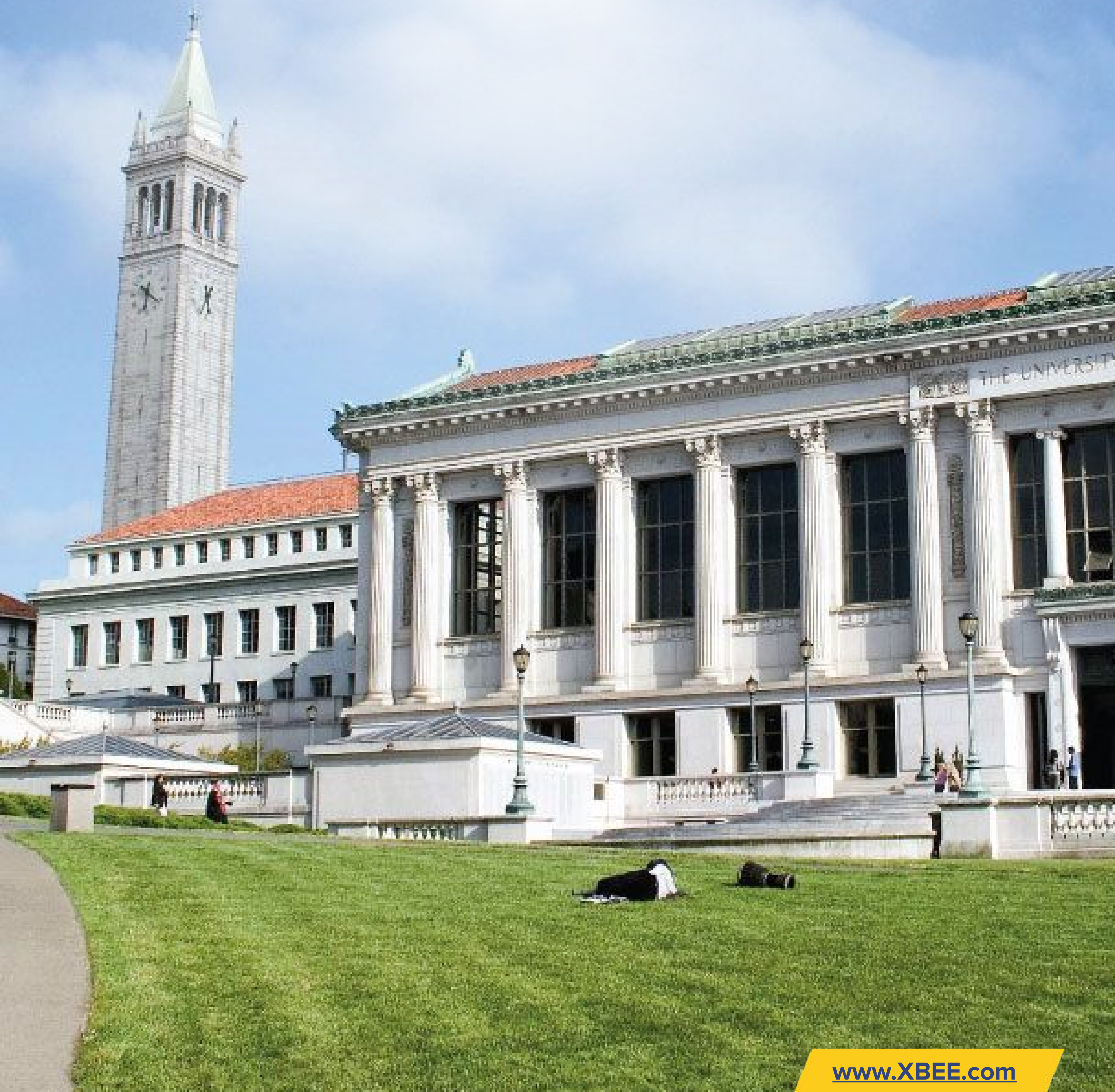
REPORT:
UC BERKELEY COMBUSTION LABORATORY



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Summary

Better fuel,
better performance.
Better combustion,
better emissions.
XBEE: naturally better.

Context

On March 28, 2006 the company Biodiesel Industries Inc. located in California, USA shared their conclusions regarding an extensive study covering biodiesels and their gas emissions.

Bay Area Air Quality Management District

This contract was funded by the District to study the feasibility of manufacturing and using biodiesel in the Bay Area. Almost half of the State's petroleum refineries reside in the Bay Area. The District designed the contract parameters around proving both the economic feasibility of refining biodiesel from local feed stocks, as well as the availability of methods to reduce NO_x, which is biodiesel's largest drawback.

