Theoretical Yield of Renewable Diesel from Camelina

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Date: 5 July 2017

Pathway: Veg Oil Renewable Diesel
- Renewable diesel produced from camelina oil through hydrotreating process

Renewable Diesel Yield
Vegetable oils and fats are composed of triglyceride molecules with its arms varying in chain length and saturation. Renewable diesel (RD) is formed by breaking the propane knuckle from the triglyceride molecule, removing the oxygen and adding sufficient hydrogen to replace broken bonds as well as saturating the produced alkane chains. The composition of feedstock provides the basis for an upper limit of the yield of renewable diesel referred to as the theoretical yield (Table 1).

Two reaction routes, hydro-deoxygenation and decarboxylation, affect the yield and hydrogen use rates. The former route involves conversion of triglyceride-bound oxygen into water.

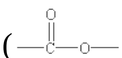
Decarboxylation involves breaking the three ester groups () from triglyceride and converting them into CO_2 instead of removing oxygens as water. This reduces the hydrogen demand of the process but also removes a carbon from the alkane chain. Thus, decreasing the RD yield due to reduced alkane chain length.

Table 1. Theoretical yield of products from hydrotreating of camelina oil using different fate/chemical pathways.

Feedstock		**Camelina Oil**[*]	
Molecular weight (MW, F)	g/mol	902.7	
Hydrotreating fate		Hydro-deoxygenation	Decarboxylation
Propane	g/mol	44	44
RD (includes RN)[**]	g/mol	785	743
Carbon oxides as CO_2	g/mol	0	132
H_2O	g/mol	108	0
H_2 demand	g/mol	35	16
Yield (RD + RN)[**]		0.870	0.823
Allocation factor[***]	Energy basis	94.8%	94.5%
H_2 demand[**]	Btu/lb, LHV	1,944 - 2,187	937 - 1,126

[*]Toncea, I., Necseriu, D., Prisecaru, T., Balint, L. N., Ghilvacs, M. I., & Popa, M. (2013). The seed's and oil composition of Camelia - first romanian cultivar of camelina (Camelina sativa, L. Crantz). *Romanian Biotechnological Letters*, *18*(5), 8594–8602.

[**]*Some of the RD alkane chains can be broken into smaller alkane chains to co-produce renewable naphtha (RN). Breaking additional bonds to produce RN requires additional hydrogen to replace the broken bonds, thereby increasing the hydrogen demand.*

[***]$Energy\ based\ Allocation\ factor = \frac{\frac{RD}{MW,F} \times LHV_{RD+RN}}{\frac{RD}{MW,F} \times LHV_{RD+RN} + \frac{Propane}{MW,F} \times LHV_{Propane}}$

