Technical News Feature

Wastewater Treatment for Edible Oil Refineries

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ABSTRACT

Systems and practices for successful treatment of edible oil refinery wastewater are reviewed, including: total plant good housekeeping, conservation of water usage, integrated system design, by-product handling, and process control and operation.

INTRODUCTION

Effective wastewater treatment depends on total plant good housekeeping, conservation of water usage, integrated treatment system design, accurate process control, and close supervision and operation. We shall consider each of these factors in detail.

GOOD HOUSEKEEPING

Good housekeeping, with respect to wastewater treatment, really means prevention whenever possible of waste materials from entering the wastewater. It means avoidance of accidental spills and tank overflows. Such things as automatic alarms and controls for tank filling operations, visible pipe line and valve identifications and convenient arrangements can help. When spills do occur, materials should be picked up as much as possible before washing down the drain. Provision in key locations of portable vacuum equipment, shovels and containers, for example, will facilitate such pick-up.

A critical review and good records of basic process operation will reveal sources of excessive continuous and intermittant equipment losses which can be corrected. This, of course, would improve overall product yield, as well.

WATER CONSERVATION

Costs for a wastewater treatment system are largely determined by the total flow rate. Therefore, conservation of water usage makes sense. My experience is that wastewater volume, as well as contaminants loading, can often be reduced up to 50% by instituting good water conservation and housekeeping procedures requiring little capital expenditure. Application of the same principles, techniques and dedication that are used for a safety program will yield effective results. Of course, installation of such major capital equipment as indirect condensers and evaporative coolers, and recirculation of barometric condenser water, will substantially reduce wastewater generation.

INTEGRATED TREATMENT SYSTEM DESIGN

Effective treatment processes and equipment, including dissolved air flotation and biological treatment, are available which, when properly applied, will purify the water.

Integrated treatment system design requires precise and complete definition of: (a) final effluent quality requirements (local, state and federal) and corresponding governmental charges; (b) determination of in-plant wastewater stream characteristics and their treatability around the clock; (c) an economical and practical strategy for recovery and/or disposal of by-products such as sludge or skimmings.

Installation of a system capable of doing the total job from the outset is usually the most practical and economical approach in the long run. Partial systems often lead to inadequate effluent quality. This, in turn, results in excessive costs to correct the situation under duress.

Final Effluent Quality Requirements

The first step in design of a wastewater treatment system is to establish final effluent quality requirements. All control limits should be considered. Often, a plant will express concern about only one or 2 contaminants such as hexane solubles or BOD because these are perhaps the main ones for which the plant is being penalized at the moment. However, pH, suspended solids and temperature usually are important for edible oil refineries as well. Some plant effluents receive a suspended solids surcharge.

The U.S. Environmental Protection Agency is developing specific effluent quality guidelines for the edible oil industry. However, presently the surcharge levels one encounters for discharge to publicly owned treatment works (POTW) are: BOD_5, 200 mg/1; suspended solids, 200 mg/1; pH, 6.5-9; and temperature, 150 F. Grease and oil was limited typically to 100 mg/1, but now may be considered part of BOD.

Copies of all currently applicable local, state and federal regulations should be obtained. A few representative samples should be analyzed completely to be sure that all parameters of concern are brought to light. Basically, it is advisable to confer with the authorities to be clear that all the target levels and requirements are clearly defined, and hopefully won't change again. This area of changing requirements is, of course, one of the most troublesome to industry.

Wastewater Characteristics, Flow Rate and Treatability

The next step in design is a plant survey to identify and characterize individual wastewater point sources and the combined total effluent stream as to their volume, contaminant levels, pH and temperature around the clock. Treatment requirements for each stream should be evaluated. The need for stream separation versus combined treatment can then be evaluated, taking into account system economy and treatment compatibility. Normally for an edible oil refinery, the entire wastewater stream, excluding sanitary waste, is handled with a single system. Deodorizer overheads and acidulated materials are preferably processed separately to remove and recover the bulk

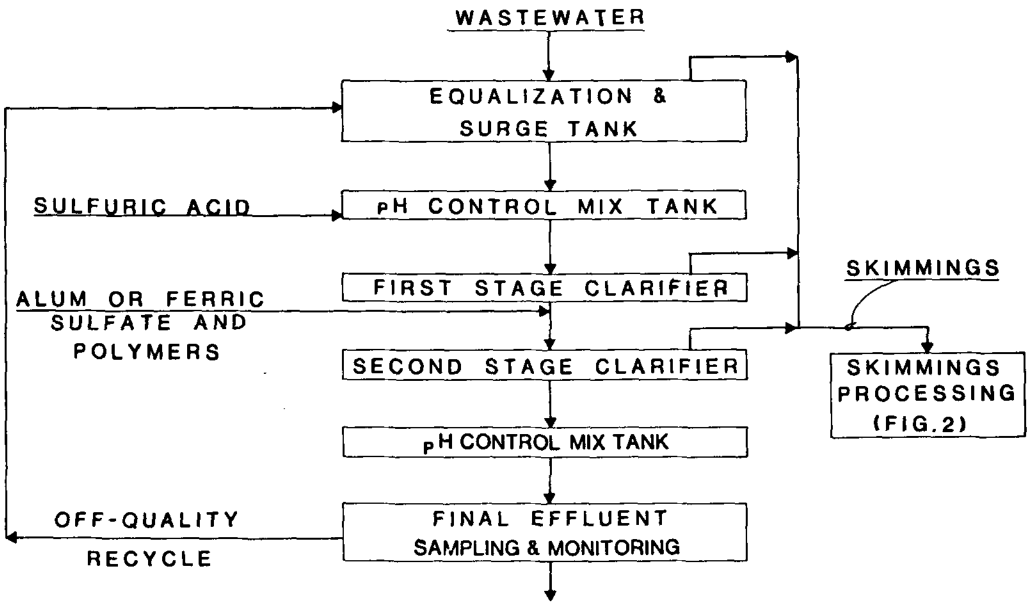

FIG. 1. Primary wastewater treatment system.

of the free fatty acids before sending the water through the main waste treatment system. Higher by-product value is the reason for separate recovery of this material.

