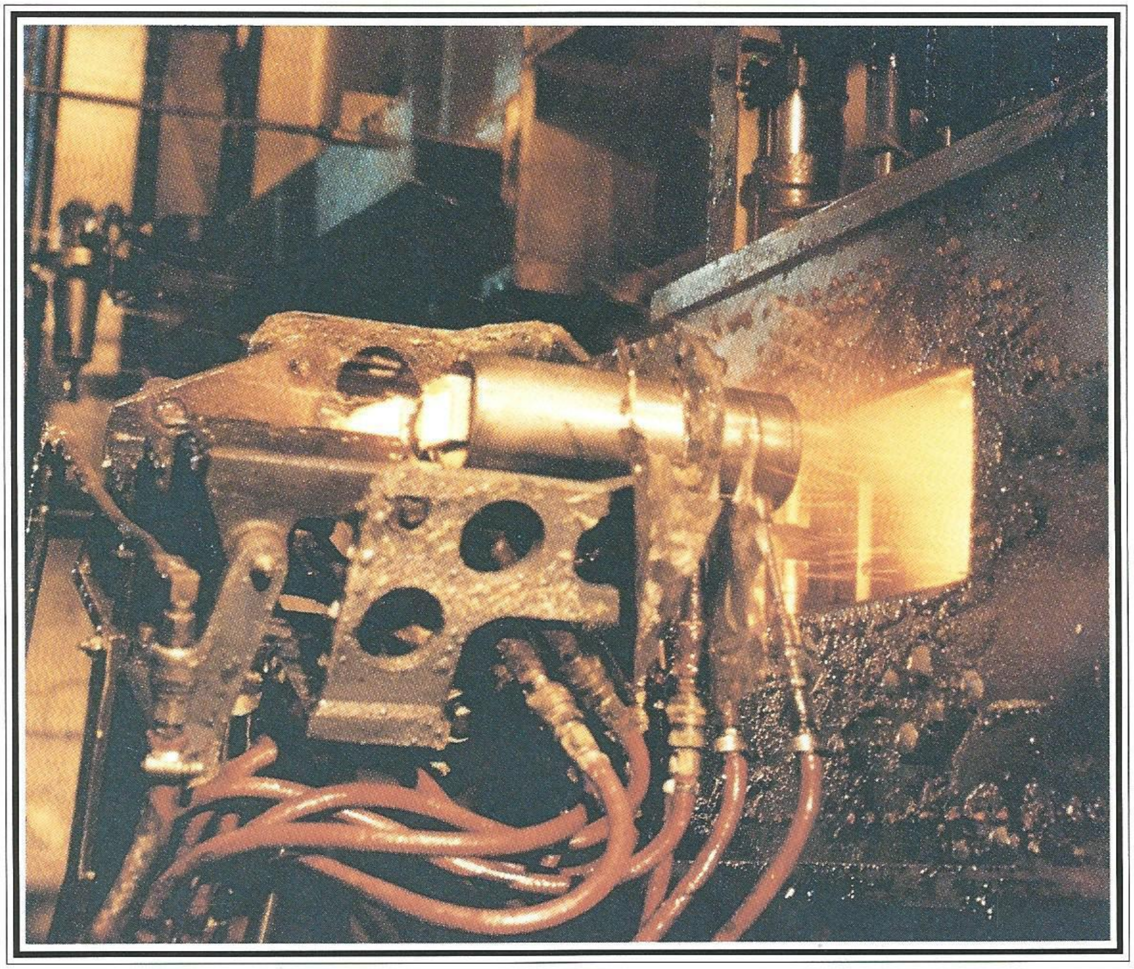
$5.00

May 10, 1993

GLASS INDUSTRY

74th year



How to Control Oil/Grease in the Effluent . . . Page 14

Reducing NOx Emissions . . . Page 18

Pollution Control Exhibit in Print . . . Page 23

How to Control Oil/Grease in the Effluent from Glass Container Plants

More stringent standards are forcing improvements in both process control and end-of-pipe treatment technology

By Timothy Keister
ProChemTech

PASSAGE of the Federal Water Pollution Control Act amendments of 1973 resulted in creation of a national system for control of both direct and indirect discharges of industrial wastewater to surface waters. Technology based effluent standards were devised by the U.S. Environmental Protection Agency for both direct dischargers, which were regulated under the NPDES permit system, and indirect dischargers, which were regulated by the receiving publicly owned treatment works (POTW) under federal or state approved pretreatment programs.

