Technical Summary Report

Date: 5/25/2016

TO: All Prospective Customers - Food Grade Oven Chain Lubricants

From: Petrochem's Chemical Formulator

Objective: Performance Comparison of three (3) various ISO 220 Food Grade Base Fluid Lubricants

(1) POE (100% Fully Synthetic Ester) (2) PAO (100% Fully Sythetic Polyalphaolefin) and (3) WMO (White Mineral Oil)

The comparative performance data consist of three (3) various base fluids used for High temperature chain applications such as in baking, drying, flour & corn tortilla ovens: (1) Our Petrochem FOODSAFE PETRO-GARD FG-220 to (2) food grade polyalphaolefin (PAO) and (3) food grade white mineral oil (WMO). To support this request, Petrochem's Chemical Formulator laboratory conducted pan testing, panel-coker and TGA experiments. The results are summarized herein.

Pan Test Results

Three pan test experiments were conducted: 240°C/20hrs, 240°C/44hrs, and 260°C/20hrs. Samples were prepared for thin film properties in aluminum pans and were maintained at the test temperature (± 0.5°C) for the prescribed period.
The results of the tests are graphically represented in figures 1-3.

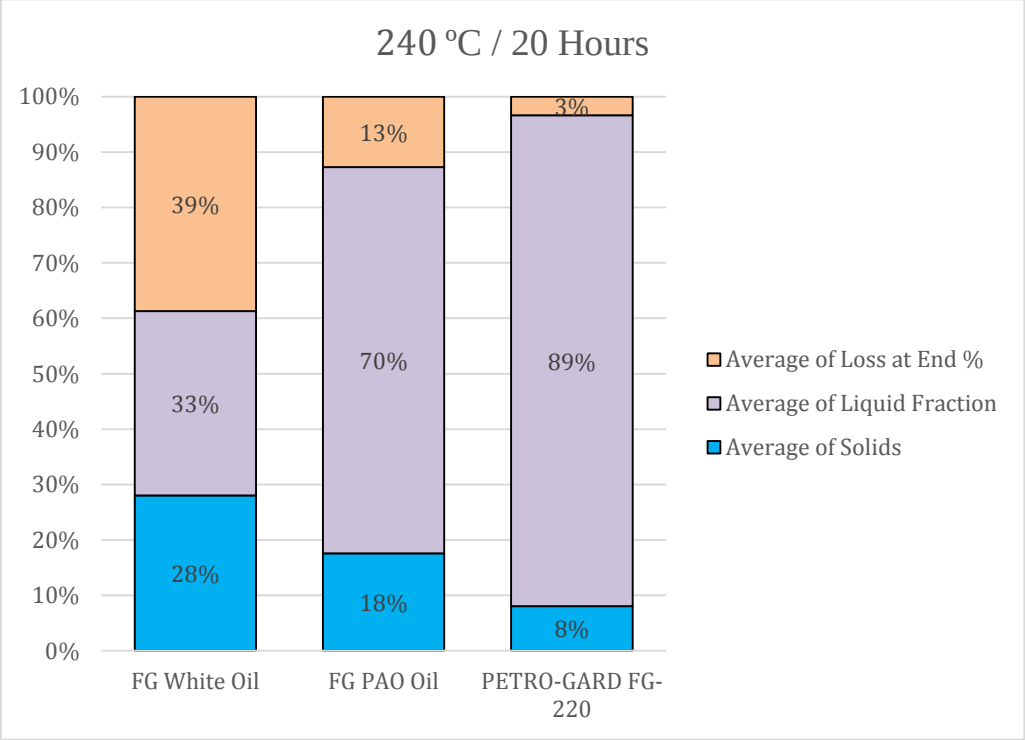

Figure 1: Comparison of solid, liquid and evaporative fractions of the samples after 20hrs at 240°C.

