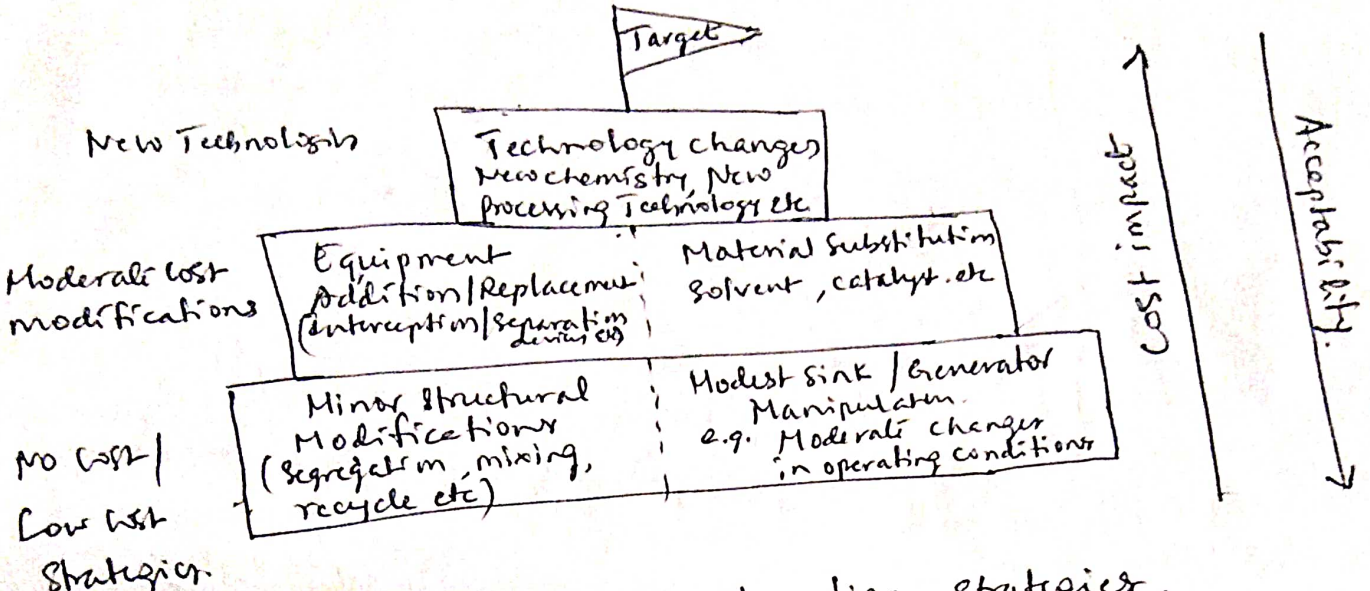
Mass Integration Strategies for attaining Targets.



Hierarchy of Mass-Integration strategies.

Once the target is determined, it is necessary to develop cost-effective strategies to reach the target. In general these strategies include stream segregation, mixing, recycle, interception using separation devices, changes in design and operating conditions of units, materials substitution, and technology changes including the use of alternate chemical pathways. These strategies can be classified into hierarchy of three categories

No / low cost changes
Moderate cost modifications
New technologies.

Three main factors can be used in describing these strategies, economics, impact, and acceptability. The economic dimension can be assessed by a variety of criteria such as capital cost, return on investment, net present worth, and payback period. Impact is a measure of the effectiveness of the proposed solution in reducing negative ecological and hazard consequences of the process such as reduction in emissions and effluent from the plant.

Acceptability is a measure of the likelihood of a proposed strategy to be accepted and implemented by the plant. In addition to cost, acceptability depends upon several factors including corporate culture, dependability, safety and operability

① Reduction of Acetic Acid Fresh usage and terminal losses in a vinyl acetate plant.