By-product Recovery/Disposal Strategy

Frequently, the most difficult waste treatment design problem is recovery and/or disposal of the by-products generated from the water treatment system. They may be oily skimmings from a clarifier or sludges from a biological waste treatment system. So, during the treatability studies, one should program work to define requirements and develop a strategy for disposal of these by-products. An expanded industrywide program is urged to develop technical information in this area.

Treatment Systems

For discharge to POTW, only pretreatment is necessary to meet effluent quality requirements. When low levels of oil and grease are required, this pretreatment often consists of dissolved air flotation clarifiers, preferably using chemical treatment to enhance flocculation and flotation. For discharge to rivers and streams, biological treatment is used, commonly following a pretreatment system. Typically, one of several available types of activated sludge systems is used.

Figure 1 illustrates in simplified form the elements of a primary treatment system applicable to edible oil refinery wastewater, particularly where low levels of oil and grease are required. Many variations are used, depending on the treatability requirements for specific plant wastewaters.

Plant wastes are collected normally in a below-grade sump and then pumped up into an equalization tank equipped with oil skimming features. This equalization tank provides for: (a) stabilization of the flow rate through the rest of the system; (b) equalization of pH and contaminants loading; and (c) storage capacity for recycle of off-quality treated effluent.

The equalization tank is preferably insulated to keep

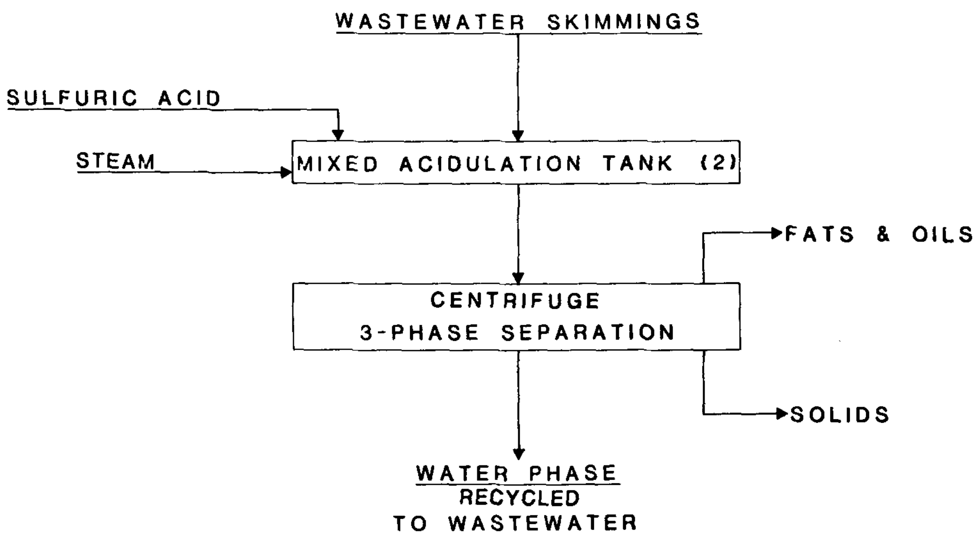

FIG. 2. Clarifier skimmings processing.

the wastewater warm. Generally, the higher the temperature, the better the oil separation. Actually, the addition of steam heating may be justified. Levels of chemical treatment in the second stage clarifier may also be reduced.

From the equalization tank, the wastewater is pumped into a pH control mix tank where sulfuric acid is added automatically to hold pH between about 3.5 and 6 pH, depending on the kind of chemical treatment planned. Adjustment to the acid side is practiced to break at least partially the oil/water emulsion and allow free oil to separate in the first stage clarifier. The lower the pH, the better the initial separation.

Coagulants, such as alum or ferric sulfate, plus polymers are added before the wastewater flows to the second stage flotation unit. The final effluent pH is then adjusted, usually to 6.5 to 9, before final discharge and sampling.

By-product Recovery

By-product handling, in this case the oily clarifier skimmings, is often neglected in design considerations even though it is often the most difficult problem. This author and others under a USEPA demonstration project have shown that skimmings can be recovered and dewatered to 95-99+% hexane-soluble material by means of the acidulation/centrifugal system illustrated in Figure 2. The skimmings are heated to 180 F, acidulated with sulfuric acid to 2.5 pH, then separated into 3 phases: water, oil and sludge. The water phase is recycled to the first stage clarifiers, thereby recovering up to 85% of the coagulant chemicals which were redissolved by the acidulation. The sludge phase is disposed on land. The concentrated oil phase is reused for nonedible products.

Increased use of such a recovery system is recommended in view of the increasing value of oily by-products, as well as the high costs and difficulties of current methods of disposal.

PROCESS CONTROL AND OPERATION

Millions of dollars can be spent to design and install a waste treatment system. But, it is to no avail without accurate process control, quality operation, and close supervision. No longer can wastewater treatment be considered a minor part of modern plant operation.

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