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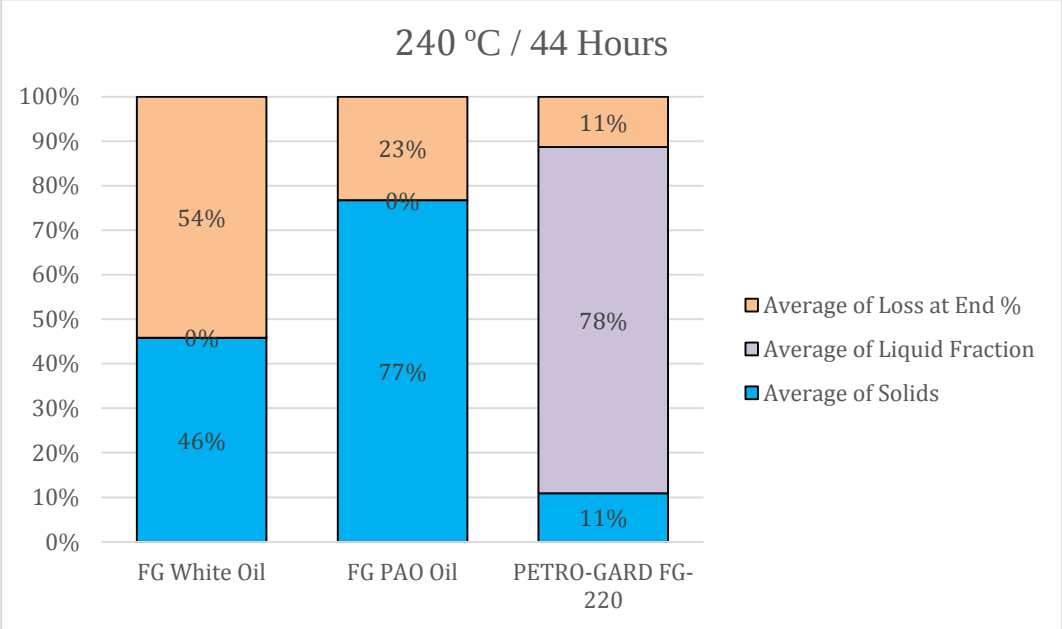

Figure 2: Comparison of solid, liquid and evaporative fractions of the samples after 44hrs at 240°C.

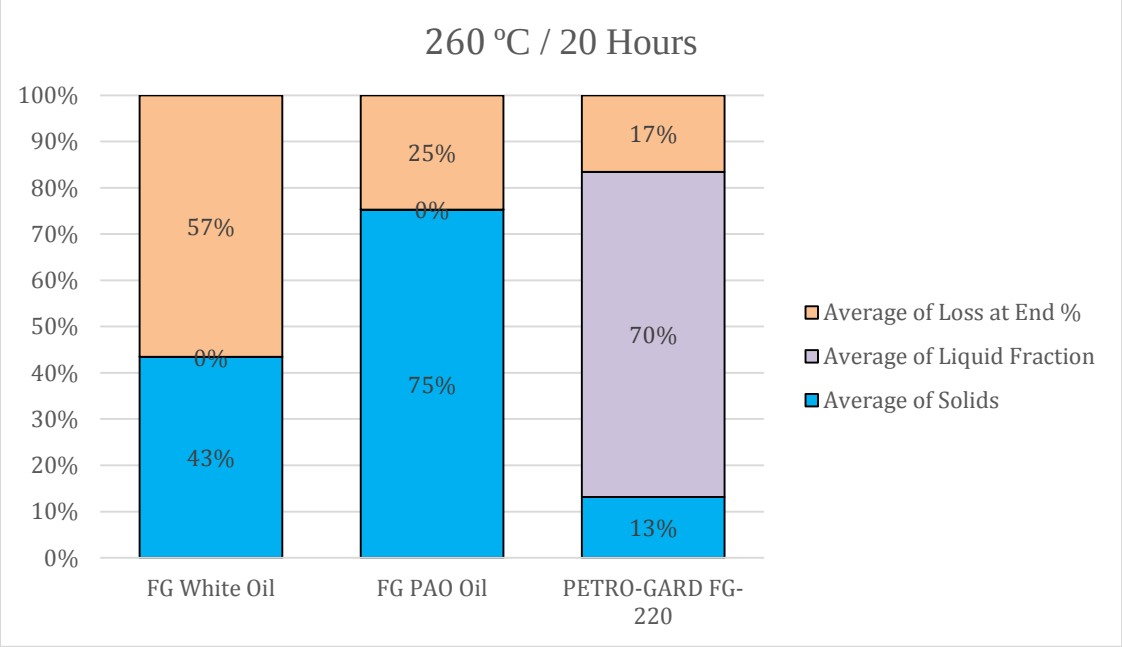

Figure 3: Comparison of solid, liquid and evaporative fractions of the samples after 20hrs at 260°C.

