Save Energy & Protect Equipment with WISE High Viscosity Formulations

The Super High Viscosity Index of our non-GMO high oleic vegetable oils allows us to think unconventionally about formulation and can add performance value that cannot be reached with ordinary petroleum base oils. This summary report and graphs below explain the exceptional performance of patented WISE renewable technology in reducing energy use and protecting equipment from wear.

High temperature and high pressure hydraulic systems can stress the hydraulic fluid, providing thermal and permanent mechanical shear of the fluid film (apparent viscosity). The different hydraulic system designs can also increase the mechanical shear at a faster rate depending on pump rotation speed, pump pressure, and hours of operation. This mechanical shear can be experienced in gear drive units that can also provide permanent loss of the fluid film. In addition, studies have shown that during pump stand tests and laboratory oxidation tests, the higher temperatures can also create permanent loss of viscosity in some synthetic ester-based formulations.

In designing formulations, understanding mechanical and thermal shear is important to providing the proper fluid film with energy conserving properties. Synthetic base oils with a higher viscosity index (VI) between 125 to 200 are known in the industry to be able to improve these properties, but cost two to eight times that of vegetable based oils. Rheological studies can be conducted in the lab, but pump stand tests and field studies will give a more realistic understanding of the fluid performance. These tests have shown that permanent loss in viscosity varies from 5% and up to 30% within the first 100 hours of operation. Taking into consideration this fluid film shear and to prevent system failure, it is most important to study the viscosity at the actual operating temperature. This is why higher VI formulations with reserved fluid film at higher temperatures (reduced thermal shear) can provide improved performance over a wider range of temperatures. These high VI formulations provide less lubrication friction in the start up mode and at the lower temperatures that can reduce energy input, but also provide improved lubrication fluid film at the higher pressures and operating temperatures between 50^{o} C and 120^{o} C or higher.

Today, with energy conservation and climate protection becoming a key part of every industrial society, controlled thermal and mechanical shear can significantly save energy by reducing lubricant friction. Lower operating temperatures have also been experienced through lower lubrication friction and improved heat transfer. Many original equipment manufacturers and lubrication engineers have experienced the improved performance of high VI, multi-grade formulations and have recommended one grade down in the ISO viscosity providing successful performance over conventional 100 VI petroleum formulas.

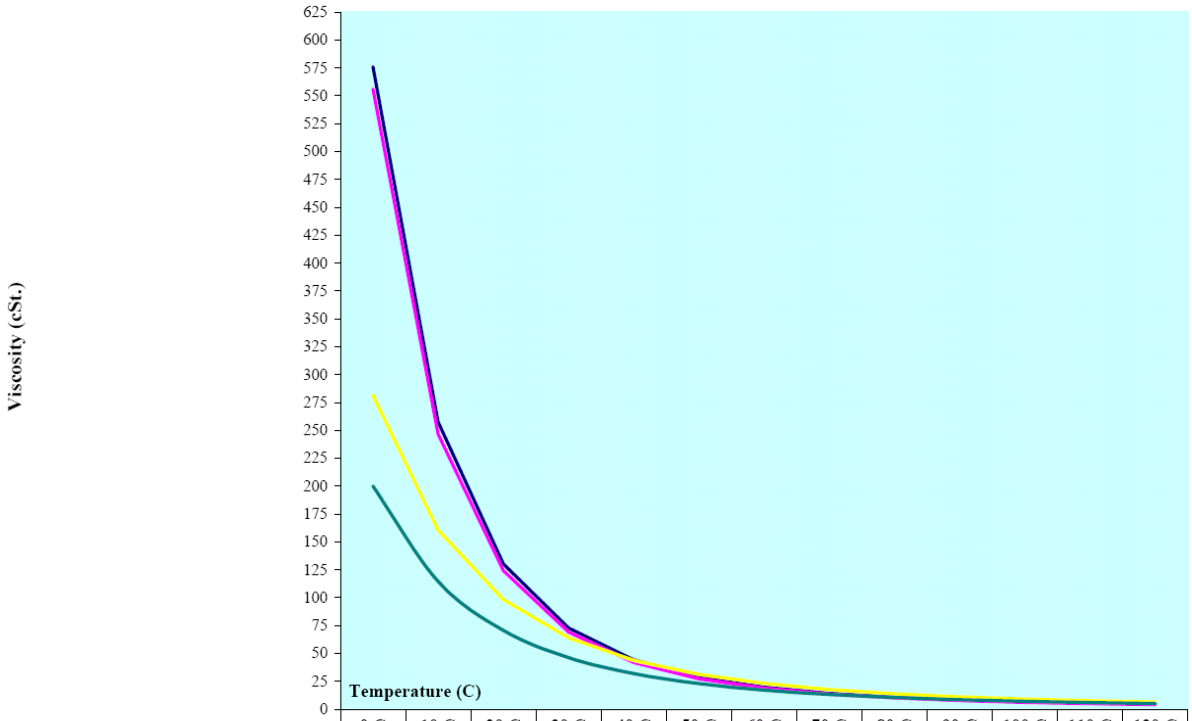
Permanent shear must be considered with every fluid design from straight weight ISO Grade formulations to multi-grade formulations containing VI improvers. The use of VI improvers can improve thermal shear and provide energy conserving properties, but care must be taken in

