SESSION III — PROCESSING VEGETABLE FATS AND OILS

Crude Oil Handling and Storage

JOHN P. BURKHALTER, Assistant to the Vice-President of Engineering and Operations, Cargill, Inc., Minneapolis, Minnesota, USA

ABSTRACT

Methods of handling and storing crude vegetable oils are often overlooked in the production of good quality finished products at the lowest possible costs. While good methods are not difficult to understand and implement, they are extremely important. Areas that will be discussed are effects of temperature, time, tank size, agitation, and blending.

INTRODUCTION

The purpose or objective of a storage and handling system is to deliver to the refining operation a known quantity of oil at a known quality. The quality of oil should be no lower than that of the oil acquired for the refinery.

What design factors and operation procedures should be considered to accomplish the above objective?

WEIGHTS AND INVENTORIES

Let us first consider the problem of accurate weights and inventories. In these days, the difference between an efficient refining operation and an inefficient one is measured in tenths of a percent and, in some cases, in thousandths of a percent. This being the case, we must know with extreme accuracy the weight of the crude oil going to the refinery. A good operation will weigh oil to the storage facility and from the storage facility. Each tank will be strapped or measured so that the exact volume is known. Ample access to the oil in each tank is provided so that average temperatures can be obtained. Volumetric inventories are regularly compared to weighed inventories as a check against poor scales and human error.

Piping arrangement should be designed, and procedures should be set up to reduce the possibility of oil bypassing the scaling process. For example, if it is necessary to have a line which bypasses the scale, make sure it is normally blanked off or double valved.

Many of us have been plagued with a shrink problem only to discover that a leaky valve was the culprit.

Each storage facility must make a trade off between tank farm flexibility and the probability of errors being made. This is particularly the case when it comes to quality control.

The question will always arise: How much money should be spent on the internal control of weights? There is no correct answer that will fit all solutions, but we do believe that an inventory control system which does not have a confidence level of ±0.1% is not a great deal better than no control at all. Some may feel this is an unrealistic figure, too difficult to obtain. However, with the high cost of our raw materials today, we cannot really afford to be less accurate than that.

QUALITY DETERIORATION

Maintaining an ever-improving raw material quality is the second major object of the storage and handling system.

Quality deterioration of oil can occur in various ways:

1. Contamination
   a. Other oils
   b. Foreign material—dust and water
2. Color increase and/or fixation
3. Chemical change
   a. Free fatty acid increase
   b. Oxidation

Let's look at each of these possibilities.

Contamination by Other Oils

One of the most common problems in any tank farm is the unwanted mixing of oils, either by operator error or by faulty equipment or design. A good tank farm operator will keep all three of these at a minimum. Much can be done to keep this contamination to a minimum.

Design Factors

Where economically possible, there should be a separate piping system for each major oil handled or for oils with critical physical properties. In reality, separate systems are very hard to justify and good operational procedures must be set down and followed.

The use of a few large tanks rather than numerous small tanks can minimize the chance of contamination. Large tanks are less costly per unit to construct than small tanks. However, when contamination does occur, more oil is usually affected.

Tanks should be filled using an inverted U-shaped piping arrangement with a siphon beaker at the top. This type of design serves several purposes. First, it lessens the possibility of oil in a full tank unknowingly flowing to a tank with a lower level of oil. Secondly, by filling the tank from the bottom, it minimizes the exposure of oil to air as it enters the tank. This can be a significant factor in preserving oil quality.

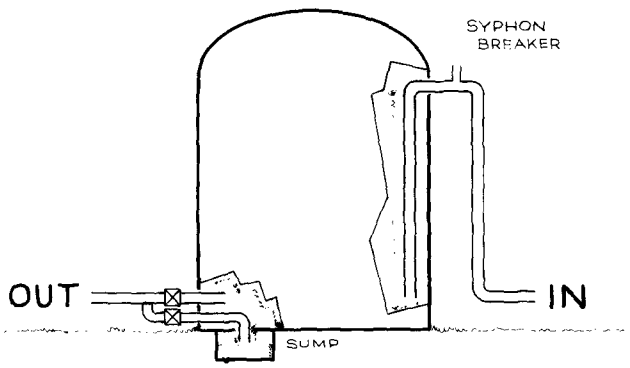

FIG. 1. Typical in-out piping for storage tank.

