**Explosion Parameters of Hydrocarbons from Fischer-Tropsch Synthesis**

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**Highlights**

* Explosion parameters of HCs from F-T synthesis for the first time.
* Preliminary investigation in the 20-L vessel before being scaled-up to 1.00 m3.
* Comparison with pure HCs.

**1. Introduction**

Nowadays there is a worldwide demand to develop energy efficient and economical processes for sustainable production of alternative chemical compounds and fuels as a substitute for those emerging from petroleum [1]. Small-scale characterisation in the liquid phase towards understanding explosion deflagration over a range of fuel concentrations, temperatures and pressures has been published limitedly [2-6].  In comparison with the pure liquid-fuels for the more complex mixtures, no studies are available. The present paper describes a series of preliminary experiments performed to study the explosion parameters of complex hydrocarbons (HCs) fuel produced from micro-scale Fischer-Tropsch Synthesis (FTS). Such metodology allows rigorous insightful chemical interpretation of well-defined sample and deeper experimental view into a chemical explosion problem. The results could be in the future used to evaluate mass burning rate and flame development duration and combustion duration.

**2. Methods**

A micro-scale FT plant with fixed bed reactor was designed and used at ERC, VŠB-TU of Ostrava to study the production of liquid hydrocarbons over Co-based FT catalysts. A simulated N2-rich syngas (containing: H2, CO and N2) was used to feed into the reactor inlet for the production of synthetic liquid hydrocarbon fuels. The liquid hydrocarbon products were analyzed off-line using a DB1 column combined with a gas chromatography-mass spectrometry (GC–MS) PerkinElmer. These products include light hydrocarbons (C1 and C2), olefins, LPG (C3-C4), naphtha (C5-C11), diesel (C12-C20) and wax (>C20) fractions. Explosion parameters values of the pure liquids and the mixtures were determined experimentally according to the EN 15967:2011. The 0.02 m3 oil-heated spherical vessel setup was used to record pressure-time curves. The 0.02 m3 apparatus incorporated a digitally adjustable external control device Presto A30 (SN: 10291377, JULABO GmbH, Seelbach, Germany).  The dynamic pressure in the vessel was measured by a pair of quartz pressure sensors (SN: 4512821 and SN: 4512822, model 701A, Kistler, Winterthur, Switzerland) and recorded with a charge amplifier (Kistler, model 5041E0). Programmable logic controller (model 5073A211 in 0.02 m3, Siemens, Munich, Germany) connected to a PC was used with the interface (PROMOTIC system, MICROSYS, spol. s.r.o., Ostrava, Czech Republic) to automatically control the whole testing procedure.

**3. Results and discussion**

Figure 1 plot examples of the normalized explosion pressure, pmax/p0, versus the concentration for FT–air mixtures. The normalized explosion pressures were obtained at initial temperature (78 °C). The maximum value of explosion pressure and the deflagration index were found at the concentration close to 12 vol. %. The shape of the explosion pressure versus concentration show a reasonable agreement with the previous studies [2-6] with the exception for the explosion pressure difference between the lower/upper explosion limit and its subsequent concentration. As compared with the published experimental results, the presented values sharply drop to zero from 4.8 bar and 5.8 bar, respectively. Such a behaviour involves the lower ignitability in comparison with the pure liquid-fuels. The described behaviour needs more rigorous experimental investigation from the chemical point of view to elucidate the possible mechanisms of action behind the presented experiments.



**Figure 1.** The explosion pressure and the deflagration index at different concentrations.

**4. Conclusions**

The explosion pressure pexp and and the deflagration index KG, were examined on the basis of combustion pressure history and compared with the pure liquid-fuels.

1. Explosion pressure and deflagration index of the F-T mixture reach maximum values at the stoichiometric concentration C = 12.0 vol. % within the studied range from 5.0 to 18.0 vol. % at representative initial temperature of 78 °C and initial pressure of 101 kPa.
2. The maximum explosion pressure, pmax, was determined as the highest pex found for the mixture compositions investigated and is equal to 7.9 ± 0.2 bar.
3. The deflagration index was calculated from the experimentally determined (dp/dt)max value and is equal to 122 ± 10 bar.m/s.

**References**

1. Q. Li; Y. Cheng; Z. Huang *J. Loss Prev. Proc.* **2015**, *37*, 91–100.
2. Q. Li; Y. Cheng; W. Jin; Z. Huang *Fuel* **2015**, *161*, 78–86.
3. M. Mitu; E. Brandes *Fuel* **2015**, *158*, 217–223.
4. M. Mitu; E. Brandes *Fuel* **2017**, *203*, 460–468.
5. M. Mitu; E. Brandes; W. Hirsch *Process Saf. Environ. Prot.* **2018**, *117*, 190–199.
6. J. Skrinsky ; T. Ochodek, *Energies* **2019**, *12*(8), 1574.