B20 to B100 Blends as Heating Fuels

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The following is an excerpt from *B20 to B100 Blends as Heating Fuels*, released November 2018

Technical Summary

Combustion Performance of B-20 Biodiesel Blends in Residential Heating Appliances

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Introduction - Qualification of any fuel for use in the home heating market requires demonstration of acceptable combustion performance. Specific aspects of this include: reliable ignition under field conditions, flame stability, low air pollutant emissions, low potential for formation of coke on burner heads, and safe/reliable operation of the burner sensors and controls. Several important laboratory studies have been done on the combustion performance of biodiesel/heating oil blends in North America. Here, an overview of the key findings with an emphasis on blends at the B-20 level is presented.

Key Results—The technical data all indicate that B20 and lower blends will perform as expected in the existing equipment base without modification. Higher blends also perform as expected, however as blend levels approaching 100 percent adjustments to the flame sensor system may be required due to the cleaner burning nature of biodiesel.

Laboratory Studies -Initial laboratory testing of biodiesel as a fuel was done by the R.W. Beckett Corporation in 1993. Using conventional burners this involved a simple comparison of B-100 and normal heating oil of the S5000 sulfur grade with nominal sulfur level of 1500 ppm. In a later study at Beckett [1] a comparison was done of the NO_x and SO_2 emissions of heating oil, B-20, and B-100.

Results of testing with a variety of space heating appliances were reported by Batey in 2003 [2]. This study directly compared performance of a conventional heating oil with a B-20 blend of soy-based biodiesel blended into 500 ppm sulfur oil. Equipment evaluated included a commercial steam boiler, an older residential hot water boiler, a compact residential hot water boiler, an older residential warm air furnace, and two additional typical residential hot water boilers. The work focused on steady state CO, smoke number, and NO_x emissions.

In another lab study, reported by Krishna et.al. in 2001 [3] both startup and steady state performance of biodiesel blends and conventional heating oil were studied using a conventional residential boiler. Blend levels to B-100 were included. In the transient part of this study CO emission profiles from cold start were compared. High startup CO emissions are an indicator of poor ignition performance, and were compared and found to be independent of biodiesel content.

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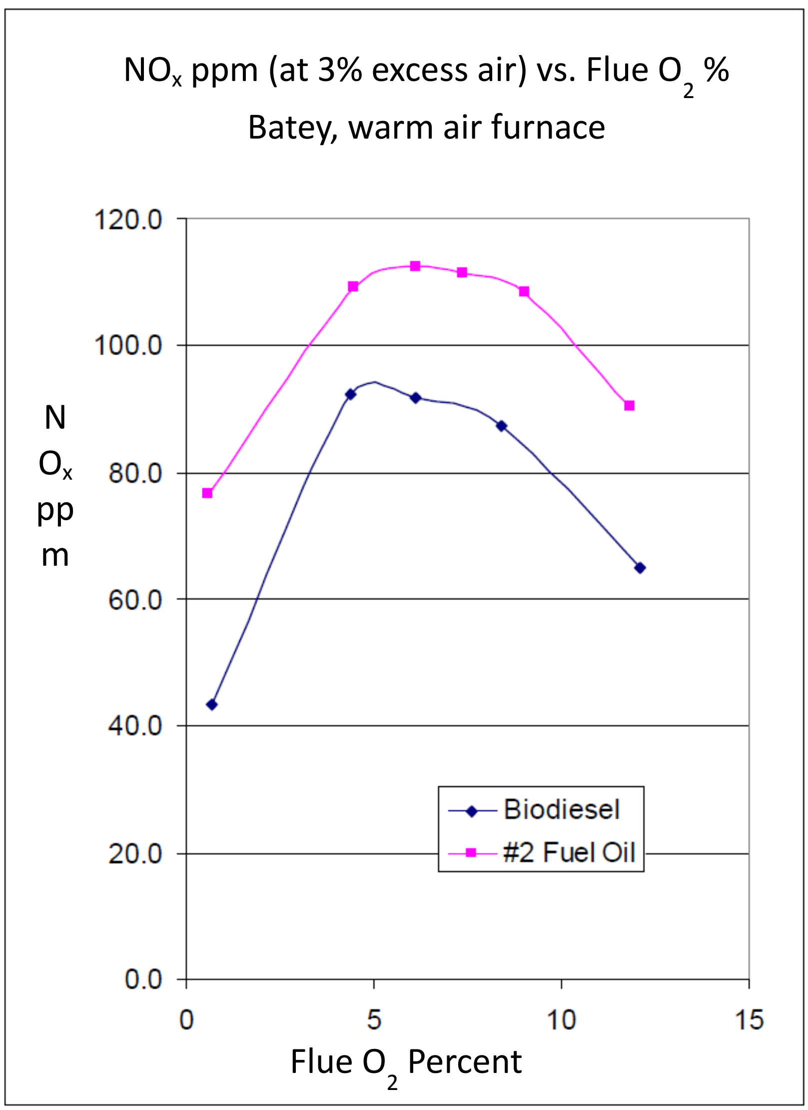
Cold start in this case was with the boiler at 55 F, much colder than typical in normal field operation.

