4 Cyanide Destruction

The basic pretreatment system for removing cyanide prior to precipitation is commonly referred to as a two-stage “cyanide destruction” system. The cyanide is first oxidized to cyanogen chloride and then sodium cyanate in the first stage and then further oxidized to carbon dioxide and nitrogen in the second stage. Common oxidation agents include sodium hypochlorite (NaOCl) or chlorine gas.

In the first stage, the pH is maintained at 10.5 to 11 while sodium hypochlorite is added to keep the oxidation-reduction potential (ORP) above +670 mV. If the pH falls to 9.5, the ORP must be increased to maintain an optimum rate of reaction. At a pH below 9.5, cyanogen chloride (tear gas) is liberated from solution and the reaction stops. At neutral to acidic pH, toxic hydrogen cyanide gas can be released.

In the second stage, the sodium cyanate is oxidized to carbon dioxide and nitrogen gas. The pH must be controlled between 8.5 and 9.5 and the ORP must be maintained above +800 mV by adding sodium hypochlorite. If the pH falls below 7, the sodium cyanate reacts with water to form ammonium compounds which may chelate metals such as copper and inhibit or prevent their removal.

Factors Which Make Cyanide Destruction Successful

- ✓ Amenable (i.e., readily oxidized) cyanides include compounds of cadmium and zinc. Copper and nickel compounds are more difficult to oxidize and they require longer retention time. Iron compounds are highly refractory and difficult to treat.
- ✓ Conduct cyanide destruction in two separate tanks connected in series. The use of a single tank divided in two may not provide sufficient retention time. A leaking or failed divider can result in noncompliance and the generation of tear

gas.

✓ Provide the optimum pH for cyanide destruction in each stage (i.e., a pH of 10 to 11 for the first stage and a pH of 8.5 to 9.5 for the second stage). Rigorous pH control is needed to safely and adequately treat cyanide-bearing wastes.

WARNING!

If the pH in the first stage falls below 10, tear gas (cyanogen chloride) may be released.
At neutral to acidic pH, highly toxic hydrogen cyanide gas can be released!

✓ Control the Oxidation Reduction Potential (ORP) level above +670 mV in the first stage and provide a retention time of 20 to 45 minutes. In the second stage, maintain the ORP level above +800 mV and provide a retention time of 45 to 90 minutes. Provide mechanical agitation to ensure complete mixing.

Common Causes of Cyanide Noncompliance

Cause	Corrective Action
First stage pH is too high or too low.	Check the pH and ORP controls to ensure that they are functioning correctly. If not, repair and recalibrate. Also check the solution strength of the oxidant and the pH adjustment chemicals (if diluted before use).
	If pH is above 11, add more sulfuric acid to drop the pH but do not let it drop below 10. If the pH falls below 10, the rate of reaction will slow and cyanogen chloride (tear gas) may be released.
	If pH is below 10, add more caustic to raise the pH but do not let it go above 11. If the pH exceeds 11.5, excessive sodium hypochlorite will be required to maintain an ORP value of +670 mV.
Second stage pH is too high or too low.	Check the pH and ORP controls to ensure that they are functioning correctly. If not, repair and recalibrate. Also check the solution strength of the oxidant and the pH adjustment chemicals (if diluted before use).
	If pH is above 9.5, add more sulfuric acid to drop the pH but do not let it drop below 8.5. If the pH falls below 8.5, ammonium compounds are formed. These compounds may complex with copper and prevent its removal.
	If pH is below 8.5, add more caustic to raise the pH but do not let it go above 9.5. Sodium hypochlorite is used to maintain a minimum ORP value of +800 mV.

Cause	Corrective Action
Inadequate reduction of cyanide.	Provide sufficient retention time in each stage to assure complete reaction. The required change in pH should be conducted slowly; a rapid change in pH can result in the release of toxic gas.
Presence of cyanide and/or metals in the final effluent.	Soluble iron forms very stable ferrocyanide complexes that prevent the cyanide from being oxidized. Streams containing soluble iron should be kept segregated from cyanide bearing streams. Check your supply of sulfuric acid for iron contamination.
	Keep the pH of the second stage above 8.5 to avoid the formation of ammonium compounds. Ammonium compounds can complex with metals such as copper and prevent their removal via hydroxide precipitation.
	After the second stage, a polymer may be added to aid in the settling of solids. The settling tank should provide a minimum retention time of 1 hour or more based on jar tests and settling tests.