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As it can be seen in figures 1-3, the PETRO-GARD FG-220 consistently outperforms both the WMO and PAO oils, maintaining significantly higher liquid fractions and lower evaporation and solids. It should be noted that both the WMO and PAO have completely polymerized in the 240°C/44hr and 260°C/20hr test conditions, maintaining no liquid lubricant at the end of the test interval. The cleanliness of the ester can also be seen in figures 4-5, showing the pans after being drained of any liquid.

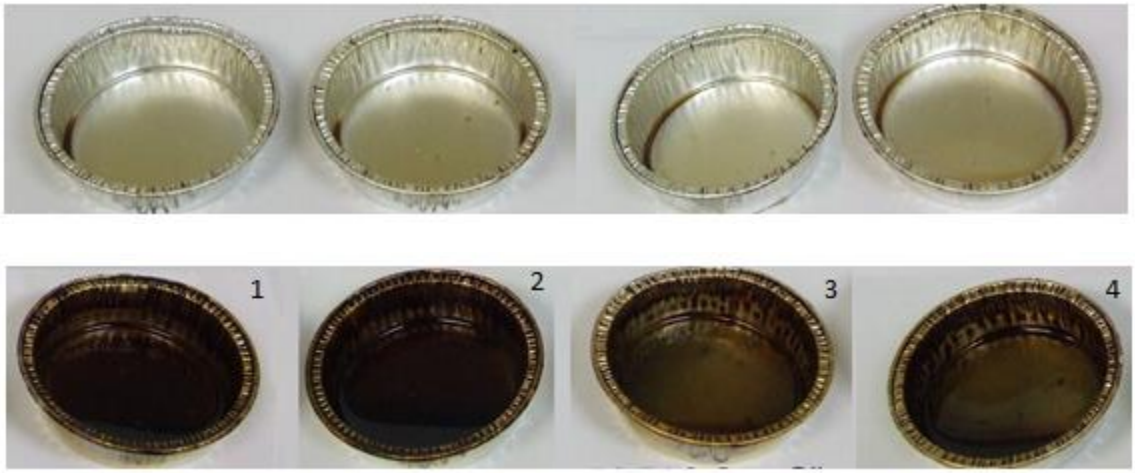

Figure 4: Pans after 20hrs at 240°C. Top Row - PETRO-GARD FG-220; Bottom Row - WMO (1,2), PAO (3,4)