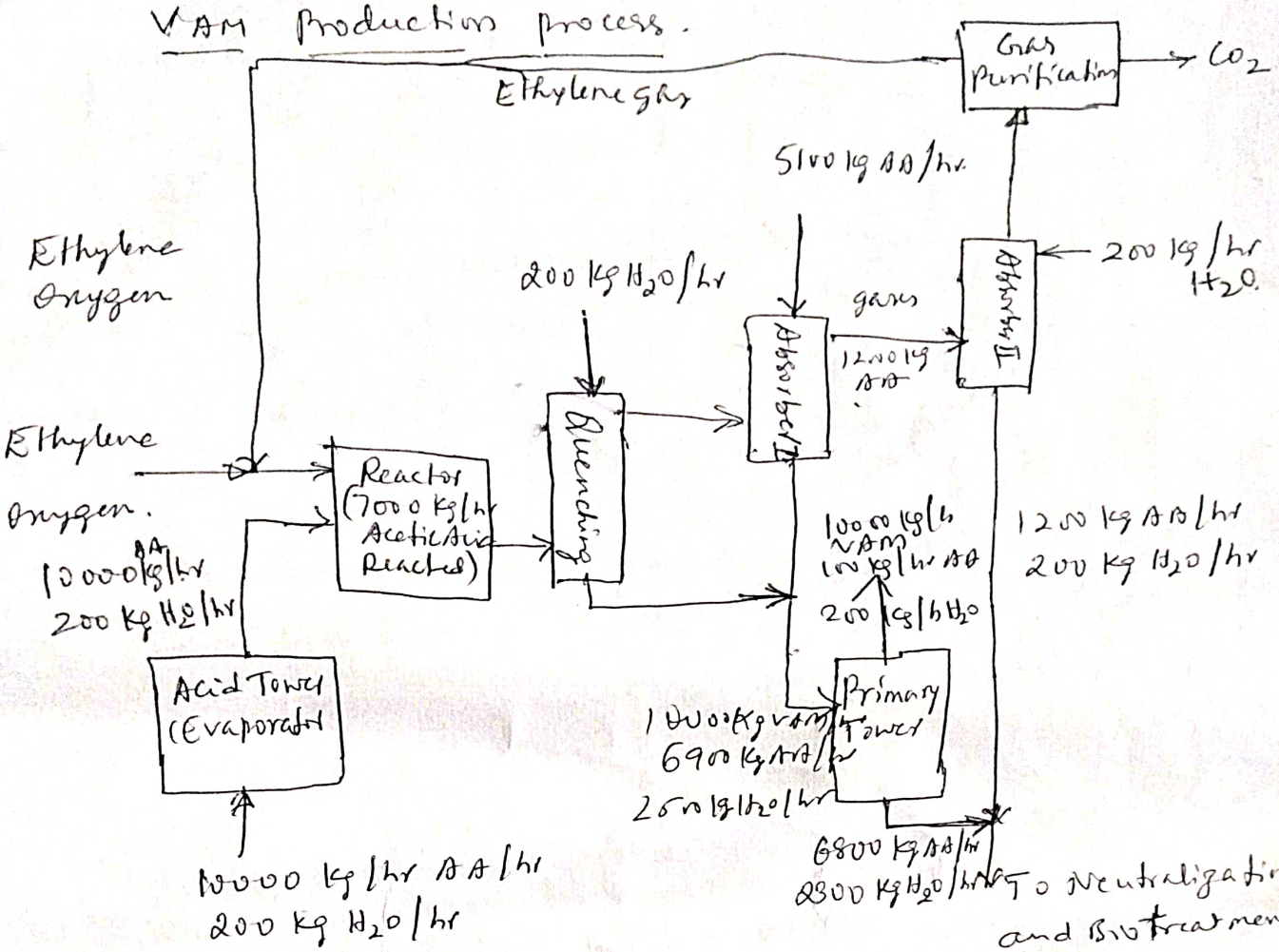
Vinyl acetate monomer (VAM) is manufactured by reacting acetic acid with oxygen and ethylene according to the following chemical reactions.

$$C_2H_4 + 0.5O_2 + C_2H_4O_2 = C_4H_6O_2 + H_2O$$

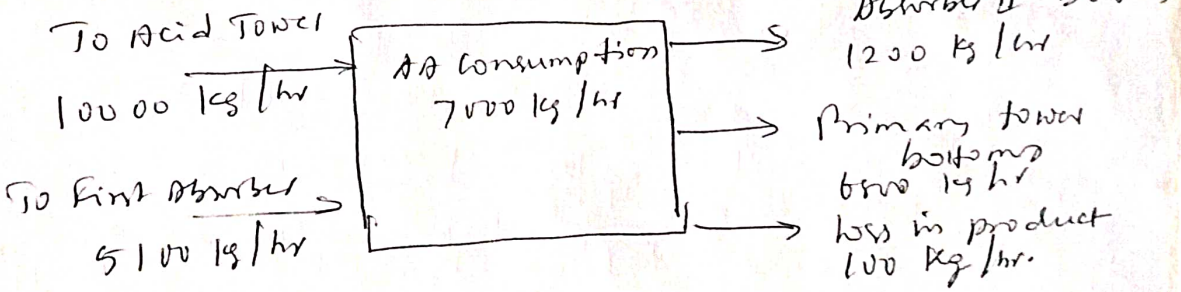
Ethylene Oxygen Acetic Acid VAM Water.

A fresh feed of 10000 kg/h of acetic acid (AA) along with 200 kg/h of water are evaporated in an acid tower. The vapor in fed with oxygen and ethylene to the reactor where reactor off-gas in cooled and fed to the first absorber where AA (5100 kg/h) in used as a solvent. Almost all the gases leave from top of the first absorption column together with 1200 kg/h of AA. This stream in fed to the second absorption column where water (200 kg/hr) in used to scrub acetic acid. The bottom product of the first absorption column in fed to the primary distillation tower where VAM in recovered as a top product (10000 kg/h) along with 200 kg/h of water and a small amount of AA (100 kg/h). This stream in sent to final finishing. The bottom product of the primary tower (6800 kg/h of AA and 230 kg/h of water) is mixed with the bottom product of the second absorption columns. (1200 kg/h of AA and 200 kg/h of water). The mixed waste in fed to a biotreatment. In this eg, let us consider the case when no changes are made to the consumption by chemical reaction and there are no adjustments in design or operating conditions to reduce ~~the~~ fresh AA consumption. What in the target for minimum fresh usage and minimum terminal losses of AA?

