5.ENERGY BALANCE

Assumption: Heat of dilution of oleum is neglected

Sulfonator:

Temperature of the reactor = 30^0C

General Heat balance:

Heat input + heat of reaction = heat output + Q

Specific heat of alkyl benzene = 3.536KJ/KgK

Specific heat of oleum = 1.403 KJ/KgK

Specific heat of alkyl benzene sulfonic acid = 3.057 KJ/kgK

Specific heat of sulfuric acid (98%) = 1.415 KJ/kgK

Heat of formation of alkyl benzene = -13.508 Kcal/mole

Heat of formation of sulfuric acid = -192 Kcal/mole

Heat of formation of alkyl benzene sulfuric acid = - 8.908 Kcal/mole

Heat of formation of oleum = -163.46 Kcal/mole

Taking reference temperature 0^0C

Input :- Entering temp = 28^0C

Mass flow rates:

Alkyl benzene – 1.77 kg/sec

Oleum – 1.95 kg/sec

Output :- Leaving temp = 30^0C

Mass flow rates

ABS – 2.304 Kg/sec

H_2SO_4 – 1.34 kg/sec

Heat input = (mCpt) $_{AB}$+$(mCpt)_{oleum}$

= 175.64 + 76.6

= 250.95 KJ/sec

Heat of formation at 25°C for the reaction(1) = 23.38 Kcal/mole

Heat generated in the reactor = 23.38 x 4.18 x 7.2

= 703.85 KJ/sec

Heat output = $(mCpt)_{ABS}$+$(mCpt)_{H2SO4}$

= 210.9 + 87.16

= 270.75 KJ/sec

Q= 250.95+703.85 – 270

= 684.8 KJ/sec

[Heat transferred to the cooling medium]

Dryer:-

Assume inlet gas temperature = 300^0C

Standard m^3 of air per tonne of powder made from slurry containing 42% water for 300^0C is 12,500

Outlet gas temperature = 100^0C

Properties:

The density of the gas at 100^0C is 0.94 Kg/m^3

The specific heat of air is 0.24 Kg cal/Kg^{0}C

Gas temperature after admixture with 10% cold air = 272^0C

Water evaporated to produce 1 tonne of powder = 540 Kg.

12500 m^3 gas/tonne powder, equivalent to 12,5000 x 0.94

= 11750 Kg gas / tonne powder.

Reference temperature = 20^0C

Heat in = 11750 x (272 – 20) x 0.24

= 711000 Kg cal / tonne powder.

Heat out [in Kcal / tonne powder]

Latent heat required = 540x550

= 297000

Radiation and convection losses, Say 5% of input

Reference temperature = 20^0C

Heat in = 11750 x (272 – 20) x 0.24

= 711000 Kg cal / tonne powder.

Heat out [in Kcal / tonne powder]

Latent heat required = 540x550

= 297000

Radiation and convection losses, Say 5% of input

= 35000

In gas exhausted from the tower

=11750 x (100 – 20) x 0.24 = 226000

Errors (by difference) = 1,74,500(24.5%)

Total=7,11,000