Biodiesel Behavior/Characteristics Experiment

10/7/2008

Purpose: The purpose of this experiment is to address the problems experienced by Districts 12 and 7 in the use of biodiesel, specifically B20, a solution of 80% Diesel and 20% B100. In the Winter of 2007-2008 trucks used to apply deicing materials to snow and ice covered roads failed to operate as a result of clogged fuel filters. The Ohio DOT met with the Biodiesel industry and found a need to investigate biodiesel processes. In this experiment, key factors effecting the behavior of a two component system of diesel fuel and organic oil will be investigated.

Part A: Blending

At the meeting ODOT had with the biodiesel industry it was hypothesized that improper blending caused the clogged fuel filters on deicing trucks. In this section of the experiment three methods of blending will be looked at. These methods will be simulated on a laboratory scale to resemble conditions in the field. The three blending methods are described in the following section, Test Procedures.

Test Procedures:

This Bio-Diesel mixing experiment will consist of three different mixing methods/theories which include:

1.) Gravitational pour w/no agitation
2.) Gravitational pour with agitation via stir plate
3.) Gravitational pour with agitation via vehicle motion

Sample Size: Each sample in all of the subsets will contain 250 ml of B20 solution.
Two methods of analysis, Specific Gravity measurement, and Cloud Point testing, will take place to determine the effectiveness of each mixing method.
The components are listed in order of addition (ex. B100 followed by addition of summer diesel, "followed by" will be denoted with” **->**".

Test Results

A.) Specific Gravity

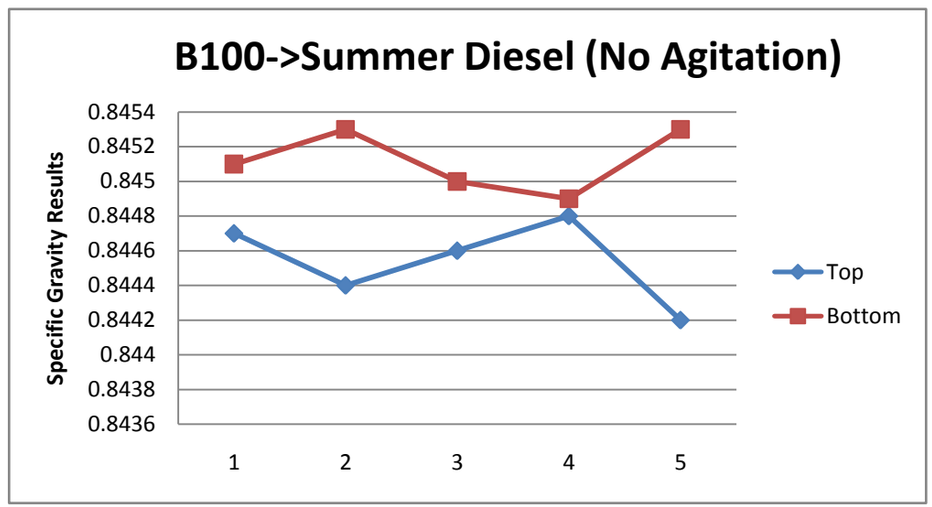
1.) Gravitational pour w/no agitation

Subset 1: Subset 1 consists of 5 samples of a B20 mixture in which B100 was introduced first into a 400 ml beaker. Summer blend diesel fuel will then be introduced on top of
the B100 at a constant rate. Once the samples have been poured they will stand for 10 minutes after which point a sample will be taken from the top
and bottom sections of the containment beakers for each sample. These samples will then be analyzed for specific gravity and results recorded.

Results - Specific Gravity

B100->Summer Diesel Blend

Sample #	Top	Bottom
1	0.8447	0.8451
2	0.8444	0.8453
3	0.8446	0.845
4	0.8448	0.8449
5	0.8442	0.8453
AVG.	**0.8445**	**0.8451**



Subset 2: Subset 2 consists of 5 samples of a B20 mixture in which summer blend diesel is introduced first into a 400 ml beaker. B100 will then be introduced on top of the summer diesel blend at a constant rate. Once the samples have been poured they will stand for 10 minutes after which point a sample will be taken from the top and bottom sections of the containment beakers for each sample. These samples will then be analyzed for specific gravity and results recorded.