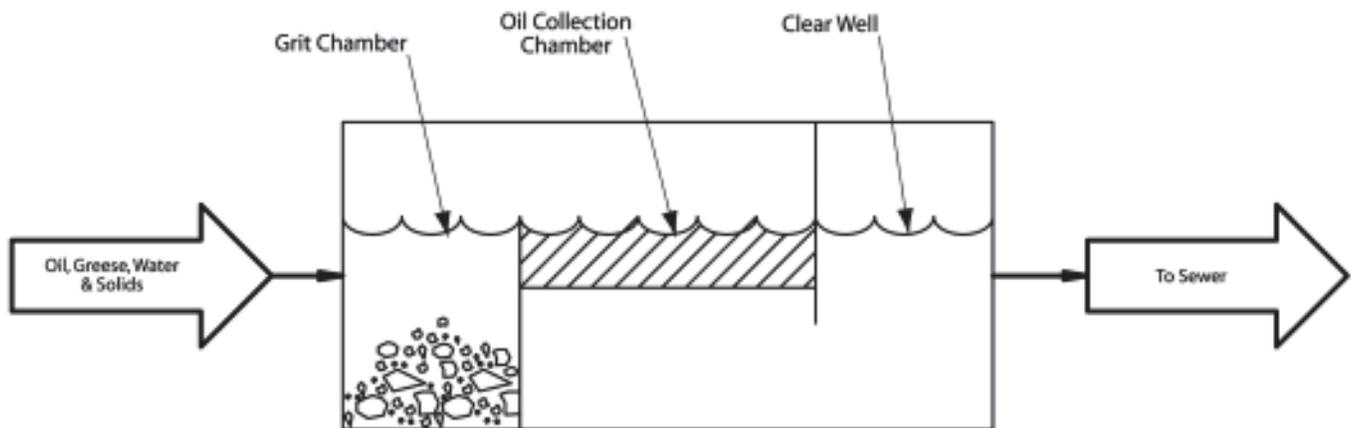
5.2.5 Physical Oil and Grease Separation

Polar oil and grease, usually biodegradable, originates from animals or vegetables and may include waxes, fatty acids, fats, oils, and soaps. Non-polar oil and grease, which is less readily biodegradable, usually originates from petroleum products such as gasoline, jet fuels, crude oils, diesel fuel, asphalt, and lubricants.

For the removal of polar oil and grease from wastewater, the Uniform Plumbing Code recommends that an approved grease trap be installed. Grease traps take advantage of the difference in specific gravity of oil and grease versus water by creating a quiescent environment in which the oil and grease can rise to the water surface. Passive traps require periodic cleaning while automatic traps employ a skimmer.

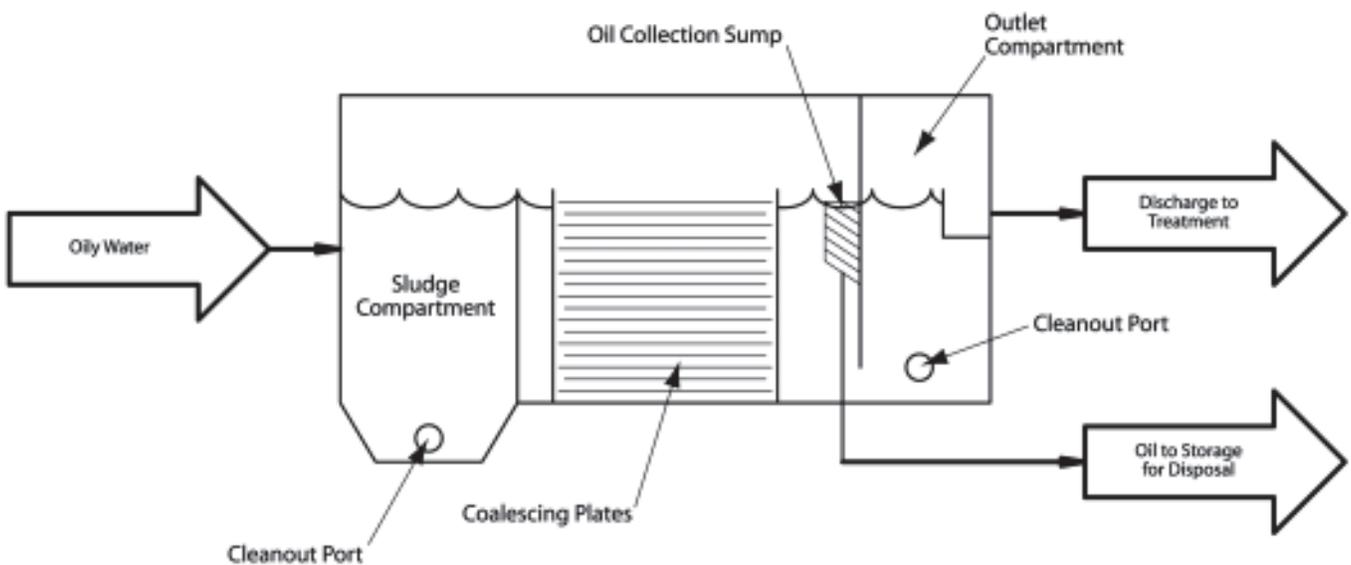
At sites handling non-polar oil and grease, either an American Petroleum Institute (API) separator or a coalescing plate interceptor (CPI) may be employed. These two styles of oil/water separator provide a much greater degree of oil and grease removal than a simple trap. Other treatment systems that may be employed to augment the removal of oil and grease include dissolved air flotation, ultrafiltration, or centrifugation. Emulsion breaking, if required, may employ the use of chemicals, heat, or electric charge.

Conceptual Drawing of Two Oil and Grease (O & G) Removal System



Gravity Separator

Solids and O & G Removal is
Performed Manually via Access
Ports in Top of Unit



Induced Gravity Separator

Solids Removal is Performed Manually
via Cleanout Ports and Oil is
Automatically Pumped to Storage
when Oil Collection Sump is Full

Note: Drawing does not show instrumentation, equipment and piping details.
Actual system design and requirements may be different.