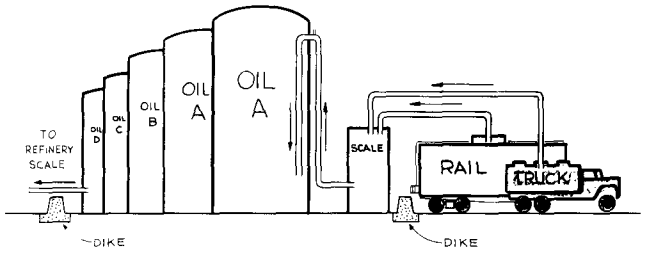

FIG. 2. Schematic of ideal oil storage facility.

Tanks can be emptied using one of two outlets, one outlet a short distance off the bottom of the tank and the second outlet coming from the sump in the tank (Fig. 1). If there is heavy foreign material in the crude oil, it will settle to the bottom; and an outlet a short distance from the bottom of the tank will not pick up that material. The tank can be periodically cleaned by using the sump outlet.

Valves and materials of contruction must be chosen carefully. In general, a tank farm is a poor place to try to save money on valves. Valves should be chosen so that it is easy to recognize if they are open or closed, e.g., rising steam valves or ball valves.

Some larger refineries have employed a fair amount of automation in their design. Flow systems are designed so that the correct valves must be open or shut and other criteria be met before a specific flow can begin.

When discussing the design criteria for a vegetable oil storage facility, one must consider, in the U.S. at least, the problem of spill prevention, containment, and control–or SPCC. Many refineries have had a ruptured tank, a broken pipe, or a human error that has resulted in lost product and, in some cases, significant harm to the environment.

Each storage facility must be properly diked, or a drainage system must be constructed which will contain any conceivable spill (Fig. 2). Procedures must be set up so that each person at a facility knows what to do in case of a spill.

Operational Factors

The most important operational factor is a well-trained, motivated operator. If he or she understands and believes the importance of the job, most any deficiency of design can be overcome. In many refineries, the tank farm operator is one of the lower paid jobs, or it is a part-time job for one man. This makes the task of obtaining first-rate performance from the person most difficult. Procedures should be set up in writing and with checklists. Don't leave procedures to chance or to be changed without good reason.

Contamination by Foreign Material

Oil can be contaminated by foreign material, particularly moisture. Crude oils which have easily hydratable materials, such as soybean oil, can be degummed right in the storage tank if conditions are just right. A combination of high humidity, warm oil, and cool temperatures can result in sweating inside the storage tank. This moisture dripping onto the oil is an effective degumming system. The result is usually a great deal of unwanted solids in the bottom of the tank.

This may be hard to eliminate in some climates but can be lessened by employing a vent system which limits the flow of air into and out of each storage vessel.

Oil can be contaminated by oxidized or hardened oils which eventually coat the inside of tanks. It may be necessary to clean the tanks on a periodic schedule to prevent this from happening.

Color Fixation

The second quality deterioration which can occur in the tank farm is color fixation. This is usually not a problem, except to the processor-refiner.

The final step of most crude oil production is final solvent stripping. Temperatures in this step may reach 120 C. The longer an oil remains at elevated temperatures, the harder it is to remove the color bodies. If the stripping process requires high temperatures, the oil should be cooled as quickly as possible. This not only aids color removal in the refining process but, more importantly, reduces oxidation of the oil.

About the only time a non-processor-refiner needs to be concerned with color fixation is when incoming crude needs to be heated before unloading. The use of high pressure steam on the heating coils of the rail car or truck should be avoided. Some facilities use hot water exclusively to avoid contacting the oils with a temperature over 98 C.

Chemical Change

The third quality deterioration is the increase of free fatty acid and other refinery loss factors. The rules to avoid this are simple:

1. Avoid high temperatures. Better yet, keep the oil cool.
   a. Don't heat with high pressure steam unless necessary.
   b. Don't run centrifugal pumps against closed valves.
2. Avoid contact with the air.
   a. Fill from the bottom of the tank.
   b. Blanket with inert gas if necessary. If blanketing is necessary, be sure to encourage venting devices which control the loss of the inert gas to the atmosphere.
3. Avoid oil contact with metal contaminants such as copper, brass, etc.

DISCUSSION

There is no great secret in running a good refinery storage facility. It requires some good planning and adherence to basic rules and common sense.

A good operator knows at all times how much oil is in storage and what the quality of that oil is. A good operator can blend oil so that consistent quality oil is fed to the refinery.

A poor storage and handling operation can get a refinery operator off to a bad start in a very competitive business.