A REVIEW OF ALTERNATE WASTEWATER PROCESSING SCHEMES FOR INDEPENDENT BULK LIQUID TERMINALS

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REGULATORY OVERVIEW

The regulatory controls by Federal, State and local government over waste liquids and solids are principally derived from four Acts.

1972 - The Federal Water Pollution Control Act (FWPCA).
1977 - The Clean Water Act (CWA).
1976 - The Toxic Substances Control Act (TSCA).
1978 - The Resource Conservation and Recovery Act (RCRA).
1980 - The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA).

The FWPCA resulted in development of a water management program known as NPDES - National Pollutant Discharge Elimination System. This covered discharges from a company property boundary into the public waterways. The regulated parameters are broad measures of waste strength, such as BOD, COD, TSS, pH. The very title of NPDES reflects the Act's intention to eventually achieve zero discharge. Since matter cannot be destroyed, merely converted in form, zero discharge is unrealistic in its approach. The pollutants removed from wastewater are usually in such forms as non-water soluble oils and sludges. Accordingly, the more recent legislation has focused not only on the quality of water leaving a company's property, but also on the management practices inside the fenceline in handling the solid phase. This has resulted in the current legislative bottleneck where the EPA has published the broad framework of Cradle-to-Grave waste handling rules, but has not published the final rules on the portion dealing with waste processing - the area of greatest potential cost savings by eliminating third party disposal of the liquid portion. A complicating factor is that not only have several hundred chemicals been declared hazardous, but sludges from oilwater separators and many wastewater treatment sludges as well.

SOURCES OF WASTE

In independent bulk liquid terminal operations wastes arise from rainwater on contaminated areas, planned cleaning of pipe and equipment, leaks from rotating equipment seals, spills in transfer hose handling and blowdown from process equipment.

Unlike a process plant whose process units are compact and the piping dedicated, terminals have large areas of high potential contamination and generally multi-service piping. It normally economic to run a separate line from every tank to each water and land-based loading/ unloading spot. Even the dedicated piping requires cleaning when a tank changes service. Thus, terminals have a higher waste load of more variable quality than do process units.

The tabulation below present the list of potential waste sources:

- Marine Ballast Water
- Parcel Tanker Cleaning
- Barge Cleaning
- Rail Car Cleaning
- Tank Car Cleaning
- Line Cleaning
- Spills from Hose Handling
- Pump Seal Leaks
- Cooling Tower Blowdown
- Boiler Blowdown
- Sanitary Sewage
- Steam Trap Discharge
- Neutralization Chemicals
- Truck Loading Slab
- Rail Loading Area
- Dock Slab

WASTE SEGREGATION AND HYDRAULICS

The areas of highest potential contamination are pump stations and loading/unloading areas. These are normally not covered to enable ready maintenance on pumps and allow fumes to escape that could accumulate. (The only areas that are sometimes covered are high volume truck racks.)

These areas are normally drained directly to the waste treatment system, so that spills do not accumulate around the pumps or tank cars/trucks. Therefore, the rain on these areas adds to the hydraulic load on the waste treatment system. For this reason pumps are grouped together in curbed pump stations to minimize the area in which stormwater falls.

The areas of lower potential contamination are the diked tank areas and the remaining open areas. Typically, the diked areas are clean as are the open areas, therefore their stormwater should require no treatment. In order to keep the size of the treatment system to a mininimum, it is usually more economic to have separate collection systems for the stormwater and the wastewater.

A masterplan that is mindfull of the need for minimizing sewer run lengths and pump station areas can help reduce capital cost. In one well-designed six million barrel facility, segregated sewers reduced the contaminated water quantity to 10 GPM as compared with the nearly 200 gpm average stormwater load.

In a two million barrel portion of another chemical terminal, the areas contributing stormwater to the waste treatment system were as follows:

Pump Stations -	4000 Sq. Ft.
Loading Area -	20,000 Sq. Ft.

WASTE SEGREGATION AND HYDRAULICS -(Continued)

At an average 50 inch/year, this contributes an average 1.4 GPM to the waste treatment system. A peak 10-year design rainfall of 3.4 inch/hr., would contribute 850 gpm to the waste treatment system.

