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Project Summary

Characterization of Operating and Maintenance Practices for Wastewater Treatment Systems in the Iron and Steel Industry

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The purpose of this study was to document effective operations and maintenance (O&M) practices for wastewater treatment systems in the iron and steel industry and to ascertain how their application might affect permit parameters and operational upsets.

The wastewater generating processes selected for study were byproduct cokemaking, ironmaking (blast furnaces), steelmaking (basic oxygen furnaces), hot forming, and acid pickling. Selections were based on pollutant loadings, system complexity, control costs, and commonality among most integrated steel mills.

Information was gathered from several sources: a literature search for wastewater-related O&M practices in the iron and steel industry, discussions with state and regional agency personnel to identify major areas of concern and effective O&M practices, review of agency files, discussions with wastewater treatment equipment vendors and chemical additive manufacturers, and discussions with industry representatives.

Various steel mills were visited, and treatment plant operators and environmental staff members were interviewed. The information produced by these visits includes typically encountered problems and their solutions, troubleshooting efforts, extent of operator training, efforts to minimize the effect of operational upsets, and preventive maintenance practices.

The study produced a report that: provides a better understanding of wastewater problems in the iron and steel industry, helps agency inspectors to be more effective in evaluating the effect of O&M practices on wastewater treatment performance, and provides information that will assist plant personnel in practical and cost-effective fine-tuning of their systems.

This Project Summary was developed by EPA's Industrial Environmental Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

Effective O&M practices at a wastewater treatment system are those that can keep the system operating at its optimum performance with minimal downtime.

It is management's responsibility to initiate and maintain an O&M plan. Although such O&M practices as communication, operator training, staffing, recordkeeping, preventive maintenance, and treatment system auditing/evaluation are probably implemented in some degree at all plants, their effectiveness depends on the degree to which they are practiced, how carefully they are practiced, and whether they are fine-tuned periodically (if necessary) to achieve optimum results.

The plant visits made during this study showed that the management organization for water pollution control has much to do with successful communications and with obtaining the cooperation necessary to solve problems expeditiously. Generally, the management structure at the plants visited was:

- The utilities (power and fuels) department is responsible for operating the wastewater treatment systems.
- The process department, responsible for the steel mill process operations, assumes at least part of the responsibility for proper handling of the wastewater.
- The environmental department keeps all pertinent personnel informed of current and expected water regulations that will have an impact on the plant. This department is a go-between for the plant's pollution control section of the utilities department and the regulatory agencies and is responsible for all correspondence with the agencies.

The wastewater generating processes studied were byproduct cokemaking, ironmaking (blast furnaces), steelmaking (basic oxygen furnaces), hot forming, and acid pickling. The report discusses the O&M problems and practices of each process separately and also presents general observations regarding the components of effective industry-wide O&M practices.

Management-Based O&M Practices

These management-based practices include communications, operator training, logs/recordkeeping, staffing, and treatment system auditing.

Communications

Good communication is essential to effective O&M. Figure 1 illustrates effective and ineffective communication structures, both of which are found in the industry. Usually, the utilities supervisor is the key person in making a communications system work. Only through effective communication ties between operators, supervisors, and maintenance personnel can problems be brought to the attention of the necessary parties, and alternate solutions discussed and implemented.

Operator Training

Proper and adequate training of operators is critical to the effective operation of a wastewater treatment system. Operators need to know:

- How their systems operate and how to handle routine problems.
- What pollutants are being removed and where they are destined to go (sinter plant, landfill, recycle, etc.).
- Where the treated water goes.

