

Applied Thermofluids-2 (ME40603/ME40701)

2<sup>nd</sup> Class Test (29<sup>th</sup> August 2017)

Max. Marks: 20

Duration: 50 minutes



**Make suitable assumptions, wherever necessary**

1. In a coal fired steam generator, 360 kg/s of water enters the steam generator with an enthalpy of 1050 kJ/kg and leaves the steam generator as superheated vapour with an enthalpy of 2812 kJ/kg. Coal at standard state and air preheated to a temperature of 600K enter the steam generator furnace. Combustion takes place inside the furnace and the combustion products leave the steam generator at a temperature of 1000K, after transferring heat to water flowing through the steam generator. The steam generator has an efficiency of 95%. Assume combustion to be complete with stoichiometric air fuel ratio. The composition of coal is given by:  $\text{CH}_{0.8}\text{N}_{0.02}\text{O}_{0.22}$ . The enthalpy of various gases as function of temperature is given below:

$$h_{f(T)} = a_0 + a_1T + a_2T^2$$

In the above equation  $h_{f(T)}$  is in kJ/kg and  $T$  is in K. The constants  $a_0, a_1$  and  $a_2$  for various gases is given below. Using the data given, find:

- a) Consumption of coal per day (in tons/day)
- b) Consumption of coal per day (in tons/day) if air also enters the furnace at standard state
- c) Volumetric flow rate of air (in  $\text{m}^3/\text{s}$ ), assuming air to behave as an ideal gas with a molecular weight of 29 kg/kmol and at a pressure of 1 atm. and 600 K. (15)

Coefficient	$\text{CO}_2$	$\text{CO}$	$\text{H}_2\text{O}$	$\text{O}_2$	$\text{H}_2$	$\text{N}_2$
$a_0$	-9281.0	-4273.0	-13982.0	-302.0	-3987.0	-310.8
$a_1$	1.006	1.04	1.725	0.955	13.338	1.013
$a_2 * 10^5$	9.743	6.643	28.06	6.234	89.807	7.069

2. If the above combustion reaction takes place in a closed chamber with both coal and air at standard state, write the stepwise procedure with suitable equations, using which the adiabatic flame temperature can be obtained (you need not find the temperature, but all the equations should be mentioned). (5)

End of the paper