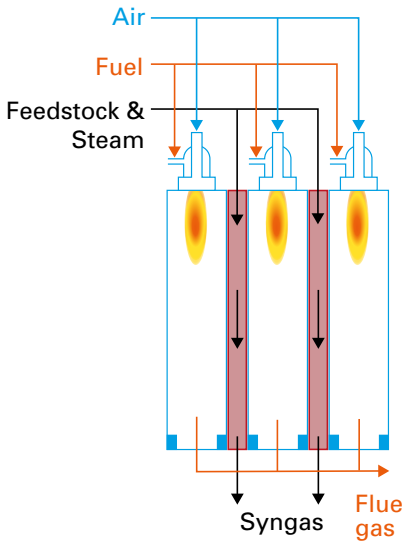
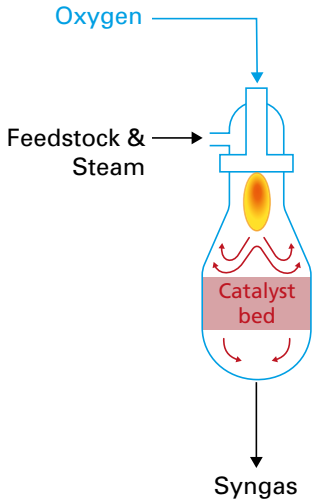
SMR, ATR, POX and GHR processes for syngas production

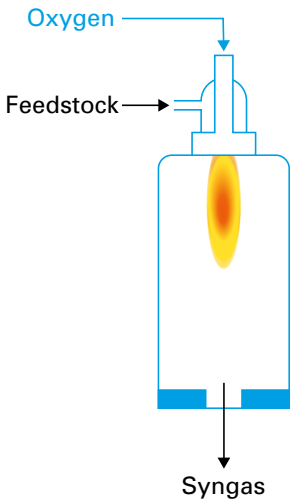
sbh4 consulting

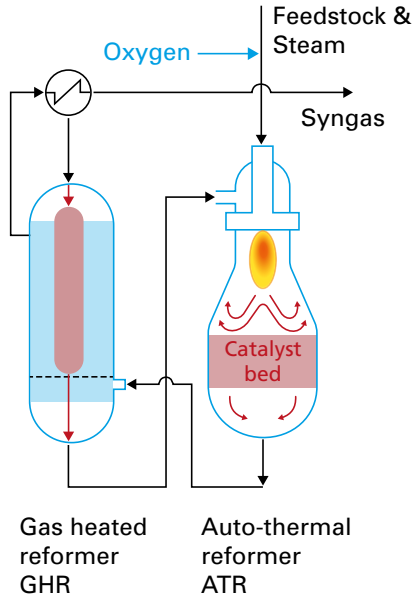
Notes:

- 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	$CH4 + H_2O \rightarrow CO + 3H_2$	$CH_4 + H_2O \rightarrow CO + 3H_2$ $2CH_4 + O_2 \rightarrow 2CO + 4H_2$	$2CH_4 + O_2 \rightarrow 2CO + 4H_2$	$CH_4 + H_2O \rightarrow CO + 3H_2$ $2CH_4 + O_2 \rightarrow 2CO + 4H_2$
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