Tutorial 1

Department of Metallurgical Engineering and Materials Science

MM624 Advanced Concepts in Steel Making **Date- 3 Mar 2022**

1. In a steel plant, the liquid steel is being made through converter route by oxidizing pig iron by blowing air into it (instead of oxygen as the normal practice). The composition and temperature of various components are given in Table below.

Wt.%	**Temp K**	**C**	**Mn**	**Si**	**P**	**S**
Liquid pig iron	1550	4.5	1.0	1.0	0.2	0.02
Liquid steel	1900	0.05	0.3	nil	0.02	0.02
Lime	300	Pure CaO				
Gases	1900	CO-90%, CO_2-10% in the carbonaceous part of gas				
Slag	1900	CaO/SiO_2= 3.5 (wt. basis), FeO- 16%, SiO_2- 16%, rest are MnO, P_2O_5 and MgO (from refractory dissolution)				

   (a) Calculate the following per one ton of steel produced:
   (i) the amount of air required to be blown into the hot metal, (ii) amount of pig iron to be added (iii) CaO to be added and (iv) amount of slag generated

   Hint: First do the mass balance (Basis 1000 Kg of pig iron) and later rewrite the mass balance for 1 ton of steel.

   (b) Calculate the excess heat generated in this overall process (for 1 ton of pig iron). How much additional scrap can be melted, if one assumes no losses from the furnace. Assume as a first approximation, scrap to be of the same composition as the final steel and its thermal properties are similar to that of pure iron.

Assume enthalpy of slag formation to be -750 kJ/kg at 1900K. ΔH^f_{P2O5} = -1490000 kJ/Kg mol, Specific heat capacity C_p (slag) = 1000 J/Kg K

Basis for the heat balance (1550 K).

Sensible heat of input material (pig iron, lime and gases) + Heat of reaction (oxide formation) = Sensible heat of Products (Liquid steel, slag and gases).

Atomic weight: Si-28, C-12, O-16, Mn-55, P-31 , S-32 , Fe-56

For enthalpies of formation and enthalpy increment equations, refer **Appendix V** and **Appendix VI** from the thermodynamic data file uploaded on Moodle.