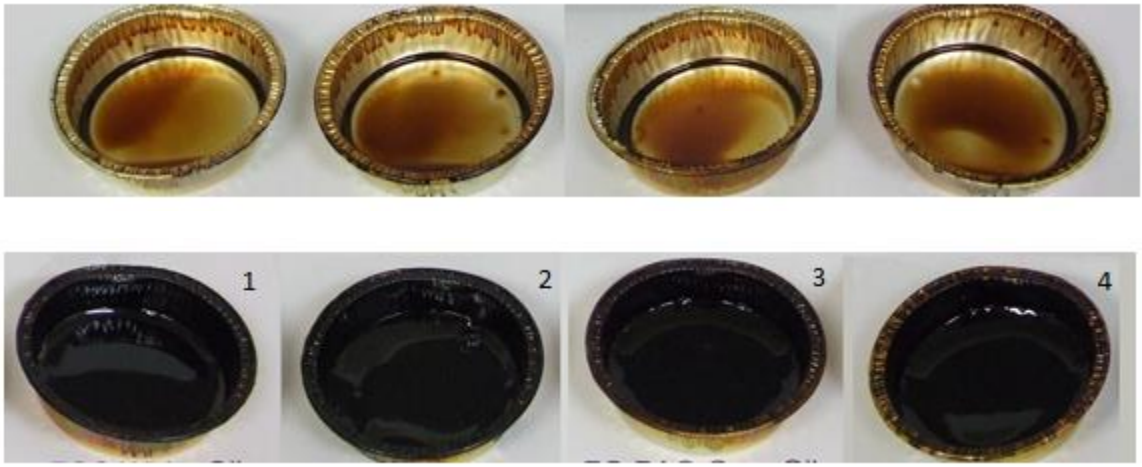

Figure 5: Pans after 20hrs at 260°C. Top Row - PETRO-GARD FG-220; Bottom Row - WMO (1,2), PAO (3,4)

The pan test indicates anticipated performance with respect to evaporation, deposit and oxidation tendencies. It can be seen that the ester oil, PETRO-GARD FG-220 clearly outperforms WMO and PAO.

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SAFE RELIABLE MACHINERY LUBRICANTS

Panel-Coker Comparison

The panel-coker accelerated deposit test provides some insight about the cleanliness and deposit-forming tendencies of lubricant oils at high temperatures on machinery and equipment. Below are the comparative panels from testing at ~400°C.

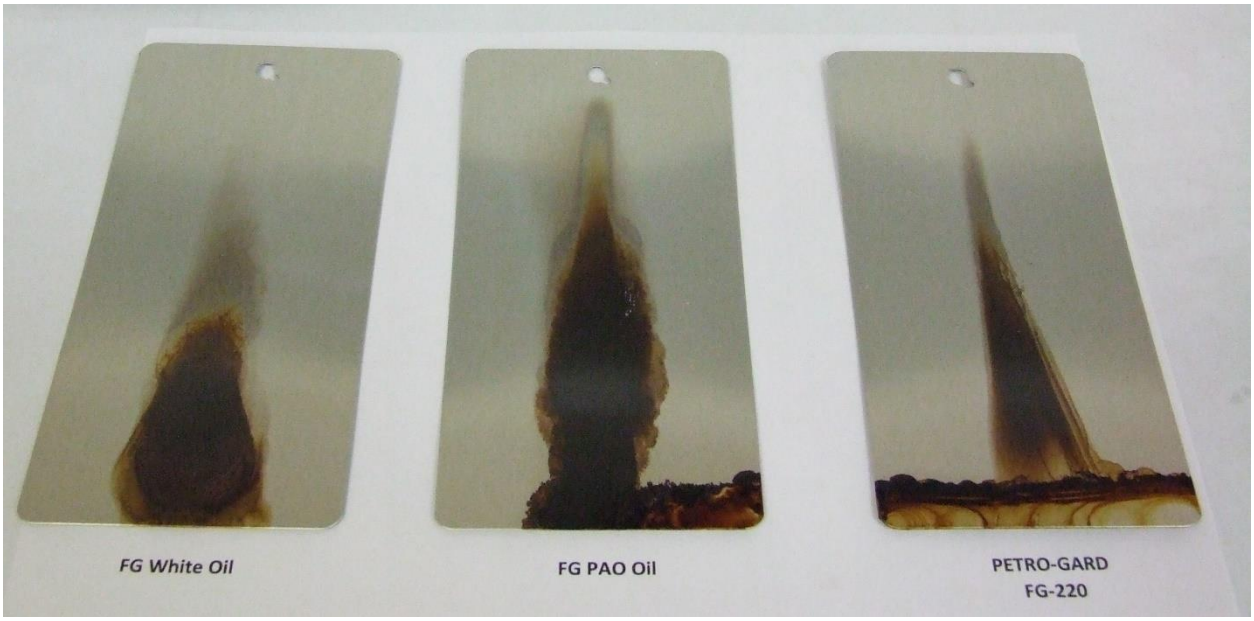

Figure 6: Panel-Coker results at ~400°C.