Factors Which Make Physical Oil and Grease Separation Successful

ü The minimum capacity of an oil and grease interceptor sized for a commercial kitchen can be based on the following equation: $\text{Size} = (\text{Number of meals per peak hour}) \times (\text{gallons of waste per meal}) \times (\text{retention time in hours}) \times (\text{a unitless storage factor})$ The Uniform Plumbing Code recommends a minimum retention time of 2.5 hours for commercial kitchen waste and a storage factor of 2 for a 16-hour operation.

ü Equipment should be designed to create the least amount of turbulence while wastewater passes through the unit. Flow equalization should be provided to prevent a sudden surge of flow through the system.

ü Specify the equipment to treat the most complex waste stream common to the facility. Discharges seldom involve simple oil and water mixtures and may include dirt, cleaning aids, fuels, and debris. Equipment selection should be based on defined performance criteria.

ü Units should be designed for ease of maintenance. The use of heavy concrete lids may require the use of a crane. Small entries may require confined space entry. Keep these issues in mind when procuring new systems.

Cause	Corrective Action
Emulsified oil and grease discharged during routine operation.	Do not discharge detergents or cleaning agents to the grease trap or oil/water separator. These products will emulsify the oil and prevent its separation from water.
	Do not use enzyme or other biological treatment products to clean a grease trap on-line. These products emulsify the oil and grease, causing pass-through.
	Hot water discharged to a trap or oil/water separator can liquefy the free-floating oil and grease and make it more soluble. The water temperature entering the unit should not exceed 110 °F.
	Lowering the pH of the wastewater with acid may break oil-in-water emulsions. After separation, the acid must be neutralized and the pH increased to a minimum value of 5.5 as specified by local limits.

Common Causes of Oil and Grease Noncompliance

Cause	Corrective Action
Free-floating oil and grease discharged during high flow condition.	Check for solids inside the grit chamber. Accumulated solids decrease available volume and reduce detention time. Remove solids and reduce loading or increase the frequency of cleaning.
	Check for an excessive amount of oil and grease inside the separation chamber. As oil and grease collects, the separation efficiency decreases and the potential for flush-out increases. Accumulated oil and grease should never exceed 75 percent of retention capacity.
	Unit may be undersized for the volume of wastewater handled during a surge event. Divert clean water flows such as stormwater away from unit (if allowed by permit), install flow equalization tank, or replace with larger unit.
	Retrofit old oil/water separators with new plate pack or vertical tube coalescers. These units improve separation by providing a coalescing surface on which the globules of oil can gather.

5.2.6 Biochemical Oxygen Demand Reduction

Biochemical pretreatment is widely used to treat wastewater with high biological oxygen demand (BOD). High levels of BOD may be due to the presence of emulsified oil and grease or other biodegradable organic matter. Most systems operate under aerobic conditions with air providing oxygen to the microorganisms. Anaerobic systems may be used to digest and treat the residual solids resulting from aerobic pretreatment.

Aerobic pretreatment system designs include trickling filter, rotating biological contactor (RBC), activated sludge aeration basin, and sequential batch reactor (SBR). Trickling filters and RBC's operate with the biomass fixed to a rigid support while aeration basins and SBR's have the biomass suspended in the wastewater.

A trickling filter may be used alone to remove low levels of BOD or it may be used as the first stage of a combined system if BOD levels are high. Small to medium sized plants that generate wastewater high in BOD often employ a high rate or roughing filter that is followed by several stages of RBC. Aeration basins and SBR's are typically found at large facilities such as breweries and chemical plants. To limit this discussion, only trickling filters and RBC systems will be discussed further.

A trickling filter consists of a large open tank filled with rock, plastic, redwood, or other support media on which the biomass

grows. Wastewater is sprayed at a controlled rate down upon the media and BOD is reduced as the water “trickles” through the filter. Most of the water is recirculated to maintain a constant hydraulic load and to prevent drying of the media. The excess water is discharged to a clarifier for biomass removal.

In an RBC, the rigid media consists of large diameter plastic disks mounted on a long horizontal shaft. The disks slowly rotate at a speed of 1 to 2 revolutions per minute with their bottom edge dipping into the wastewater. Biomass grows on the disks and the constant rotation brings the biomass into contact with the wastewater and air. Multiple stages of RBCs are often used in series and in parallel.

Factors Which Make BOD Reduction Successful

- ✓ The start-up of a biological pretreatment system can take weeks and sometimes months for the biomass to grow and acclimate to the waste. Try to schedule start-up during warm weather and avoid periods of cold (dormant growth).
- ✓ Avoid shock loads and the discharge of toxic organics that may inhibit or kill the biomass. The same applies to any sudden change in temperature, pH, or BOD composition. Most biological pretreatment systems can adjust to a change in waste composition but the acclimation process takes time.
- ✓ Fixed growth systems must have good solids removal ahead of the unit to prevent plugging of the void space, poor oxygen transfer, excessive sloughing (i.e., loss of biomass), solids in the effluent, and poor clarifier performance.
- ✓ Trickling filters can be designed to handle a wide range of organic load. Typical operating parameters include the following:
 - The loading rate, in terms of pounds of soluble BOD per day per 1,000 cubic feet of media, should be less than 25 for low rate, 25 to 40 for intermediate rate, 40 to 100 for high rate, and 100 to 300 for roughing filters.
 - The hydraulic load, including recirculation, should be a minimum of 0.5 to 0.7 gallons per minute per square foot of area to prevent drying of the media.
 - The level of dissolved oxygen in the filter effluent should be 4 to 6 milligrams per liter. If below this range, employ mechanical fans to boost oxygen levels.
- ✓ RBC’s are often used in stages following a high rate or roughing trickling filter. Typical operating parameters include the following:
 - The containment structure for an RBC stage is commonly sized to provide a minimum holding volume of 0.12 gallons per square foot of standard density filter media and a minimum contact time of one hour.
 - Organic loading on the first stage should be limited to 2 to 4 pounds of soluble BOD per day per 1,000 square foot of media. Subsequent stages should be limited to one-half this

