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Internal Assesment Test – 1

Sub: Carbon Capture and Storage (Professional Elective)				Code: 15EE743
Date: 24/09/2019	Duration: 90 mins	Max Marks: 50	Sem: 7	Sections: A&B

Answer **ANY FIVE** full questions. Explain your notations explicitly and clearly.
Sketch figures wherever necessary. Good luck!

		Marks	OBE CO	OBE RBT
Q1.	Briefly give an overview of carbon capture and storage.	[10]	CO2	L2
Q2.	Explain the carbon cycle.	[10]	CO1	L2
Q3.	Explain fossil fueled power plant and its significance.	[10]	CO3	L2
Q4.	Compare pre-combustion and post-combustion capture.	[10]	CO4	L1
Q5.	Describe the measures for mitigating growth of atmospheric carbon inventory.	[10]	CO1	L2
Q6.	Explain in brief limitations of combined cycle power plant generation.	[10]	CO4	L2
Q7.	Explain capture ready and retrofit power plant.	[10]	CO4	L2

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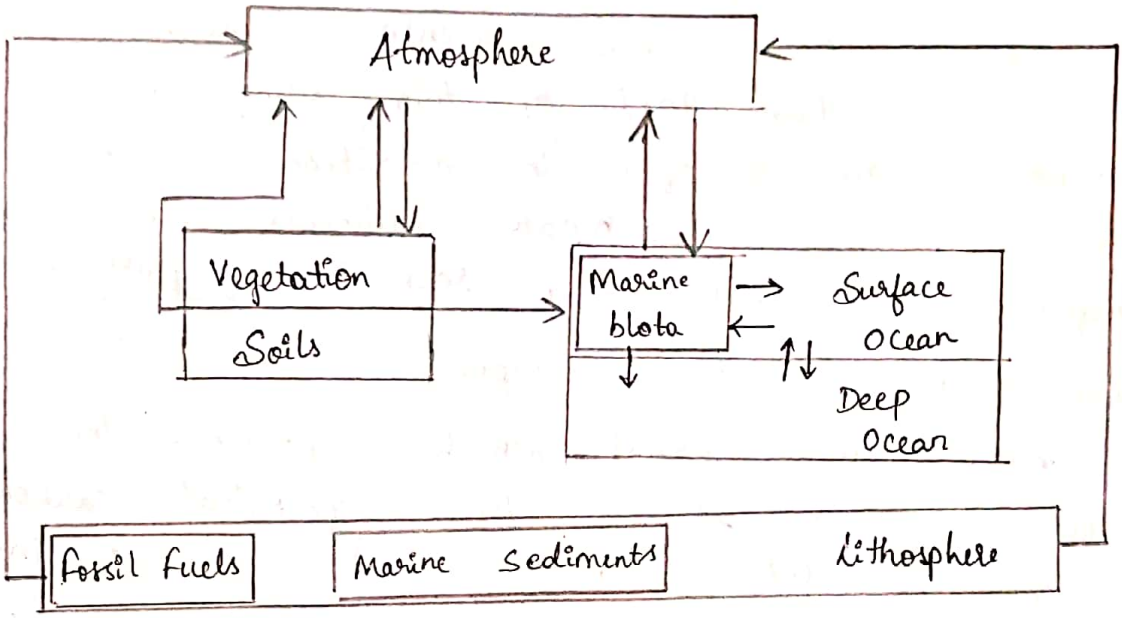
Carbon Capture And Storage

Assignment #01

Name: Sonika. A. V
Sem: 7th sem
Sec: 'B' sec
USN: 1CR16EE081

1) Explain Carbon Cycle.

Soln:



The carbon inventories in the atmosphere, biosphere soils and rocks and the oceans are linked by a complex set of natural and anthopogenic biochemical process that are collectively known as the Carbon Cycles.

The main inventories relevant to the global carbon Cycle are described in the following section.

Carbon inventory of the atmosphere:

The atmospheric carbon consists of almost entirely of CO_2 with a concentration of some 388 ppm by volume. This inventory has risen by almost 40 % since preindustrial times.

Carbon inventory of the biosphere and soils:

The terrestial carbon inventory is estimated to hold 2200. gtc - of which 600 gtc is present as living biomass and 1000 gtc as olganic carbon in soils and sediments.