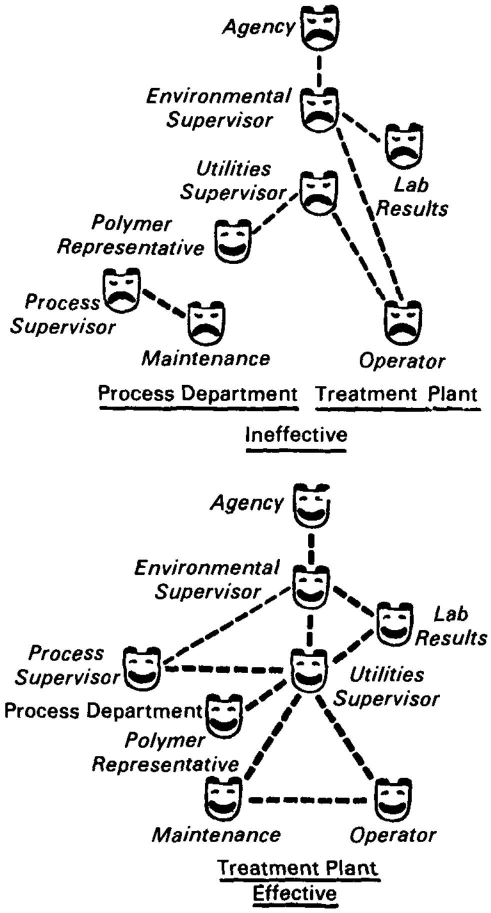

Figure 1. *O&M communication structure.*

- How the steel mill depends on their performance (directly for return of needed water, or indirectly to avoid potential regulatory action).
- What daily routines must be followed.
- What to do in emergencies.

It is important to keep subsequent generations of operators as well trained as those who were there during system start-up and had the benefit of receiving thorough training from the equipment manufacturers.

One useful aid that some operators have developed involves the use of simplified schematics of their equipment and/or overall treatment scheme. These schematics are usually much less complex than those in the O&M manuals provided by the design engineers.

Logs/Recordkeeping

Good recordkeeping is an effective O&M tool. The plant visits made during this study indicated that current practice varies from maintaining essentially no records to recording numerous operating parameters every 2 hours. Although the extent and frequency of recordkeeping vary greatly from plant to plant, it was obvious that the operators of the well-operated systems made a practice of logging key operating parameters on a periodic basis. In addition, the operating supervisors at these plants reviewed the logs for abnormal conditions and initiated required followup action. In other words, the logs were used, not just filed away. (See Figure 2.)

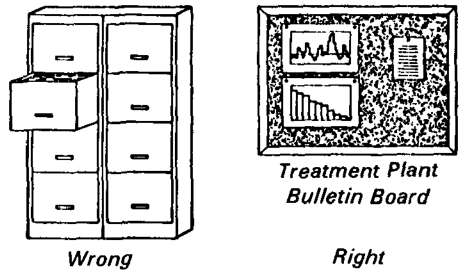

Figure 2. *Effective use of records.*

Staffing

Proper operation of a treatment system requires enough operators (and assistants and helpers) with clearly defined job functions. The plants visited were generally well staffed. At one plant, however, one operator had to devote all of his time to manually controlling the treatment system (filtration plant). Had this operator been responsible for areas other than the filtration plant or were he less efficient, the filters would have plugged and the system might have been damaged or the amount of filter effluent might have increased greatly.

Treatment System Auditing

Results of this study indicate that most plants have proceeded from permit negotiations, to system design, to routine operation without ever having stepped back to overview their situation. Some type of periodic formal O&M audit would be beneficial to provide such an overview.

It is suggested that audits or self-evaluation programs by a plant team or an outside consultant be implemented periodically (e.g., annually). When such evaluations reveal less-than-optimum conditions, corrective action should be taken, with followup to ensure that approved suggestions have been carried out.

Cokemaking—O&M Practices

Treatment systems and component arrangements for treating coke plant wastewaters vary throughout the industry, but most plants have equipment specifically designed to remove two pollutants — ammonia and phenol.

About two-thirds of the plants with coke-making facilities have ammonia stills and treatment systems for removing phenol. All of this group have free ammonia stills, and about 85 percent also have fixed ammonia stills. About half of the plants that remove phenol have dephenolizers; the rest are equipped with oxidation systems (primarily bio-oxidation). Figure 3 shows the component arrangement at one plant.

Major Areas of O&M Concern

Improper handling of or lack of attention to any of the following items can cause an upset in the bio-oxidation system ranging from minor to major proportions.

- Monitoring the performance of ammonia stills
- Controlling biological basin pH
- Controlling basin temperature
- Adding nutrient
- Aeration
- Maintaining adequate dilution water (where practiced)
- Introducing intermittent, experimental, or toxic material
- Monitoring key parameters
- Communicating
- Operator attention and know-how, and good supervisors

Some Effective O&M Practices

Ammonia Still

1) Maintaining adequate storage of crude liquor to allow the coke batteries to continue operating without interruption during still shutdowns.
2) Monitoring the return liquor flows from the lime legs to the stills. One plant monitors and records the flow rate every 2 hours.
3) Properly adjusting the steam flow to the lime leg discharge to ensure an adequate supply of steam to strip the ammonia from the liquor. Operators at one plant use an easily read chart showing proper steam/return liquor flow ratios.
4) Regular monitoring and recording of still pressure, noting changes and calling them to the attention of the maintenance department.