load. The hydraulic load to an RBC stage should be limited to 1 to 3 gallons per day per square foot of filter media.

- A minimum dissolved oxygen content of 0.5 to 1.0 mg/l should be maintained at the end of the first stage. The level of dissolved oxygen in the last stage should be 2 to 3 mg/l. – Units should be covered or located inside a building to prevent exposure to rain and sunlight. Rain can wash off the biomass, sunlight can promote algae growth and weaken the plastic media.
- ✓ Remove sludge promptly from the clarifier. Further biological activity can result in gas formation that will cause solids to float out with the effluent. Septic conditions can be avoided by maintaining the hydraulic load.

Common Causes of BOD Noncompliance

Cause	Corrective Action
Poor removal of BOD in a trickling filter.	Calculate the organic loading and compare to system design. If high, eliminate the discharge of high strength streams from within the plant or add more filters.
	Perform a microscopic examination of the biological growth. If undesirable growth is present, chlorination or disinfection of the filter may be required.
	The presence of ponding on the filter media indicates excessive biological growth. Increase sloughing by increasing the hydraulic load or flush the filter surface with a high-pressure water spray.
Poor removal of BOD in an RBC system.	Check the level of dissolved oxygen in the effluent. If low, inspect the effluent channels, underdrains, and the top of the filter media for debris. Reduce the hydraulic load if the underdrains are flooded. To increase airflow, fans may be required to induce draft.
	Check the peak organic and hydraulic loads and either make changes to reduce loading or install more RBCs if the load is more than twice the daily average load.
	Check the pH of the influent to ensure that it is in the range of 6.5 to 8.5 pH units. If not, eliminate the source or add dilute acid or base.
	Check the temperature of the influent. Biological activity will be reduced if it is less than 55 °F. Insulation of the RBCs and their containment building might help to conserve heat during winter. Heating the system may be considered on a case-by-case basis.

5.2.7 Toxic Organic Pretreatment

The removal of priority toxic pollutants or toxic organics (TO) from an aqueous stream is common in many industries such as petroleum refining, organic chemical production, pharmaceutical production, and pesticide production. TO can be harmful to plant or animal life and its discharge to a biological pretreatment system or POTW can result in serious upset.

Common methods for removing TO from an aqueous stream includes air stripping, steam stripping, and aqueous phase carbon. These methods physically remove the TO from the aqueous stream and additional operations such as off-gas incineration, recycling or incineration of recovered liquids, or carbon reactivation are used to treat the recovered TO. Air stripping or carbon adsorption is often used to remove TO prior to sewer release while steam stripping is used to remove TO prior to biological pretreatment.

One common method of air stripping employs a countercurrent packed tower. The tower contains an open space packing material that provides a very large surface area for gas-liquid contact. The TO containing water is sprayed down upon the packing while air is blown up through the packing. TO-free water exits the bottom of the tower while TO-laden air exits the top.

