

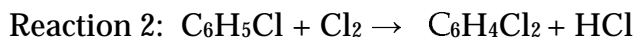
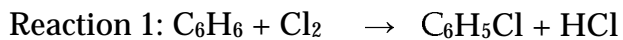
MATERIAL BALANCES OF THE PLANT

Basis: 320 days/year of operation.

The plant has to produce 23.3 kmols/hr of monochlorobenzene. Assume one hour of operation.

Balance across Chlorinator

Assume that 100% chlorination occurs in the chlorinator at 40°C. It is also assumed that 10% of the HCl produced in the chlorinator is entrained as liquid in the product. The rest leaves as vapour along with benzene, MCB and DCB. Only the p-isomer of DCB is formed in the chlorinator. It is assumed that from the chlorinator, the stream d is led into a condenser from where we recover the HCl product formed.



MCB formed = 24.03 kmols/hr

DCB formed = 3.80 kmols/hr

HCl formed = 31.63 kmols/hr

Benzene remaining = 3.80 kmols/hr

Input into chlorinator:

Benzene present = 31.63 kmols/hr

Chlorine present = 31.63 kmols/hr

Output from chlorinator:

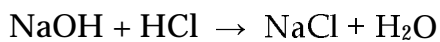
In stream d (29.65 kmols/hr):

MCB present = 0.44 kmols/hr

DCB present = 0.15 kmols/hr
HCl present = 28.47 kmols/hr
Benzene present = 0.59 kmols/hr
In stream a (33.46 kmols/hr) :
MCB present = 23.44 kmols/hr
DCB present = 3.65 kmols/hr
HCl present = 3.16 kmols/hr
Benzene present = 3.21 kmols/hr

Material balance across Neutralizer

To neutralize 3.16 kmol/hr of HCl, we need 3.16 kmol/hr of NaOH solution. The NaOH soln. is made slightly alkaline so 2.5% extra soln. is taken. The strength of NaOH soln. taken is (20+2.5) wt.%.



Input to Neutralizer:

NaOH solution = 32.82 kmols/hr.
NaOH present = 3.32 kmol/hr
Water present in soln. = 29.50 kmol/hr
Stream a (33.46 kmols/hr):
MCB present = 23.44 kmols/hr
DCB present = 3.65 kmols/hr
HCl present = 3.16 kmols/hr
Benzene present = 3.21 kmols/hr

Output from Neutraliser:

In stream b (35.98 kmols/hr):
NaCl present = 3.16 kmols/hr
Water present = 32.66 kmols/hr

NaOH present = 0.16 kmols/hr

In stream c (30.3 kmols/hr) :

MCB present = 23.44 kmols/hr

DCB present = 3.65 kmols/hr

Benzene present = 3.21 kmols/hr

Balance across benzene column

It is assumed that all the entering benzene in this column goes out as distillate as the top product. The Distillate contains 98 vol% benzene and 2 vol% MCB. Let the distillate stream be e.

Input into the benzene recovery column:

Stream c (30.3 kmols/hr):

MCB present = 23.44 kmols/hr

DCB present = 3.65 kmols/hr

Benzene present = 3.21 kmols/hr

Output from the Benzene recovery column:

in stream e (3.26 kmols/hr) :

Benzene present = 3.21 kmols/hr

MCB present = 0.05 kmols/hr

in stream f (27.04 kmols/hr) :

MCB present = 23.39 kmols/hr

DCB present = 3.65 kmols/hr

Balance for Recycle stream

It is assumed that all the benzene from the benzene column goes to the purifier from which all the benzene is recycled back into the feed stream.

Recycle r into feed stream = 3.21 kmols/hr

Fresh feed = 28.42 kmols/hr

Balance across Chlorobenzene column

The purity of the MCB in the distillate is assumed to be 99 mol% . The purity of the MCB in the residue is assumed to be 3 mol% .

Input to the chlorobenzene column:

stream f (27.04 kmols/hr) :

MCB present = 23.39 kmols/hr

DCB present = 3.65 kmols/hr

Output from the chlorobenzene column:

in stream g (23.52 kmols/hr)

MCB present = 23.28 kmols/hr

DCB present = 0.24 kmols/hr

in stream h (3.52 kmols/hr)

MCB present = 0.11 kmols/hr

DCB present = 3.41 kmols/hr