## SMR, ATR and POX processes for syngas production

### Notes:
- In the SMR the air/fuel combustion reaction takes place in a separate part of the process to the reforming reaction.
- SMR may alternatively be side-fired or upwards-fired.
- Shaded area denotes catalyst bed.

### Process Details

<table>
<thead>
<tr>
<th>Process</th>
<th>Steam Methane Reforming – SMR</th>
<th>Auto Thermal Reforming – ATR (Oxidative Steam Reforming)</th>
<th>Partial Oxidation – POX (Gasification)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon feedstock</td>
<td>Natural gas, refinery gas or naphtha</td>
<td>Natural gas or light gaseous hydrocarbons</td>
<td>Gaseous, liquid or solid hydrocarbons</td>
</tr>
<tr>
<td>Oxygen feedstock</td>
<td>Air for fuel combustion to heat the process (not used for hydrogen generation in the SMR reactor tubes)</td>
<td>Oxygen from ASU fed with controlled stoichiometry to limit CO₂ generation</td>
<td>Oxygen from ASU fed with controlled stoichiometry to limit CO₂ generation</td>
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<tr>
<td>Steam feedstock</td>
<td>Yes</td>
<td>Yes, often from combined SMR</td>
<td>No</td>
</tr>
<tr>
<td>Catalyst required</td>
<td>Yes, Nickel</td>
<td>Yes, Nickel, Cobalt and others</td>
<td>Not for thermal POX</td>
</tr>
<tr>
<td>Target chemical reactions</td>
<td>CH₄ + H₂O → CO + 3H₂</td>
<td>CH₄ + H₂O → CO + 3H₂, 2CH₄ + O₂ → 2CO + 4H₂</td>
<td>2CH₄ + O₂ → 2CO + 4H₂</td>
</tr>
<tr>
<td>Additional side reactions</td>
<td>CO + H₂O → CO₂ + H₂</td>
<td>CH₄ + O₂ → CO₂ + 2H₂</td>
<td>CH₄ + O₂ → CO₂ + 2H₂</td>
</tr>
<tr>
<td>Energy required/released</td>
<td>Endothermic, requires heat input</td>
<td>Balance of endothermic and exothermic</td>
<td>Exothermic, releases heat for steam</td>
</tr>
<tr>
<td>Hydrogen content in syngas</td>
<td>~70%</td>
<td>~65%</td>
<td>~60%</td>
</tr>
<tr>
<td>Syngas pressure</td>
<td>15 to 40 bar</td>
<td>30 to 50 bar</td>
<td>40 to 80 bar</td>
</tr>
<tr>
<td>Syngas temperature</td>
<td>850 °C</td>
<td>1000 °C</td>
<td>1400 °C</td>
</tr>
</tbody>
</table>