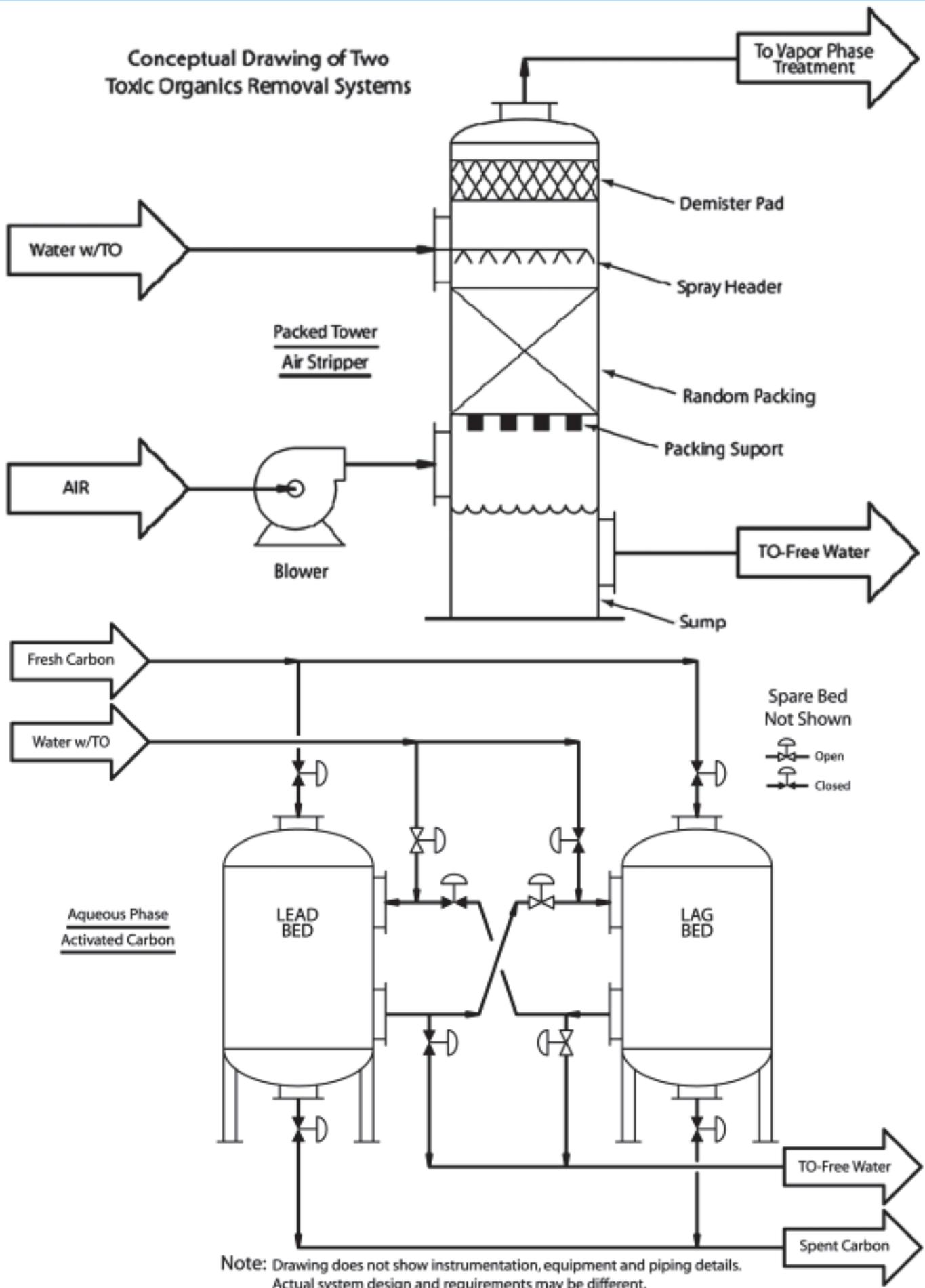
The direct discharge to atmosphere of TO-laden air is seldom allowed. The vented air is most often vented to a thermal oxidizer for TO destruction or it may be vented to vapor phase carbon for TO removal. When the carbon has reached saturation, it can be sent offsite for thermal regeneration. Systems that require a large amount of carbon will often employ onsite regeneration.

To remove high levels of volatile and semi-volatile TO, the water may be placed in a holding tank and sparged with steam. Steam stripping is very effective at removing semi-volatile organics and it produces a much smaller volume of off-gas compared to air stripping. Both water and TO are recovered from the off-gas by passing through a condenser prior to release. The resulting liquid may then undergo phase separation (if the recovered organics are insoluble) with the organic portion sent offsite for recycling or incineration and the water returned to the stripper.

In addition to air or steam stripping, aqueous phase carbon adsorption may be used to remove TO prior to sewer discharge. A typical arrangement consists of two carbon-filled vessels connected in series with a third bed as spare. The first bed removes most organics and the second bed provides a safeguard against break-through. When the first bed becomes loaded, it is removed from service and regenerated. The second bed now serves as the first bed and the spare serves as the second bed. After the first bed is regenerated, it takes the place of the spare bed.

Cause	Corrective Action
Poor removal of BOD in an RBC system. (cont.)	Healthy biomass is uniformly brown in color and evenly distributed over the media in a thin layer. Heavy and shaggy biomass indicates organic overload. Reduce loading and increase the rotational speed of the shaft to promote sloughing. If the biomass is white or gray, the RBC is septic and air should be supplied. High levels of sulfides in the influent can also cause this condition.
	RBCs should not be stopped or shutdown for more than 4 hours at a time or the biomass may dry out. Gently spray the exposed biomass to prevent drying. The shaft should also be rotated one-quarter turn every 4 hours.
	For outdoor units, inspect the cover for cracks, gaps, and damaged gaskets. Entering rain can wash biomass from the media and sunlight can promote algae growth. Check that access doors and manways are closed after inspecting or servicing the unit.
High level of suspended solids in the final clarifier effluent.	Check the clarifier for septic conditions that will cause the solids to float. If septic, increase the hydraulic load and recirculate the effluent to the pretreatment system. An increase in flow will boost the level of dissolved oxygen and prevent septic conditions. Peroxide may be added as a temporary fix.
	If the clarifier is not septic, either increase the rate of solids removal or reduce the hydraulic load to allow more time for settling. A reduction in hydraulic load will require placing an additional clarifier in service or reducing the daily amount of wastewater generated.
	Check the clarifier influent for excessive solids. A large amount of biomass may have been discharged from the pretreatment system because of shock loading or a sudden change in pH, temperature, or composition. If so, adopt measures to prevent such upsets.

Conceptual Drawing of Two Toxic Organics Removal Systems



Note: Drawing does not show instrumentation, equipment and piping details. Actual system design and requirements may be different.

