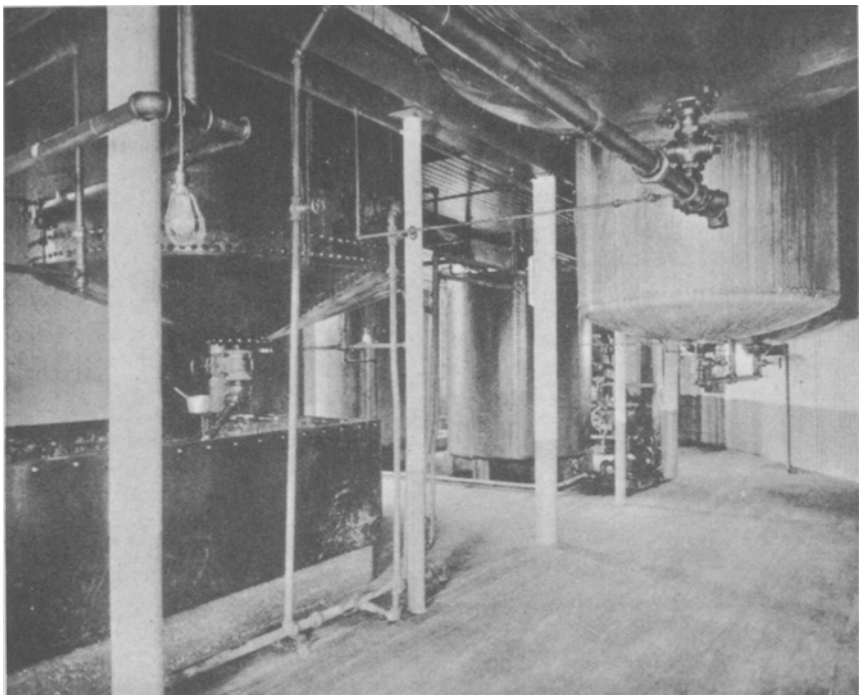
Inventory and Production Control in Oil Refineries

Many refineries suffer "dead losses" running from two to ten per cent.

By ALAN PORTER LEE

MOST edible oil refineries are subject to occasional real or apparent losses of profit due to inability to reconcile the book records of purchases and sales of merchandise with the actual physical inventories taken periodically.



Well-kept refineries show few inventory losses

This failure of reconciliation may be due to any one or more of several causes, or to all of them. The cause may be inaccuracy in gauging of tanks; or in taking weights when filling packages. It may be carelessness of employes in the matter of thoroughly emptying tank-cars or barrels in which raw materials are received. Leaky pipe-lines or accidental overflow of tanks may be responsible wholly or in part. The most frequent underlying cause, however, is to be found in some weakness of production process methods.

The methods at present in general use in the United States for

refining vegetable oils of all kinds are essentially uniform in all refineries, embracing the steps of:

1. Neutralizing free fatty acids with caustic soda solution.

2. Removal of the soap formed in the first step. This is accomplished by settling the oil or washing it with hot water; or by a combination of both these methods.

3. Drying, bleaching and filtration of the refined oil for clarification and improvement of color.

4. Deodorization of the oil by distillation with steam, either at atmospheric pressure or in vacuo.

At first glance it would appear that processes so well standardized would offer but small possibility of unexpected inventory losses; but each process is subject to some variations of procedure in different plants and there are many opportunities at each stage for slight losses of product.

In the neutralizing step, the addition of too great excess of caustic soda above the amount calculated as necessary to combine chemically with the free fatty acid will result in losses of neutral oil into the soapstock by-product; either chemically or mechanically, or in both these ways.

The washing operation, which is generally in use with oils other than cottonseed oil (and in some refineries with that oil) presents a fertile field for losses of oil, through disregard of proper temperature-control of oil and water, or through carelessness in settling and drawing off wash waters.

In the drying operation, if conducted in vacuo, oil may be lost through over-filling the vacuum-tank, causing priming, which may be caused also by the presence of small amounts of soap remaining in oil that has been incompletely washed or insufficiently settled.

The bleaching operation may be the source of small but persistent inventory losses, if excessive amounts of bleaching materials are used; or if bleaching kettles and filter presses are not properly operated to insure minimum absorption of oil by the bleaching materials.

In deodorizing, the most fruitful source of inventory losses is to be found, somewhat surprisingly, in the engineering design of the deodorizing equipment. The purpose of deodorization is the removal of the aldehydic bodies causing flavor and odor. This is accomplished by distillation with a current of live steam and is inevitably accompanied by the entrainment of some oil in the steam current. In vacuum systems some of this oil can be recovered by skimming from condenser hot-wells; but in any system a portion of the oil so entrained by the steam blast will be lost.