VAM Production process.



Solve

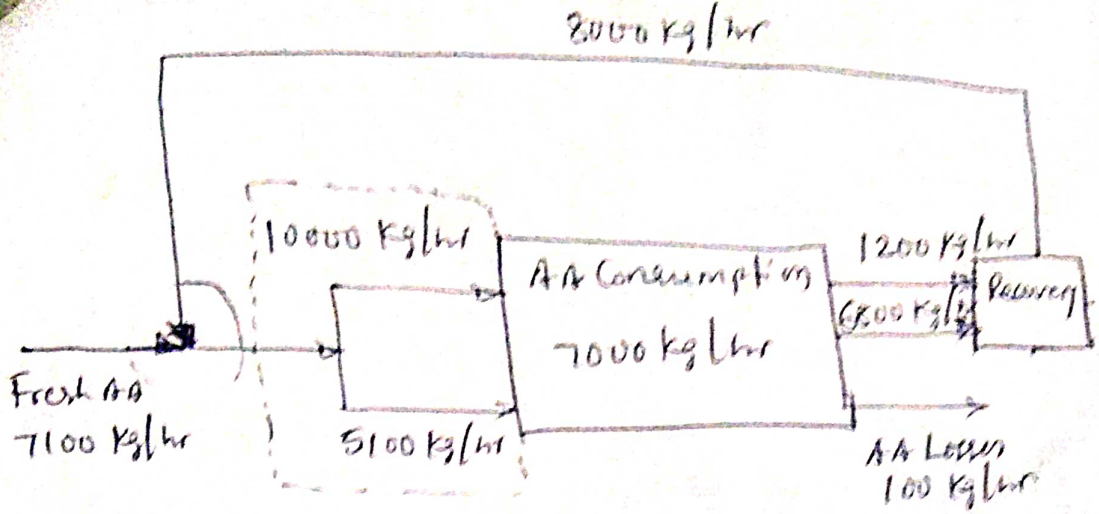


Overall AA Material balance for VAM Process

The data are presented in Fig. Net consumption of 7000 kg AA/h is the equivalent of -7000 kg AA/h of net generation.

Given: No allowable changes in reaction or design and operating conditions affecting fresh consumptions.

Try recovery from terminal streams, recycle and replacement of fresh AA



Note recoverable load from terminal stream (8000 kg on/hr

< fresh load 15100 kg/hr

∴ R_{max} is lowest of these two streams

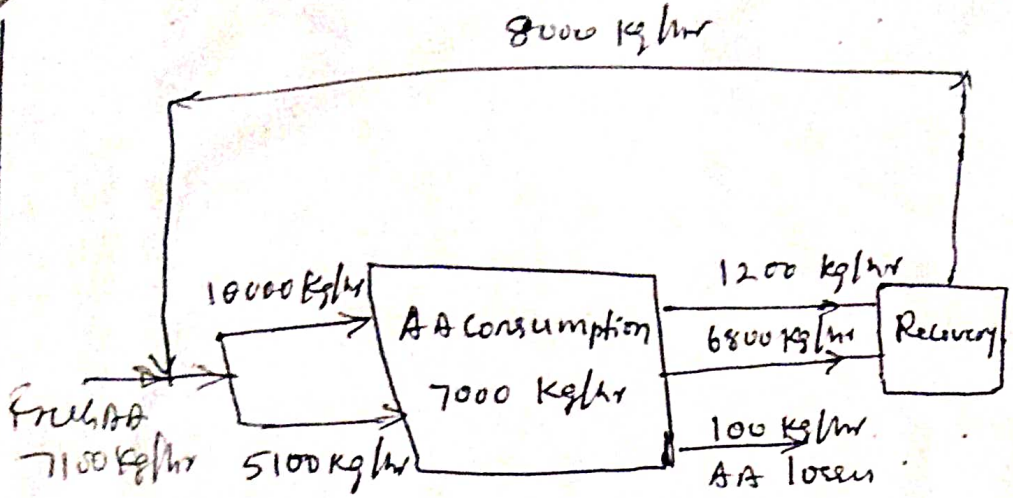
i.e R^{max} = 8000 kg/hr

As a result of recycle the fresh load after mass integration we get target for minimum fresh usage.

$$F^{AMI} = F^{APR} - R^{max}$$

$$= 15100 - 8000$$

$$= 7100 \text{ kg/hr}$$



Total 15100 kg/hr 8100 kg/hr

It is worth noting that the recoverable load from the terminal streams (8000 kg/h) is less than the fresh load (15100 kg/h)

Target for minimum fresh usage

$$F^{AMI} = F^{ARR} - R^{max.}$$

F^{AMI} - Fresh load after mass integration changes

F^{ARR} - min. load of targeted species in the fresh feeds after reduction.

R^{max} - Maximum recyclable load

$$\therefore F^{AMI} = 15100 - 8000$$

$$= 7100 \text{ kg AA/h}$$

Target for minimum terminal losses = 100 kg/h AA