Effluent standards and guidelines covering both direct and indirect wastewater discharges from glass container manufacturing plants were promulgated by the EPA in 1975 as CFR 426.80/87. The pollutant of most concern regulated by these standards was oil/grease; limitations imposed on suspended solids and pH presented only minor compliance problems to the industry. To obtain compliance with these initial EPA standards, the preferred lowest cost technology package was installation of cullet quench water recirculation systems, conversion from mineral base to biodegradable base shear oils, and switching from stream to POTW discharge. Some of the better controlled plants actually attained zero discharge of process wastewater by recirculation, but have subsequently found that such a condition is difficult to maintain on a consistent basis.

While the national standards have not been revised to date, the effluent limitations utilized by many state and local regulatory agencies have become so stringent that they are now lower than the values set by the EPA. With the water pollution control regulatory scheme used in the United States, the more stringent effluent standard is controlling. The result is that state stream discharge limits have been set as low as 5 mg/l total oil/grease, while discharges to POTW have been limited to as little as 50 mg/l total oil/grease.

As these more stringent state and local effluent standards are not obtainable with the technology package used to attain compliance with the national standards, many glass container manufacturing plants are now facing a definite need to upgrade their wastewater treatment technology. Fortunately, significant improvement has been made in many technologies for control of oil/grease in wastewater since setting of the first national standards by the EPA in 1975. These improvements include modifications to improve the control of existing cullet quench water recirculation systems, use of low pollution shear oils, zero discharge operation of cooling towers, control or elimination of excess influent water to cullet quench systems, and end-of-pipe treatment processes.

POLLUTANT AND FLOW SOURCES

Past research has established that the majority of the total oil/grease found in the effluent from a glass container manufacturing plant comes from just a few sources, which are listed in order of importance based on the amount contributed and difficulty of treatment:

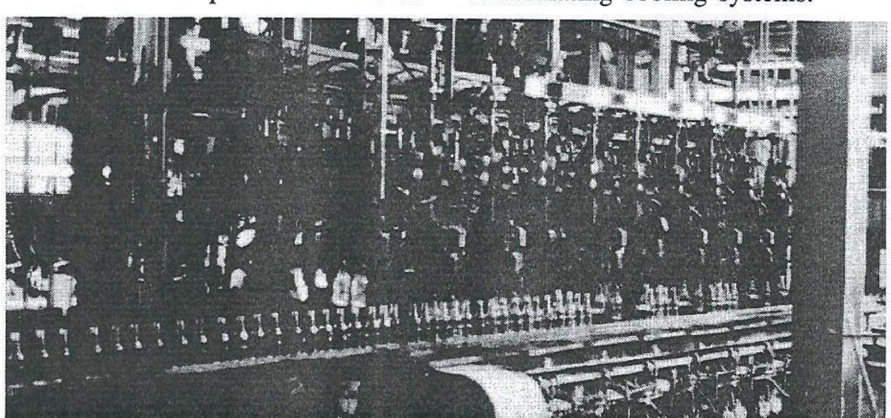
- Soluble oils used in glass shearing (shear oils).
- Forming machine lubrication oils.
- Condensate from compressed air systems.

Note should be made that shear oil is both the major source of oil/grease in the effluent, and is responsible for additional emulsification of forming machine oils when the two materials are mixed. This property of the shear oil increases the amount of total oil/grease in the soluble, or emulsified, state, thus increasing the problem of attaining compliance by increasing the amount of oil/grease in the difficult to treat emulsified form.

