



A Winning Combination:

Renewable Hydrocarbon Diesel and Biodiesel Blend





An RHD and biodiesel blend is the perfect marriage



Benefits of the Newest Renewable Blend

The latest innovation in renewable fuel is the blending together of two leading diesel replacements: biodiesel and renewable hydrocarbon diesel. It's receiving rave reviews from early users, and it's easy to see why.

Biodiesel is a competitively priced product with a proven track record of providing fleets and individual drivers with strong performance while reducing emissions and petroleum consumption.

Renewable hydrocarbon diesel (RHD) is a newer alternative fuel that also has excellent environmental and performance benefits while being a drop-in replacement for petroleum diesel.

Blending biodiesel and RHD with each other — instead of only with petroleum diesel — results in a product that features the best characteristics of the two fuels.



Emissions

Significantly reduces a fleet's carbon footprint and emissions, including total hydrocarbons, particulate matter, carbon monoxide and nitrogen oxides (NOx).



Performance

Great Cetane, lubricity, lower aromatics and Cloud Point.



Ease of use

The fuels are easy to blend, store and handle.



Supply

With RHD demand outpacing supply, blending in biodiesel can help organizations stretch their RHD allocation while still offering an extensively renewable product.

"An RHD and biodiesel blend is the perfect marriage," says Brian Deninger, co-owner of a fuel retail company and a travel company with a large bus fleet in San Francisco. "We can exceed emissions standards, improve engine performance and help the nation become more energy independent."




What is Biodiesel?

To understand an RHD and biodiesel blend, one needs to understand RHD and biodiesel individually. Biodiesel is an advanced biofuel that is renewable and has been used for decades as a cleaner-burning alternative to petroleum diesel.

How is it made?

The most common biodiesel feedstocks are recycled cooking oil, waste animal fats and vegetable oils. In the production process, the feedstock is reacted with methanol to get fatty acid methyl esters (FAME). This process is called transesterification.

What are the benefits?

-  **Price** — Let's start with the benefit you probably care about most. Biodiesel often has positive economics over petroleum diesel. From a straight up price advantage to state and federal tax incentives to the value of Renewable Identification Numbers (RINs) and carbon credits — biodiesel makes great financial sense.
-  **Performance** — Fleets of all types achieve strong performance with biodiesel blends year-round. There are even performance advantages, including higher Cetane and added lubricity (see the chart on Pg. 5). Lubricity is absent in ULSD, so the lubricity brought by biodiesel is critical for maintaining engine functionality. Biodiesel falls under ASTM D6751.
-  **Emissions** — Biodiesel has significantly lower emissions of total hydrocarbons, particulate matter and carbon monoxide compared with petroleum diesel.



What is Renewable Hydrocarbon Diesel?

RHD is made from the same feedstocks as biodiesel, but it has a different production process and is a distinct fuel. With RHD, the feedstock is reacted with hydrogen during what is known as the hydrotreating process. Another difference is RHD has no oxygen, whereas biodiesel does.

Why the “hydrocarbon”?

RHD meets ASTM D975, the diesel spec, and is a drop-in replacement for petroleum diesel. To be considered a diesel fuel, a product must be comprised of hydrocarbon molecules. That’s why REG makes a point of including “hydrocarbon” in the name — it distinguishes its RHD from products that some producers claim to be diesel but do not meet the definition found in ASTM D975.

What are the benefits?



Performance — Although RHD falls under the ASTM spec for diesel fuel, REG-produced RHD has a much higher Cetane number than ULSD and much lower sulfur content and aromatics. At minus 10 degrees Celsius, RHD also can achieve a Cloud Point that is unattainable with most biodiesel and meets the diesel pipeline winter spec.



Blending — RHD can be blended at any level with diesel and biodiesel.



Emissions — Like biodiesel, RHD has lower particulate matter, total hydrocarbon and carbon emissions than ULSD. It also reduces NOx emissions.



The Best Specs From Each Fuel

The benefits of RHD and biodiesel really come together — and in some ways are enhanced — when they are blended because, in many cases, they have different strengths.

Let's look at performance first.

RHD being a hydrocarbon contributes to its great Cetane. It also has a low cloud point. On the other hand, the presence of oxygen gives biodiesel a more complete combustion and added lubricity, as well as making it more biodegradable. Both fuels are low in aromatics, which are compounds that are unhealthy for people and the environment.

In general, the specs on an RHD and biodiesel blend are treated like a biodiesel blend because RHD meets the diesel spec. For instance, a blend of 80 percent RHD and 20 percent biodiesel, which REG calls RD B20, would be similar to a B20 blend. The key difference is that RHD outperforms petroleum diesel in some categories. The following chart shows how RHD and biodiesel produced by REG compare to the ASTM diesel spec.