Results - Specific Gravity

Summer Diesel Blend->B100

Sample #	Top	Bottom
1	0.8351	0.8691
2	0.8397	0.8498
3	0.8351	0.8700
4	0.8354	0.8668
5	0.8351	0.8682
AVG.	**0.8361**	**0.8648**

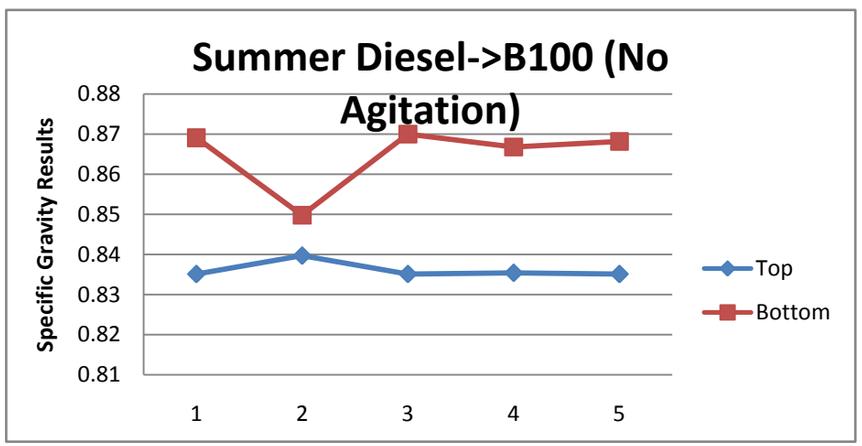
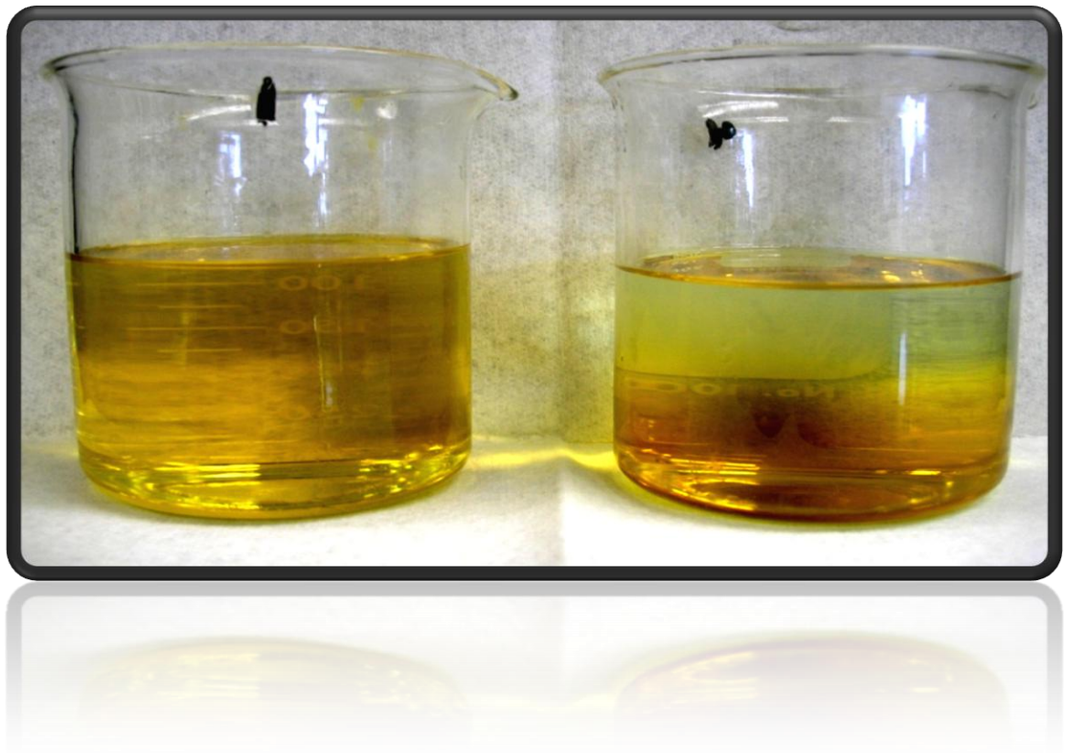


Image 1: Represents the visual appearance of the bio-diesel fuels when switching the order of component addition.



