

BIODIESEL AND RENEWABLE DIESEL

USED IN CAT[®] MACHINES

DID YOU KNOW THAT YOUR CAT MACHINE CAN RUN ON BIO-FUELS?

Biodiesel can be used in Cat engines at various blend levels and has been used for over twenty years. Successful use is based on understanding the fuel quality, managing storage and handling appropriately. Biodiesel fuels must comply with industry and/or Caterpillar specifications, as minimum requirements to ensure successful use.

What is Biodiesel and Renewable Diesel?

Biodiesel and Renewable Diesel or Hydrotreated Vegetable Oil (HVO) are renewable fuels that can power diesel engines while reducing the carbon intensity of the engine. Both fuels can be used in engines with no or minimal conversion process.

Biodiesel and Renewable Diesel (HVO) are

made from various vegetable oils, animal fats or used cooking oils. Processing of these feedstocks is different for biodiesel than for HVO resulting for fuels that are readily combustible in diesel engines but of different chemistries. Either fuel can be used at 100 percent (with some limitations for biodiesel) or blended with diesel at various blend levels.



Biodiesel environmental impacts:

- At B100, biodiesel reduce Greenhouse Gas Emissions (GHG) by 45 to 85% on a well to tank basis
- Lowers particulate matter emissions by over 40%.
- Reduces emissions of hydrocarbon by over 60%
- Reduces CO, Polycyclic aromatic hydrocarbons and other emissions. Emissions Reduction effects vary per engine duty cycle.


Renewable Diesel HVO environmental impacts:

- At 100%, HVO reduces GHG by 45 to 85% on a well to tank basis
- Lowers particulate matter emissions by over 30%
- Reduces emissions of carbon monoxide by over 10%
- HVO may reduce nitrogen oxide emissions. Emissions reductions effects vary per engine duty cycle.



- **HVO:** Can be used as replacement for Diesel. Fuel must comply with specification EN 15940.
- **B100:** Can be used as replacement for Diesel under certain conditions. Fuel must comply with ASTM D6751; EN 14214 and Cat specifications and managed appropriately.

B100 Biodiesel & HVO Renewable Diesel use:

| | Biodiesel (FAME) | Hydrotreated Vegetable Oil (HVO) (Renewable Diesel) |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Source | Vegetable oils and fats | Vegetable oils and fats |
| Process | Transesterification | Hydrotreating |
| Chemistry | Oxygenated, ester  Fatty Acid Methyl Ester | Non-oxygenated, paraffin n - Paraffin $\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_3$ <i>n - Decane C₁₀H₂₂</i> |
| Replacement for diesel? | Yes, with some cautions | Yes |
| Specifications | ASTM D6751, EN 14214, Cat Spec | EN 15940* |

*: HVO is per diesel specifications except for density.

Biodiesel has lower energy content than diesel fuel due to its oxygen content. Typically, the loss of power output is measurable and can reach 8% at B100.

Lessons from successful usage of biodiesel including high blend levels



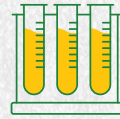
Quality control of the fuel – Per spec fuels



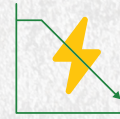
Tank/storage management – temperature control, water ingress prevention and age control



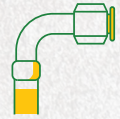
Filter plugging and Cloud point management



Management of oil drain intervals – implement an oil testing program for blends higher than B20



Understanding impact on power output: higher blends result in reduced engine power output



Materials compatibility – use appropriate hoses and elastomers materials

Guidance and details of operational recommendations are provided in Caterpillar publications.

Biodiesel

Most common blends:

B5 5% biodiesel + 95% diesel fuel (by volume). Any diesel fuel and in Europe can be B5. This is considered drop-in replacement for diesel in any Cat engine. B5 is per typical diesel fuel specifications.

B20 20% biodiesel + 80% diesel fuel. This is a common blend level and majority of Caterpillar engines can run successfully on per-spec B20 that is managed appropriately.

B100 100% Biodiesel. This is applicable in some Cat engines that are Tier III or prior. B100 has to be per specifications and has to be managed for aging and other aspects to ensure successful application in engines.

✓ **HVO fuels can be used at 100% or as blend levels.**

✓ **Biodiesel and HVO can be mixed, together and with diesel.**

For more details, talk to your Finning Representative today