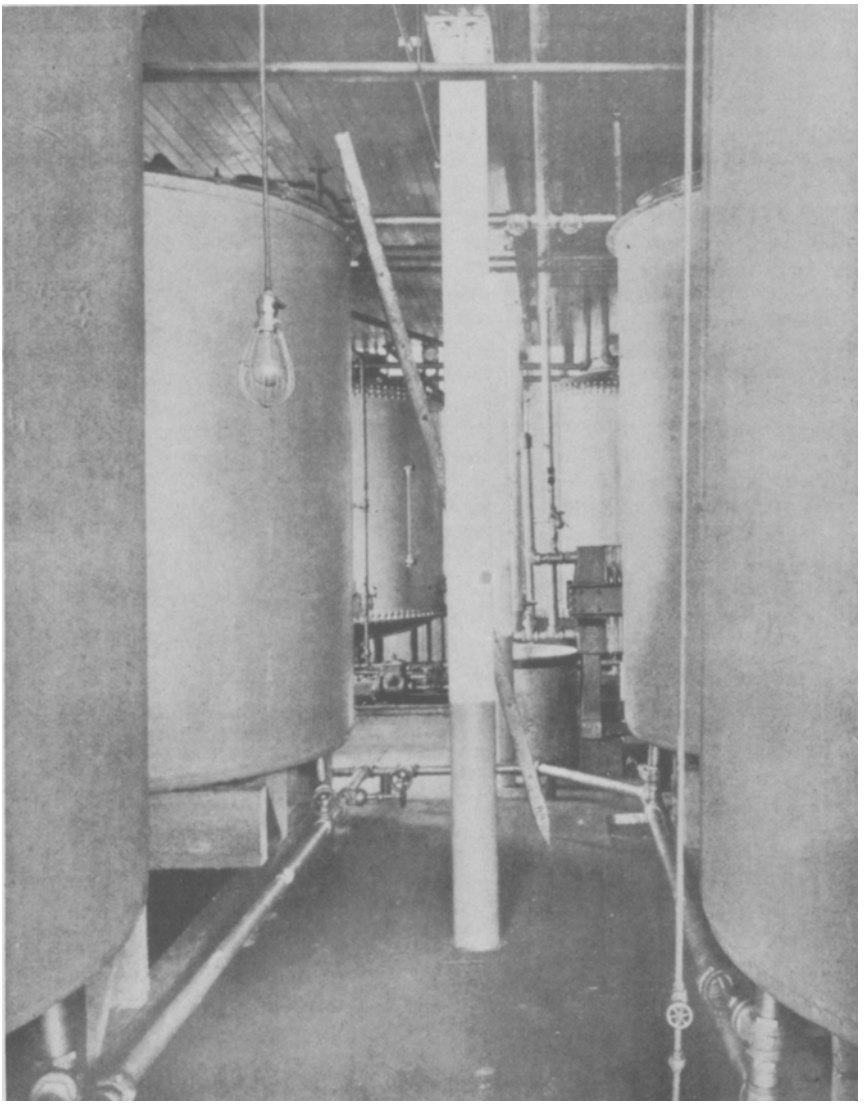
The value of proper engineering design for the deodorizing equipment lies in the fact that, other things being equal, the deodorizer built to operate with the lowest practicable velocity of steam through the exhaust outlet, will show least losses of oil by entrainment, due to the fact that low steam velocity permits entrained oil to separate from the steam and drop back to the deodorizing tank more readily than would be the case with high velocity of steam through the exhaust pipe or the condenser.

The combined effect of these small inventory losses throughout the production process causes what is known as "dead loss" as distinguished from "refining loss," the latter being the term used to describe conversion of fatty acids and some neutral oil into soap or "soapstock." Some "refining loss" of course is inevitable, the amount thereof being dependent chiefly

upon the amount of free fatty acids in the original crude oil; but theoretically "dead loss" should be nothing whatever.

In practice, however, various refineries have suffered "dead losses" ranging from two to six per cent, and (in extreme cases) as much as ten per cent, in which amounts, of course, any moisture and settlings which may be present in the original crude oil will be factors.

It generally has been the practice of cottonseed oil refiners to accept without protest small amounts of water and meal in crude oil, and to



A sanitary attractive storage department

rely upon allowances for excess loss, if any, to reimburse them for the shortage of oil due to the presence of these impurities.