✓ TO pretreatment systems are expensive and labor intensive due to stringent discharge requirements. The best method for compliance is to reduce, eliminate, and prevent the use of TO, if possible.

✓ Air stripping works best for removing TO that are volatile and insoluble in water. Steam stripping may be employed to remove semivolatile TO. Carbon adsorption may be used to remove TO that are water-soluble.

✓ Screen or filter the water to remove solids and prevent system fouling. Water with high levels of iron will form solids upon exposure to air and should be pretreated to remove iron prior to air stripping. Aqueous carbon systems are prone to biological fouling and should be periodically disinfected.

✓ During packing installation or carbon change out, make sure that the material is properly placed and evenly distributed to avoid channeling. The flow distribution header should be designed and maintained to provide uniform flow over the entire cross-section of the tower or bed.

Common Causes of Toxic Organic Noncompliance

Cause	Corrective Action
A sudden or gradual drop in the removal efficiency of air stripping	Inspect the flow distribution nozzles and check the spray pattern. Poor performance may be caused by blockage of the nozzle opening, a buildup of mineral scale around the opening, or by an increase in the size of opening due to erosion. Clean or replace nozzles, as necessary.
	Check the overall spray pattern and confirm that flow is evenly distributed across the tower. Poor distribution can result in channeling, flooding, and solids fouling due to drying of the packing.
	Inspect packing for biological growth and a buildup of solids. Fouled packing can be cleaned and disinfected, but it requires the handling and subsequent disposal of hazardous chemicals. Packing replacement may be more practical, but can be expensive.
	Precipitation prior to stripping may be required to prevent fouling caused by iron. Aeration and filtering to remove oxidation products or use of chelating agents to inhibit oxidation may also be used to reduce fouling. Bag filters should be routinely inspected for bag breakage.

Cause	Corrective Action
A sudden or gradual drop in the removal efficiency of carbon adsorption.	Look for the presence of unsuspected compounds in the wastewater stream. Organic compounds that are readily removed by carbon can kick out and release compounds that are less readily adsorbed.
	Check the flow rate entering the carbon system. The performance of the system is highly dependent on total contact time. Contact times for industrial wastewaters should be a minimum of 60 minutes. Hydraulic loading rates should range from 2 to 10 gallons per minute per square foot of cross-sectional area.
	Inspect the valves and make sure that they are properly configured. Three-way valves are often used to allow up-flow and down-flow operation. An incorrect setting can result in bypassing. The second bed should always contain clean carbon to guard against break-through.
	Check the pressure drop across each bed and compare this to the design loss. Too high a pressure drop across the bed indicates the need for backwashing.
	Check the effluent for the presence of fines. Carbon fines count against your suspended solids limit. One cause of fines generation is the rubbing of the carbon against the effluent screen. Another cause might be the presence of a hole in the screen.

5.2.8 Suspended Solids Removal

Specific gravity and particle size are two key factors that determine the settling rate of solids. Large and heavy solids can be readily removed via gravity sedimentation while the removal of small and light (i.e., suspended) solids requires screening or filtration. Screening is often used to remove suspended solids in the 20 to 50 micron size range prior to discharge. Please refer to Section 5.1.3 for further information on screening.

To remove suspended solids in the 5 to 10 micron size range, the wastewater may be filtered. Filtration effectively removes solids by forcing the water to pass through a bed of granular media where the solids become trapped in the pore space. The trapped solids are periodically removed from the media by backwashing. The use of single media (silica sand), dual media

(anthracite coal and sand), or multi-media (coal, sand, and garnet) is dependent on solids loading and tolerance to breakthrough.