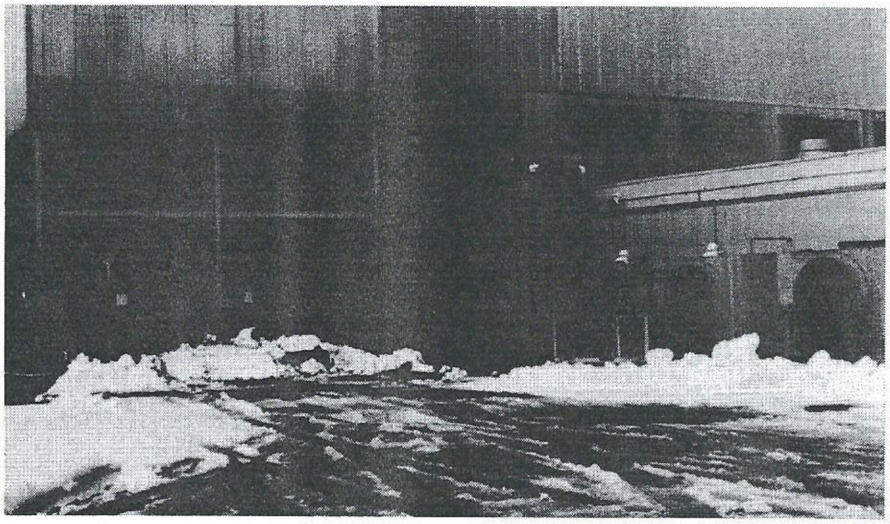
Wastewater flows from the following sources are often channeled through the cullet quench system, increasing the discharge from these highly contaminated systems:

One-pass supplemental cullet quench cooling water.*

- One-pass cooling waters from compressor, furnace, and forming machine cooling.
- Blowdown and leakage from recirculating cooling systems.



This modern high speed IS machine has an output of over 350 bottles per minute.



A new glass container plant features numerous cooling towers for recirculation of cooling and cullet quench waters.

- One-pass mold cooling water.*
- Backwash and regeneration water from water softeners.
- Shear water.*
- Backwash and regeneration water from demineralizers.
- Reject from reverse osmosis units.
- Boiler blowdown.
- Cold end spray excess and washout water.*
- Air system blowoff.*
- Air dryer discharge.*

A glass container plant, which has state-of-the-art systems and is properly operated, should have a total influent water usage of less than 150 gallons per ton of glass produced. Influent water usage in excess of this value should be investigated as it is likely that significant effluent flow reductions can be achieved by water conservation and water system control measures.

Review of this listing shows many "one-pass" uses and leakages which can be readily recycled or eliminated. The only wastewaters intentionally discharged to the cullet quench system are those contaminated with oil/grease, which are marked with an * in the list. All "clean" wastewaters should be routed around the cullet quench system and discharged following any other appropriate treatment.

ZERO DISCHARGE

While not a new technology, zero process water discharge is being reconsidered by many plants as an answer to compliance problems. Zero discharge can be attained via careful control of water input to the cullet quench system, use of cullet quench water as batch wetting water, and/or installation of an evaporator for disposal of excess wastewater.

Zero discharge based on control of input water to the cullet quench water recirculation system has been successful only with an ongoing commitment to control all the plant water systems. While it has been successful for limited time periods, usually in smaller glass container plants, to date it has not proven to be a long term answer to the attainment of zero discharge. This is due to the difficulties in long term control of water input in larger, more complex plants, and the general loss of technical staff in the glass container industry.

Use of cullet quench water as batch wetting water has been practiced in some plants for at least 15 years and is considered to be a viable technology. Unfortunately, the amount of wastewater that can be disposed of by this technology is limited to the amount of batch wetting water utilized, which is often less than the amount of wastewater available. Strict biological control of the cullet quench system is required to ensure smooth operation of batch wetting systems using wastewater, while effective treatment for suspended solids removal is needed to prevent transfer of stone causing impurities to the glass batch from the cullet quench system.

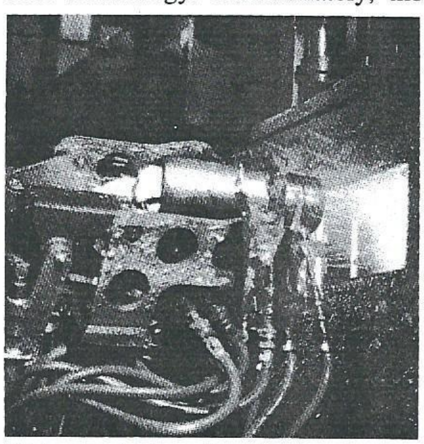
Installation of an evaporator is seen by many as the ultimate means to control wastewater problems. This is true only for small discharges as the operating cost for evaporation is around $60 per thousand gallons, as compared to a typical POTW charge of $3 per thousand gallons.

