## Nomenclature

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta A$, $\Delta B$, $\Delta C$, $\Delta D$</td>
<td>The coefficients for determining the specific heat</td>
</tr>
<tr>
<td>A, B, C, D</td>
<td>Heat capacity constant</td>
</tr>
<tr>
<td>A/F&lt;sub&gt;st&lt;/sub&gt;</td>
<td>Stoichiometric air fuel ratio</td>
</tr>
<tr>
<td>A&lt;sub&gt;n&lt;/sub&gt;</td>
<td>Nozzle flow area (cm$^2$)</td>
</tr>
<tr>
<td>AS</td>
<td>Almond shell</td>
</tr>
<tr>
<td>A&lt;sub&gt;th&lt;/sub&gt;</td>
<td>Throat area (cm$^2$)</td>
</tr>
<tr>
<td>BC</td>
<td>Black coal</td>
</tr>
<tr>
<td>B&lt;sub&gt;g&lt;/sub&gt;</td>
<td>Hearth load (Nm$^3$/h·cm$^2$)</td>
</tr>
<tr>
<td>B&lt;sub&gt;s&lt;/sub&gt;</td>
<td>Hearth load (kg/h·cm$^2$)</td>
</tr>
<tr>
<td>C</td>
<td>Carbon</td>
</tr>
<tr>
<td>C%</td>
<td>Mass fraction of carbon</td>
</tr>
<tr>
<td>CC</td>
<td>Colombian coal</td>
</tr>
<tr>
<td>CGE</td>
<td>Cold gas efficiency (%)</td>
</tr>
<tr>
<td>CH</td>
<td>Chestnut tree</td>
</tr>
<tr>
<td>CH&lt;sub&gt;4&lt;/sub&gt;</td>
<td>Methane</td>
</tr>
<tr>
<td>CHP</td>
<td>Combined heat and power</td>
</tr>
<tr>
<td>CO</td>
<td>Carbon monoxide</td>
</tr>
<tr>
<td>CO&lt;sub&gt;2&lt;/sub&gt;</td>
<td>Carbon dioxide</td>
</tr>
<tr>
<td>Cp</td>
<td>Specific heat at constant pressure (kJ/kmol K)</td>
</tr>
<tr>
<td>C&lt;sub&gt;2&lt;/sub&gt;H&lt;sub&gt;2&lt;/sub&gt;</td>
<td>Acetylene</td>
</tr>
<tr>
<td>C&lt;sub&gt;2&lt;/sub&gt;H&lt;sub&gt;4&lt;/sub&gt;</td>
<td>Ethylene</td>
</tr>
<tr>
<td>C&lt;sub&gt;2&lt;/sub&gt;H&lt;sub&gt;6&lt;/sub&gt;</td>
<td>Ethane</td>
</tr>
<tr>
<td>C&lt;sub&gt;6&lt;/sub&gt;H&lt;sub&gt;6&lt;/sub&gt;</td>
<td>Benzene</td>
</tr>
<tr>
<td>D</td>
<td>Number of data</td>
</tr>
<tr>
<td>d&lt;sub&gt;n&lt;/sub&gt;</td>
<td>Nozzle diameter</td>
</tr>
<tr>
<td>d&lt;sub&gt;nt&lt;/sub&gt;</td>
<td>Nozzle tip ring diameter</td>
</tr>
<tr>
<td>d&lt;sub&gt;p&lt;/sub&gt;</td>
<td>Particle size</td>
</tr>
<tr>
<td>D&lt;sub&gt;shell&lt;/sub&gt;</td>
<td>Hopper diameter</td>
</tr>
<tr>
<td>D&lt;sub&gt;th&lt;/sub&gt;</td>
<td>Throat diameter</td>
</tr>
<tr>
<td>e</td>
<td>Molar quantity of water per kmol of fuel mixture</td>
</tr>
</tbody>
</table>
Specific molar exergy of air

Eucalyptus

Chemical exergy of product gas

Chemical exergy of biomass or coal

Empty brunch fruit

Edible oil wastes

Physical exergy of product gas

Equivalence ratio

Molar quantity of oxygen per kmol of fuel mixture

Fuel/air ratio

Gaseous state

Gas chromatograph

Standard Gibbs function of formation

Heat of formation (kJ/kmol)

Hydrogen (monoatomic)

Mass fraction of hydrogen

Hydrogen (diatomic)

Water

Enthalpy of vaporization of water (kJ/kg)

Higher heating value

Higher heating value of lignite (kJ/kg)