Lime Slaker

1) Periodic checking of the level of the lime storage bin or tank and reporting low levels to the foreman.
2) Controlling slaker feed water. Feed to the slaker should be steady and relatively uniform in size. Lime mixing spray should be inspected for blockages. Also, lime quality should be closely controlled; e.g., lime size as received (about 80 percent less than ¼-in. or 0.635 cm) and lime slurry temperature (90 to 95°C). Carefully controlling these parameters improves dissolution of lime into the slaker water and reduces lime consumption considerably.
3) Controlling pH of the still effluent to control the amount of lime water being fed to the lime legs for reaction with the crude liquor. Because of inherent plugging problems, a pH controller with pH probes is not dependable in a lime-based system; therefore, effective O&M practices are required to back up (or substitute for) pH control. At one plant the operators check the pH of the effluent and of the liquor from the lime leg every 2 hours.
4) Preventive maintenance; e.g., frequent inspections, scheduled cleaning.

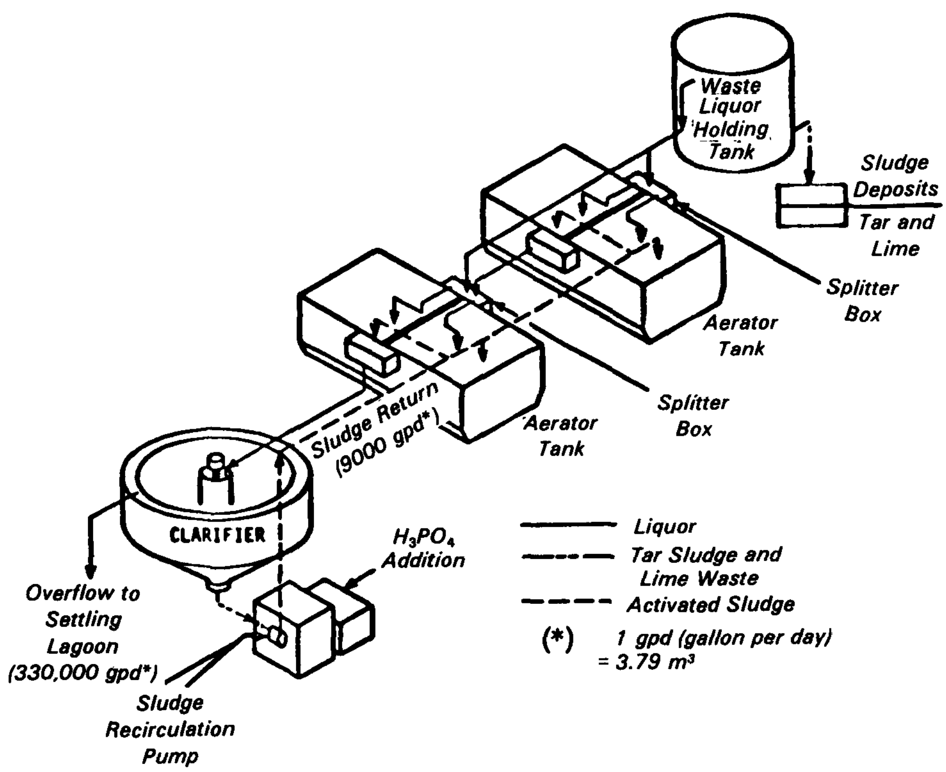

Figure 3. *Biological plant flow diagram.*

Biological Treatment Systems

1) Controlling pH in aeration basin. The most effective practice observed is monitoring the basin pH and its sources. At one plant, operators take samples every 4 hours from the equalization tank effluent, secondary storage tanks' influent and effluent, basin inlet sump, and basin outlet sump. The pH's are analyzed and recorded on a daily log sheet. At another plant, wastewater treatment plant operators take bihourly wastewater samples from the ammonia stills and daily samples from the basin wastewater feed and clarifier overflow. These samples are analyzed for pH and recorded. These practices permit early detection of pH deviations and allow the immediate implementation of corrective action to protect the system and effluent quality (e.g., diversion to an emergency storage tank, if necessary).
2) Controlling basin temperature. Microorganism activity diminishes if the wastewater becomes too cold, and microorganisms can be killed if wastewater temperatures get too high. Plants are equipped with monitors, control valves, and recorders on control panels, but operators still should manually record temperatures at the source and log this information to ensure good temperature control.
3) Checking nutrient addition. All of the systems visited use phosphoric acid as a nutrient. Some plants check the phosphate residual daily. One effective practice is to observe the addition of

phosphoric acid to the primary clarifier every 2 hours. This was not difficult at one plant, as the addition point is about 1 ft (30 cm) above the water level. At one plant the phosphoric acid tank is on stilts, above the primary clarifier (which returns sludge to the basins); this allows the acid to flow by gravity into the clarifier's sludge recycle pump. Gravity always works, and the operators can visually check the flow of acid.