Property	D975 Diesel	REG-9000 Biodiesel	REG-9000 RHD
Cetane Number	40, min.	47, min.	65, min.
Sulfur	15 ppm, max.	15 ppm, max.	5 ppm, max.
Aromaticity	35 %volume	N/A	2 %volume
Water & Sediment	0.05 %volume, max.	0.01 %volume, max.	0.05 %volume, max.
Flashpoint	52° C, min.	93° C, min.	52° C, min.
Ash	0.01 %mass, max.	0.02 %mass, max.	0.01 %mass, max.
Kinematic Viscosity	1.9 - 4.1 mm ² /sec.	3.8 - 5.0 mm ² /sec.	1.9 - 4.1 mm ² /sec.
Copper Corrosion	No. 3, max.	No. 1a, max.	No. 1b, max.



*When you blend RHD and biodiesel, the benefits are complementary of each other.
With a blended product, you still get the benefits of each fuel.*



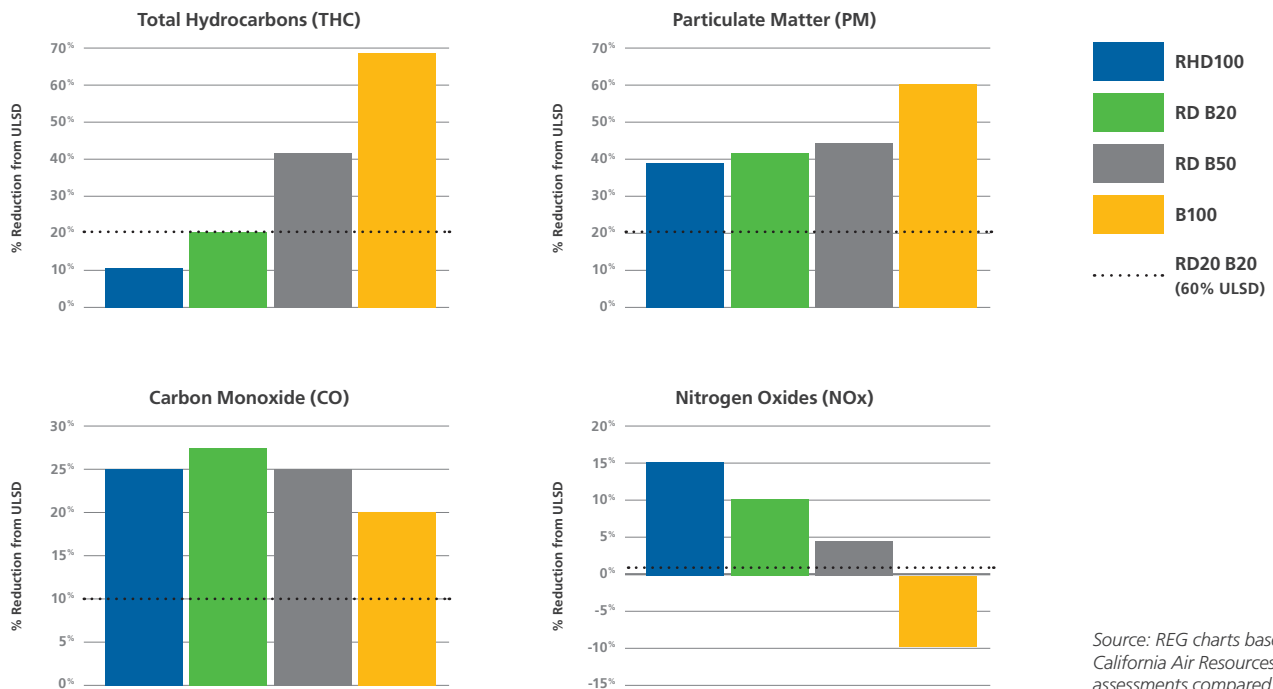
— Dave Slade, Executive Director, Biofuel Technology and Services, REG

A Better Product for the Environment

The biggest benefits of an RHD and biodiesel blend are on the environmental side.

“Fleets will have a better emissions profile than they would with RHD or biodiesel alone — and significantly better than with ULSD,” Slade says. “This will help companies meet sustainability goals. And if they do business on the West Coast, where low carbon fuel standards are in place, an RHD and biodiesel blend is a game-changer for lowering carbon intensity.”

The charts below show how significant the emission gains are. Biodiesel does a better job than RHD of reducing total hydrocarbons and particulate matter, whereas RHD outperforms biodiesel with carbon monoxide and NOx. Blended together, they are more environmentally friendly than any product containing ULSD.



Source: REG charts based on California Air Resources Board assessments compared to federal ULSD



As an outdoor travel company based in Northern California, we take people to our nation’s most treasured natural areas, such as Yosemite National Park. We feel protecting these destinations falls squarely on us and we must lead by example to ensure we take every step we can to reduce our carbon footprint. The RHD and biodiesel blend is a key part of our strategy.



— Brian Deninger, Co-owner, Incredible Adventures

A Simple Solution

If a company is experienced with blending, handling and storing biodiesel, then it will have no problem with an RHD and biodiesel blend.