choosing the proper VI improver and the ratio of VI improver to base oils. A balanced formulation of shear stable VI improvers and high VI vegetable base oils can provide an energy conserving formulation with reserved fluidity to protect against mechanical and thermal shear.

The use of Super High VI biobased oils (210 to 240 VI) can provide increased fluid film protection and additional energy conserving properties. In addition, because of their considerably lower viscosity at low temperatures, they provide faster system warm-up and flow that prevents start-up system chatter, foam and air entrainment, and pump cavitations. The performance of these vegetable base oils, when properly formulated, can provide performance advantages in many applications including circulating, gear, and drive systems.

The graph shown below compares the viscosities and VI of WISE Bio-1000 ISO 46 Hydraulic Fluid (VI of 195), and a conventional ISO 46 hydraulic fluid with a VI of 100. For purposes of demonstrating mechanical shear, the conventional hydraulic fluid is also shown with a viscosity reduction of 5%, which could be considered the limit for the fluid film for higher temperatures.

ENERGY CONSERVING FORMULATIONS
WITH RESERVED FLUID VALUE



	0 C	10 C	20 C	30 C	40 C	50 C	60 C	70 C	80 C	90 C	100 C	110 C	120 C
Conventional Hyd. Fluid, 46 VI 100 Vis	575.87	257.48	130.22	72.8	44.17	28.67	19.68	14.14	10.56	8.15	6.46	5.24	4.34
Conventional Hydraulic Fluid, 5% Reduction in Viscosity	555.92	246.58	124.04	69.11	41.85	27.13	18.61	13.37	9.99	7.71	6.12	4.97	4.12
WISE Bio-1000 Hyd. Fluid, ISO 46 VI 195	281.42	160.5	98.29	63.91	43.7	31.18	23.08	17.62	13.81	11.08	9.07	7.55	6.39
WISE Bio-1000 Hyd. Fluid, ISO 32 VI 186	200.02	114.47	70.5	46.15	31.8	22.87	17.06	13.13	10.37	8.38	6.91	5.79	4.93

In addition, the WISE Bio-1000 ISO 32 Hydraulic Fluid is shown to give a comparison of a viscosity reduction of 27% compared to the ISO 46 formulations. Even with the 27% reduction, the Bio-1000 ISO 32 rheological properties outperform both conventional hydraulic fluids providing **reserved fluid film** at the higher operating temperatures. Both Bio-Hydraulic fluids

show considerable reduction in viscosities at the lower temperatures reducing energy input and demonstrating exceptional reserved fluid value at the higher operating temperatures and pressures where the use of the viscosity is more valuable. Now consider the additional performance value of this technology if you take these Bio-Hydraulic Fluids further in the cold temperatures of -30° C with a Brookfield of only 2000 to 4000 cP to the higher temperatures of over 120° C where fluid film is considered even more value added.

