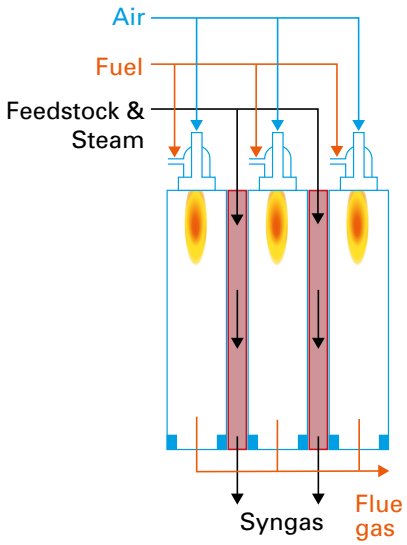
# SMR, ATR, POX and GHR processes for syngas production

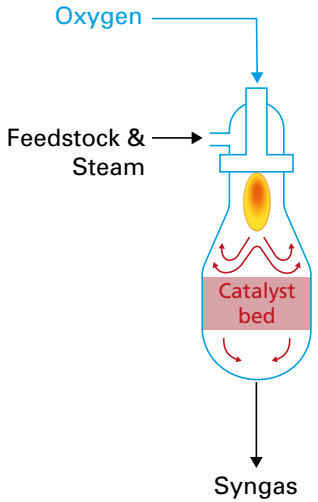
sbh4 consulting

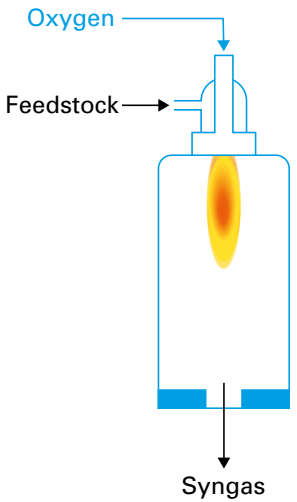
**Notes:**

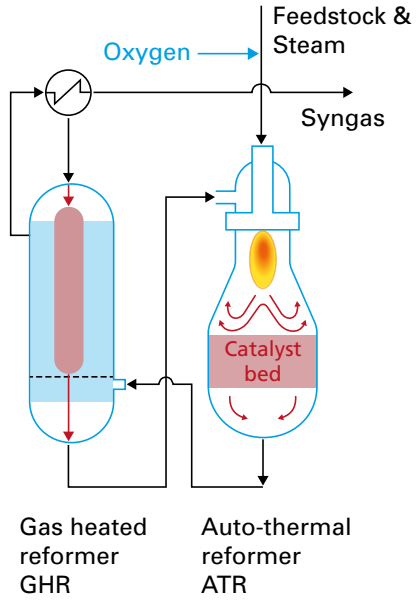
- In the SMR the air/fuel combustion reaction takes place in a separate part of the process to the reforming reaction
- SMR may alternatively be side-fired or upwards-fired
- Shaded area denotes catalyst bed
- GHR may be combined with POX instead of ATR






| Process | Steam Methane Reforming – SMR | Auto Thermal Reforming – ATR (Oxidative Steam Reforming) | Partial Oxidation – POX (Gasification) | Gas Heated Reactor (GHR) |
|---|---|---|---|---|
| Carbon feedstock | Natural gas, refinery gas or naphtha | Natural gas or light gaseous hydrocarbons | Gaseous, liquid or solid hydro-carbons | Natural gas or light gaseous hydrocarbons |
| Oxygen feedstock | Air for fuel combustion to heat the process (not used for hyd-rogen generation in the SMR reactor tubes) | Oxygen from ASU fed with controlled stoichiometry to limit $CO_2$ generation | Oxygen from ASU fed with controlled stoichiometry to limit $CO_2$ generation | Oxygen from ASU fed with controlled stoichiometry to limit $CO_2$ generation |
| Steam feedstock | Yes | Yes, often from combined SMR | No | Yes |
| Catalyst required | Yes, Nickel | Yes, Nickel, Cobalt and others | Not for thermal POX | Yes, Nickel, Cobalt and others |
| Target chemical reactions | $CH4 + H_2O \rightarrow CO + 3H_2$ | $CH_4 + H_2O \rightarrow CO + 3H_2$<br>$2CH_4 + O_2 \rightarrow 2CO + 4H_2$ | $2CH_4 + O_2 \rightarrow 2CO + 4H_2$ | $CH_4 + H_2O \rightarrow CO + 3H_2$<br>$2CH_4 + O_2 \rightarrow 2CO + 4H_2$ |
| Additional side reactions | $CO + H_2O \rightarrow CO_2 + H_2$ | $CH_4 + O_2 \rightarrow CO_2 + 2H_2$ | $CH_4 + O_2 \rightarrow CO_2 + 2H_2$ | $CH_4 + O_2 \rightarrow CO_2 + 2H_2$ |
| Energy required/released | Endothermic, requires heat in-put | Balance of endothermic and exothermic | Exothermic, releases heat for steam | Balance of endothermic and exothermic |
| Hydrogen content in syngas | ~70% | ~65% | ~60% | ~65% |
| Syngas pressure | 15 to 40 bar | 30 to 50 bar | 40 to 80 bar | 30 to 50 bar |
| Syngas temperature | 850 °C | 1000 °C | 1400 °C | 1000 °C |