Supercritical Fuel Pyrolysis

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Supercritical Conditions for Fuels in Next-Generation High-Speed Aircraft

FUEL USED AS A COOLING AGENT IN HIGH-SPEED AIRCRAFT

HIGH PRESSURES AND HIGH TEMPERATURES SUSTAINED IN THE FUEL LINES

PYROLYTIC REACTIONS PRODUCE POLYCYCLIC AROMATIC HYDROCARBONS (PAH), PRECURSORS TO CARBONACEOUS SOLID DEPOSITS

TO UNDERSTAND THE REACTION CHEMISTRY, SUPERCritical PYROLYSIS EXPERIMENTS ARE PERFORMED WITH MODEL FUELS
Model Fuels

\( n \)-Decane

\[ T_c = 345 \, ^\circ C \]
\[ P_c = 21 \, \text{atm} \]

1-Methylnaphthalene

\[ T_c = 499 \, ^\circ C \]
\[ P_c = 36 \, \text{atm} \]

Toluene

\[ T_c = 319 \, ^\circ C \]
\[ P_c = 41 \, \text{atm} \]
Model Fuels

\[ n\text{-Decane} \]

\[ \text{98} - 105 \text{ kcal/mol} \]

\[ 86.1 - 87.5 \text{ kcal/mol} \]

\[ 102.0 \text{ kcal/mol} \]

\[ 88.5 \text{ kcal/mol} \]

1-Methylnaphthalene

\[ 85.1 \text{ kcal/mol} \]

\[ 103.8 \text{ kcal/mol} \]

\[ 112.2 \text{ kcal/mol} \]

\[ 122.3 \text{ kcal/mol} \]

Toluene

\[ 88.5 \text{ kcal/mol} \]

\[ 102.0 \text{ kcal/mol} \]

\[ 112.9 \text{ kcal/mol} \]

\[ 122.3 \text{ kcal/mol} \]
Supercritical Fuel Pyrolysis Reactor System

- Fuel Spargge Vessel
- High-Pressure Pump
- Pressure Transducers
- Filter
- Back-Pressure Regulator
- Heat Exchanger
- Reactor Coil
- Fluidized Alumina Bath
- Furnace
- Gas-Phase Product Collection
- Liquid-Phase Product Collection
Summary and Conclusions

Supercritical $n$-decane pyrolysis experiments conducted at 100 atm, 133 sec, and at six temperatures from 530 to 570 °C. PAH products analyzed by HPLC.

The majority of the aromatic products of supercritical $n$-decane pyrolysis are methylated one- and two-ring aromatics, but PAH of up to nine rings are also produced at conditions corresponding to incipient solids formation.

Many of the identified PAH products of supercritical $n$-decane pyrolysis can be formed by the mechanisms that are also responsible for PAH formation during supercritical toluene or 1-methylnaphthalene pyrolysis. These mechanisms involve the addition of an $n$-ring aromatic and an $m$-ring aromatic to produce a PAH of $n + m + 1$ aromatic rings.

However, many of the PAH products of supercritical $n$-decane pyrolysis—particularly the large-ring-number, peri-condensed PAH that are the immediate precursors to the solids—cannot be accounted for by the mechanisms above. Determining the reaction pathways responsible for the formation of these PAH is a primary focus of future work.
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