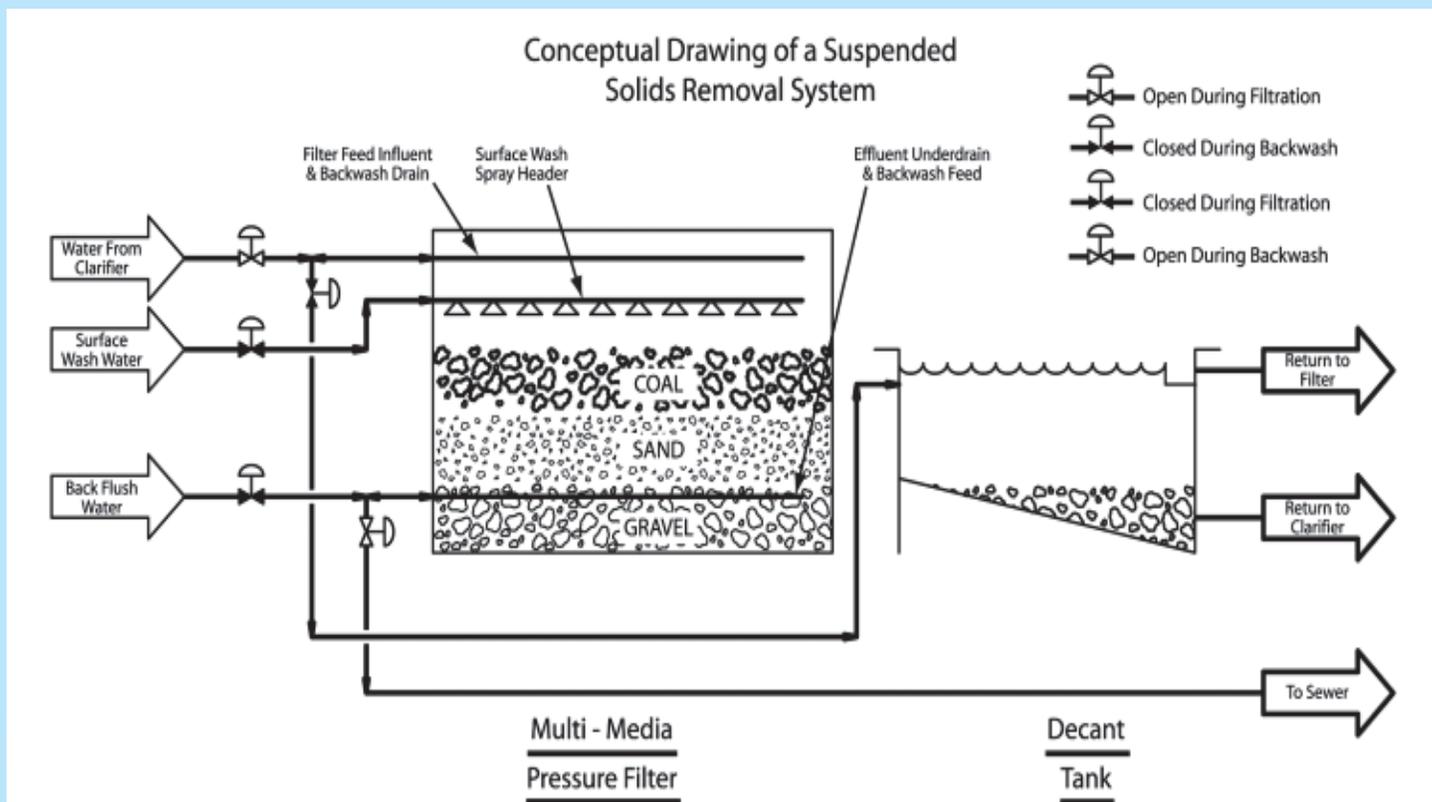
The need for cleaning is determined by monitoring the increase in head loss (i.e., pressure drop) across the filter. When head loss reaches a preset value, the filter is taken offline for cleaning. The cleaning cycle begins by surface washing the media for a few minutes to remove mud balls. This is followed by backwashing and surface washing which promotes turnover of the upper bed and the freeing of trapped solids.

Surface washing stops several minutes before the completion of the backwash cycle so that the suspended media has time to reclassify. With backwashing completed, clean water is supplied to the filter influent line to aid in settling, remove any generated fines, and to check for proper operation before placing the filter back in service. All of the water and solids generated during the cleaning cycle may be sent to a decant tank for further handling.

To remove suspended solids that are smaller than 2 to 4 microns in size, various membrane filtration systems may be employed. Microfiltration (down to 0.1 microns), ultrafiltration (down to 0.005 microns), and reverse osmosis (salts and dissolved minerals) are often used to treat various effluents so that they can be reused or recycled. These techniques are also gaining acceptance as an alternative to conventional treatment. Since the use of membrane filtration tends to be very site and process-specific, it will not be discussed any further.

Factors That Make Suspended Solids Removal Successful

- ✓ Select the media that is best suited for your given application. A single media filter is not as prone to solids breakthrough but it requires frequent backwashing. A dual media filter allows greater solids loading but is more prone to breakthrough. A key factor in performance is the use of media with uniform particle size.
- ✓ Filter size is often based on the inlet solids concentration and an optimal cleaning frequency of once every 24 hours. If loading is consistently less than 30 mg/l, a filter rate of 10 to 15 gallons per minute per square foot of surface area (gpm/ft²) may be employed. For 50 to 100 mg/l, a rate of 5 gpm/ft² is a better selection.
- ✓ In a dual media bed, the coal should be as coarse as practical to prevent surface blinding. The sand should be as fine as practical for good solids removal but no smaller than 0.4 millimeters. The use of finer sand will cause bed reversal (the sand will be trapped above the coal) during the first backwash cycle.
- ✓ During backwashing, the wash rate is set to provide a 25 to 30 percent expansion of the bed. Dual media used to remove chemical floc may require a wash rate of 12 to 15 gpm/ft² (at 18 °C) while coarser media used to remove biological floc may require a wash rate of 18 to 20 gpm/ft².
- ✓ The wash rate required for a specific amount of bed



Note: Drawing does not show instrumentation, equipment and piping details. Actual system design and requirements may be different.

expansion is a function of water temperature and the size, shape, and specific gravity of the media. A 10 to 20 °C increase in water temperature may require a 30 percent increase in wash rate to provide the same degree of bed expansion.

✓ Backwash, if returned to an upstream clarifier, can cause upset because of its large volume and high flow rate. It is best to store the backwash in a decant tank and return the underflow to the clarifier at a controlled rate.