This seems a shortsighted policy, for the loss allowance is based upon the difference in value between oil and soapstock, which latter is sold either upon a total fatty acid or total saponifiable material basis. Neither reckoning will take into account substances such as water or meal, which are absolutely valueless to the refiner. If he ships soapstock on a fifty per cent total fatty acid basis, either he or his customer pays freight upon these inert materials — of no value for soapmaking — and the quality of the soapstock is materially reduced without any recompense to the refiner. In case the refiner sells acidulated soapstock or distilled fatty acids on the basis of total saponifiable matter, any moisture or meal contained in the original crude oil is removed in the process of purifying the soapstock and again becomes a "dead loss" to the refiner.

Among refiners of vegetable oils other than cottonseed, the practice varies with regard to moisture and settlings allowances. Some refiners of coconut and peanut oils, for example, insist on proportionate allowances from the mill for any moisture and settlings present, no matter how little; other refiners are content to receive allowance for all moisture and impurities in excess of a total of one per cent for both substances; and still others purchase "fair average quality" oil, without recourse of any sort in case of excessive moisture and meal content.

Some of the larger refiners of the country have attacked the problem of reducing to a minimum the inventory adjustments necessary to balance receipts and shipments, regardless of whether these adjustments are needed because of errors in gauging or weighing, or are due to actual "dead losses."

The most effective means of control for this problem is based upon a perpetual inventory system, combined with daily physical inventory of all oil in tanks, and rigid control of all oil transfers by means of a planning or despatching chart. A primary requirement of the system is that no stock be transferred from one department to another without written order from the superintendent or production clerk and written receipt from the foreman of the department receiving the oil, showing the grade as well as the amount (by scale or gauge) of material handled.

The center of the entire control system is the despatching chart, generally called a "planning board." On this board are laid out the various departments of the refining plant, in the order of operation, showing the department numbers and tank numbers; with a picture hook or nail driven into the board at the number of each tank, including storage tanks. By co-operation between the production department, purchasing, and sales departments, space is also provided on the board for showing the amount of crude oil purchased and in transit and the amounts of finished products in the factory and branch warehouses, as well as the unfilled orders on hand.

The board is provided with tags, which may be of cardboard, or preferably of metal made to take a small card-insert, upon which can be recorded the exact number of pounds of oil in each tank at all times.

In the average vegetable oil refinery all the work of perpetual inventory records and despatching

of work can generally be handled by one factory clerk, under the direction of the superintendent.

The forms necessary for control of merchandise consist of blanks for daily inventory of tanks by departments (a separate blank for each department), with space to record measurements of oil in tanks; grades, temperatures, pounds per inch, and total pounds; perpetual inventory sheets by departments, showing dates; amounts, and grades of all oil on hand at beginning of day, receipts, deliveries, balance by book, balance by next morning's physical inventory and difference, plus or minus; oil transfer orders and foremen's receipts, which latter two can be combined in one form, perforated for separation.

The procedure of maintaining the perpetual inventory is very simple. Each morning that the plant operates, before any pumping operation is started, each foreman takes the measurement and temperature of the oil in every tank in his department, reporting it on the proper form to the factory clerk. This clerk calculates the weight of oil and records it in the inventory book; also upon a tag to be hung on the proper hook on the planning board for each tank. When any production operation is complete the foreman of the department notifies the production clerk, who then issues a transfer order for the movement of the amount of oil involved to the proper department for the next process operation scheduled for that oil; or orders it retained in the storage tanks of the department reporting. The foreman of each department receiving oil on a transfer order, returns a receipt showing measurement received and temperature to the clerk, who again makes the necessary charge and credit in the perpetual inventory book and on the planning board.

The superintendent has only to refer to his planning board to obtain at any time a comprehensive view of the stock on hand and the production situation with reference to unfilled orders and to raw material arriving. Thus he is enabled to issue such production orders to each department as will enable him most promptly to fill his shipping orders and expeditionsly to unload and process arriving crude oil.

Under this system any marked discrepancy between receipts and deliveries of oil from any one department will indicate leaks or spills in that department or carelessness on the part of the foreman.

Small errors of measurement of tanks will likely balance themselves in the course of a month and if they fail to do so, there will be indication of a slightly leaky tank, or of a basic error in the measurement of some one of the tanks affected, which should be recalibrated for contents.

The system of inventory and production control above outlined has proved of greatest value to edible oil refineries in the determination and reduction of "dead losses"; for its application immediately reveals the amount of such losses by departments, knowledge of which enables the application of systematic effort for the elimination or reduction of the losses.

The application of these methods of control in a refinery handling an average of two tank-cars a day of various oils not only eliminated a most unfavorable record of frequent apparent inventory losses, but reduced a determinable "dead loss" from over two per cent to less than three-quarters of one per cent. The improvement was effected within two months' operation.