4) Ensuring adequate aeration. The practice at one plant is to make an occasional check of the dissolved oxygen content of the basin water and to make a physical check of the aerators twice per shift to see if they appear to be operating properly. Instead of regularly monitoring the dissolved oxygen content, one plant has installed ammeters in a pump house, which are connected to the aerator motors. Normal readings are 25 to 30 amps. The operators observe these readings bihourly, and enter a check on the logsheet if the readings are in this range; if not, the actual reading is recorded, and if the deviation is more than a couple of amps outside the normal range, the operating supervisor is notified. The amp readings correlate well with cell wastewater dissolved oxygen levels of 1 to 2 ppm. One plant that recently had a problem with stratification of the dissolved oxygen installed air lances for use at these times to promote better localized mixing. The lances also serve as a backup when an aerator fails or is taken out of service for a maintenance check.

Blast Furnace—O&M Practices

Blast furnace treatment systems do not vary much from plant to plant. They generally consist of recycle systems with a thickener/clarifier for solids removal, a cooling tower, and a chemical treatment system for deposit or scaling control. Several plants use alkaline chlorination for removal of ammonia and cyanide for blowdown water.

Major Areas of O&M Concern

- Controlling pH
- Removing phenol
- Removing cyanide
- Removing ammonia
- Controlling scaling by dissolved solids
- Handling sludge
- Maintaining a tight recycle for hydraulic balance
- Temperature of recycle water
- Adding chemicals

Some Effective O&M Practices

O&M concerns at the operating level focus primarily on the condition of the equipment and the parameters used for daily monitoring of the system. Effluent water quality, on the other hand, is the concern of the environmental department. The following O&M practices were observed:

Controlling pH

1) Daily inspection of oxidation reduction potential (ORP) and pH probes for scaling problems and cleaning as necessary. Maintaining spare probes and experimenting with new types of probes as they become available.
2) Manually checking pH readings. One plant checks the pH of the blowdown twice a shift and the pH at several other locations in the system once a shift.
3) Using standard solutions of 6 and 9 pH to calibrate pH probes rather than the usual standards, which are outside of this control range.

Controlling Scaling by Dissolved Solids

1) Maintaining chemical feed in a tight recycle system. Some experiments with softening have been reported.
2) Monitoring hardness, alkalinity, and conductivity on each shift.
3) Adding a deposit control agent at the hot well of the cooling tower.
4) Adding an antifoulant and dispersant at the main recirculation sump.
5) Long-term analysis of hardness, alkalinity, and conductivity, and using graphical plots versus time to detect and correct scaling trends.

Handling Sludge

1) Scheduled preventive maintenance, which includes:
   a) Changing gear box oil every 6 months.
   b) Checking and lubricating all pumps and other moving equipment every week.
2) When a pump fails to work:
   a) Operator checks to see if suction line is plugged; if so, cleans line and replaces it.
   b) If problem is more major (e.g., a badly worn impeller), maintenance department repairs the pump.

Basic Oxygen Furnace—O&M Practices

A basic oxygen furnace (BOF) shop typically has two furnaces. Each has a separate scrubber, but both share a common water treatment system. The primary pollutant of concern is suspended solids. Since the water is recirculated, the concerns of dissolved solids and scaling are similar to those in blast furnace systems.

Major Areas of O&M Concern

Focus is primarily on BOF systems that have recycle loops because many plants have recirculation systems and because this technology is emphasized in the guidelines for steel mill effluent limitations.

- Controlling dissolved solids
- Controlling pH
- Controlling suspended solids
- Maintaining a proper rate of sludge removal from thickeners/clarifiers to avoid thickener upsets and/or rake change.

Some Effective O&M Practices

Controlling Dissolved Solids

1) Using pH control, balanced schedule of blowdown and makeup, and chemical treatment. Two or sometimes all three controls are combined.
2) Periodically inspecting the acid system and pH sampling/analysis (to back up automatic systems).
3) Regularly cleaning pH probes.
4) Manually adjusting acid metering pump and periodically inspecting to see if it is regulated properly.
5) Checking the discharge of blowdown against the individual plant's criteria and adjusting it if iron and zinc concentrations are too high.