Carbon inventory of the oceans:

The oceanic carbon inventory amounts to 39000 gtc with more than 90% of this being present as bicarbonate ion (HCO_3^-) in addition some 2500 gtc is present in marine carbonate sediments which are gradually transformed into sedimentary rock over geological time.

Carbon inventory of the lithosphere:

The earth's crust which represents the upper part of the lithosphere is the final geological carbon sink and is estimated to hold 5.10^7 gtc in sedimentary rocks.

2) Briefly give an overview of carbon capture and storage.

Sol: There are 3 main approaches to CO_2 capture:

1) As a pure of near pure CO_2 stream either from an existing industrial process of by rengering a process to generate such a stream.

2) Conc. of the discharge from an industrial process into a pure of near pure CO_2 stream.

3) Direct air capture into a pure CO_2 stream of into a chemically stable end product.

Carbon stages:

Geological storage: Injection into oil, gas and water bearing geological formation is widely regarded as the front running option for CO_2 storage and is the only option that has no far been applied on a commerical scale.

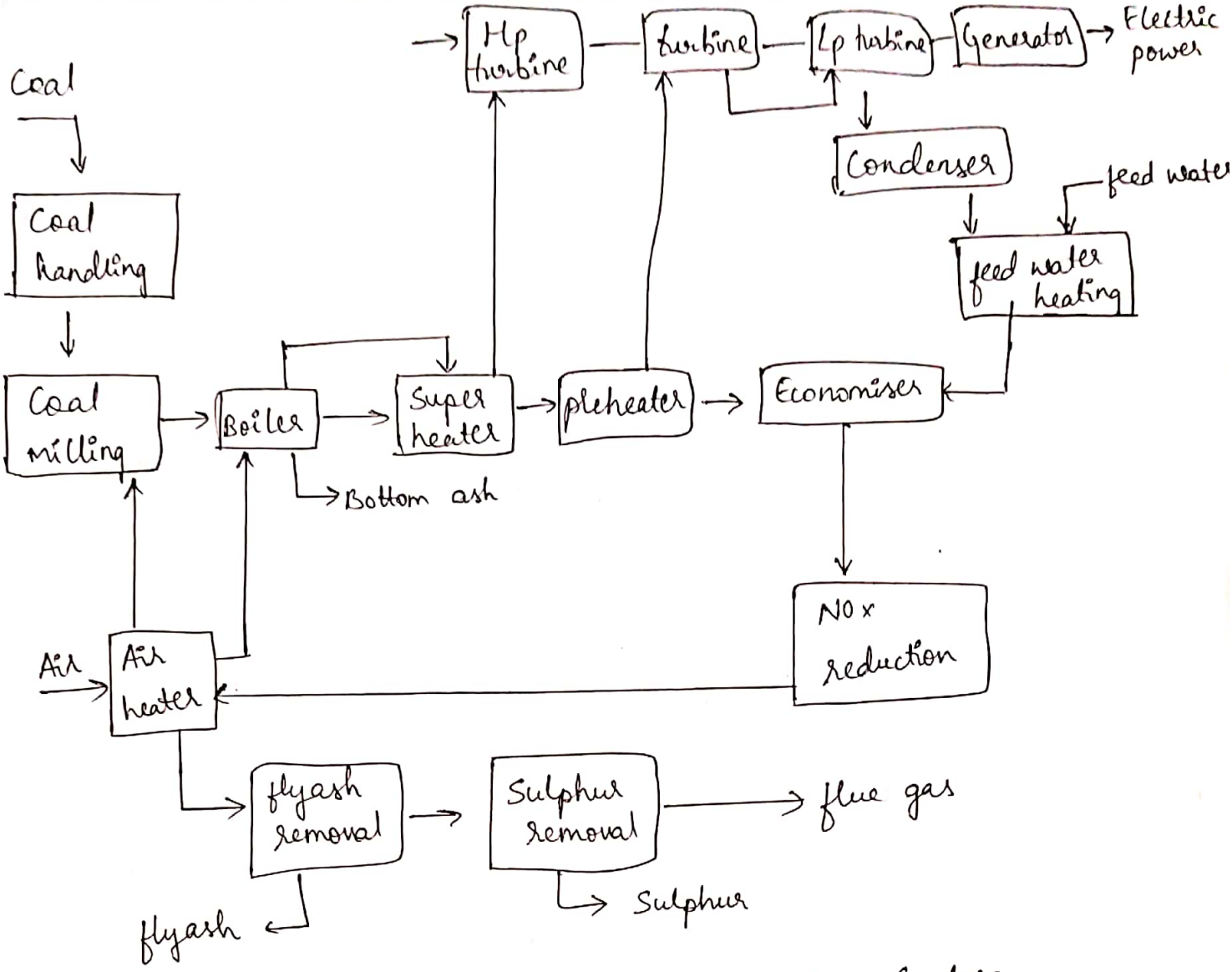
Ocean storage: With carbon inventory some 50 times greater than the atmosphere. The ocean is a prime candidate for storage of capture CO_2. and several option have been investigated.

