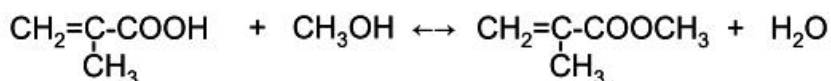


## 2.6 Esterification Section

The ester grade MMA is produced by continuous esterification of MAA with ME in liquid phase using cationic ion exchange resin as the catalyst in the esterification reactor (R-1310A/B).

The reaction is equilibrium, and the reaction goes to the right hand by the elimination of the reacted products.



Methacrylic Acid(MAA)   Methanol(ME)   Methyl Methacrylate(MMA)

The effluent liquid from the reactor is led to the MAA separation column (T-1320), where the reaction product and the excess ME are distilled off from the top and MAA is separated into the bottom liquid.

For the removal of high boiling point by-products from the system, a part of the T-1320 bottom liquid is introduced to the heavy-ends cut column (T-1330) and then to the T-1330 bottom evaporator (E-1340).

The distillate of T-1320 is led to the T-1320 top receiver (TK-1322), where the distillate is separated into lighter ester phase and heavier aqueous phase.

The aqueous phase liquid is fed to the ME(MeOH) recovery column (T-1350).

The ester phase liquid is led to the subsequent purification section.

### 1) Esterification Reactor (R-1310A/B)

In this process, two esterification reactors (R-1310A/B) are provided, in which alternatively one reactor is used.

The ester grade MAA from T-1220 is filtrated through R-1310A/B feed filter (F-1315A/B), and mixed with fresh ME and recovered ME to an appropriate molar ratio.

In addition to the above, the bottom liquid of T-1320 containing unreacted MAA is recycled to the reactor.

The reactant liquid, composed of the ester grade MAA, fresh ME, recovered ME and T-1320 bottom liquid, is mixed homogeneously by the R-1310A/B feed mixers (M-1315A/B), and fed to the top of R-1310A/B.

MAA is continuously esterified in the liquid phase with ME in the presence of cation exchange resin as the catalyst.

The reaction temperature is from 80 to 95 deg. C.

The reactors are of packed bed type with Johnson screen to support the catalyst bed.

To adjust the feed temperature of the reactant, R-1310A/B pre-heater (E-1315A) is provided.

For the purpose of preheating before start-up and cooling down after taken out of service, R-1310A/B pre-heater (E-1315C) is provided.

### 2) MAA Separation Column (T-1320)

The reaction product liquid is introduced to the bottom of T-1320, where a mixture of MMA and water, as the reaction products, and the excess ME, not containing MAA and high boiling by-products is obtained as the distillate, and the unreacted MAA is separated into the bottom liquid accompanied with MMA.

The distillate condensed through the T-1370 bottom heater (E-1322A) and the T-1320 condenser (E-1322B) is settled in TK-1322, where the distillate is separated into lighter ester phase and heavier ME rich aqueous phase.

The aqueous phase liquid is fed to T-1350, and a part of the ester phase liquid is returned to the column top as the reflux, and the balance is introduced to the light-ends cut column (T-1360).

A part of the bottom liquid is introduced to T-1330, and the balance is recycled to the reactor through the T-1320 bottom receiver (TK-1321) and the recycle MAA filter (F-1321A/B), in which a resin similar to the catalyst is packed.

For the prevention from polymerization, HQ solution from TK-1364A/B is injected to the reflux line and sprayed over E-1322A. Also a part of the distillate is sprayed over E-1322A and the vent condenser (E-1323). Further air is injected to the T-1320 reboiler for the same purpose.

A small amount of acids is contained in the distillate.

To remove these acids by extraction, a part of the bottom liquid of T-1350 is sprayed to E-1322A.

This column has 30 stages of perforated tray without downcomer, and is equipped with a thermosiphon reboiler (E-1321).

The operating pressure is atmospheric.

To recover the latent heat of condensing of the top vapor, T-1370 bottom liquid is circulated as the coolant through shell side of E-1322A.

E-1322A and E-1322B are connected together sharing a common intermediate channel, and the distillate flows through tube side of both heat exchangers.

### 3) Heavy-Ends Cut Column (T-1330)

A part of the T-1320 bottom liquid, which contains MMA, MAA, and some high boiling point by-products, is fed to the middle of T-1330.

MAA and MMA are recovered as the distillate and fed to TK-1321 after condensed in T-1330 condenser (E-1332).

A part of the distillate is returned to the column top as the reflux.

This column has three beds of CMR packing, and is equipped with E-1332, a vent condenser (E-1333) and a thermosiphon reboiler (E-1331).

The operating pressure of this column is around 60 mmHg at the top.

The bottom liquid is fed to E-1340.

E-1340 is a rotating film evaporator operated under a reduced pressure of around 45 mmHg.

The high boiling point by-products are concentrated in this evaporator, and taken out as waste oil, which is used as auxiliary fuel in the waste water incineration system with dilute agent ME.

The distillate from the evaporator is condensed in a condenser (E-1342), and recycled to the T-1330 bottom.

For the prevention of polymerization in this system, the T-1320 bottom liquid which contains HQ is sprayed over T-1330 bottom and E-1340 vent condenser (E-1343).

Also, HQ solution from TK-1364A/B is sprayed over E-1332, and the distillate is sprayed over E-1332 and E-1333. Further air is injected to E-1331.

As for E-1340, a part of feed liquid is sprayed at the vapor outlet and over E-1342. Also air is injected to E-1340 and the waste oil drum (D-1341).

### 4) ME (MeOH) Recovery Column (T-1350)

The aqueous phase liquid from TK-1322 is introduced to T-1350 through the T-1350 feed heater (E-1355) together with the aqueous phase liquid from distillate of T-1360.

A mixture of ME and MMA is distilled off from the column top and a part of the distillate, after condensed in T-1350 condenser (E-1352), is recycled to R-1310A/B as the recycled ME, and the balance is returned to the column top as the reflux.

A part of the bottom liquid is utilized as spray water for E-1322A, E-1362 and T-1393, and the balance is discharged as waste water to be treated in outside the battery limit.

This column has 50 stages of perforated tray without downcomer, and is equipped with a thermosiphon reboiler (E-1351), E-1352 and a vent condenser (E-1353).

This column is operated under atmospheric pressure.

For the prevention of polymerization in this column, HQ solution from TK-1364A/B is injected to E-1352, and air is injected to E-1351.