Common Causes of Suspended Solids Noncompliance

Cause	Corrective Action
Poor media distribution after the backwash cycle.	Very low head loss, or failure to buildup head loss over time, may indicate poor media distribution or excessive channeling. Poor distribution may be due to excessive surface washing and inadequate time for reclassification. Air entering the filter can result in channeling. To restore efficiency, backwash the filter again and check all flow rates and timing cycles for proper operation.
Poor solids removal during the backwash cycle	Monitor head loss across the filter immediately after each backwash cycle. High head loss may indicate incomplete cleaning and the presence of mud balls in the media. To improve mud ball removal, increase surface washing time and reduce the rate of backwash. Inspect the surface-washing header and check the spray pattern. Poor nozzle performance may be caused by blockage, a buildup of mineral scale, or erosion. Clean or replace nozzles, as necessary. Inspect media for biological growth. Light fouling can often be treated on-line with biocides. Heavy fouling may require media replacement.
Media fines in the effluent.	Excessive scouring during the backwash cycle can result in the generation of fines. Reducing the backwash rate may help reduce the generation of fines but it may also reduce the effectiveness of solids removal. This may trigger the need for more frequent backwashing.

Cause	Corrective Action
Increase in temperature of influent or backwash water.	Warm water will release gases more readily than cold water. Check the filter for a buildup of air and purge as needed. Trapped air can prevent the passage of water through the media during filtration. To provide the same degree of bed expansion during backwashing, increase the backwash flow rate.
Disturbed or damaged filter underdrain.	Damage to the underdrain can occur if the maximum backwash rate enters an empty filter or if the system experiences severe water hammer. Damage may be noted by poor solids removal and little buildup of head loss, by the presence of boiling zones and dead spots during backwash, or by the presence of media in the effluent. A damaged underdrain requires media removal and repair.

6.0 TRACKING DOWN INCIDENTAL POLLUTANTS



Sometimes the source of a noncompliance problem is related to the discharge of an incidental pollutant. One such example might be the discharge of copper from a facility that is not conducting any metal plating or metal finishing activities. In this situation, potential sources could be the incoming raw water supply, the leaching of copper from pipes inside the facility, or from the use of copper-containing biocides to control fouling in the cooling water system. While the following listing is far from complete, it should offer some help to facilities faced with tracking down an incidental pollutant.

- ✓ Copper and lead are commonly present in water supplies due to corrosion of the piping distribution system. Zinc compounds used to control corrosion can also be found in the water supply. Shallow groundwater supplies may draw in pollutants such as heavy metals, solvents, or petroleum products.
- ✓ Boiler blowdown and cooling tower discharges may contain high levels of copper, nickel, and zinc due to uncontrolled corrosion. Biocides used to control biological growth in the cooling water system may contain copper or chlorinated organics.
- ✓ Chemical supplies may contain impurities that can upset the production process and the pretreatment system. Sulfuric acid may contain high levels of iron or heavy metals due to metal corrosion during storage or it may be due to prior use for steel pickling.
- ✓ Stormwater falling on the roof of a process building may pick up pollutants during the first flush. Pollutants in sewer lines may be flushed out during the first rain.

- ✓ The use of steam educators for vacuum production creates a condensate stream that is contaminated with the purged vapors.
- ✓ During maintenance, careful consideration should be given to the materials of construction. Brass valves should not be used in alkaline service because they will leach zinc and lead. Some plastic piping contains high levels of plasticizer that will leach out during use.
- ✓ Janitorial chemicals often contain chlorinated and other hazardous compounds that may end up in the wastewater stream through improper use or sewer cross-connections. The use of safer substitutes is not without risk because they may contain complexing agents such as ammonia or EDTA.

7.0 THE EMERGING ROLE OF EMS

Many facilities are actively implementing environmental management systems (EMS) in their effort to maintain and improve environmental performance and to stay competitive. One major driver in this effort has been the issuance of a set of voluntary environmental standards known as ISO 14000. The International Organization for Standardization developed these standards and while they are voluntary, they are often viewed as a de-facto requirement for doing business internationally.

The specific requirements for an environmental management system are covered under ISO 14001. The ISO 14001 standard is not a technical standard nor does it prescribe a standard of performance. Instead, it requires a facility to adopt and implement certain practices and procedures that, when taken together, results in the establishment of an environmental management system. The seven major requirements of an EMS under ISO 14001 include:

- ✓ A policy statement committing to pollution prevention, continual improvement in environmental performance, and compliance with applicable regulations.
- ✓ Identification of all aspects of the facilities activities that could have a significant impact on the environment, including those that are not regulated.
- ✓ Setting performance objectives and targets for the management system which link back to the commitments established in the policy statement.
- ✓ Implementing EMS by training employees, establishing work instructions and practices, and developing metrics for measuring objectives and targets.
- ✓ Establishing a program to periodically audit the operation of the EMS.
- ✓ Checking and taking corrective actions when deviations from the EMS occur, including periodically evaluating the organization's regulatory compliance.
- ✓ Undertaking periodic reviews of the EMS by top manage-

ment to ensure its continuing performance and making adjustments, as necessary.

For facilities wanting to know more about ISO registration and how the adoption of ISO standards can help their business, on-line sources of information are readily available. There are also support organizations that maintain contact lists of firms and consultants that specialize in ISO training and certification.

8.0 SOURCES OF INFORMATION / HELP

IWMD strives to maintain close contact with all industrial users and works hard to effectively protect the wastewater system while remaining sensitive to business needs. Through the publication of this guide, IWMD hopes to support all industrial users in their efforts to maintain compliance and find ways to cost-effectively reduce or eliminate pollutant discharges to the sewer.

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