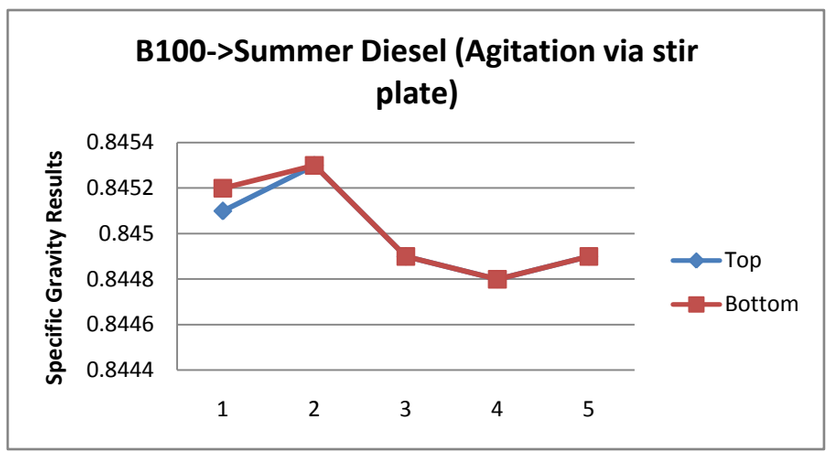
2.) Gravitational pour with agitation via stir plate

Subset 1: Subset 1 consists of 5 samples of a B20 mixture in which B100 was introduced first into a 400 ml beaker. Summer blend diesel fuel will then be introduced on top of the B100 at a constant rate. Once the samples have been poured they will agitate via stir plate for 10 minutes. A sample will be taken from the top and bottom sections of the containment beakers for each sample. These samples will then be analyzed for specific gravity and results recorded.

Results - Specific Gravity

B100->Summer Diesel Blend

Sample#	Top	Bottom
1	0.8451	0.8452
2	0.8453	0.8453
3	0.8449	0.8449
4	0.8448	0.8448
5	0.8449	0.8449
AVG.	**0.8450**	**0.8450**

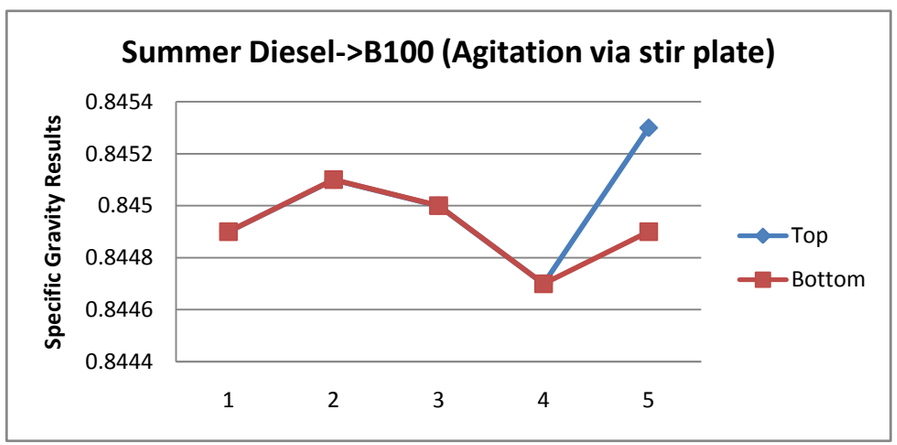


Subset 2: Subset 2 consists of 5 samples of a B20 mixture in which summer blend diesel was introduced first into a 400 ml beaker. B100 fuel will then be introduced on top of the summer blend diesel at a constant rate. Once the samples have been poured they will agitate via stir plate for 10 minutes. A sample will be taken from the top and bottom sections of the containment beakers for each sample. These samples will then be analyzed for specific gravity and results recorded.