For one six million barrel terminal, the controlled sources averaged 12 GPM; for another 3.5 million barrel terminal, the controlled flow averaged 3.5 GPM. For a 25 truck/day truck washing facility the flow averaged 10.5 GPM.

The contribution from controlled sources depends greatly on how many tanks, vessels and vehicles are cleaned into the waste treatment system. While tank cleaning costs are often passed through by the independent terminal to the customer, the costs of outside disposal are several times higher than the operating cost of any of the treatment schemes discussed in the following pages.

The extreme hydraulic variations are handled by sizing full flow primary oil-separation facilities and discharging these into an equalization basin and then sizing for the average flow rate in the balance of the treatment system. Retention facilities provide the surge for both the hydraulic variations and the composition changes experienced in public terminal's wastes.

Recent changes in the regulations may justify use of steel open top tanks rather than earthen impoundments for equalization facilities.

WASTE CHARACTERIZATION

From a treatability point of view, the following parameters of each waste affect the system design.

- Solubility in water
- Oxygen demand
- Volume
- Flow surges
- Salinity
- Bio-Refractory (Difficult to Biodegrade)
- Bio-Toxicity
- Recoverable product content

Most independent liquid terminals have one waste treatment processing train through which all wastes pass. One exception to this is oily ballast water which is high volume, low oxygen demand compared to the other wastes. It typically is treated mechanically with primary (e.g., API separator) and secondary (e.g., dissolved air flotation) to meet the discharge water permit requirements for ballast water for the petroleum refining point source category as published by the USEPA.

All the other wastes tend to have a high COD/BOD ratio and high oxygen demand. This, when combined with the segregated stormwater gives a BOD level such as 2400 mg/l and COD of 1.3 times this figure. However, even in the relatively constant hydraulic loads from truck washing, the BOD levels were seen to range from 400-1200 mg/l after gravity separation, and the COD/BOD ratio from 1.2 to 1.9. This illustrates the different oxygen demand of different chemicals, as well as the varying volume of tank heel.

Although there is no federal point source category for terminals, the typical treated effluent quality for discharge water in Texas prior to the passage of RCRA, was:

BOD	45 mg/l
TSS	45 mg/l
COD	450 mg/l
Oil and Grease	15 mg/l

WASTE CHARACTERIZATION (Continued)

Other parameters such as phosphorus, ammonia, fecal coliform, and phenols are often regulated if there are wastes containing nitrogenous compounds, phosphates, sewage or phenolics present.

PRIMARY TREATMENT

This section discusses the equipment required in the separation of oils and solids from the influent and the equalization of hydraulic load and oxygen demand load.

In a bulk liquid terminal, the first piece of processing equipment is the oil-water separator. There may be a number of these in a large terminal or in a terminal handling high pour point oils and waxes. These should be located so that the wastewater comes in by gravity flow, since the shear action of a centrifugal pump impeller finely divides the oil droplets which causes difficulty in separating the oil/water mixture. If site layout requires pumping, a progressive cavity pump, or even positive displacement will cause less shear than centrifugal pumps.

Gravity API-separators are more common than plate-type separators, except for terminals that do not handle viscous products. The front chamber of the separator also acts as a low velocity area for solids to settle. The waste collection piping is normally sized for velocities in excess of two feet/second to reduce the tendency for solids to settle. The API separator formula calls for a low three feet/minute forward velocity, well below the settling velocity.

The separator outlet is often valved so that it can act as a spill control device in the event of a spill. The sides of the separator should be at least as high in elevation as the curbs in the pump stations and loading areas to improve spill control.

A gravity separator, if properly sized, can often meet a 15 mg/l oil and grease limit. If it does rise above 15, most secondary treatment units can tolerate a small amount of oil without reduction in performance.

PRIMARY TREATMENT (Continued)

For a terminal with a high ratio of oil products to water-soluble products, a flotation unit is a good investment. These units introduce a gas (often air) by induction or pressure into the wastewater. Bubbles form a froth that carries not only oil but much of the suspended solids. Since suspended solids often have oxygen demand, the flotation device can also reduce waste load.

