Tailoring Pour Point and Oxidative Stability in Estolide Base Oils using a Blend of Saturated and Unsaturated Estolide Chemistry

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When formulating a finished lubricant there are many parameters that need to be considered depending on the end-use application of the lubricant. In this regard a novel set of Estolide compounds have been produced to determine how Pour Point and Oxidative stability are affected using a two-component blend of saturated and unsaturated Estolides. The structure of the Estolides are presented below in Figure 1:

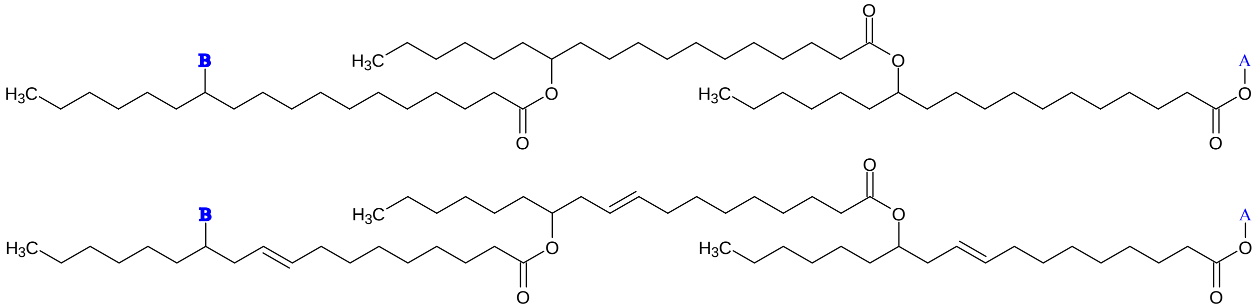


Figure 1 - Chemical Structure of Saturated and Unsaturated Estolides

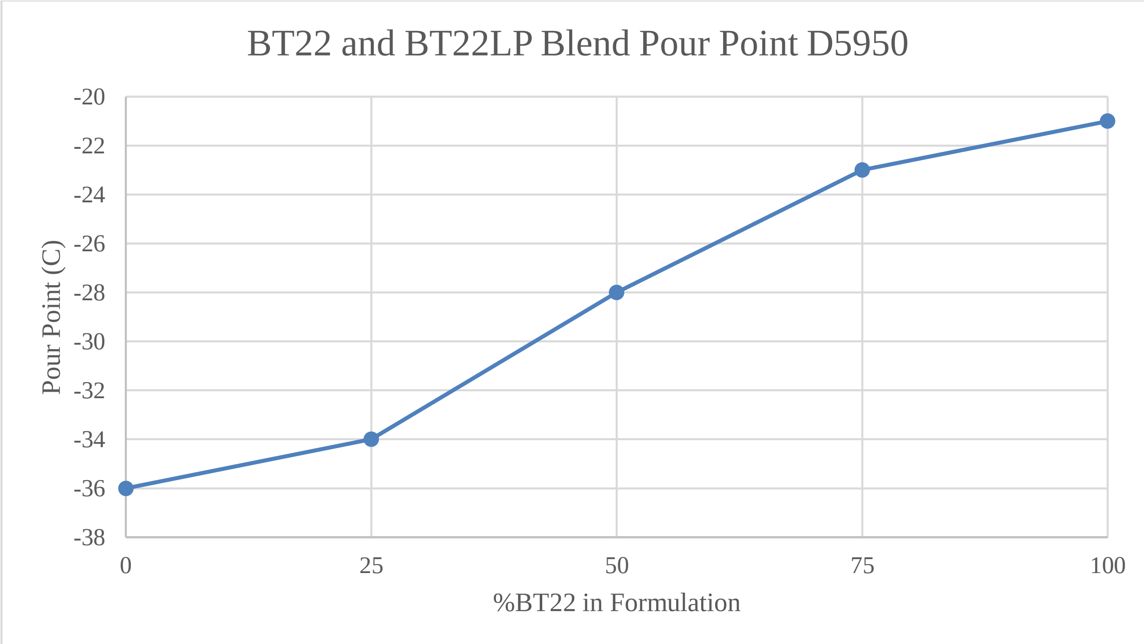
The synthetized esotolides used in the study are nearly identical in structure. The Alpha (A) and Beta (B) groups were selected to maximize the hydrolytic stability of the molecule and good demulsability for the base oil. Estolides in general have significantly higher hydrolytic stability due to the steric hindrance of the secondary ester bond used to polymerize the Estolide. The degree of polymerization was nearly identical as well, with a targeted viscosity of 150 cSt at 40°C. This is shown through comparison of the physical properties in Table 1 below:

Property	Method	BT22	BT22LP
KV100 (cSt)	D445	22.4	26.3
KV40 (cSt)	D445	154.4	159.3
VI	D2270	171.3	187.4
Pour Point (°C)	D5950	-21	-36

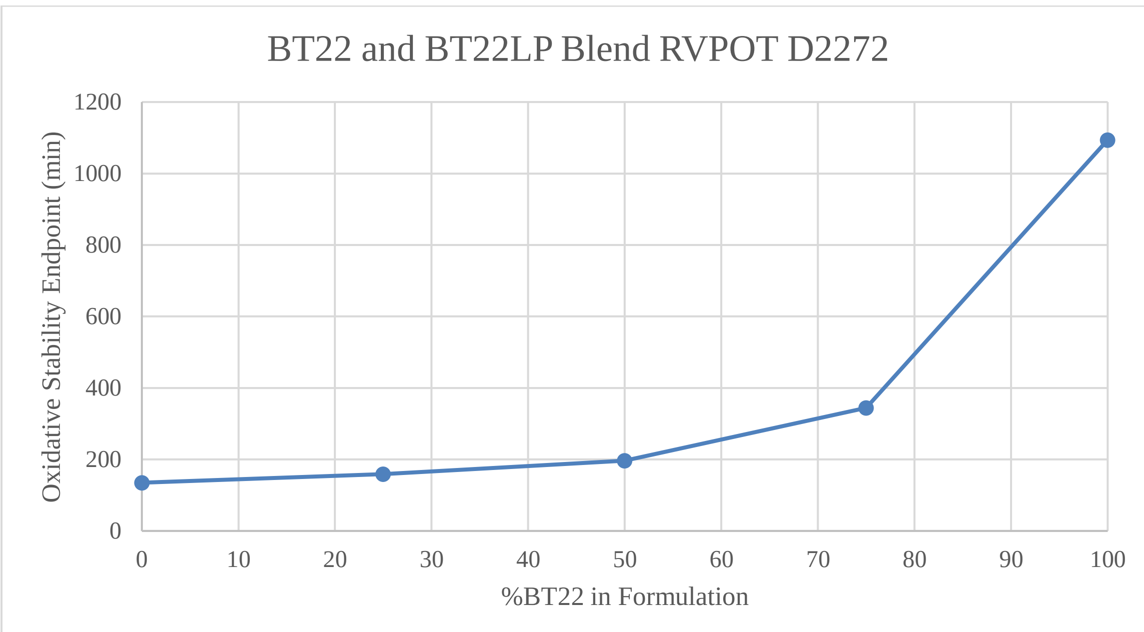
Table 1 - Physical Properties of Base Oils used in Blend Study

The BT22 product is a fully saturated Estolide, whereas the BT22LP (LP stand for Low Pour point) utilizes a site of unsaturation on each C18 unit. The KV100, KV40, and viscosity index all show similar results. However, the Pour Point of the BT22LP is reduced by 15°C from the BT22 product. This clearly shows that a site of unsaturation has little effect on viscosity or viscosity index, but a significant enhancement to pour point.

To better understand the trade-offs between pour point and oxidative stability blends of the two estolides were produced at 0%, 25%, 50%, 75%, and 100% content of BT22. The blends were produced through stirring under gentle heat to ensure a homogenous mixture of the two-components. Each resultant blend was then analyzed using the ASTM method D5950 for pour point and D2272 for oxidative stability. The results are presented below in Graph 1 and Graph 2:



Graph 1 - Plot of Pour Point versus Percent BT22 in 2 Component Blend



Graph 2 - Plot of Oxidative Stability versus Percent BT22 in 2 Component Blend

Graph 1 shows the response to pour point change is not linear and instead takes on the pour point properties of the dominant blend component. A 50/50 blend produces a 7°C drop in pour point, whereas a 75/25 blend produces almost double that at 13°C. The effect of adding double bonds is even more pronounced in terms of oxidative stability. It is well understood the even small amounts of unsaturation can dramatically decrease oxidative stability. This trend is verified in Estolide chemistry as well in seeing a drop from 1094 minutes to 355 minutes with a 25% addition of the BT22LP product in Graph 2. In an idealized world no tradeoffs would ever have to be made, but as shown hear the pour points of Estolides can be optimized at the cost of oxidative stability. However for many applications that demand good pour point, exceptional hydrolytic stability, and good demulsability the BT22LP is a excellent product.