Off-site disposal of process wastewater has been practiced by a few glass container plants which have been placed into zero discharge situations for one reason or the other. This is not a viable long term method because the present cost, which often exceeds $250 per thousand gallons, is likely to increase substantially in the future.

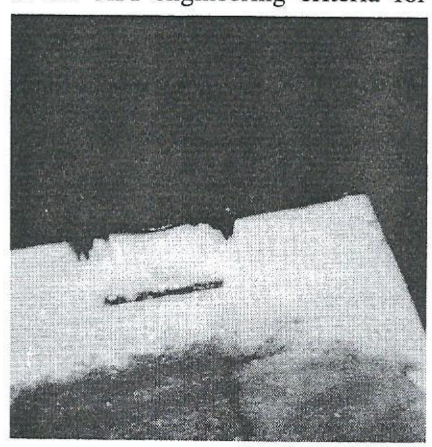
UPGRADING CULLET QUENCH

For glass container plants with discharges which slightly exceed regulatory standards, modification of existing systems may prove to be the most economical route to compliance. The following areas should be considered if this appears to be a viable approach.

Design and operation of the cullet quench recirculation system and oil separator should be reviewed. The units should be designed according to the API engineering criteria for



High speed glass shearing can provide dispersal of shear spray.



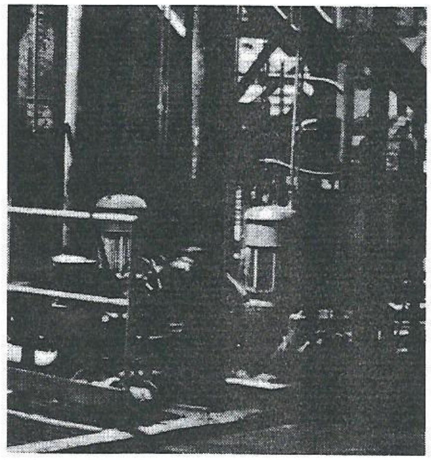
Recirculated cullet quench water, has a milk white color and floating oil.

oil/solids separators based on Stoke's law equations. These criteria have been proven to provide the best performance. Installation of a cooling tower circuit within the cullet quench system should be considered if not provided for in the original design and installation. Plants not so equipped often use supplemental one-pass cooling water during power outages and shop/tank drains, resulting in violation of effluent limits due to hydraulic overload of the oil separator. Any cooling tower circuit installed should have sufficient cooling capacity to reject the heat from drain of the rated melting tonnage of the plant furnaces(s).

Operation of the actual installed equipment should be reviewed. Items such as level controls, grit chambers, valve positions, and oil skimmers should be checked for compliance with original design, the cited criteria, and proper operation. I have noted more than a few installations that were either improperly designed, or which while properly designed and installed have subsequently been degraded through either improper operation or repair. In some cases, increased plant production capacity has resulted in simple hydraulic, or thermal, overload of a system due to present loads exceeding its original design criteria.

Due to the biodegradable nature of emulsified oil, cullet quench systems are subject to severe biological growth problems. Biological growth within cullet quench systems degrades oil/grease removal efficiency, often resulting in effluent values exceeding regulatory standards. In addition, the biologically fouled cullet quench system presents a health hazard from Legionnaire's Disease as well as creating unpleasant working conditions for employees.

The lowest cost solution for biological problems is to chlorinate the cullet quench system on a routine basis using gas chlorine. Due to SARA Title III and safety considerations, this option has been ruled out by some glass container plants. In this event, acceptable results have been obtained at a higher cost using either hydrogen peroxide, or on-site generated chlorine dioxide solutions. Please note that the various proprietary biocides proposed by many water treatment chemical com-



Cullet quench water treatment and reuse system.

panies for use in cullet quench systems do not provide very good performance when compared to the noted oxidizers, and are substantially more expensive. While sodium hypochlorite has been used to obtain cost effective biological control results, the high alkalinity of this chemical tends to increase the emulsification of oil/grease in the cullet quench water and I do not recommend its use.