If site elevations allow gravity flow from the separator to the equalization basin it eliminates the need for high volume pumps to handle peak stormwater flows. Such pumps, however, may be useful to divert the last part of a large rain directly to stormwater discharge.

The equalization basin for chemical wastewater requires much more retention time than the typical 24 hours for municipal sewage plants. This is because of the need to provide a dilute environment for toxic chemicals and the more bio-refractory materials compared to sanitary sewage.

In addition, the large rain volume from a storm can easily equal one months capacity. For example, in Southeast Texas, a ten-year design, 24 hour storm is nine inches of rain compared with annual average of fifty inches. This represents 18% of the years rain. If the stormwater represents half the total waste volume, then one 9 inch rain contributes 9% of the years hydraulic load, equal to 33 days.

The basin will normally operate at a low level to have adequate surge for a large rain and still meet the federal 2 foot freeboard requirements. Sufficient oxygen should be supplied to the basin to prevent odor problems, but not so high is to cause significant biological activity with attendant sludge formation. A dissolved oxygen level of 2 ppm is usually sufficient to maintain an aerobic surface layer.

PRIMARY TREATMENT (Continued)

This oxygen level can be achieved with surface aerators or subsurface diffusers. It is cheaper to bubble air through water than toss water through the air, thus subsurface diffusers costs less. Another alternate is to recirculate oxygenated water from a trickle filter.

One organization that has discovered the benefits of oxygenated equalization is the Gulf Coast Waste Disposal Authority Central Treatment Plan in Bayport, Texas. This facility has segregated waste streams they receive from chemical plants. In the last year they have added a large equalization capacity in front of the existing treatment in order to overcome odor problems and hydraulic overload.

SECONDARY TREATMENT

Following primary treatment, a number of secondary treatment alternates are possible. They can be broadly grouped as following:

- Thermal
- Chemical
- Biological

Thermal involves technologies such as steam stripping and incineration. Given the high energy per pound to vaporize water, these are normally used only by facilities with low volume, highly concentrated or toxic wastes.

Chemical technologies include solvent extraction, sedimentation, floculation. These are common where the waste composition is steady and predictable. For a multi-product terminal with tanks changing service, they are of limited use.

Biological technologies come in a number of different geometries. One group, such as trickle filters and rotating biological contactors, have an inert high-surface medium, usually plastic, on which a biological slime is constantly wetted by the wastewater. The thin layer of slime is provided oxygen by natural draft.

Another group, the aerated ponds, are supplied with subsurface air and are usually operated with extended residence time to minimize sludge formation. As a biological reactor, two ponds in series provide more overall waste reduction than one large pond of equivalent volume.

A variation on the aerated pond is activated sludge where a portion of the sludge is recycled to maintain a high solids content in the unit. An activated sludge unit provides more waste processing ability for a given volume and are popular with package plant manufacturers. The sludge return pumps are air-driven from the same blower providing the sub-surface air.

TERTIARY TREATMENT

Secondary treatment alone is often sufficient to meet discharge parameters, particularly if there are few bio-refractory compounds. Some terminals elect to add tertiary treatment since it will produce water quality suitable for reuse as utility water, thus reducing the discharge volume, and supplement cost of supplying raw water for utility water.

Tertiary treatment includes technologies such as reverse osmosis, ion exchange, carbon absorption and disinfection.

Reverse osmosis and ion exchange have application in terminals handling a known narrow range of products.

Activated carbon can be used either by passing the wastewater through beds of granulated activated carbon, or adding powdered carbon to the aeration cell.

Disinfection is required for fecal coliform from sanitary sewage. Chlorination is usually sufficient, although it can turn certain organic compounds into halogenated hydrocarbons. A preferred technique is ozonation or ultraviolet treatment which do not have this side-effect.

SLUDGE TREATMENT

Since API separator sludge is classified as hazardous, many terminals elect to contract for offsite disposal to avoid the monitoring requirements and post-closure requirements of onsite landfills.