Chemical Treatment

1) Quick maintenance action if the polymer system breaks down and becomes plugged.

Controlling Solids/Sludge

1) Inspecting cyclones and classifiers each shift and periodically replacing the rubber lining in cyclones.
2) Monthly inspection of classifiers by maintenance department and work performed as needed. A spare is maintained.
3) Draining thickeners yearly for thorough inspection.
4) Visually inspecting sludge pumps (by operators) each shift.
5) Periodic testing polymer additions by the manufacturer to ensure optimum dosage rate. Polymer representatives work closely with operators and periodically perform bench tests with new polymers against which operators can compare their bench tests to see if they are in agreement.
6) Providing automatic rake-lifting devices on thickeners if torque becomes too great.

7) Periodically monitoring and recording torque by operators and notifying supervisors if readings are above normal.
8) Maintaining on-line spares for all sludge pumps.

Hot Forming—O&M Practices

Treatment technologies used in hot forming include: primary sedimentation, surface oil removal, secondary settling or filtration, and recycle.

Major Areas of O&M Concern

The major areas of O&M concern for hot forming (primarily on hot strip mills) wastewater treatment systems are:

- Operating scale pits
- Communicating
- Handling sludge
- Treating with chemicals
- Backwashing filters
- Operator and maintenance attention/inspection/monitoring of key parameters

Some Effective O&M Practices

Operating Scale Pits

1) Systematically removing material that has settled out in the scale pits once a week. This permits maintenance of good working volume and reasonably constant retention time.
2) Clam-shelling of finishing scale pit on Sunday (when the hot strip mill is down) to allow the solids adequate time to settle before start-up of the mill the following day. This was observed at one plant.
3) Frequently inspecting the scale pit by the operator to allow him to detect and remove debris (e.g., twigs) on the rope skimmers. This is very important; several hundred gallons of oil could accumulate if a "short-circuited" skimmer went undetected for several hours.
4) Maintaining a good supply of spare rope skimmers on site.
5) Attaching heat lamps near the skimmer's driving gear mechanism to reduce skimmer stiffness during cold weather.
6) Monitoring key parameters; e.g., frequency of backwashing and the filter media level at a plant with deep-bed gravity filters.
7) Monitoring the following parameters at plants with settling ponds:
   a) Pond levels and flows (once per shift)
   b) Oil skimming equipment (once per shift)
   c) Periodic checks (every several months) of solids depth in the ponds. (Sometimes determined by taking soundings from a boat.)

Backwashing Filters

1) Extended backwashing of sand filters to remove accumulated solids that ordinary backwashes do not remove (performed every weekend).
2) Periodically steam cleaning filters to remove accumulated oil and grease.

Other Observed Practices

1) Periodically inspecting pipes that are subject to abrasion to see if thicknesses are safe (by sonic testing).
2) Stringing floating booms diagonally across settling basins to direct floating oil and grease to belt skimmers. These booms are replaced about every 3 or 4 months. Catwalks at the end of the basins allow access to the final settling area to pump off floating oil.
3) Periodically sampling filter media by a contractor who performs an ash test to see how much scale is accumulating. This information is used to determine when the media should be changed.
4) Notifying the utilities operator by phone (by mill rolling foreman) of shutdown and start-up times and oil spills.
5) Routinely maintaining wastewater-related equipment: lubricating; vibration monitoring/testing of major pumps, motors, and air blowers; calibrating meters; checking software weekly; maintaining computer software; and inspecting electrical equipment.

Acid Pickling—O&M Practices

Wastewater is generated from three sources in the pickling operation: rinse water, fume scrubber water, and spent acid.

Major Areas of O&M Concern

Major areas of O&M concern in the acid pickling wastewater treatment systems are:

- Sludge accumulation
- pH monitors
- Lime addition
- Sludge buildup in aeration tank
- Exhaust fan
- Reactor cyclone
- Waste pickle liquor feed point
- System pressure drop
- Preventive maintenance
- Fines formation

Some Effective O&M Practices

pH Monitors

1) Frequent checking of the readout of pH monitors in the system, using a portable pH meter.
2) Checking pH hourly, and plotting on a daily chart to illustrate pH control and variation in the aerators.