XBEE in biofuels

It is generally accepted that test methods for diesel also effect the test itself, therefore this contract required a variety of engines, both laboratory and field testing, as well as different testing technologies, to give the most accurate overall picture of how biodiesel and emission reduction additives will perform across real world fleets.

The contractor was Biodiesel Industries Inc., which was recently awarded a US patent in biodiesel refining technology, and is a member of the National Biodiesel Board.

Data

1 | Conditions of the evaluation

Arrangements were made to have testing done under the direction of Professor Robert Dibble at the Combustion Analysis Laboratory at the University of California at Berkeley. Professor Dibble, with the support of some of his graduate students, ran the testing protocols on a Cummins 5.9 liter diesel installed at the Combustion Analysis Laboratory during the summer of 2004.

The reference diesel fuel used for the tests was CARB ultra low sulfur diesel (ULSD) procured from the British Petroleum distributor in San Jose, Western States Oil. The biodiesel used was made using the Mini Modular Production Unit from feedstocks acquired in the Bay Area consisting of virgin refined soybean oil and used fryer oil. These two types of biodiesel were selected because research published by the USEPA suggests that NOx emissions would be highest with soy based biodiesel and lowest with used fryer oil based biodiesel.

Various blends of biodiesel and ULSD were tested, including 100% ULSD, 100% biodiesel produced from aggregate used vegetable oil, and 100% virgin soy oil.

2 | Measured parameters

UC Berkeley has measured the following parameters using a Dynamometer:

- Hydrocarbons – HC (ppm)
- Carbon monoxide – CO (ppm)
- Particulate matter – PM (mg/m^3)
- Nitrogen oxides – NO_x (ppm)

Data analysis

The most obvious result of the emissions tests was that by using **XBEE Enzyme Fuel Technology**, NO_x is substantially reduced in all formulas, and at either mix blends, B-20 or B-100. In addition to NO_x, unburned hydrocarbons (HC), carbon monoxide (CO) and particulate matter (PM) also dropped substantially. The most effective fuel for total emissions reductions was B100 made from virgin soy oil and **XBEE**.

Aggregate used vegetable oils (B100)	W/o XBEE	With XBEE	Difference
HC – Hydrocarbons (ppm)	7.70	5.30	-31.17%
CO – Carbon Monoxide (ppm)	33.30	32.40	-2.70%
PM – Particulate Matter (mg/m^3)	2.20	2.00	-9.09%
NO_x – Nitrogen Oxide (ppm)	656	554	-15.55%

Virgin soy oil (B100)	W/o XBEE	With XBEE	Difference
HC – Hydrocarbons (ppm)	10.00	5.20	-48.00%
CO – Carbon Monoxide (ppm)	36.30	32.10	-11.57%
PM – Particulate Matter (mg/m^3)	2.30	1.80	-21.74%
NO_x – Nitrogen Oxide (ppm)	720	559	-22.36%

Conclusions

HC

-40%

CO

-7%

NOx

-38%

One of the most notable tests was actually the XBEE/CARB Ultra low diesel test, without any biodiesel. Alone, XBEE reduced HC by 54%, CO by 14%, and PM by 37%, with no penalty in NO_x. This test demonstrates that even in one of the world's most highly refined fuel, CARB Ultra Low Sulfur Diesel, XBEE is highly effective in reducing emissions. XBEE is actually more effective than neat B20 biodiesel, and at a fraction of the cost.

Based on these data measured by UC Berkeley Combustion Analysis Laboratory, we can observe XBEE positive impact in different blends of B100:

- -39.58% reduction of hydrocarbons
- -7.13% reduction of carbon monoxide
- -15.41% reduction of particulate matter
- -37.91% reduction of nitrogen oxides

You are entitled to expect the best from **XBEE Enzyme Fuel Technology**.

We offer a wide range of benefits: cleaning fuel systems, saving money, reducing pollution.