Results - Specific Gravity

Summer Diesel Blend->B100

Sample#	Top	Bottom
1	0.8449	0.8449
2	0.8451	0.8451
3	0.845	0.845
4	0.8447	0.8447
5	0.8453	0.8449
AVG.	**0.8450**	**0.8449**



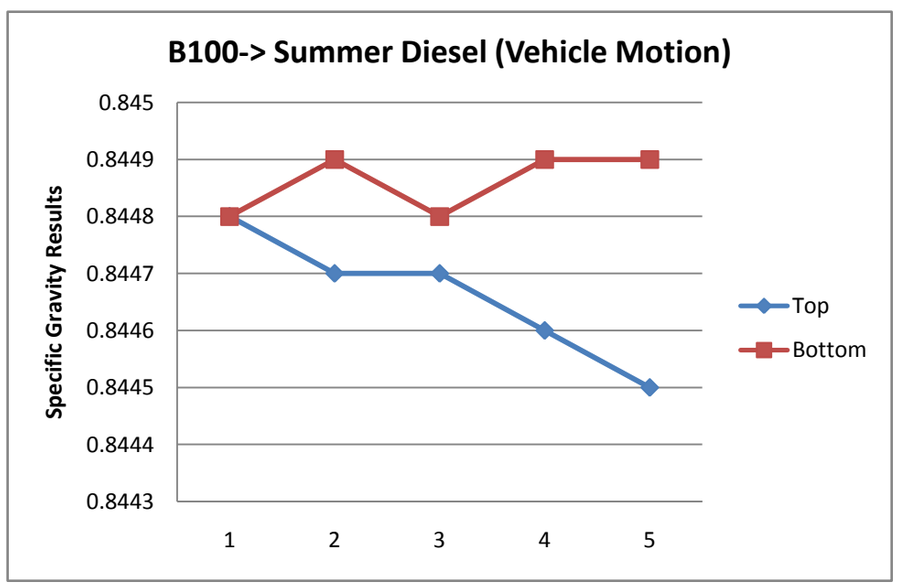
3.) Gravitational pour with agitation via vehicle motion

Subset 1: Subset 1 consists of 5 samples of a B20 mixture in which B100 was introduced first into a 400 ml beaker. Summer blend diesel fuel will then be introduced on top of the B100 at a constant rate. Once the samples have been poured they will agitate by way of vehicle motion or 10 minutes. A sample will then be taken from the top and bottom sections of the containment beakers for each sample. These samples will then be analyzed for specific gravity and results recorded.

Results - Specific Gravity

B100->Summer Diesel Blend

Sample#	Top	Bottom
1	0.8448	0.8448
2	0.8447	0.8449
3	0.8447	0.8448
4	0.8446	0.8449
5	0.8445	0.8449
AVG.	**0.8447**	**0.8449**



Subset 2**:** Subset 2 consists of 5 samples of a B20 mixture in which summer blend diesel is introduced first into a 400 ml beaker. B100 will then be introduced on top of the summer diesel blend at a constant rate. Once the samples have been poured they will stand for 10 minutes after which point a sample will be taken from the top and bottom sections of the containment beakers for each sample. These samples will then be analyzed for specific gravity and results recorded.

Results - Specific Gravity Analysis

Summer Diesel Blend->B100

Sample#	Top	Bottom
1	0.8360	0.8624
2	0.8356	0.8681
3	0.8381	0.8589
4	0.8354	0.8670
5	0.8361	0.8619
AVG.	**0.8428**	**0.8637**

