Module 7: Combustion and Environment

Lecture 38: Species Emission and Its Corrected Value

The Lecture Contains:

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Species Emission and Its Corrected Value

The oxygen coefficient is given by

$$a = \frac{x + \left(1 + X_{O_2,wet}\right) y/2}{\left(1 - 4.76 X_{O_2,wet}\right)}$$

OR

$$a = \frac{x + \left(1 + X_{O_2,dry}\right) y/2}{\left(1 - 4.76 X_{O_2,dry}\right)}$$

The measured concentration of i^{th} species at given oxygen level can be corrected to a specific oxygen level as below

$$X_{i,mO_2} = X_{i,nO_2} \frac{N_{i,nO_2}}{N_{i,mO_2}}$$

In order to assess the emission in a combustor or engine, it is important to define a normalized indicator of emission level as below,

$$EI_i = \frac{\dot{m}_i}{\dot{m}_F}$$

For combustion of hydrocarbon fuel, the emission index i^{th} species is given by,

$$DI_i = \left(\frac{X_i}{X_{co} + X_{co_2}}\right)\left(\frac{NMW_i}{MW_F}\right)$$

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Emission Control Methods

- Best method of reducing emission is to avoid using excess fuel.
- Public awareness must be initiated to avoid unwanted burning of fuels.
- Eco-friendly combustion devices have to be designed and developed.
- Cost effective methods can be devised to treat the combustion products before allowing them to the atmosphere.

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Emission Control Methods

CO_X Emission control

Storage in oceans may not be feasible due to non-availability of technology, however, geological reservoirs are promising options for CO_2 storage.

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Emission Control Methods

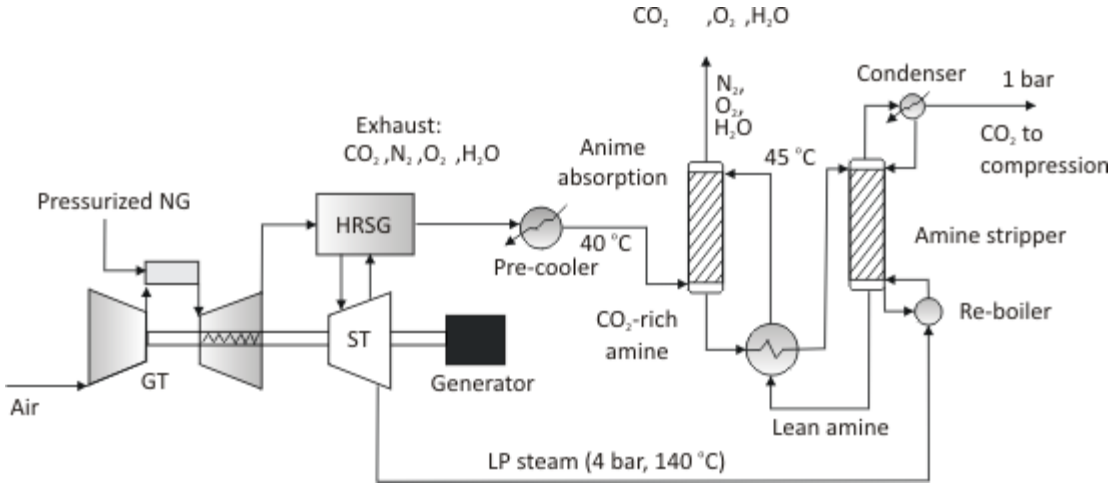

Figure: *Schematic diagram of a CO_2 capture pilot plant for coal-based power plant*

(Figure 38.1)

- CO_2 is separated by means of absorption using mono-ethanol amine (MEA).
- The plant consists of three parts
  i. Absorber,
  ii. Regenerator,
  iii. Exchanger.
- Exhaust gas is cooled to to 40-50°C and fed to the absorption tower.
- In the absorber, exhaust gas is mixed with mono-ethanol amine (MEA), which captures 90% of CO_2 in the exhaust gas.
- Amine stripper is used in the regenerator, which separates MEA and sends back to amine absorption tower. This plant captures 1 million CO_2 per hour.

