

Why Solvent Fractionation?

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Why do we fractionate? To separate higher melting components from lower melting, liquid components to increase the functionality and profitability of the oil stream.

But why use Solvent Fractionation? It requires a complex and hazardous plant, being more energy intensive for cooling and solvent recovery, and therefore higher plant investment and operating costs!! Its use therefore depends on:

- Higher product value.
- Uniqueness in oil stream processing.
- Efficiency of operation.

This paper discusses the points above.

Higher product value. Product value often depends on sharp melting and “purity”. For this situation the stearin is the product. Sharp melting and purity is a result of high “Separation Efficiency” or SE. In dry fractionation it is easy to define the final achieved SE as the % solids divided by the % stearin yield in the filter cake. In Solvent Fractionation, SE is related to filter cake displacement washing. The cake is effectively a porous bed of crystals with olein, dissolved in solvent, in the void. This olein containing solvent is displaced by clean solvent during filter cake washing. A modern dry fractionation plant can achieve an SE of 70 to 75%. Using solvent fractionation the SE can easily be up to 95%.

Uniqueness in Oil Stream processing. The uniqueness of Solvent Fractionation is related to the stearin yield obtainable. Dry fractionation can only effectively manage a maximum of $\pm 30\%$ solids and 35 to 40% stearin yield in the crystallising oil. E.g. Using the De Smet Statoliser® process for Palm Kernel fractionation. However, how does one achieve an 80% stearin yield from e.g. Cocoa Butter? There is no way of achieving this with dry fractionation as the best SE is 75 to 80% which means you get out what you put in, even assuming you could “process” the lump of solid fat with 75%, or more, solids! With Solvent Fractionation the amount of solvent is varied in proportion to the % of solids being created in the oil and therefore the crystallising slurry is always processable and then with cake washing one can easily achieve an 80% stearin yield with an SE of 95%.

Efficiency of operation. Solvent fractionation demands more energy for both refrigeration and solvent recovery. So what is efficiency of operation? There are two main points:

- Speed of crystallisation. For example, the crystallisation times in solvent can be between 10 and 30 minutes whereas in dry fractionation they can be 5 to 20 hours (or more). This reduces plant volume and implies potentially small plants with high throughputs.

- Higher Separation Efficiencies. This avoids the need for multi-staging or counter-current style operations with the benefit of higher yields of high value product and less by-product.

Hazards and HACCP. Both dry and solvent fractionation plants will probably use ammonia as the refrigerant. Therefore both plants have areas requiring special regulations for explosion and toxic hazard. These will be discussed together with HACCP.

Metastable zone width and crystal morphology of 1,3-dipalmitoyl-2-oleoylglycerol and tripalmitoylglycerol and their mixtures crystallised from acetone

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A solvent fractionation process is particularly useful to isolate sharp-melting fractions suitable for use in confectionery fats from raw materials such as palm oil. This process provides the necessary solid-liquid separation efficiency that can be difficult to achieve using dry fractionation. The viability and profitability of the fractionation process is dependent on the ease and efficiency of this separation, which is, in turn, dependent on the type of crystals present in the slurries.

The work reported here examines the influence of the metastable zone width on the crystal morphology. The metastable zone width has been determined for the crystallisation of 1,3-dipalmitoyl-2-oleoylglycerol (POP), tripalmitoylglycerol (PPP) and their mixtures from acetone. The metastable zone width was found to be relatively insensitive to cooling rate for POP but PPP metastable zone width demonstrated a slight dependence on concentration.

The spherulitic POP crystals had a more open structure at slower cooling rates. PPP had more plate-like crystals but produced powdery, amorphous crystals at high cooling rates.

In pure POP systems, onset of crystallisation was quickly followed by rapid crystal growth. While the presence of PPP in POP greatly raised the crystallisation onset temperature (by 17°C at 8% PPP), the temperature at which the main crystal growth occurred did not increase to the same extent.

Although the clear point of the pure systems was not dependent on previous cooling rate, it decreased with increasing cooling rate in the mixed system, suggesting that a greater proportion of PPP-rich phase separated during slower cooling.

The morphology of the crystals from the mixed system shifted from spherulitic (in the pure POP system) to a more lamellar structure with as little as 2% PPP.

These changes in structure, although relatively minor, nevertheless may be crucially important in relation to palm olein processing, where the presence of trisaturated triacylglycerols can help to reduce the degree of undercooling necessary prior to crystallisation and thereby improve the ease of washing of the resulting precipitate.