NUMERICAL INVESTIGATION ON PERFORMANCE AND EMISSIONS CHARACTERISTICS IN HOMOGENEOUS CHARGE COMPRESSION IGNITION ENGINE

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LIST OF SYMBOLS

a Crank radius
A Pre-exponential term
b Temperature dependent exponent
B Bore
c Half event angle
D Inner seat diameter
dQ Heat release dependent on the variation of crank angle \( d\theta \)
dV Variation of cylinder volume
i Mass fraction of species
j Number of flows in or out of the system
k Reaction rate co-efficient
l Connecting rod length
L Stroke length
m Total mass in the system
N Engine speed
p In-cylinder pressure
R Ratio of connecting rod length
s Distance between crank axis and piston pin axis
U Internal energy
V Instantaneous cylinder volume
W Work
y Valve profile
\( \gamma \) Ratio of specific heats
\( \kappa \) Ratio of specific heat values
\( \tau \)  Indicated torque
\( \Phi \)  Equivalence ratio
\( \omega \)  Rotational speed
\( A_c \)  Effective valve open area
\( A_p \)  Piston area
\( A_w \)  Wall area
\( C_d \)  Discharge co-efficient
\( D_s \)  Valve stem diameter
\( D_v \)  Valve head diameter
\( E_A \)  Activation energy
\( h_c \)  Heat transfer coefficient
\( H_f \)  Enthalpy of flows entering or leaving the system
\( L_v \)  Valve lift
\( p_0 \)  Upstream stagnation pressure
\( p_T \)  Downstream static pressure
\( Q_h \)  Heat transfer
\( R_c \)  Compression ratio
\( R_u \)  Universal gas constant
\( S_p \)  Instantaneous piston speed
\( S_w \)  Valve seat width
\( t_0 \)  Upstream stagnation temperature
\( T_w \)  Wall temperature
\( V_c \)  Clearance volume
\( V_d \)  Displacement volume
\( W_{mv} \)  Mean molecular weight of the mixture
\( W_{net} \) Net work done

\( Y_{in} \) Inlet mass fraction

\( \eta_{th} \) Ratio of energy

\( \omega_i \) Mass reaction rate of the species \( i \)
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>AC</td>
<td>Air cooled</td>
</tr>
<tr>
<td>AFR</td>
<td>Air fuel ratio</td>
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<tr>
<td>ASTM</td>
<td>American society for testing and materials</td>
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<tr>
<td>ATDC</td>
<td>After top dead center</td>
</tr>
<tr>
<td>BDC</td>
<td>Bottom dead center</td>
</tr>
<tr>
<td>BSFC</td>
<td>Brake specific fuel consumption</td>
</tr>
<tr>
<td>BTDC</td>
<td>Before top dead center</td>
</tr>
<tr>
<td>BTE</td>
<td>Brake thermal efficiency</td>
</tr>
<tr>
<td>CA</td>
<td>Crank angle</td>
</tr>
<tr>
<td>CFD</td>
<td>Computational fluid dynamics</td>
</tr>
<tr>
<td>CFR</td>
<td>Co-operative fuel research</td>
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<tr>
<td>CI</td>
<td>Compression ignition</td>
</tr>
<tr>
<td>CO</td>
<td>Carbon monoxide</td>
</tr>
<tr>
<td>CPU</td>
<td>Central processing unit</td>
</tr>
<tr>
<td>CR</td>
<td>Compression ratio</td>
</tr>
<tr>
<td>DEE</td>
<td>Diethyl ether</td>
</tr>
<tr>
<td>DI</td>
<td>Direct injection</td>
</tr>
<tr>
<td>EGR</td>
<td>Exhaust gas recirculation</td>
</tr>
<tr>
<td>EPA</td>
<td>Environmental protection agency</td>
</tr>
<tr>
<td>EVO</td>
<td>Exhaust valve open</td>
</tr>
<tr>
<td>GDI</td>
<td>Gasoline direct injection</td>
</tr>
<tr>
<td>HC</td>
<td>Hydrocarbon</td>
</tr>
<tr>
<td>HCCI</td>
<td>Homogeneous charge compression ignition</td>
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<td>HCT</td>
<td>Hydrodynamics chemistry and transport</td>
</tr>
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<td>Abbreviation</td>
<td>Definition</td>
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<tr>
<td>HRD</td>
<td>Heat release duration</td>
</tr>
<tr>
<td>HRR</td>
<td>Heat release rate</td>
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<td>HSDI</td>
<td>High speed direct injection</td>
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<td>HTR</td>
<td>High temperature region</td>
</tr>
<tr>
<td>IC</td>
<td>Internal combustion</td>
</tr>
<tr>
<td>IMEP</td>
<td>Indicated mean effective pressure</td>
</tr>
<tr>
<td>IP</td>
<td>Indicated power</td>
</tr>
<tr>
<td>ISFC</td>
<td>Indicated specific fuel consumption</td>
</tr>
<tr>
<td>IT</td>
<td>Indicated torque</td>
</tr>
<tr>
<td>ITE</td>
<td>Indicated thermal efficiency</td>
</tr>
<tr>
<td>IVC</td>
<td>Inlet valve close</td>
</tr>
<tr>
<td>LPG</td>
<td>Liquefied petroleum gas</td>
</tr>
<tr>
<td>LTR</td>
<td>Low temperature region</td>
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<tr>
<td>MCS</td>
<td>Main combustion stage</td>
</tr>
<tr>
<td>NA</td>
<td>Naturally aspirated</td>
</tr>
<tr>
<td>NO</td>
<td>Nitric oxide</td>
</tr>
<tr>
<td>NTC</td>
<td>Negative temperature co-efficient</td>
</tr>
<tr>
<td>OH</td>
<td>Hydroxide</td>
</tr>
<tr>
<td>PCI</td>
<td>Premixed compression ignition</td>
</tr>
<tr>
<td>PCCI</td>
<td>Premixed charge compression ignition</td>
</tr>
<tr>
<td>PFI</td>
<td>Port fuel injection</td>
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<tr>
<td>PM</td>
<td>Particulate matter</td>
</tr>
<tr>
<td>RP</td>
<td>Rated power</td>
</tr>
<tr>
<td>RPM</td>
<td>Revolution per minute</td>
</tr>
<tr>
<td>RS</td>
<td>Rated speed</td>
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</table>
SACI  Spark-assisted compression ignition
SFC   Specific fuel consumption
SI    Spark ignition
SOC   Start of combustion
SOI   Start of ignition
TDC   Top dead center
TRG   Trapped residual gas
UHC   Unburned hydrocarbon
VCR   Variable compression ratio
VGR   Variable geometry turbocharger
WC    Water cooled
CO₂   Carbon dioxide
NO₂   Nitrogen dioxide
4S    Four stroke