All formulated lubricant oils will form some type of deposit in the panel-coker test. The most stable oils will maintain liquid to the base of the panel. The thick line at the base of the PETRO-GARD FG-220 panel indicates that liquid was pooling at the base of the panel. The same can be seen for the FG PAO Oil, but to a lesser extent and with more varnish/deposit. The FG White oil did not survive the drip, and hence no oil pooled at the base of the panel, indicating it has the least thermal and oxidative stability.

TGA Results

Thermo-gravimetric analysis was conducted in N_2 to highlight thermal stability. The method and overlay are summarized below.

1. Select gas 1 - N_2
2. Equilibrate at 40 ºC
3. Ramp 10 ºC/min to 300 ºC
4. Isothermal for 180 minutes

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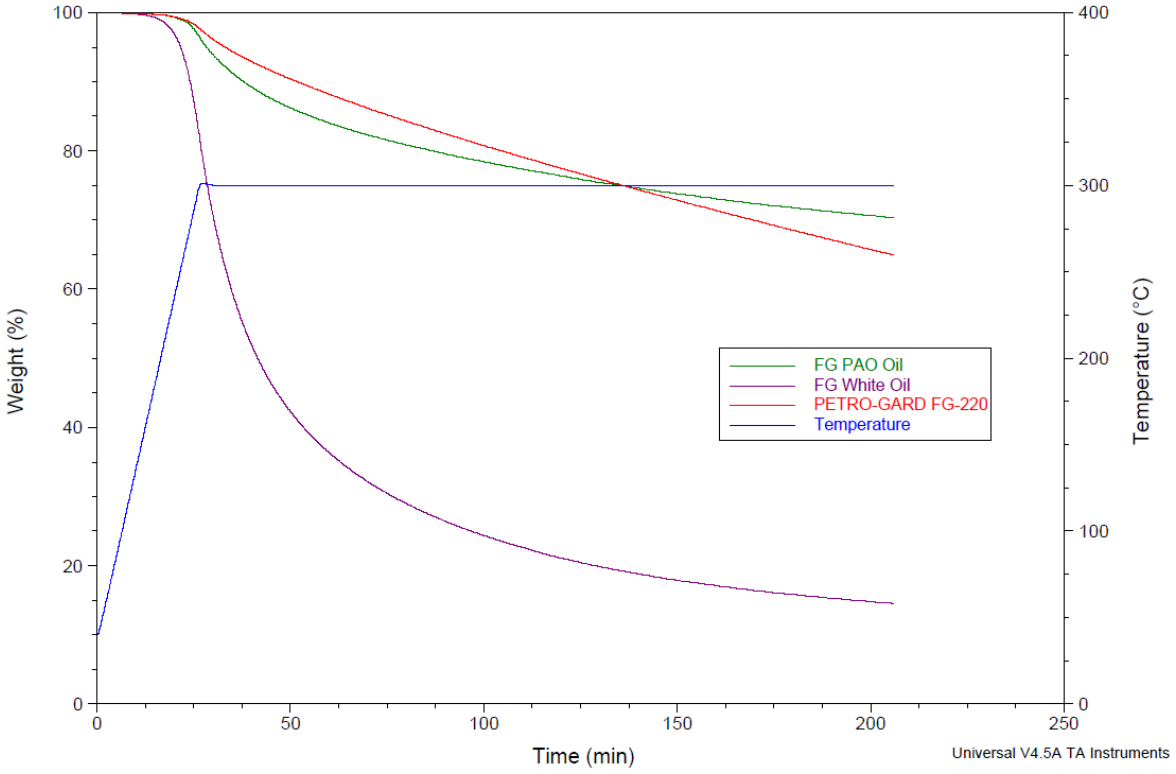

Figure 7: Thermogram overlay in nitrogen

Figure 7 indicates that the PETRO-GARD FG-220 and PAO have better thermal stability than WMO, and that PAO and PETRO-GARD FG-220 have similar volatility. A longer test would be needed to fully compare the volatilities.

Conclusions

PETRO-GARD FG-220 consistently outperforms both WMO and PAO in high temperature test regimes, indicating its superior thermal and oxidative stability.

Please contact me if there are any further questions.

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