Lime Addition

1) Maintaining the proper ratio of hydrated lime to limestone.
2) Checking lime shipments to ensure that the lime meets plant quality standards.
3) Using a single supplier (when possible), for a more consistent quality of lime.

Clarifiers

1) Checking the height of the water above sludge blanket (i.e., sludge depth) every shift.
2) Inspecting the chemical additive system and dosage rate, and visually observing the formed floc to note anything unusual about its appearance.

General O&M Practices - Treatment Components

This discussion covers problems concerned with the common treatment components in use at steel mills and current or suggested O&M practices. Many of the components (e.g., clarifiers, filters) are used to treat different process wastewaters (e.g., blast furnace, basic oxygen furnace).

Clarifier/Thickener

One of the most common clarifier maintenance problems is a plugged sludge line. Items such as hardhats, tools, and general debris find their way into the clarifier. At some facilities, a wire mesh or some other barrier across the top or on the sides of the clarifier prevents large objects from falling in. When the clarifier is emptied for maintenance, the sludge pump should be inspected thoroughly before the unit is put back on stream to ensure that nuts, bolts, etc. have not been left there by maintenance personnel.

The condition of the clarifier feed can be checked with a simple settling test, consisting of putting a sample of clarifier feed in a graduated cylinder or Imhoff cone and noting the sludge level after a specific time. Although such a test does not give an absolute measure of the settling rate, it will detect an upset in the system. If tested every few hours, a problem in the clarifier feed can sometimes be detected before it leads to a major upset.

Turbidity in the clarifier overflow should be checked frequently, either manually or with an instrument. If an instrument is used, turbidity should still occasionally be checked manually, to ensure that the instrument is operating properly.

A visual inspection of the clarifier will show the operator if the sludge level is getting near the overflow weir. The operator should also check the uniformity of the effluent flow over the clarifier perimeter weir.

To be sure the clarifier is not operating at too high a feed rate, the operator should check the actual feed rate against the design feed rate.

The flocculation and settling performance of the clarifier feed can be checked, using a standard jar test apparatus. After the settling rate has been determined, some of the liquid can be siphoned from the jar for a suspended solids analysis. The suspended solids level should approximate the clarifier overflow, but this test is most useful for comparison against a benchmark test. Sometimes, settling can be improved by switching polymers.

Water Recycling

Recirculating water in a process treatment system or as part of an overall plant recirculation strategy involves many different considerations; e.g., maintaining system tightness, hydraulic balance, and water chemistry, and providing adequate monitoring and sampling. The report discusses each in detail.

Scale Pits/Sedimentation Basins

Although scale pits are among the least sophisticated and most low-profile treatment technologies, they play a key role in the performance of water treatment plants at hot strip mills. If properly operated, systematically cleaned, and equipped with oil-skimming equipment, they provide an effective pretreatment step prior to secondary treatment.

The solids removal efficiency of any scale pit is a function of the effective detention time. It is not uncommon for plants to experience increased solids loadings out of the pit during scale removal activities; therefore, it is advisable to dredge the pits during mill operation downtimes or to have additional cells or spare pits. Good housekeeping and well-maintained oil skimmers are the most effective controls for scale pits. If used, these controls can intercept much of the free oil resulting from oil spills and line breaks.

Filtration

In the iron and steel industry, filtration is used to remove suspended solids from wastewater (polishing filters) and to dewater sludge (dewatering filters).

Polishing Filters

One of the mills visited was trying to improve the operation of its multimedia filters: it was experimenting with declining rate filtration. This operation begins the filtration cycle at a high flow rate and then reduces the rate for the rest of the run, which reduces the suspended solids in the filter effluent.

Another plant reported oil buildup in the filter media. One way to wash out this excess oil is to use steam (in addition to air and water) when backwashing the filter.

At one plant, with a horizontal multimedia filter, the media was being washed out on the backwash cycle. This filter had slotted distributor plates, and the bottom distributor plates were covered with gravel. To solve the problem, the plant put screens on the slotted plates at the top of the filter and bubble-cap strainers on the bottom distributor plates.

This plant also had rectangular sand filters, and (during backwash) the air scour created so much turbulence that the media washed into the troughs and out with the backwash water. This problem was solved by screens on the rims of the discharge troughs.