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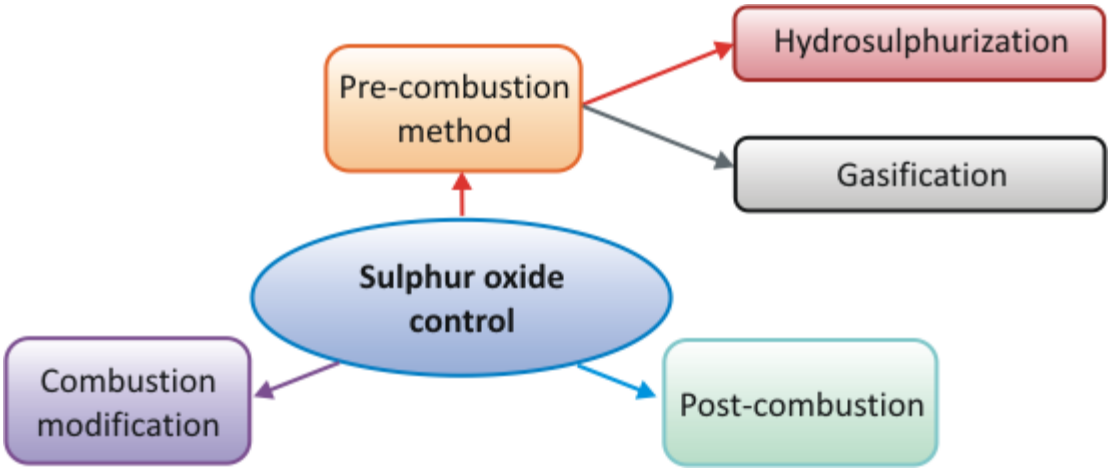
SO_X Emission and Its Control

- Sulphur is relatively inert and harmless to human beings.
- Oxides of sulphur poses serious environmental problem.
- Sulphur oxides are corrosive in nature.
- Organic fuels such as coal, oil, wood, etc contain some sulphur.
- SO is a highly reactive radical and its life time is few milliseconds.
- Under fuel rich conditions, in addition to sulphur oxides, hydrogen sulphide, carbonyl sulphide, and elemental sulphur are formed.
- Understanding of the mechanism of sulphur oxides have not evolved to a maturity level.



(Figure 38.2)

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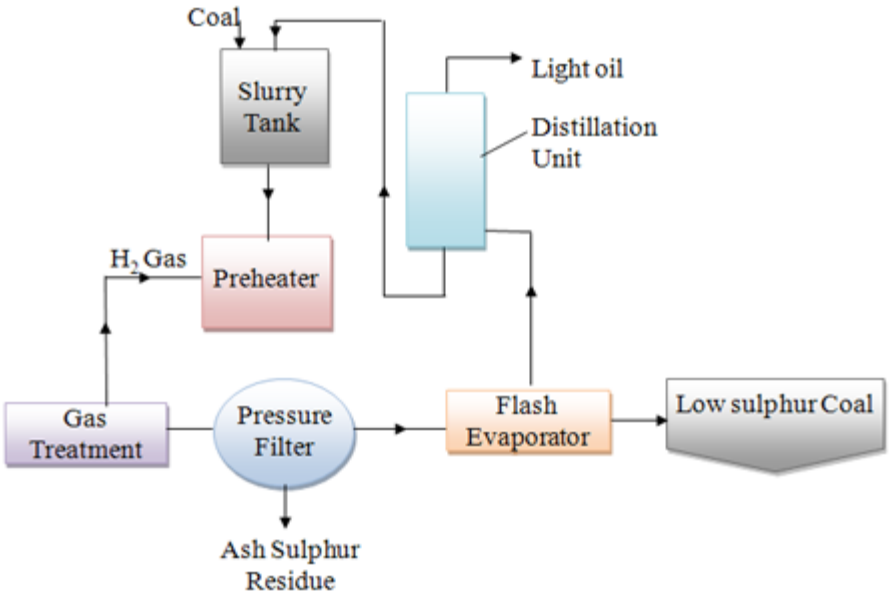
SO_X Emission and Its Control

Hydrosulphurization method

- Effective method of desulphurizing coal and oil fuels.
- This method treats fuels in the presence of hydrogen at high pressure and temperature.
- Finely grounded coal is mixed with anthracene oil along with hydrogen to produce slurry.
- The dissolved coal is passed through a pressure filtration unit in which pyretic sulphur is removed.
- A flash evaporator is used to convert the dissolved coal to low sulphur coal.



(Figure 38.3)

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