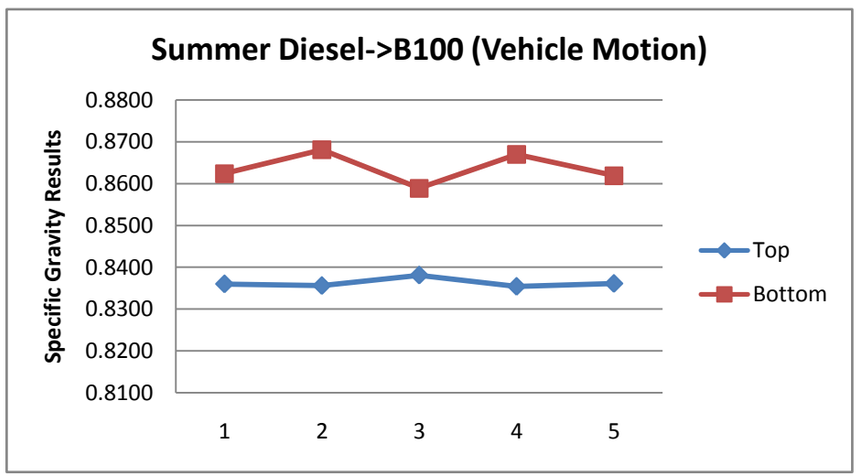
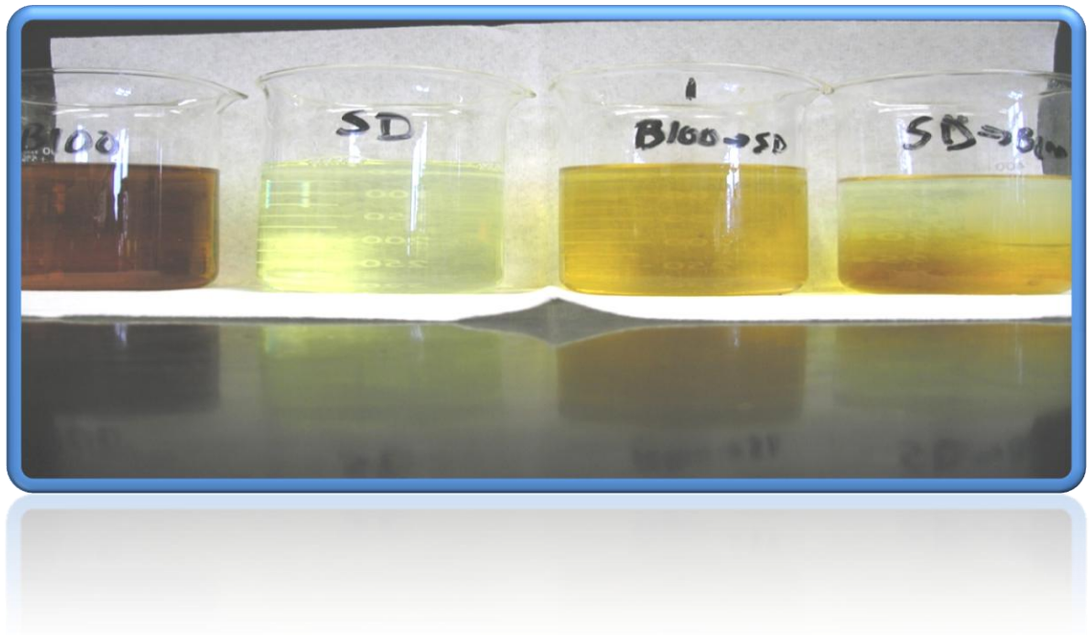


Image 2: Represents the visual appearance of the single components along with the switched order of addition samples.



1.) Gravitational pour w/no agitation

Subset 1**:** Subset 1 consists of 3 samples of a B20 mixture in which B100 was introduced first into a 400 ml beaker. Summer blend diesel fuel will then be introduced on top of the B100 at a constant rate. Once the samples have been poured they will stand for 10 minutes after which point a sample will be taken from the bottom section of the containment beaker for each sample. These samples will then be analyzed for cloud point and results recorded.

Results - Cloud Point

B100->Summer Diesel Blend

Sample#	Bottom
1	-19.8
2	-19.7
3	-20
AVG.	**-19.8**
STD. DEV.	**0.2**

Subset 2: Subset 2 consists of 3 samples of a B20 mixture in which summer blend diesel is introduced first into a 400 ml beaker. B100 will then be introduced on top of the summer diesel blend at a constant rate. Once the samples have been poured they will stand for 10 minutes after which point a sample will be taken from the bottom section of the containment beakers for each sample. These samples will then be analyzed for cloud point and results recorded.

