3rd Generation green fuels via hydrogenation of microalgae oil

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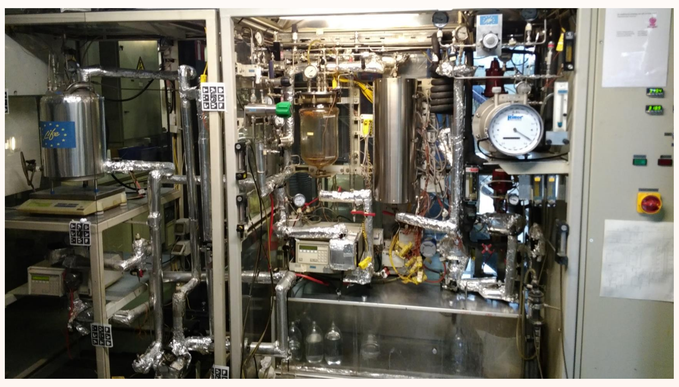
Introduction

- Bio-based fuels are considered sustainable and constitute key alternatives to fossil-derived fuels.
- The main target of the current research is to investigate and optimize the hydrotreatment process of microalgae oil to 3rd generation green transportation fuels (diesel) based on fuel quality and process performance in terms of hydrogen consumption and product yields.
- All Hydrotreating experiments performed in a TRL 3 continuous flow, pilot-scale hydroprocessing plant VB01 of the Chemical Process & Energy Resources Institute (CPERI) of the Center for Research and Technology Hellas (CERTH).
- A commercial hydrotreating catalyst NiMo/Al_2O_3 was employed.
- The effect of temperature and pressure in hydrotreating process of microalgae oil from C. Vulgaris was investigated



Picture: TRL 3 Hydrotreating unit

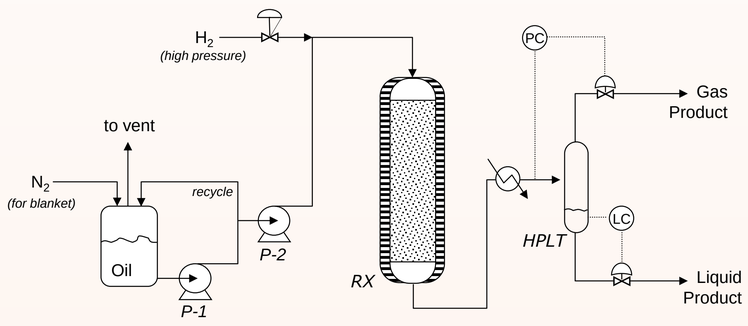


Table 1: Operating hydrotreating window tested

Parameters	Units	Cond. 1	Cond. 2	Cond. 3	Cond. 4
Temperature	°C	300	330	360	360
Pressure	psi	1200	1200	1200	2000
H2/Oil ratio	scfb	3000	3000	3000	3000
LHSV	hr^{-1}	1	1	1	1

Results & Discussion

- Diesel range hydrocarbons were produced in all examined operating conditions (Figure 1)
- Temperature and pressure do not affect the mass recovery curve of the products (Figure 1)
- Product are characterized by high HHV and cetane index (Table 2)