Dewatering Filters

Most plants consider dewatering filters to be a high-maintenance item because the filter cloths are easily torn and the belt on a drum filter can stretch and get out of alignment. It is necessary to keep an adequate inventory of spare cloths for each filter.

pH Control Systems

The pH electrode assemblies are a frequent cause of malfunction of pH control systems. The proper maintenance of these electrodes is important to the precision and the accuracy of pH control and monitoring. The three types of maintenance required are calibration, cleaning, and replacement. Many plants calibrate daily, and daily cleaning is not unusual. One plant piped service water to the line containing the pH electrodes; the process flow is turned off periodically, and the service water valve is opened to flush the electrodes with clean water.

Because of its low cost, lime is frequently used for pH control. The amount of calcium oxide in the lime must be controlled for consistent operation. Sometimes a temperature test is used to quickly evaluate the quality of lime shipments. Measured amounts of water and lime are mixed, and the temperature is recorded to determine the calcium oxide content. Plants should be especially cautious of lime quality with changing vendors.

A common problem that occurs when lime slurry is used to adjust pH is plugged equipment. A control valve in lime slurry service should be checked regularly for signs of pluggage or erosion. Maintaining a historical record of electrode failures, control valve failures, line pluggage, etc., will allow a plant to set up a preventive maintenance schedule to avoid these problems. Good preventive maintenance is the key to successful pH control.

Chemical Addition Systems

Because the flow rate of chemical additives (e.g., polymers) is low, it is sometimes difficult to determine if they are flowing. Ideally, these chemicals should be introduced above the level of the liquid to which they are being added so the operator can see them falling from the end of the pipe into the tank and thereby verify the flow.

Care should be taken that the vendor's instructions regarding the use and mixing of a specific polymer are followed closely. Excessive mixing can shear the polymer and damage its effectiveness. Also, to achieve maximum efficiency, many polymers must be aged for 12 to 24 hours after they are mixed.

Care should be taken not to use a polymer that is so old it has lost its effectiveness. Also, polymers should be stored where they are protected from freezing, which is damaging to them.

Some vendors provide jar test apparatus to evaluate their polymers for application in a particular plant. An evaluation by plant personnel may be more objective, however, and certainly would provide results for comparison against those of the vendors.

Oil Skimming System

The simplicity of oil skimmer systems makes them very reliable, and maintenance relatively easy. Nevertheless, they should be checked daily. The skimming mechanism requires periodic lubrication, adjustment, and replacement of worn parts. Heating is suggested during winter months to keep the skimmer from freezing. If this is not possible, a backup removal system (e.g., a vacuum truck) should be provided.

The paddle skimmer should be checked to ensure that each blade touches the water for the full length of the blade. Rope skimmers should be checked to ensure that the rope is not rubbing against an object that could scrape off collected oil or abrade the rope. The inspector should observe the rope for one full revolution to be sure it is not abraded at some point. The operator at one plant said rope skimmers could be more effective if the tubes penetrated the water surface better. The plant was going to experiment by injecting some lightweight antifreeze fluid into the plastic tubes to provide additional weight for better immersion. (This might also make the skimmer operate better in subfreezing weather.) Belt skimmers also should be observed for one full revolution to check for rips, holes, or other problems with the belt. The operator also should check the scraper blade on the belt to be sure it is removing the oil from the belt.

The skimmed oil usually falls into a trough that drains into a collection tank. These troughs must be kept clean so that the oil does not build up and overflow. The level of oil in the tank itself also should be checked periodically.

Cooling Towers

Cooling towers remove heat from water by evaporating the water. The ones discussed here involve contact water systems (such as those used in blast furnace recycle systems and, to a lesser extent, in coke plant and rolling mill treatment operations).

It is important that the makeup and blowdown rates be checked and that the cycles be calculated (to minimize corrosion, deposits, and slime). Factors that affect corrosion, deposits, and slime are controlled by a bleed stream or blowdown, by coagulation and filtering, or by adding inhibitors and chemicals that attack the specific problems. The latter include dispersants, fungicides, and slimicides. Adding chemicals properly is important, not only for performance, but also because fungicides and slimicides are toxic.

Ammonia Stills

Ammonia stills reduce the ammonia concentration in the weak ammonia solution that is produced in the collecting mains of coke ovens when water is sprayed on the hot gases leaving the ovens.

Most problems with ammonia-stripping systems involve the handling of lime. It is important for incoming shipments to be checked to ensure the calcium oxide content and particle size. Because lime tends to foul and plug lines, control valves, instrumentation, and the stripping column itself, a preventive maintenance schedule should be set up to break apart and clean the equipment before it becomes inoperable. Such a schedule was developed by an operation's supervisor at one plant. He plotted the ammonia still effluent concentrations over a period of time (Figure 4) and reviewed maintenance logs to see if the times of equipment pluggage and/or breakdown correlated with the excursion dates. When a definite correlation was evident, he developed a schedule incorporating the finding.