Height of the nozzle plane above throat section

Hopper height

Constant of integration

Constant

Equilibrium constant

Equilibrium constant for Boudouard reaction

Equilibrium constant for methane reaction

Equilibrium constant for steam reforming reaction

Equilibrium constant for water gas reaction

Equilibrium constant for water-gas shift reaction

Liquid state

Lignite consumption rate (kg/hr.)
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LHV</td>
<td>Lower heating value</td>
</tr>
<tr>
<td>LHV&lt;sub&gt;g&lt;/sub&gt;</td>
<td>Lower heating value of producer or syngas (kJ/Nm&lt;sup&gt;3&lt;/sup&gt;)</td>
</tr>
<tr>
<td>LHV&lt;sub&gt;1&lt;/sub&gt;</td>
<td>Lower heating value of lignite (kJ/kg)</td>
</tr>
<tr>
<td>MC</td>
<td>Moisture content</td>
</tr>
<tr>
<td>MHV</td>
<td>Medium heating value</td>
</tr>
<tr>
<td>M&lt;sub&gt;i&lt;/sub&gt;</td>
<td>Molecular weight of species ‘i’ (kg/kmol)</td>
</tr>
<tr>
<td>N</td>
<td>Nitrogen (monoatomic)</td>
</tr>
<tr>
<td>n&lt;sub&gt;air&lt;/sub&gt;</td>
<td>Molar amount of air</td>
</tr>
<tr>
<td>N&lt;sub&gt;%&lt;/sub&gt;</td>
<td>Mass fraction of nitrogen</td>
</tr>
<tr>
<td>N&lt;sub&gt;2&lt;/sub&gt;</td>
<td>Nitrogen (diatomic)</td>
</tr>
<tr>
<td>n&lt;sub&gt;gas&lt;/sub&gt;</td>
<td>Molar amount of product gas</td>
</tr>
<tr>
<td>N&lt;sub&gt;n&lt;/sub&gt;</td>
<td>Number of nozzle</td>
</tr>
<tr>
<td>NOx</td>
<td>Nitrogen oxides</td>
</tr>
<tr>
<td>n&lt;sub&gt;1&lt;/sub&gt;</td>
<td>Mole of CO per mole of fuel mixture</td>
</tr>
<tr>
<td>n&lt;sub&gt;2&lt;/sub&gt;</td>
<td>Mole of CO&lt;sub&gt;2&lt;/sub&gt; per mole of fuel mixture</td>
</tr>
<tr>
<td>n&lt;sub&gt;3&lt;/sub&gt;</td>
<td>Mole of H&lt;sub&gt;2&lt;/sub&gt; per mole of fuel mixture</td>
</tr>
<tr>
<td>n&lt;sub&gt;4&lt;/sub&gt;</td>
<td>Mole of H&lt;sub&gt;2&lt;/sub&gt;O per mole of fuel mixture</td>
</tr>
<tr>
<td>n&lt;sub&gt;5&lt;/sub&gt;</td>
<td>Mole of CH&lt;sub&gt;4&lt;/sub&gt; per mole of fuel mixture</td>
</tr>
<tr>
<td>n&lt;sub&gt;6&lt;/sub&gt;</td>
<td>Mole of N&lt;sub&gt;2&lt;/sub&gt; per mole of fuel mixture</td>
</tr>
<tr>
<td>O</td>
<td>Oxygen (monoatomic)</td>
</tr>
<tr>
<td>O&lt;sub&gt;%&lt;/sub&gt;</td>
<td>Mass fraction of oxygen</td>
</tr>
<tr>
<td>OP</td>
<td>Olive pulp</td>
</tr>
<tr>
<td>OS</td>
<td>Olive stone</td>
</tr>
<tr>
<td>P</td>
<td>Pressure</td>
</tr>
<tr>
<td>PC</td>
<td>Puertollano coal</td>
</tr>
<tr>
<td>P&lt;sub&gt;g&lt;/sub&gt;</td>
<td>Thermal power available at gasifier outlet (kW)</td>
</tr>
<tr>
<td>P&lt;sub&gt;m&lt;/sub&gt;</td>
<td>Engine power (kW)</td>
</tr>
<tr>
<td>PS</td>
<td>Pine sawdust</td>
</tr>
<tr>
<td>P&lt;sub&gt;t&lt;/sub&gt;</td>
<td>Thermal input at gasifier inlet (kW)</td>
</tr>
<tr>
<td>Q&lt;sub&gt;air&lt;/sub&gt;</td>
<td>Air flow rate (m&lt;sup&gt;3&lt;/sup&gt;/hr)</td>
</tr>
<tr>
<td>Q&lt;sub&gt;gen&lt;/sub&gt;</td>
<td>Gas generation rate (Nm&lt;sup&gt;3&lt;/sup&gt;/hr.)</td>
</tr>
<tr>
<td>Q&lt;sub&gt;loss&lt;/sub&gt;</td>
<td>Heat loss from gasifier</td>
</tr>
<tr>
<td>RDF</td>
<td>Refused derived fuel</td>
</tr>
</tbody>
</table>
RMS  Root mean square
Ra  Universal gas constant
SC  Sabero coal
SGR  Specific gasification rate (Nm$^3$/h-cm$^2$)
SOx  Sulfur oxides
SSR  Specific solid flow rate
T  Temperature
T$_0$  Reference temperature (298.15 K)
T$_{av}$  Arithmetic mean temperature
V$_a$  Air velocity (m/s)
V$_{ab}$  Air blast velocity (m/s)
WC  The mass based water content of the fuel mixture
W/L  Wood-lignite ratio

Greek symbols
\( \alpha \)  Actual mole of carbon participating in equilibrium reactions per mole of fuel mixture
\( \eta \)  Efficiency
\( \psi \)  Exergy efficiency

Subscripts
\( a \)  Number of hydrogen atoms per carbon atom in fuel mixture
\( b \)  Number of oxygen atoms per carbon atom in fuel mixture
\( c \)  Number of nitrogen atoms per carbon atom in fuel mixture
\( fm \)  Fuel mixture
\( cg \)  Cold gas
\( g \)  Gasifier
\( en \)  Engine