SHEAR AND MACHINE OILS

One obvious method to decrease the amount of oil/grease in the effluent is to convert the shear oil from an oil base (mineral or biodegradable) to a non-oil base shear oil. Research started at Brockway Glass in 1978, and carried on by my firm, has resulted in development, testing, and production use of a new shear oil that contains approximately 14 percent the total oil/grease content of the mineral and lard oil base products in common use. In many cases where the effluent standards are not extremely stringent, this "no cost" change will bring the effluent into compliance.

I should also point out that usage control, as well as capture and recirculation of used shear oil solutions have been practiced as other approaches to controlling oil/grease in the wastewater discharge. Usage control can be quite effective, but requires a substantial degree of management control to remain effective over time. Capture and recirculation has proven to be effective if the plant recognizes the fact that the used shear oil solution will be contaminated with solids, free mineral oil, and microbes. To control plugging of shear nozzles, the used shear oil solution must be treated for removal of solids and free oil, and an effective biological control agent, like 1,5 pentanediol, added to the system.

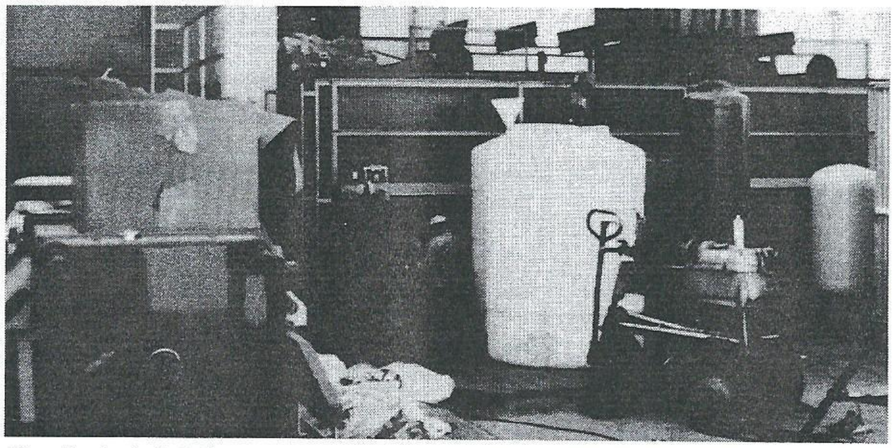
While not a major oil/grease contributor, the emulsion characteristics of the forming machine oil should also be checked. I have found an extremely wide range of emulsifibility for these products, ranging from 100 mg/l to over 12,000 mg/l total oil/grease in water mixed with the oil. If at all possible, a low emulsion forming machine oil should be used. In the event that this is not possible, good housekeeping should be employed to reduce the amount of forming machine oil reaching the cullet quench system where it can emulsify on its own, and also react with any shear oil emulsifiers present.

The oil/grease found in the condensate from compressed air systems generally results from the addition of oil to the compressors for air side lubrication and corrosion control. As with forming machine oils, a wide range of emulsifibility exists in the products supplied for this use. Even with this source being the smallest contributor of both free and emulsified oil/grease in the plant effluent, the oils in use should be selected for minimum emulsion formation. Free oils should not be discharged into the cullet quench system as that merely adds another source of oil to be emulsified by the surfactants present from the shear oil.

TREATMENT OPTIONS

Systems installed to physically, or chemically, remove emulsified oil/grease from generated wastewater are termed end-of-pipe technology by the EPA to distinguish them from the process modifications already discussed. Due to the inherent difficulty of breaking the emulsified oil/grease found in glass container plant wastewater, only three technologies have been identified and proven in use for this service: carbon absorption, chemical coagulation with dissolved air flotation, and ultrafiltration.