Pressure drop across the column is a good indicator of tray fouling, and the operator should keep frequent watch to note when the trays need to be cleaned. Operators should also monitor the pressure in the bottom of the ammonia still. When the pressure reaches an established upper limit, the column should be taken off line and cleaned.

Since pH control is important, cleaning the pH probe should be included as preventive

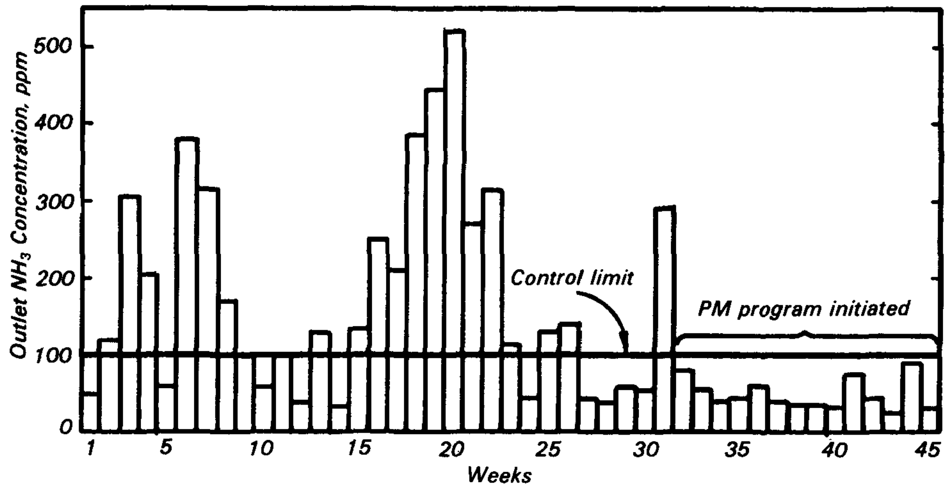

Figure 4. *Ammonia still performance.*

maintenance. The operator should manually check pH as often as necessary.

Steam flow is critical to efficient still operation, and should be adjusted to maintain the proper ratio with feed liquor flow. Inadequate steam flow lowers column efficiency dramatically.

Water going to the ammonia stills comes from moisture in the coking coals. During periods of high humidity and rainfall, this moisture and the resulting water flow to the ammonia columns increase noticeably. These flow variations necessitate close operator attention to the water level in the ammonia column feed tank, even during periods of relatively constant coke plant production.

Conclusions

Wastewater treatment O&M practices varied at each plant visited during this study. Without exception, however, in plants where supervisors and operators incorporated effective O&M practices into the operation of their systems, fewer operating problems occurred and the treatment systems operated more smoothly and consistently.

Of particular interest was the high degree of operator knowhow and job interest observed. Systems were well monitored, concern for pollution control was evident, and careful attention was given to visual inspections.

The observations did reveal some areas of concern, however. These included lack of communication between process operators and wastewater treatment operators; competition between treatment plant and production processes for maintenance resources; poor performance of pH monitoring, on-line analyzers, and flow-measurement devices; poor hydraulic balance; excessive oil from rolling mills; high maintenance required on lime-based ammonia stills; debris in clarifiers/tanks/open-top containers; lack of detailed maintenance records; and lack of self audits.

Additional Highlights of Complete Report

This summary includes only a cross section of the kind of information collected during the study. The report itself contains detailed discussions of observed practices, presents examples of log sheets and other recordkeeping forms, describes the effects of upsets on the wastewater treatment systems, and illustrates the relationship between O&M practices, upsets, and effluent quality.

Also included in the report are descriptions of the instrumentation used to monitor critical operating parameters, the problems they present, and some effective O&M practices actually used at steel mills.

One report section summarizes the causes of noncompliance incidents at 35 steel mills over an average time period of 2 years. This information is arranged to show the number of excursions by pollutant, the primary causes of outfall excursions, and the reported corrective action taken.

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***Jeff Chappell** is the EPA Project Officer (see below).*
The complete report, entitled "Characterization of Operating and Maintenance Practices for Wastewater Treatment Systems in the Iron and Steel Industry," (Order No. PB 84-182 666; Cost: $29.50, subject to change) will be available only from:
National Technical Information Service
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The EPA Project Officer can be contacted at:
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