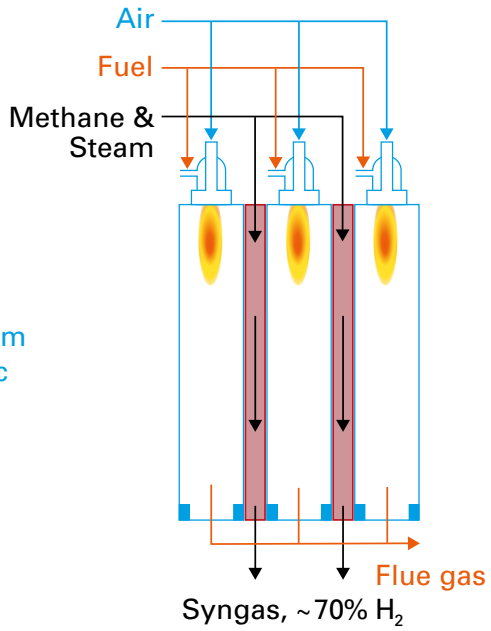
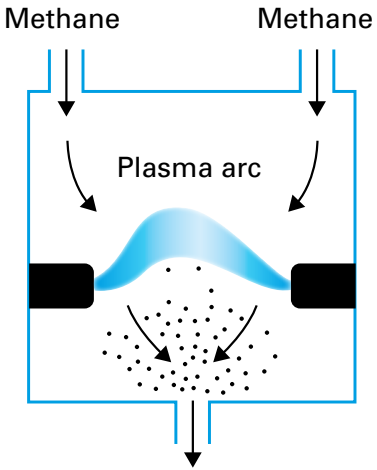
Methane reforming, pyrolysis, gasification and combustion

sbh4 consulting

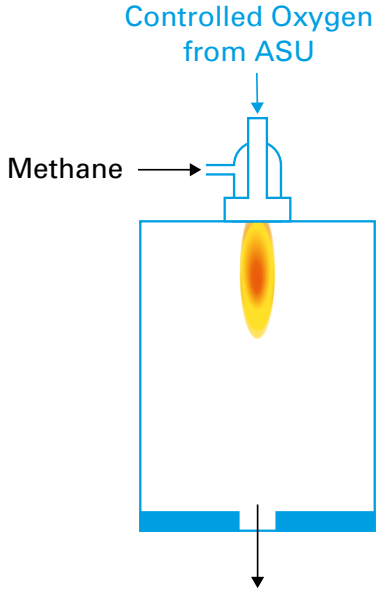
Notes:

- Energy for pyrolysis may be from combustion of fuel, or from an electric plasma arc
- Pyrolysis diagram shown is for thermal plasma pyrolysis
- POX diagram shows non-catalytic POX

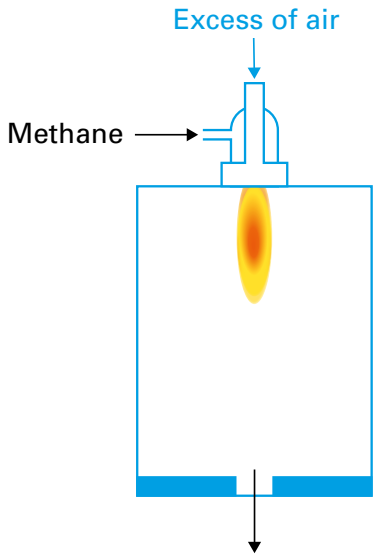




~95% H2, unreacted methane and carbon black powder



Syngas, 60% H_2 at 40 – 80 bar



Fluegas at low pressure

Process	Steam Methane Reforming	Methane Pyrolysis (Methane splitting or cracking)	Methane Partial Oxidation – POX (Gasification)	Methane Combustion (Thermal oxidation)
Oxygen feedstock	Oxygen is supplied as part of the water molecule with the steam	None, oxygen-free process	Oxygen from ASU	Air fed in excess
Catalyst required	Yes, generally Nickel	No	Not for thermal POX	No
Energy required/released	Endothermic, requires heat input	Endothermic, requires heat input	Exothermic, steam generation	Exothermic, steam generation
Chemical reaction	$CH_4 + H_2O \rightarrow CO + 3H_2$	$CH_4 \rightarrow C + 2H_2$	$2CH_4 + O_2 \rightarrow 2CO + 4H_2$ (ideal case)	$CH_4+2O_2 \rightarrow CO_2+2H_2O$ (ideal case)
Carbon product	CO and CO_2	Carbon black powder	CO and CO_2 from side reactions	CO_2
Hydrogen content in product gas	~70%	~95%	~60%	Zero, complete oxidation to CO_2 & H_2O is ideal case
Product gas pressure	15 to 40 bar	Atmospheric pressure	40 to 80 bar	Atmospheric pressure
Product gas temperature	~850 °C	~1700 °C	~1400 °C	~1400 °C