

## Focus Ester PA BX – 4-Ball Wear Study with PAO

Polyalphaolefins (PAOs) are used in many different automotive and industrial applications that include crankcase oils, two-stroke cycle engine oils, automatic transmission fluids, gear oils, greases, hydraulic oils, compressor oils and heat transfer fluids. These synthetic, saturated hydrocarbons have many advantages over mineral oils. They include a higher viscosity index, lower volatility, and better oxidative and thermal stability. Categorized as an API Group IV base fluid, PAOs exhibit superior properties mentioned above over Group I and even over the higher refined Group II and III oils. However, the lack of aromatic groups and other impurities (e.g. sulfur & nitrogen) in PAOs does introduce a few shortcomings for these synthetic fluids: namely lower lubricity/anti-wear properties and poor solubility with many essential additives. **Focus Ester PA BX**, a high molecular weight polymeric ester that is soluble with most PAOs, can be used to augment PAO lubrication and anti-wear properties.

In addition to its excellent PAO solubility and enhanced lubrication properties, **Focus Ester PA BX** also shares these attributes:

- Ashless: will not cause staining or promote harmful deposits in systems
- Good oxidative stability: high degree of saturation
- Good thermal and hydrolytic stability: ester derived from more stable polyol chemistry
- High viscosity index: can augment a PAO's viscosity index profile
- Dispersancy properties: polar ester groups help disperse sludge deposits formed in systems

### Study Results and Conclusions

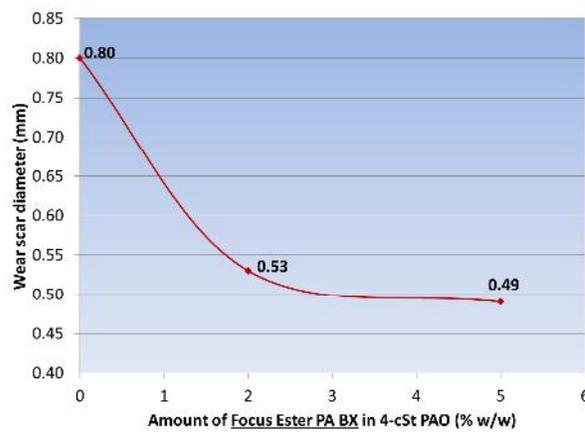
To help illustrate that anti-wear properties of polyalphaolefins can be improved significantly by incorporating **Focus Ester PA BX**, four-ball wear testing was employed. Specifically, ASTM D 4172 was used for all anti-wear test runs conducted in this study with the following test parameters:

- Temperature: 75 °C (167 °F)
- Speed: 1200 rpm
- Duration: 60 min
- Load: 40 kgf (392 N)

4-cSt polyalphaolefin, a very common commercial grade PAO, was selected for this study. Four-ball wear tests were run on three different fluids:

- 4-cSt PAO (without any additional additives)
- 2% w/w **Focus Ester PA BX** in 4-cSt PAO
- 5% w/w **Focus Ester PA BX** in 4-cSt PAO

Upon completion of the four-ball test run, the wear scar diameter was measured for each fluid. The results are shown in Figure 1 below. Incorporating only 2% of **Focus Ester PA BX** in the PAO reduced the wear scar diameter by over a third of the PAO's original value.



**Figure 1: Four-ball Wear Results with Focus Ester PA BX**

Another advantage most PAOs possess is that they have excellent low temperature properties. At very low temperatures, many PAOs remain liquid and do not solidify easily. As a result, PAOs generally have exceptionally low pour points. Many commercially available polymeric esters have pour points that are above freezing (> 0 °C). When they are used in combination with PAOs, the beneficial low temperature properties of the base fluid are substantially compromised. The pour point for **Focus Ester PA BX** is one of the lowest among commercially available polymeric esters used in lubricants. Figure 2 shows the pour point values obtained (determined per



ASTM D 97) for the same three fluids tested previously by four-ball wear. While pour points did increase when **Focus Ester PA BX** was added to the PAO, the pour point temperatures are still within operating ranges for most lubrication applications.

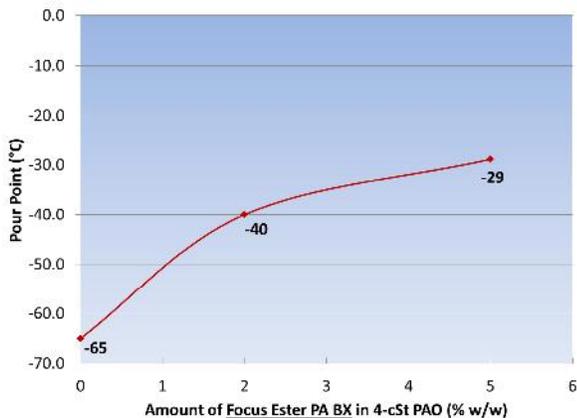


Figure 2: Pour Point Results with Focus Ester PA BX

The solubility properties of **Focus Ester PA BX** were evaluated in virtually all traditional commercially available viscosity grade PAOs. Ester treat rates of up to 10% by weight were tested in 2-, 4-, 8-, 10-, 40- and 100-cSt PAOs. For the PAO viscosity grades that have aniline points between 100-150 °C (2-cSt thru 10-cSt PAOs), **Focus Ester PA BX** was completely soluble. However, the ester did have solubility issues with the

higher viscosity grade PAOs (40-cSt & 100-cSt) that had much higher aniline points (> 300 °C).

As stated already, PAOs have an added advantage over other base fluids due to their higher viscosity index values. The viscosity index of **Focus Ester PA BX** is even higher than conventional polyalphaolefins. As a result, PAO blends containing **Focus Ester PA BX** will demonstrate higher viscosity indices depending on treat levels of ester incorporated into the PAO. Figure 3 shows the effect of the ester in PAO at various concentration levels.

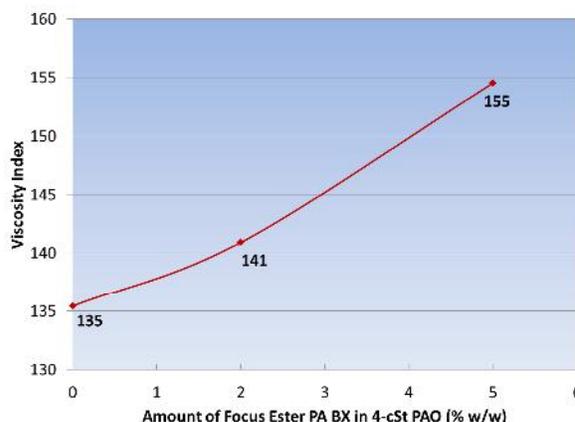


Figure 3: Viscosity Index Results with Focus Ester PA BX

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