The second graph compares the viscosities and VI of the WISE Bio-Synthetic EP Gear Oil ISO 220 with a VI of 179 and conventional gear oil ISO 220 with a VI of 95. The Bio-Synthetic Gear Oil again shows considerable reduction in viscosity at the lower temperature reducing energy and reserved fluid value at the higher operating temperature of 50° C and higher. This reserve fluid film is also an added cushioning value reducing wear in the Extreme Pressure area of the gears.

ENERGY CONSERVING FORMULATIONS
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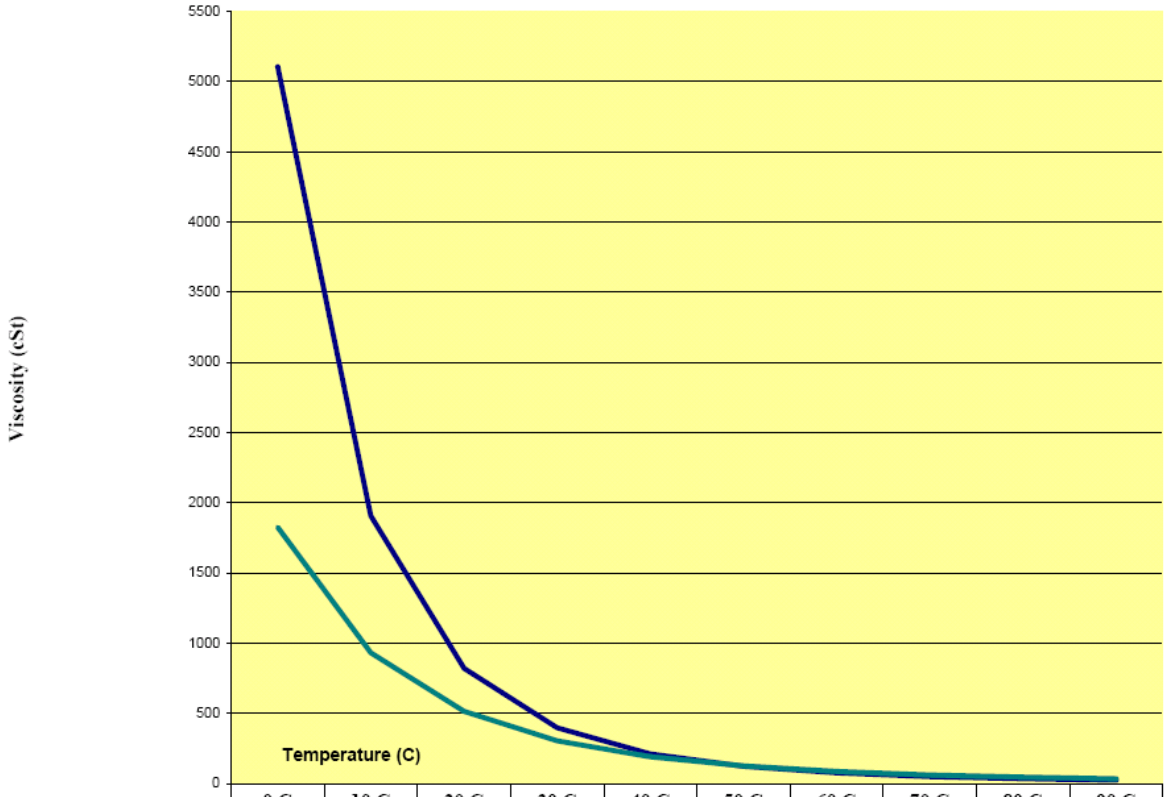

	0 C	10 C	20 C	30 C	40 C	50 C	60 C	70 C	80 C	90 C
Conventional Gear Oil ISO 220 VI 96	5105.26	1907.2	820.96	397.34	212	122.71	76.05	49.93	34.42	24.72
Bio-Syn EP Gear ISO 220 VI 179	1826.58	931.3	514.6	304.48	191	125.98	86.76	62.03	45.81	34.8

See www.wisesolutions.ws for further information about WISE ultimate performance, renewable biolubricants for a wide variety of applications.