For a large facility, some sludge treatment may be justified to reduce the volume of solids, since the cost of contract disposal is usually directly proportional to the quantity to be disposed.

A common technique is dewatering by either centrifuge, filter press or belt filter. For a small facility, simple gravity thickening in drying beds with decanting of the liquid will give a modest reduction in volume.

LIQUID DISPOSAL

If properly treated, effluent can be directly disposed of to the public waterways under permit.

Other disposal alternates for liquid disposal include deep well injection, which usually requires pretreatment. Another alternate is chemical fixation as a solid in a properly managed landfill. Evaporation is sometimes used to reduce disposal volumes in arid areas where net evaporation exceeds net rainfall by a significant amount. Evaporation does not remove any pollutants except volatile ones.

Good waste management includes contracting for offsite disposal of known highly biorefractory compounds.

The attached table is from the "NPDES Best Management Practices Guidance Document" and lists approximately 100 common chemicals, of these, around 75% are biodegradable.

OPERATING COSTS DISCUSSION

The costs associated with operating a terminal waste treatment system can be categorized as follows:

- Management - Training
- Clerical - Record Keeping
- Analytical - Lab Analysis
- Operations - Operator
- Utilities - Electricity, Steam, Gas, etc.
- Chemicals - Neutralizers, defoamers, odor control, activated carbon

One of the most significant cost items is the use of activated carbon in the processing scheme. If used as tertiary treatment as a final polishing step the costs are relatively low. This approach is shown in the "Treatment Technology Overview" figure taken from the summary volume of the five-volume EPA manual on treatability.

If used as a primary treatment to reduce load to biological systems the carbon cost can be over 50% of the total operating cost. In the case of a truck washing operation, it amounted to $20.62 per thousand gallons out of an overall direct operating cost of $36.10.

Although carbon will do a good job of screening toxics and high molecular weight bio-refractory compounds, an equalization pond with 30 days retention time will achieve much the same result at no operating cost other than circulating horsepower. The pond achieves this by providing the necessary dilution to reduce the chemical concentration below the level of toxicity and allow time for the system to acclimate .

REFERENCES

The list of publications below contain related reference material to help evaluate wastewater processing schemes, management practices for waste, and federal regulations.

Federal Register - May 19, 1980 - Hazardous Waste Management Systems.

Federal Register - Jan. 12, 1981 - Standards applicable to owners and operators of hazardous waste treatment, storage and disposal facilities. [Note - covers, tanks, surface impoundments and waste piles only.]

Federal Register - Jan. 11, 1982 - Standards applicable to generators of hazardous waste.

"NPDES Best Management Practices Guidance Document" EPA - 600/9-79-045.

"Selected Biodegradation Techniques for Treatment and/or Ultimate Disposal of Organic Materials" EPA-600/2-79-006.

"Investigation of Biodegradability and Toxicity of Organic Compounds" EPA-600/2-79-163

"Treatability Manual" EPA-600/8-80-0429 A through E.

"Draft Development Document for proposed effluent limitations, guidelines and new source performance standards for the truck segment of the transportation industry point source category" EPA-Cincinnati 1974.

"Truck Washing Terminal Water Pollution Control" EPA-600/2-80-161

Texas Department of Water Resources Permanent Rules:

Chapter 22 - Industrial Solid Waste Management
Chapter 25 - Consolidated Permits
Chapter 27 - Underground Injection Control

REFERENCES (continued)

"Treatment of Hazardous Waste-Proceedings of the Sixth Annual Research Symposium" EPA-600/9-80-011

"Disposal of Hazardous Waste-Proceedings of the Sixth Annual Research Symposium" EPA-600/9-80-010

"Barrel and Drum Reconditioning Industry Assessment" EPA-600/52-81-231.

"A Systems approach to Reducing and Handling In-Plant Bulk Liquid Terminal Petrochemical Spills". The Fifth Annual International Pollution Engineering Congress. Emserv Division of Paktank Corporation, Mark W. Hooper, President.

"Physical, Chemical and Biological Treatment Techniques for Industrial Wastes". Arthur D. Little & Company. November, 1976 for EPA.