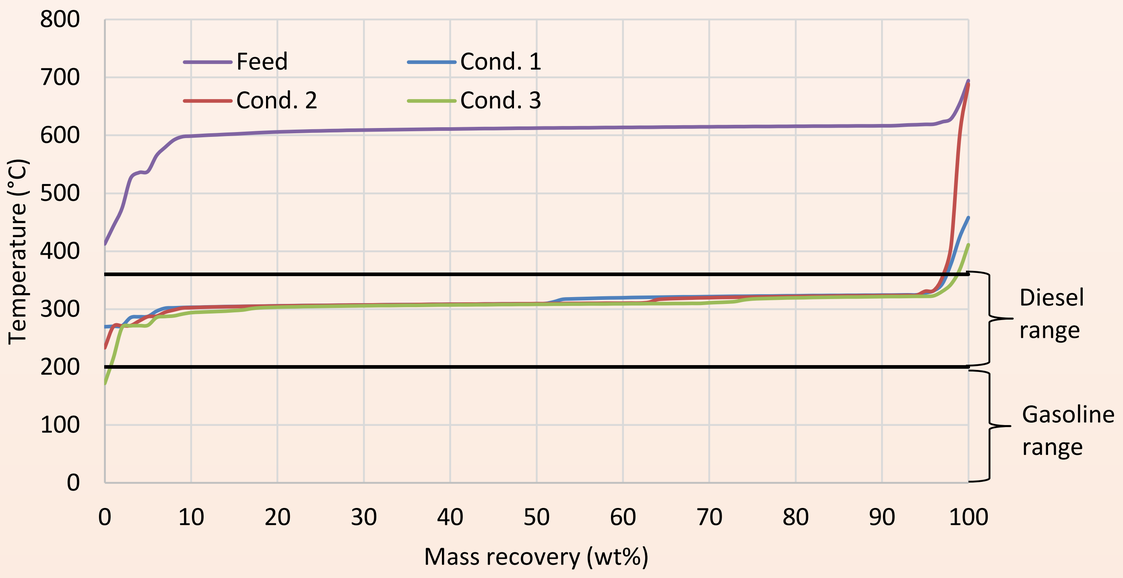


Figure 1: Mass recovery curve from both feed and products

Table 2: Feed and products properties

Parameters	Units	Feed	Cond. 1	Cond. 2	Cond. 3	Cond. 4
Density at 15°C	gr/ml	0.9201	0.7877	0.7874	0.7868	0.7872
S on dry basis	wt%	1.68	0.01	0.00	0.00	0.00
H on dry basis	wt%	11.31	14.85	14.82	14.91	15.06
C on dry basis	wt%	74.86	83.70	85.15	85.00	84.91
O on dry basis	wt%	12.08	1.44	0.03	0.09	0.03
Aqueous phase	v/v%	-	5.89	5.51	3.48	3.57
Pour point	°C	-21	24	21	18	21
Cetane index	-	-	78.17	78.17	78.43	78.6
HHV	MJ/kg	38.38	46.57	47.18	47.23	47.38

Based on the liquid product elemental composition and gas product chromatograph analysis the oxygen balance and distribution was performed.

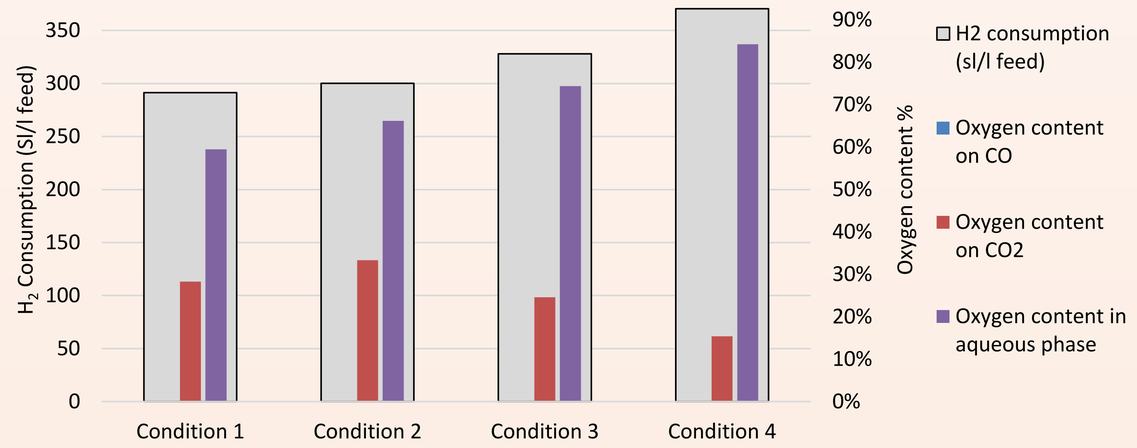


Figure 2: Oxygen distribution in HDT products

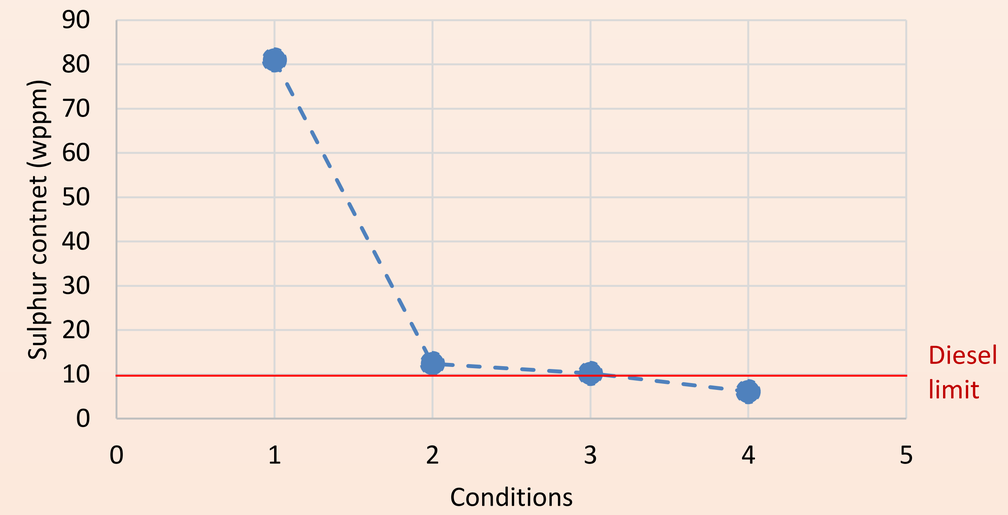


Figure 3: Sulphur content in organic liquid product

Optimum condition is No. 2 as the sulphur content is close to diesel max limit (10 wppm) and most of the oxygen was removed via hydrodeoxygenation reactions without too high hydrogen consumption

Conclusions

- Diesel range HC can be produced with high HHV and cetane index
- Temperature and pressure do not influence the mass recovery curve
- Optimum hydrotreating condition was found at 330°C, 1200 psi, 3000 scfb and $1hr^{-1}$
- Hydrotreating totally removed the oxygenates from the microalgae oil via hydrodeoxygenation reactions

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