Problems in the Bulk Handling and Transport of Edible Oils

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INTRODUCTION

Bulk transport conditions for vegetable oils are not uniformly satisfactory and at times there is undesirable loss of quality. Evidence has been collected for the palm oil trade of defects in the transport system and of the types of deterioration resulting. Much of this information is relevant to other edible oils.

We have encountered the two main types of deterioration to which oils and fats are subject, i.e., oxidation and hydrolysis. Contamination by foreign material has been minimal.

OXIDATION

Aeration

The provision and maintenance of an inert gas blanket on storage tanks is effective in preventing oxidation, but it is not regarded as economical in most cases. Much can, however, be done to reduce contact between air and the oil.

- Pipelines loading ships' tanks often terminate at the top of the tank. During a drop of up to 40 ft, the oil is effectively aerated. We have seen a ship's tank in which the oil stream impinged on a platform so that it was virtually atomized.
- Leaky pump glands can allow air to be sucked in and effectively distributed through the oil during pumping.
- Aeration also occurs during pumping into land tanks.

It is apparent that thorough saturation of the oil with oxygen can occur several times during transit with sufficient time in between for the dissolved oxygen to be used up in reaction.

Heating

For oils that are semisolid, it is necessary to provide for heating facilities in ship and shore tanks and possibly also in road or rail tankers and on pipelines.

The most usual heating system consists of mild steel coils connected to a steam supply, typically of ca. 2 kg/cm^2 pressure, giving a coil surface temperature of ca. 130 C. If the tank contents are partly solidified, convection currents are inhibited and local overheating may occur.

The oils and fats trade associations advise that appropriate minimum tank temperatures should be maintained during transit and that a maximum heat-up rate should be observed. Such recommendations are difficult to observe in practice: because the heating system and its controls are unsophisticated; because of the effect of the tank environment on temperature, e.g., proximity of cold sea water; and because adequate mixing facilities are not usually available.

CATALYSIS

Copper is the most active prooxidant metal, and its use is to be avoided in the handling of vegetable oils. We have found copper or its alloy in current use in sampling instruments and thermometers, ships' heating coils (aluminum bronze), coupling connections to stainless steel heating coils, valves and hose connections on road tankers. The use in heating coils is probably the most series, because of the local high temperatures mentioned above.

The effect of iron, though less intense, is also significant because mild steel is the commonest construction material for tanks and pipelines. In the case of palm oil, contamination occurs during the oil mill process unless stainless steel is used in those parts of the mill most subject to attrition. By this means, a normal Fe content of 5 ppm can be reduced to 1 ppm. If the oil is fully refined, the iron is almost entirely removed. However, palm stearin is often exported in the crude state. The iron content is concentrated in the stearin fraction, and may be as high as 20 ppm at the time of loading. Iron contents as high as 25-30 ppm have been reported on arrival in Europe, indicating some further contamination during transit.

Pipeline installations are only very rarely given an inert protective coating. Ships' tanks are more often so protected, but the condition of the coating is not always intact. Shore installations are normally not protected. It is highly desirable to have coated tanks wherever processed oils are stored. While prevention of rusting and catalysis is the prime consideration, coated tanks are also more easily emptied and cleaned.

HYDROLYSIS

The most important factors promoting hydrolytic action are the presence of moisture or acidity. Residual phosphorus compounds also play a role.

Moisture

Both crude and processed oils should be dry at the time they enter the transport chain, though ca. 0.1% moisture may be in solution. Contamination may result from inadequate draining and drying of pipeline systems and tanks after washing.

Acidity

Any free fatty acids (FFA) present catalyze hydrolysis (Loncin, 1956). This is particularly significant for crude oils but, in our experience, refined oil with 0-0.05% FFA is significantly more stable during transport and storage than oil with 0.05-0.10% (which would still be within normally accepted limits for refined oils). The role of residual phosphorus as a cause of instability is currently under investigation. We know that some oils showing a rapid rise in FFA content have a residual phosphorus content significantly above the desirable limit of 4-5 ppm (as phosphorus).

The proportion of oils suffering serious deterioration is small. Nevertheless, it is in the general interest that it should be minimized. It is clear, from the type of defects found, that the surveyors play a key role in maintaining good standards or obtaining improvements. Their investigations should be rigorous including, for example, close inspection of the inside of all tanks and of the coil systems, and their reports should be detailed. However, the chief parties involved in the commodity – that is, the seller and the buyer – have the most important role of specifying the standard of service they want from all parties involved, i.e., from ships, shore installations, surveyors, road tankers and analytical chemists and in ensuring adequate supervision at all stages.

This paper may conveniently be summarized in a series of "do"s and "don't"s.

"DO"S

Pipelines

- Provide droplines to fill tanks from the bottom.
- Provide pigging systems to empty and clean pipelines.
- Check pumps for air leaks.
- Where possible, draw first runnings (3-10 tons) from delivery line into separate container for inspection.
- If manifold to be used for several oils, load in proper order.

Storage Tanks

- Provide inert coating suitable for edible oils.
- Ensure tank is clean and dry before filling. In the case of uncoated tanks, remove all loose rust and wipe surface clean.
- Ensure heating system provides sufficient capacity for the size of tank.
- Provide a vertical "hairpin" coil in ships' tanks to aid convection currents.
- Provide stirrers or recirculation systems for mixing wherever possible.

General

- Ask for full details of tank and pipeline conditions in surveyor's report.
- Ask for detailed figures of ship's heating log to be reported.
- Ask for loading sample to be carried by first officer and submitted to you.

"DON'T"S

- Use ships' tanks that have not been passed by surveyor.
- Allow copper or copper containing alloys to come in contact with edible oils in any way, whether in sampling tools or as constructional materials.
- Exceed heating rates and maximum temperatures recommended for the product.