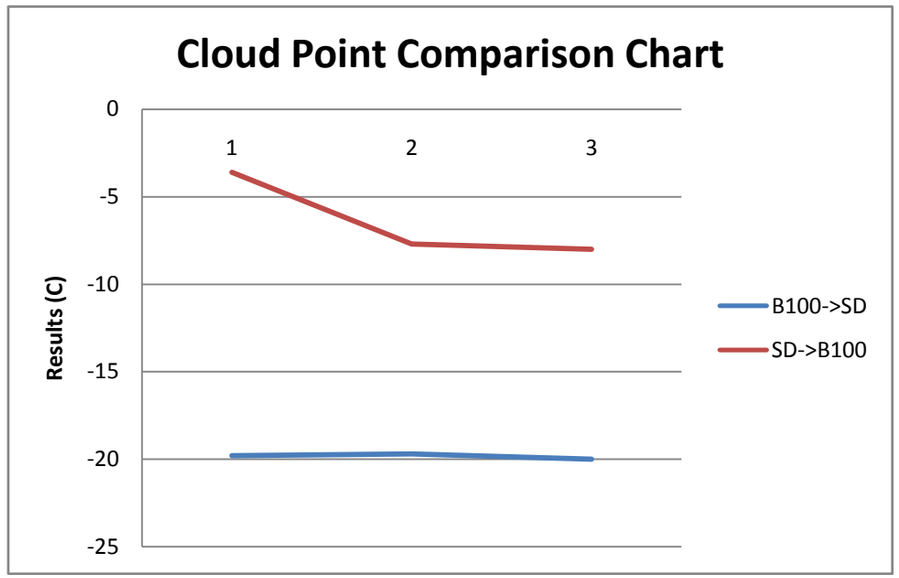
Results - Cloud Point

Summer Diesel Blend->B100

Sample#	Bottom
1	-3.6
2	-7.7
3	-8
AVG.	**-6.4**
STD. DEV.	**2.5**

Comparison Chart - Gravitational pour w/no agitation

-19.8	-3.6
-19.7	-7.7
-20	-8



2.) Gravitational pour with agitation via stir plate

Subset 1**:** Subset 1 consists of 3 samples of a B20 mixture in which B100 was introduced first into a 400 ml beaker. Summer blend diesel fuel will then be introduced on top of the B100 at a constant rate. Once the samples have been poured they will be agitated via stir plate for 10 minutes. A sample will be taken from the top and bottom sections of the containment beakers for each sample. These samples will then be analyzed for cloud point and results recorded.

Results - Cloud Point

B100->Summer Diesel Blend

Sample#	Bottom
1	-17.4
2	-18.6
3	-20
AVG.	**-18.7**
STD. DEV.	**1.3**

Subset 2: Subset 2 consists of 3 samples of a B20 mixture in which summer blend diesel is introduced first into a 400 ml beaker. B100 will then be introduced on top of the summer diesel blend at a constant rate. Once the samples have been poured they will be agitated via stir plate for 10 minutes after which point a sample will be taken from the bottom section of the containment beakers for each sample. These samples will then be analyzed for cloud point and results recorded.

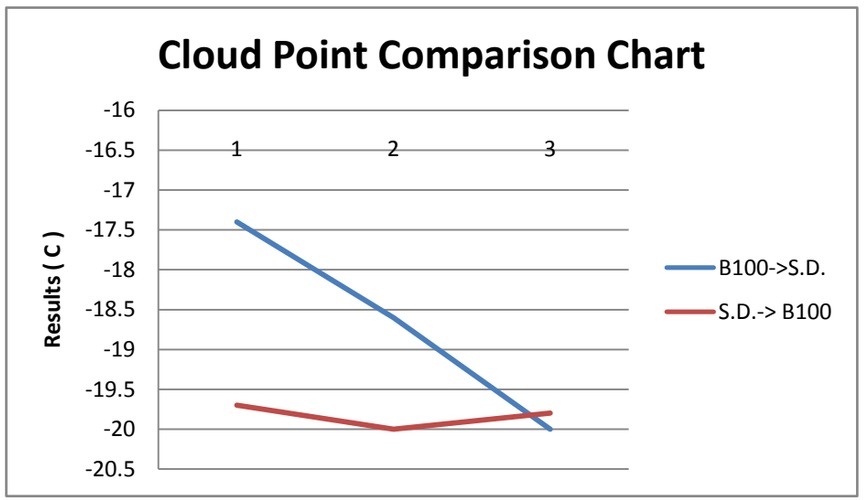
Results - Cloud Point

Summer Diesel Blend->B100

Sample#	Bottom
1	-19.7
2	-20
3	-19.8
AVG.	**-19.8**
STD. DEV.	**0.2**

Comparison Chart - Gravitational pour with agitation via stir plate

-17.4	-19.7
-18.6	-20
-20	-19.8



3.) Gravitational pour with agitation via vehicle motion

Subset 1: Subset 1 consists of 3 samples of a B20 mixture in which B100 was introduced first into a 400 ml beaker. Summer blend diesel fuel will then be introduced on top of the B100 at a constant rate. Once the samples have been poured they will be agitated by way of vehicle motion for 10 minutes. A sample will be taken from the top and bottom sections of the containment beakers for each sample. These samples will then be analyzed for cloud point and results recorded.