“Because RHD meets the ASTM spec for diesel, it’s treated like diesel fuel, and biodiesel is biodiesel,” says Slade. “So RD B10, which is 90 percent RHD and 10 percent biodiesel, is the same as a B10 blend.”

The good news for companies handling biodiesel for the first time is it’s very easy to implement at their locations, whether they are a distributor, a retailer or a fleet. Blending the products together in-line ensures the best mix. The Cloud Point of the biodiesel will determine the storage temperature of the blended fuel. Once it’s blended it will not separate. Be sure tanks are clean before adding biodiesel blends and also be sure they remain free of water. Some providers offer a pre-blended product.



The storage and handling for our RHD and biodiesel blend is the same as what we do with our regular biodiesel blends. It’s easy for us, and our customers are happy with the reduced emissions and the overall experience of using it in their vehicles.



— Jaime Duenas, President, California Fuels & Lubricants

Get the Most Out of Your RHD Supply

In the past couple of years, RHD has quickly become popular among private and government fleets. Perhaps too quickly, because supply has not been able to keep up with demand.

This is where an RHD and biodiesel blend again brings out the best of both fuels. Domestic biodiesel producers have the capacity and supply lines to meet demand. An RHD and biodiesel blend allows users to supplement their RHD with another renewable fuel that has positive emissions and performance profiles.

Also, RHD and biodiesel can be blended with petroleum diesel. For example, the blended product could be 20 percent biodiesel, 20 percent RHD and 60 percent ULSD. While the benefits won't be the same as a 100 percent biodiesel and RHD blend, it's still a 40 percent renewable product. That's a step up from lower biodiesel blends, like B10.



There's a lot of demand for RHD in California. By blending it with 20 percent biodiesel, we expand our supplies while also giving drivers a cleaner-burning fuel.



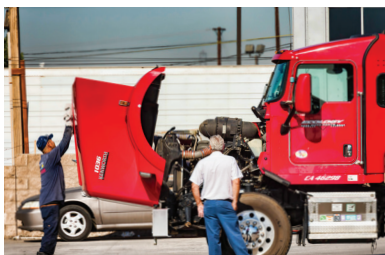
— Abdul Mardini, General Manager, Fontana Truck Stop Center



Case Study: RHD and Biodiesel Blend in Action

Three California companies show how users at different points in the supply chain benefit from an RHD and biodiesel blend.

California Fuels & Lubricants provides fuel to government, trucking, construction and port fleets in the Los Angeles area. In addition to biodiesel and RHD, it offers an RHD and biodiesel blend. “The biggest appeal was that it was a better, cleaner fuel that we could offer our customers to reduce their carbon footprints,” says President Jaime Duenas. “The performance is strong — we run our own trucks on the blended product — and storage and handling is easy.”



About 45 miles to the east, Fontana Truck Stop Center is located in one of America’s major trucking hubs. That’s good for business, but it also puts them in a very competitive environment.

“A lot of fleets are sending their trucks to locations that have renewable fuels, like biodiesel and renewable hydrocarbon diesel,” says company co-owner Lonnie Tabbaa. “Offering different fuels attracts drivers, and

that helps drive customers inside the store and to services like our wash and detail centers.”

Fontana Truck Stop Center started selling an RHD and biodiesel blend (RD B20) after hearing about the product from REG.

“We realize a greater margin on the fuel than petroleum diesel” says General Manager Abdul Mardini. “It also helps us extend our RHD supply.”

Up in Northern California, travel company Incredible Adventures has been using biodiesel in its bus fleet since 2002. Co-owner Brian Deninger notes that while there’s been a lot of buzz surrounding RHD in recent years, biodiesel actually does a superior job of reducing most tailpipe emissions. Where RHD has an advantage is with NOx. So in 2016, his fleet started running on RD B20.





“We are reducing greenhouse gas emissions and protecting the destinations our fleets visit, including national parks,” he says. “At the same time, we have improved power and reduced diesel exhaust fluid and filter cleaning intervals.”





4 Big Benefits with an RHD and Biodiesel Blend

To recap, the top advantages for marketers, retailers and fleets with an RHD and biodiesel blend are:

-  **Significantly reduced emissions.**
-  **Enjoying the best specs of each fuel, including Cetane, lubricity, low sulfur content and Cloud Point.**
-  **Simple blending, handling and storage.**
-  **Getting more out of their supply of hard-to-find RHD.**

Want to learn more?

REG is a leading producer and supplier of biodiesel and RHD. It also offers RD B5 and RD B20 on the West Coast. Additionally, fuel distributors throughout the country can inquire about buying the fuels from REG and blending them themselves.

For more information, contact **Todd Ellis**, Executive Director, West Region for REG at **(515) 239-8104** or **Todd.Ellis@regi.com**. For more information about REG products and services, visit regi.com/products-services.