Win Lee et al [4] conducted a set of careful measurements in a test facility in Ottawa, Canada using a cast iron, residential hot water boiler. Tests were run on the baseline fuel oil and on a B20 blend made from a commercial soy biodiesel. These studies included particulate emissions as well as gas-phase emissions.

Key Results A common result from all of the studies done is that the basic burner operation with biodiesel blends at B-20 (at least) is the same as with unblended heating oil. Observations are that startup behavior and flame stability are seamless. This general observation was specifically documented in the transient CO measurements made by Krishna et.al. [3]. Another observation is that smoke number and CO emissions in steady state are either the same or lower than with unblended heating oil.

Most of the studies showed that NO_x emissions are lower with B-20 although in some cases, at some excess air levels similar NO_x levels were reported.

Sulfur dioxide emissions are a function only of the sulfur content of the fuel. Relative to unblended heating oil, biodiesel can be considered nearly sulfur-free and so reductions in SO_2 were observed in proportion. Similarly, it has been shown that most of the fine particulate emissions from small oil burners are due to sulfates and these emissions are directly proportional to fuel sulfur content. Again, this leads to lower emissions with the biodiesel blends.



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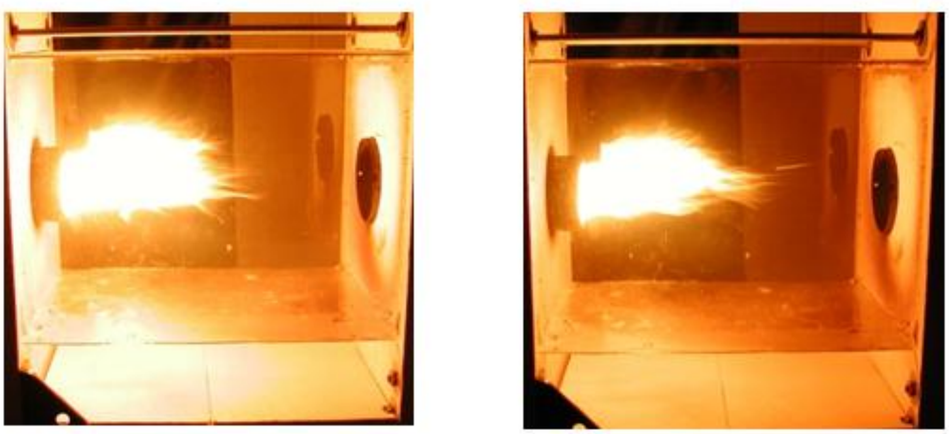
In tests at much higher blend levels, to B-100, it was shown that the amount of visible light produced by a biodiesel flame is lower than that of a flame from unblended heating oil. This is most likely due to the lower particulate emission and cleaner burning nature of biodiesel. The practical implication of this is that it could impact the ability of the flame sensor to detect a viable flame with higher concentrations of biodiesel and shut off the burner unnecessarily. The flame sensor is part of the flame safety control system whose function is to determine if there is a viable flame when fuel is flowing through the burner nozzle. This helps ensure unburned fuel does not accumulate in the burner chamber. If high biodiesel blends are used, the flame sensing system may need to be modified to insure the unit does not shut off due to a cleaner, non-detectable flame with high concentrations of biodiesel. There have been no reports of this as a concern at the B-20 level.

Figure 1 Example comparison of NOx emissions, B-20 and unblended heating oil



Biodiesel blend Unblended No. 2 oil

Figure 2 Comparison of the flame from a biodiesel blend and No. 2 oil.

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