

Power Plant Using High Pressure CO₂

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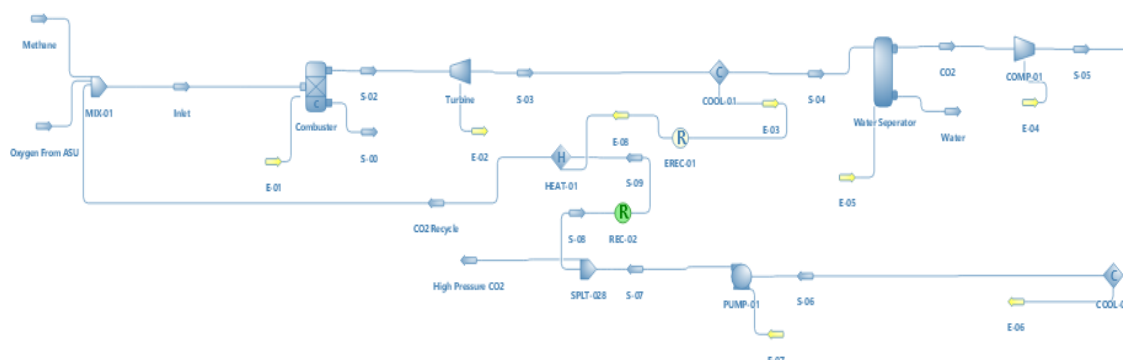
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Background & Description:

Generally, in Power plant heat generated by gas is used to convert water into steam and then the steam is passed through turbine for generating electricity. Therefore, steam is called the working fluid in thermal power plant as it turns the turbine for generating electricity. But in NET power system carbon dioxide is used as working fluid i.e. to turn the turbine and generate electricity.

This process flow sheet shows the working of high-pressure carbon dioxide power plant. Input to the combustor consists of up to 95% of CO₂ at 300 bar and 750 °C along with oxygen (from air separation unit) and methane (natural gas). The output from the combustor is then passed through turbine with efficiency of 75% and then the gas is cooled and water is separated using water separator. The CO₂ steam is then compressed to 80 bar and then further cooled until it is nearly liquid form as energy required by pump will be less for liquid state. Then it is recycled back to the combustor for running the turbine.

Flowsheet:



Results:

Object	S-05	S-03	S-02	Inlet	CO2 Recycle	
Temperature	207.286	840.509	1150	713.906	750	C
Pressure	80	30	300	300	300	bar
Mass Flow	186231	189772	189772	189772	181768	kg/h
Molar Flow	4317.8	4514.32	4514.32	4514.32	4214.32	kmol/h
Volumetric Flow	2155.84	13932.6	1780.46	1234.88	1194.97	m3/h
Mass Fraction (Mixture) / Oxygen	1.46357E-15	1.43628E-15	1.43628E-15	0.0337234	1.44745E-15	
Mass Fraction (Mixture) / Carbon dioxide	0.985885	0.967494	0.967494	0.944304	0.985885	
Molar Fraction (Mixture) / Methane	2.63329E-15	2.51867E-15	2.51867E-15	0.0221517	2.64398E-15	
Molar Fraction (Mixture) / Water	0.0337924	0.0758502	0.0758502	0.0315467	0.0337924	

HEAT-01	Heat Added	41647.2	kW
Combuster	Methane: Conversion	100	%
Combuster	Oxygen: Conversion	100	%

Object	Turbine	
Adiabatic Efficiency	75	%
Power Generated	21703.4	kW

Conclusion:

The estimated overall efficiency was 59% (includes energy for air separation unit, pump, compressor, burning gas etc) however thermal efficiency was found to be nearly 38%.

Reference:

1. <http://www.carboncapturejournal.com/news/carbon-capture--cheaper-than-a-plant-without-it/3490.aspx?Category=all>