3) Explain fossil fueled power plant and its significance.

Sol: The process diagram of a typical pulverized coal power plant is shown.

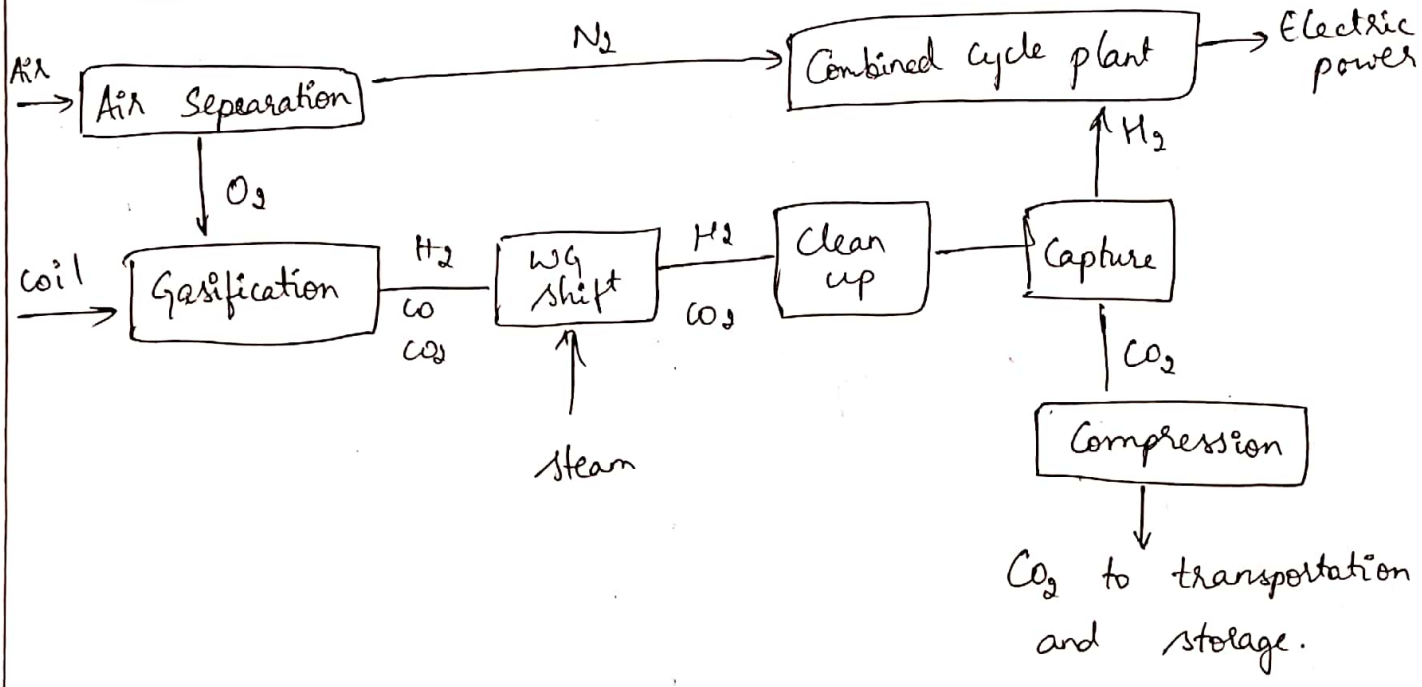
The pulverised fuel is shown blown into the furnace by a draft of air, which is preheated in a heat excharger by the flue gas excisting the boiler, initial boiling takes place in the water cooled wall of the furance and the final steam temperature to drive the Hp steam turbine stage is acheived in a super heater.

Hp turbine exhaust steam is reheated to drive the intermediate pressure turbine stage and may be reheated again to drive the Lp stage. The three turbine stages are linked by a single shaft to the generator.