Carbon absorption consists of passing the wastewater through a bed of activated carbon where the oil/grease present will be absorbed. Us-



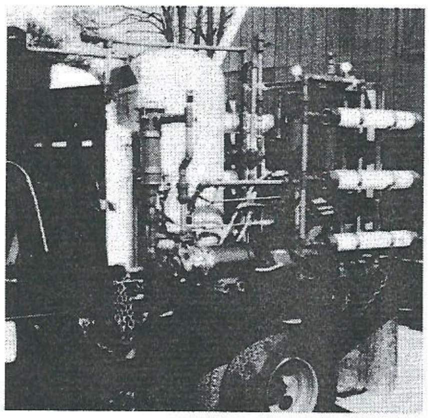
Dissolved air flotation system being installed.

age of activated carbon is directly dependent on the amount of oil/grease removed from the wastewater.

This technology was proven to be a viable means of removing emulsified oil/grease from glass container plant wastewater during plant trials conducted by Brockway Glass Co. during 1983. The research showed that levels of total oil/grease less than 5 mg/1 could be obtained in the effluent on a routine basis and that the process was quite resistant to upset from simple operator error. Activated carbon was also found to be regenerable on-site using steam as the driving force, which lowers the substantial operation cost of the process due to replacement and disposal of spent activated carbon.

Due to the fact that carbon absorption beds must be sized and regenerated based on flow and loading, the technology is applicable only to small flows with relatively low oil/grease loadings as the capital expense of the large carbon beds required for high flows and/or loadings is substantial.

Chemical coagulation followed by dissolved air flotation (DAF) is a process where chemical emulsion breakers, flocculants, and coagulants are added to the wastewater to break the emulsion and absorb the freed oil/grease in chemically produced precipitates. The precipitates are then removed from the wastewater by flotation via depressurization of pressurized, air saturated water added to the wastewater. This action produces tremendous numbers of tiny air bubbles, which function as the actual flotation media by attachment to the produced precipitates. Floated precipitates are skimmed from the surface of the water by mechanical means and usually dewatered using a filter press prior to disposal.



Ultrafiltration system being readied for truck shipment.

The DAF process has been successfully utilized for removal of emulsified oil/grease from various industrial wastewaters for many years. It is considered to be a mature technology with recent innovations taking place only in the specific chemistries employed to destabilize, flocculate, and coagulate the emulsified oil/grease.

New chemistries using combinations of organic and inorganic polymers have proven to be much better than older chemistries using iron or aluminum salts followed by lime addition. A major benefit, given the ever increasing cost of sludge disposal, is that the new chemistries decrease sludge generation by up to 75 percent.

While this technology can readily treat any combination of flow and pollutant loadings, the high capital cost of the equipment needed, along with the level of technical expertise needed to obtain good results, tends to restrict it to larger plants with high flow rates, or plants with high pollutant loadings. At the lower levels proposed for stream discharge, such as 5 mg/1, this treatment technology may have to be followed by a polishing step, such as carbon absorption or pressure filtration, to ensure compliance. It can readily maintain compliance with the 50 mg/1 total oil/grease limit used by some POTW.

Ultrafiltration is basically a cross flow filtration process where clean water is forced under pressure through a membrane leaving the pollutants behind in a concentrate flow. It is one of a family of new membrane processes that began to be developed during the early 1970s.

Initial pilot work in 1979 with the process at Brockway Glass showed that it could readily produce an effluent containing less than 5 mg/1 total oil/grease, but was rather "fragile" for use in a glass manufacturing plant environment as well as being quite costly on a capital basis. Continued development of this process has resulted in much tougher membranes that produce higher unit flow rates. In addition, the larger number of firms producing both membranes, and assembled systems, has resulted in substantial lowering of prices for industrial duty systems.

Recent installations using the newer membrane technology has shown the process to be capable of excellent pollutant removal, easy operation, and reasonable durability. With present equipment pricing, use of this technology will likely be limited to systems processing from 500 to 35,000 gpd due to capital costs. Larger flows are more economically treated using chemical coagulation and dissolved air flotation. ☆

Timothy Keister holds a B.S. in Ceramic Science from Pennsylvania State University. Prior to establishing Pro-ChemTech in 1987, he was employed for 13 years by Brockway Glass Co. as section head, water/wastewater control. He was responsible for ensuring that company production facilities were in compliance with applicable water and wastewater regulations. As Brockway's representative on the Glass Packaging Institute water pollution control subcommittee, he was directly involved with the U.S. EPA during promulgation of the effluent guidelines and standards for the glass industry in 1974 and 1975.