Annexes

Original database

Run	Reference Fuels-Run in 5.9L, 6 Cylinder, Cummins	Blend	Fuel Filter	Additive	Additive Concentration	Speed (RPM)	Load (%)	HC (ppm)	HC (%)	CO (ppm)	CO (%)	PM (filters) (mg/m^3)	PM (%)	Nox (ppm)	Nox (%)	Total (%)
1	CARB ULS Diesel	N/A	No	No	N/A	1800	80	16.2	0.0%	42.8	0.0%	3.0	0.0%	636	0.0%	0.0%
2	Biodiesel Produced from Aggregate Used Vegetable Oil	B20	No	No	N/A	1800	80	12.8	-21.0%	39.2	-8.4%	2.7	-10.0%	646	1.6%	-37.8%
3	Biodiesel Produced from Virgin Soy Oil	B100	No	No	N/A	1800	80	10.0	-38.3%	36.3	-15.2%	2.3	-23.3%	720	13.2%	-63.6%
4	Biodiesel Produced from Virgin Soy Oil	B20	No	No	N/A	1800	80	10.8	-33.3%	37.9	-11.4%	1.9	-36.7%	645	1.4%	-80.0%
5	Biodiesel Produced from Aggregate Used Vegetable Oil	B100	No	No	N/A	1800	80	7.7	-52.5%	33.3	-22.2%	2.2	-26.7%	656	3.1%	-98.3%
6	Biodiesel Produced from Virgin Soy Oil	B20	No	Yes	1:2000	1800	80	11.8	-27.2%	41.9	-2.1%	1.9	-36.7%	576	-9.4%	-75.4%
7	Biodiesel Produced from Aggregate Used Vegetable Oil	B20	No	Yes	1:2000	1800	80	10.6	-34.6%	38.9	-9.1%	2.0	-33.3%	559	-12.1%	-89.1%
8	CARB ULS Diesel	N/A	No	Yes	1:2000	1800	80	7.4	-54.3%	37.0	-13.6%	1.9	-36.7%	632	-0.6%	-105.2%
9	CARB ULS Diesel	N/A	Yes	No	N/A	1800	80	12.2	-24.7%	39.2	-8.4%	2.5	-26.7%	510	-19.8%	-79.6%
10	Biodiesel Produced from Aggregate Used Vegetable Oil	B20	Yes	No	N/A	1800	80	11.1	-31.5%	35.1	-18.0%	1.6	-46.7%	530	-16.7%	-112.9%
11	Biodiesel Produced from Virgin Soy Oil	B20	Yes	No	N/A	1800	80	12.8	-21.0%	40.9	-4.4%	1.5	-50.0%	528	-17.0%	-92.4%
12	Biodiesel Produced from Virgin Soy Oil	B100	Yes	No	N/A	1800	80	8.4	-48.1%	34.5	-19.4%	1.7	-43.3%	591	-7.1%	-117.9%
13	Biodiesel Produced from Aggregate Used Vegetable Oil	B100	Yes	No	N/A	1800	80	6.8	-58.0%	31.7	-25.9%	2.1	-30.0%	601	-5.5%	-119.4%
14	Biodiesel Produced from Aggregate Used Vegetable Oil	B20	Yes	Yes	1:2000	1800	80	9.8	-39.5%	39.0	-8.9%	1.7	-43.3%	515	-19.0%	-110.7%
15	Biodiesel Produced from Virgin Soy Oil	B20	Yes	Yes	1:2000	1800	80	9.0	-44.4%	37.1	-13.3%	1.8	-40.0%	505	-20.6%	-118.3%
16	Biodiesel Produced from Aggregate Used Vegetable Oil	B100	No	Yes	1:2000	1800	80	7.7	-52.5%	27.7	-35.3%	1.9	-36.7%	560	-11.9%	-136.4%
17	Biodiesel Produced from Virgin Soy Oil	B100	No	Yes	1:2000	1800	80	7.9	-53.3%	32.5	-24.1%	1.8	-40.0%	563	-11.5%	-128.8%
18	Biodiesel Produced from Virgin Soy Oil	B100	No	Yes	1:1000	1800	80	6.6	-59.3%	31.7	-25.9%	2.2	-26.7%	610	-4.1%	-115.9%
19	Biodiesel Produced from Aggregate Used Vegetable Oil	B100	No	Yes	1:1000	1800	80	6.4	-60.5%	30.7	-28.3%	1.9	-36.7%	550	-13.5%	-139.0%
20	Biodiesel Produced from Aggregate Used Vegetable Oil	B100	No	Yes	1:4000	1800	80	5.3	-67.3%	32.4	-24.3%	2.0	-33.3%	554	-12.9%	-137.8%
21	Biodiesel Produced from Virgin Soy Oil	B100	No	Yes	1:4000	1800	80	5.2	-67.9%	32.1	-25.0%	1.8	-40.0%	559	-12.1%	-145.0%

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