4) Compare precombustion and post combustion Capture.

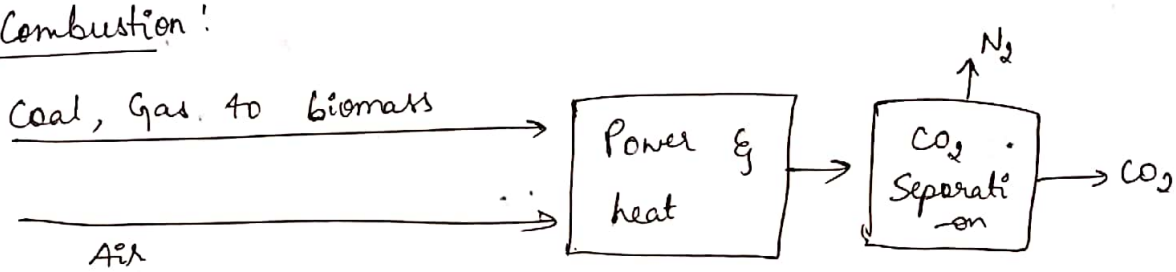
Sol: Precombustion:



Precombustion capture involves decarbonation by gasification of the primary fuel, commonly coal or biomass to produce hydrogen through a combination of partial combustion. reforming and wairings shifting and the separation of CO_2 from the resulting reaction product steam.

The separation of CO_2, H_2 can be acheived using a number of technologies of which the use of physical sediments is currently the most commerical development.

Post Combustion:



In post combustion capture, CO_2 is removed from the combustion reaction product steam flue gases before emission to the atmosphere. Post combustion capture is thus an exension of the flue gas treatment for Nox and SOx removal. made from exchanging by relatively higher quantities of CO_2 in the steam.

5) Describe the measures for mitigating growth of atmospheric Carbon inventory?

Sol: Anthopogenic Emission Scenarios:

The future level of anthopogenic CO_2 emission both from fossil fuel combustion and from land use changes will be dicated by a wide range of denographic, socienomic, environmental and technological

factors including:

→ Population growth
→ Economic growth and the globalization of trade.
→ Energy inventory of industrial production.
→ Fossil fuel NO_x within total energy supply.
→ technology development in primary energy production.

Enivormental pressures & Policy-driven incentives:
To predicting anyone of these factors over a 100 year time carries a wide range of uncertainty and the problem of combining multiple uncertainties is best handled by the operation of a number of scenarios based on storage time that depict how these factors coved play out in future with help of incentives.

CO_2 stabilization Scenarios:

The models used to predict (CO_2) for a given emissions scenolies can also be seen to establish that the range of the emission scenolies that would be in result in the stabilization of (CO_2) at a specific level.

6) Explain in brief limitation of Combined cycle power plant generation?

Sol: A combined cycle plant combines two or more thermodynamic cycles to higher thermal efficiency range & reach a higher thermal efficiency than would be possible with a single cycle. This is acheived by using the relatively high temperature reject heat from the first cycle to drive a second cycle, efficiency reducing and overall TC.

In power generation applications, the most commonly combined cycle plant comprises two stages.

A gas turbine operating a Brayton cycle and fired either by natural gas or integrated with a gassification plant followed by.

A steam turbine operating a Rankine cycle driven by a heat recovery steam generator that recovers heat from the high temperature exhaust gases exiting the gas turbine.

In the first generation, cycle natural gas is burned in a combustion turbine which directly given an electrical generators, combustion temperature are the typically in the range of 1000 - 1400°c in the generators.

Q) Explain Capture ready and retrofit power plant?

Sol: Capture ready power plant:

To be considered as capture-ready, the retrofit of capture systems should be both technically and economically feasible, although the latter, requirement may be problematic to demonstrate at the planning stage in view of uncertainties in the future carbon market and cost of installation.

In case of only fueling, these link that plobibitive additional requirements may emerge as the technology reaches full development & deployment can be mitigated by also considering requirements for post combustion capture.

Retrofitting Capture Capability:

In retrofitting carbon cycles, it capture to existing power plants that have not been designed as capture ready, all of consideration for less efficient plant, the captial cost as well as the increased operating and maintainance cost of the post-retrofit plant, coupled with a ~40% of reduction in net output if make up power is not added.