Available online at www.sciencedirect.com

ScienceDirect

Proceedings of the Combustion Institute 38 (2021) 5923–5931

Proceedings of the Combustion Institute

www.elsevier.com/locate/proci

# Effect of flash boiling injection on combustion and PN emissions of DISI optical engine fueled with butanol isomers/TPRF blends ☆

Mohamed Nour [a,b], Zhe Sun [a], Mingli Cui [a], Shangze Yang [a], David Hung [a,c], Xuesong Li [a,*], Min Xu [a]

[a] *School of Mechanical Engineering, Shanghai Jiao Tong University, Dongchuan Road 800, Shanghai 200240, China*
[b] *Mechanical Engineering Department, Benha Faculty of Engineering, Benha University, Benha 13512, Egypt*
[c] *University of Michigan-Shanghai Jiao Tong University Joint Institute, Shanghai Jiao Tong University, Dongchuan Road 800, Shanghai 200240, China*

Received 7 November 2019; accepted 14 October 2020
Available online 1 November 2020

**Abstract**

Direct injection spark ignition (DISI) engines have been widely used in passenger cars due to their lower fuel consumption, better controllability, and high efficiency. However, DISI engines are suffering from wall wetting, imperfect mixture formation, excess soot emissions, and cyclic variations. Applying a new fuel atomization technique and using biofuels with their distinctive properties can potentially aid in improving DISI engines. In this research, the effects of isobutanol and 2-butanol and their blends with Toluene Primary Reference Fuel (TPRF) on spray characteristics, DISI engine combustion, and particle number (PN) emissions are investigated for conditions with and without flash boiling of the injected fuel. Spray characteristics are investigated using a constant volume chamber. Then, the combustion, flame propagation, and PN emissions are examined using an optical DISI engine. The fuel temperature is set to 298 K and 453 K for liquid injection and flash boiling injection, respectively. The tested blending ratio is 30 vol% butanol isomers and 70 vol% TPRF. The results of the spray test reveal that liquid fuel plumes are distinctly observed, and butanol blends show a slightly wider spray angle with lower penetration length compared to TPRF. However, under flash boiling injection, the sprays collapse towards the injector axis, forming a more extended single central vapor jet due to the plumes' interaction. Meanwhile, butanol blends yield a narrow spray angle with more extended penetration compared to TPRF. The flame visualization test shows that the flash boiling injection reduced yellow flames compared to liquid fuel injection, reflecting the improvements in mixture formation. Thus, improvements were noted in the heat release and PN emissions. Butanol addition reduced the PN emissions

☆ Colloquium: RECIPROCATING INTERNAL COMBUSTION ENGINES.

* Corresponding author.
*E-mail address:* xuesonl@sjtu.edu.cn (X. Li).

https://doi.org/10.1016/j.proci.2020.10.006