BIOdiesel Tech NOTES

Issue TN #3 (Fall/Winter 2005)

Biodiesel Education Program, University of Idaho
Sponsored by the USDA under the Farm Bill

IMPACT OF ADDITIVES ON COLD FLOW PROPERTIES OF BIODIESEL

Based on a paper entitled "Evaluation of Cold Flow Additives for Biodiesel", by D. S. Shrestha, J. Van Gerpen, and J. Thompson, 2005

In the United States and other cold regions of the world, one of the greatest concerns of biodiesel users is its unfavorable cold weather operability. Biodiesel has a higher cloud point (CP) and pour point (PP) than regular diesel fuel. The American Society for Testing and Materials (ASTM) biodiesel specification does not state a specific requirement for CP, but it requires that the producer provide this to a fuel purchaser. The standard does not require stating the PP temperature.

The cold filter plugging point (CFPP) temperature is more closely related to the actual cold weather operability of biodiesel, but it has been shown that CFPP correlates well to CP. Since CP and PP are easy to measure, they are routinely used to characterize the cold flow operability of diesel fuels.

Different fuel additives are available to improve the cold flow properties of diesel and biodiesel. In general, these additives act by distorting the wax crystal shape and size to inhibit crystal growth and thereby reducing PP temperatures. The additives contain proprietary components that are usually copolymers of ethylene and vinyl acetate or other olefin-ester copolymers. Fuel additives are available in the market for pure biodiesel and biodiesel-diesel blends that are supposed to reduce the pour point temperature of the fuel so it can be used at low temperature.

A study has been conducted at the University of Idaho to evaluate the performance of different biodiesel additives on reducing PP and CP of soy biodiesel and its blends with summer diesel. Four different commercially available biodiesel additives were chosen as fuel additives: Flozol 503 (The Lubrizol Corporation, Wickliffe, OH), Bioflow 875 (Octel Sterron, Newark, DE), MCC P205 (Midcontinental chemical, Overland Park, KS), and Arctic Express 0.25% (Power Service, Weatherford, TX). The biodiesel blend levels selected for testing were B5, B20 and B100. A summer-grade No. 2 diesel fuel, with a cloud point of -17°C (1.4°F) and a pour point of -22 °C (-7.6 °F) was used to produce the various blends.

Effect on Cloud Point

The effects of the four additives on the CP are shown in Table 1. Since the additives inhibit the growth of crystals and not necessarily their first appearance, they usually have minimal impact on the CP. This is confirmed by the results in Table 1.

TABLE 1: CLOUD POINT IN °CELSIUS WITH AND WITHOUT FUEL ADDITIVES AT MANUFACTURER'S RECOMMENDED LEVEL

%BD	None	BioFlow	Flozol	MCC	Arctic
0	-17.0	-18.0	-18.0	-18.5	-18.0
5	-16.0	-17.5	-17.0	-17.7	-16.3
20	-13.0	-14.0	-14.0	-14.8	-13.0
100	0.8	- 0.2	-0.5	-0.5	0.0

The reductions in CP were only about 0 to 1.3 ºC (2.3 °F) and most of the differences between the additives were not statistically significant.

When twice the recommended level (200% level) was used for each of the fuel additives, all of the fuel additives showed some additional reduction in cloud point. Arctic Express showed the highest response to excess additive. At the 200% level, there was no significant difference among any of the additives for cloud point reduction. At this level, the average cloud point reduction was 1.5°C (2.7 °F) compared to the average 1.0°C (1.8 °F) reduction observed with the recommended dosage.

When three times the recommended level of additive was used, the average cloud point was reduced by 1.7°C (3.1 °F) but this was not significantly different from the 1.5°C (2.7 °F) observed at the 200% additive level. One of the most interesting results at the 300% additive level was that the effect on B100 from all of the additives was less than or equal to the effect at the 200% level. For B100, the maximum CP reduction was observed at either the 100% or 200% loading. In general, it was observed that an excess amount of additive helped lower the CP of diesel fuel but increased the CP of biodiesel. Therefore, adding up to 300% of the recommended amount of additive helped reduce the CP only for low blends of biodiesel. For higher blends, adding more additive could have an adverse effect.

Effect on Pour Point

The measured pour points with and without fuel additives are shown in Table 2.

TABLE 2: AVERAGE POUR POINT IN °CELSIUS WITH AND WITHOUT FUEL ADDITIVES AT MANUFACTURER'S RECOMMENDED LEVEL

%BD	None	BioFlow	Flozol	MCC	Arctic
0	-22.0	-18.0	-18.0	-18.5	-18.0
5	-16.0	-17.5	-17.0	-17.7	-16.3
20	-13.0	-14.0	-14.0	-14.8	-13.0
100	0.8	- 0.2	-0.5	-0.5	0.0

The pour point tests were terminated when the temperature reached -36°C (-32.8 °F). The PP was recorded as less than or equal to -36°C if the fuel did not gel at this temperature. This was considered the lower limit of the instrument used for the tests and in most actual operating conditions the temperature is almost always above -36°C.

When the additives were tested in the baseline diesel fuel, they all reduced the PP to less than -36°C (-32.8°F). All of the fuel additives tested were equally effective in reducing the PP of the B5 blend. For B20, all of the fuel additives reduced the PP to less than or equal to -36°C, except for Arctic Express. The effect of the percent biodiesel in the B0, B5 and B20 blends on reducing the PP temperatures was not evaluated as the actual gelling points for these blend levels were never reached. However, the statistical analysis confirmed that the additives had almost no effect on the PP for B100. In fact, except for a small change with the MCC additive, no PP reduction was observed for B100 (Table 2).

When the additives were used at twice the recommended level, the PP for B100 was reduced to -3°C (26.6°F) for all of the additives except Flozol, for which the PP remained at 0°C (32 °F). All of the additives reduced the pour points of B0, B5 and B20 to less than or equal to -36°C at 200% of the recommended loading. Using three times the recommended level of additive showed an incremental reduction in PP with MCC and Arctic Express only. At this level, the PP of B100 was reduced to -6°C (21.2°F) with MCC and -4.5°C (23.9°F) with Arctic Express.

This indicated that the fuel additives were more effective in diesel fuel than in the soy biodiesel. The observed reduction in PP at the B5 and B20 levels may primarily be due to the PP depression of the diesel fuel. Even though the fuel additives were recommended for biodiesel, none of the additives worked better for biodiesel than regular diesel fuel.

Conclusion

The effectiveness of four commercially available biodiesel cold flow additives on the low temperature behavior of soy biodiesel/diesel fuel blends was studied. As expected, the additives had almost no effect on the cloud point. A maximum reduction in cloud point of 1.8°C (3.2°F) was observed with the MCC additive on B20. All of the fuel additives were found to be effective in reducing the pour point for the baseline diesel fuel and the B5 and B20 blend levels with PPs below -36 °C (-32.8 °F) in most cases. However, very little or no effect was observed on the PP for B100.