ETHYLENE OXIDE AS A MONOPROPELLANT

William Clay Robison

Daniel and Florence Guggenheim Jet Propulsion Center
California Institute of Technology
Pasadena, California

Thermodynamic calculations to determine the theoretical performance of ethylene oxide as a monopropellant have been carried out for various possible decomposition reactions. The performance calculations were carried out, by using standard evaluation procedures (1), for two possible exothermic decomposition reactions, one of which leads to the formation of CO and CH₄, whereas the other leads to the production of CO, C, and H₂. For the process leading to carbon formation, two limiting cases were considered, viz., (a) no slippage between the carbon particles and the gases during expansion with thermodynamic equilibrium being maintained at all times, and (b) complete deposition of carbon in the combustion chamber. The results of calculations, for a chamber to exit pressure ratio of 20.42:1 and injection of the liquid monopropellant at its normal boiling point of 10.7°C, are summarized in Table I, where T_c and T_e denote the adiabatic flame temperature and the nozzle exhaust temperature, respectively, c* is the characteristic gas velocity, C_f represents the nozzle thrust coefficient, and lsp denotes the specific impulse.

The factors leading to carbon formation in combustion are not

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2 Lt., U. S. Navy. This letter is abstracted from a thesis submitted to the graduate school of the California Institute of Technology, in partial fulfillment of requirements for the degree of Aeronautical Engineer, June 1953. Details concerning the work described in this letter may be found in the thesis.

Table I. Summary of Performance Calculations for \( \text{C}_2\text{H}_4\text{O} \) Monopropellant

<table>
<thead>
<tr>
<th>Decomposition Reaction</th>
<th>( T_c (\text{K}) )</th>
<th>( T_e (\text{K}) )</th>
<th>( c^\circ (\text{m/sec}) )</th>
<th>( C_f )</th>
<th>( I_{sp} (\text{sec}) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \text{C}_2\text{H}_4\text{O} = \text{CO} + \text{CH}_4 )</td>
<td>1430</td>
<td>908</td>
<td>1230</td>
<td>1.295</td>
<td>162.2</td>
</tr>
<tr>
<td>( \text{C}_2\text{H}_4\text{O} = \text{CO} + 2\text{H}_2 + \text{C} ) (carbon in equilibrium with gas)</td>
<td>638</td>
<td>304</td>
<td>891</td>
<td>1.400</td>
<td>127.6</td>
</tr>
<tr>
<td>( \text{C}_2\text{H}_4\text{O} = \text{CO} + 2\text{H}_2 + \text{C} ) (carbon deposited in rocket chamber)</td>
<td>638</td>
<td>270</td>
<td>1025</td>
<td>1.385</td>
<td>105.4</td>
</tr>
</tbody>
</table>

Clearly understood although a considerable amount of work has been done on this subject in recent years. An extensive literature survey on the kinetics of ethylene oxide decomposition has been carried out. The results of this study are summarized in the thesis from which this letter is abstracted.