Results - Cloud Point

B100->Summer Diesel Blend

Sample#	Bottom
1	-20
2	-19.8
3	-19.6
AVG.	**-19.8**
STD. DEV.	**0.2**

Subset 2: Subset 2 consists of 3 samples of a B20 mixture in which summer blend diesel is introduced first into a 400 ml beaker. B100 will then be introduced on top of the summer diesel blend at a constant rate. Once the samples have been poured they will be agitated by way of vehicle motion for 10 minutes after which point a sample will be taken from the bottom section of the containment beakers for each sample. These samples will then be analyzed for cloud point and results recorded.

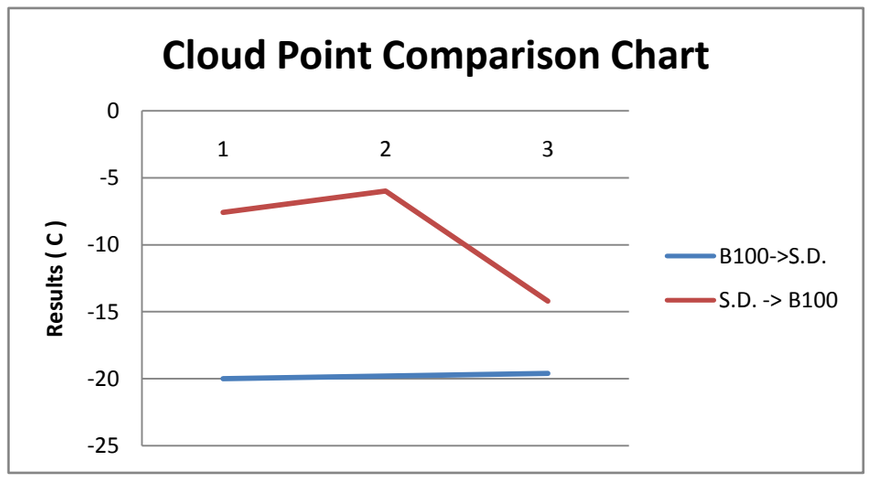
Results - Cloud Point

B100->Summer Diesel Blend

Sample#	Bottom
1	-7.6
2	-6
3	-14.2
AVG.	**-9.3**
STD. DEV.	**4.3**

Comparison Chart - Gravitational pour with agitation via vehicle motion

-20	-7.6
-19.8	-6
-19.6	-14.2



Conclusion

Upon completion of the mixing stage of the Biodiesel experiment it can be concluded that the factors increasing the frequency of producing a homogenous mixture are:

1.) The order in which the components of the B20 mixture are added

2.) The introduction of a stirring form of agitation

Mixing Order

By adding the B100 first, specific gravity results show uniformity at the top of the sample relative to the bottom of the sample, results that are consistent with a homogenous mixture. When the B100 was added first, cloud point results met minimum specifications. Conversely, adding the B100 in the reverse order yielded results in homogeneity that was inconsistent and even visually showed striation, thereby indicating that the material was not properly mixed. The results obtained by adding the B100 last show specific gravity readings that were erratic and cloud point results that in many instances did not meet minimum specification.

Agitation

1.) Agitation by stir plate

Thorough mixing of the components of the B20 mixture resulted with agitation by stir plate. Specific gravity results showed homogeneity and cloud point analysis gave consistent results.

2.) Agitation by vehicle motion

Vehicle motion gave specific gravity results that were similar to the results in the Mixing Order part of the experiment. Cloud point data was inconsistent. Apparently vehicle motion had no significant effect on the blending of the components of the B20 to produce a homogeneous mixture.

Recommendations

This part of the Biodiesel Experiment shows the affect of methods of blending on the specific gravity and the cloud point of a mixture. The homogeneity of a fuel will affect it's performance. To ensure the delivery of a homogenous biodiesel product the B20 mixture should be mechanically agitated.