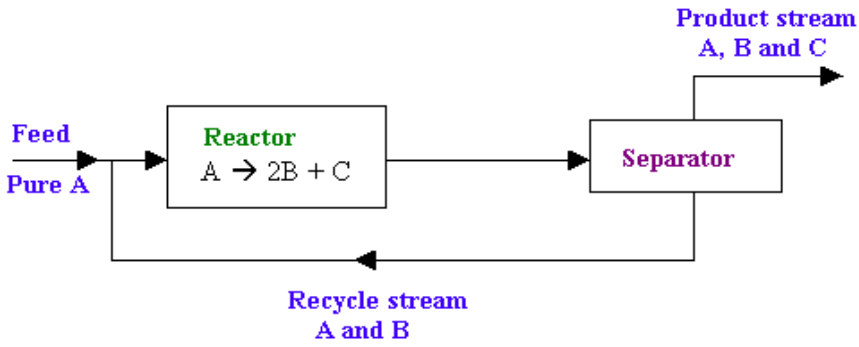
The reaction A -> 2B + C takes place in a catalytic reactor (diagram is given below). The reactor effluent is sent to a separator. The overall conversion of A is 95%. The product stream from the separator consists of B, C and 0.5% of A entering the separator, while the recycle stream consists of the remainder of the unreacted A and 1% of B entering the separator. Calculate the

a. single pass conversion of A in the reactor

b. molar ratio of recycle to feed.



Calculations:

Basis: 1 mole of pure A in the feed

From the reaction, A → 2B + C

1 mole of A produces 2 moles of B and 1 mole of C for complete conversion.

From the problem statement, overall conversion is 95%. Therefore, 1 mole of feed A will produce

2 x 0.95 mole of B ,

1 x 0.95 mole of C and the

unreacted A is 0.05 mole.

i.e.,

Product stream contains:

A : 0.05 mole

B : 1.9 mole

C : 0.95 mole

Material Balance for the compound B:

From the problem statement, B in the recycle stream = 1% of B entering the separator.

Therefore, B in the product stream = 99% of B entering the separator = 1.9 mole

Total B entering the separator = 1.9/0.99 = 1.919 mole

And, amount of B in the recycle stream = 1.919 x 0.01 = 0.019 mole.

Material Balance for the compound A:

From the problem statement, A in the product stream = 0.5% of A entering the separator.

i.e., A in the product stream = 0.5% of A entering the separator = 0.05 mole.

Therefore, amount of A entering the separator = 0.05/0.005 = 10 mole.

And, the amount of A in the recycle stream

= Amount of A entering the separator - Amount of A in the product stream

= 10 - 0.05 = 9.95 mole.

Amount of A entering the reactor = fresh A + recycle A = 1 + 9.95 = 10.95 mole.

Amount of A converted in the reactor = moles of A entering the reactor - moles of A entering the separator = 10.95 - 10 = 0.95 mole

Single pass conversion of A in the reactor

= 100 x Amount of A converted in the reactor / Amount of A entering the reactor

= 100 x (0.95/10.95) = **8.676%**

Total moles of recycle stream = moles of A in recycle stream + moles of B in recycle stream

= 9.95 + 0.019 = 9.969 mole

Molar ratio of recycle to feed = 9.969/1 = **9.969**