

Nature of Invention: Chemical molecule and synthesis route

**Applicant:** CHEMINOVA

**Inventors:** SHORYA TAMRAKAR (210993), AVNI GOUR (210240)

**Chemical Formula:** C<sub>5</sub>H<sub>8</sub>O<sub>2</sub>

**Chemical Name:** METHYL METHACRYLATE

**Chemical synthesis routes:**

## Reaction 1:

Source(patent):

Raw Materials:

- Acetone
- Hydrogen cyanide (HCN)
- Methanol
- Sulfuric acid (H<sub>2</sub>SO<sub>4</sub>)
- Ammonium sulphate ((NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub>)

Reactants:

- Acetone
- Hydrogen cyanide (HCN)
- Water (H<sub>2</sub>O)
- Sulfuric acid (H<sub>2</sub>SO<sub>4</sub>)
- Ammonium sulfate ((NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub>)
- Methanol

Catalysts:

- Sulfuric acid (H<sub>2</sub>SO<sub>4</sub>)

Formation of acetone cyanohydrin (ACH):

Step 1: Acetone + HCN → ACH

- Yield: 70-90%
- Purity: 90-95%
- Time duration: 4-5 hours
- Temperature: 25-35°C
- Pressure: Atmospheric

Hydrolysis of ACH:

Step 2:  $\text{ACH} + \text{H}_2\text{O} + \text{H}_2\text{SO}_4 \rightarrow \text{MAA} + (\text{NH}_4)_2\text{SO}_4$

- Yield: 80-90%
- Purity: 98%
- Time duration: 3-4 hours
- Temperature: 35-45°C
- Pressure: Atmospheric
- Endothermic reaction

Esterification of MAA:

Step 3:  $\text{MAA} + \text{MeOH} \rightarrow \text{MMA} + \text{H}_2\text{O}$

- Yield: 95%
- Purity: 99%
- Time duration: 3-4 hours
- Temperature: 45-55°C
- Pressure: Atmospheric
- Exothermic reaction

Purification of MMA:

Step 4: The MMA formed after the hydrolysis step can be further purified by crystallisation. This can be done by dissolving the MMA in a suitable solvent, such as hot water or ethanol, and then allowing the solution to cool slowly. As the solution cools, the MMA will gradually crystallise out of the solution. The resulting crystals can be filtered, washed, and dried to obtain highly pure MMA.

- Yield: 90-95%
- Purity: 99.5%
- Time duration: 8-12 hours
- Temperature: Room temperature
- Pressure: Atmospheric

## Reaction 2:

**RAW MATERIAL :**

- Isobutylene( $\text{C}_4\text{H}_8$ )

**CATALYSTS:**

- Zeolites

- SAPO molecular sieve

### REACTANTS:

- Isobutylene
- Methacrolein
- Methacrylic acid

### Step1 - Dehydrogenation of isobutylene

Isobutylene (C<sub>4</sub>H<sub>8</sub>) is dehydrogenated to methacrolein (C<sub>4</sub>H<sub>6</sub>O) and hydrogen gas (H<sub>2</sub>).



Conditions:

- Temperature - 250-350°C
- Pressure - 0.1-5 MPa
- Catalyst - solid catalyst such as a zeolite or SAPO molecular sieve.
- Exothermic process

### STEP 2

#### Oxidation of methacrolein:

Methacrolein is then oxidized with an oxygen-containing gas, such as air, to produce methacrylic acid (C<sub>4</sub>H<sub>6</sub>O<sub>2</sub>).

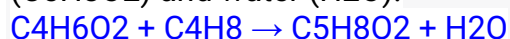


- Temperature - 200-250°C
- Pressure - 0.1-2 MPa
- Catalyst - copper or cobalt compound

### STEP 3

#### Esterification of methacrylic acid:

Methacrylic acid is esterified with isobutylene to produce methyl methacrylate (C<sub>5</sub>H<sub>8</sub>O<sub>2</sub>) and water (H<sub>2</sub>O).



Conditions:

- Temperature - 150-250°C
- Pressure - 0.1-10 MPa
- Catalyst - zeolite or SAPO molecular sieve.

### STEP 4: Purification of the product

The product stream is then further purified through various techniques, such as distillation, crystallization, or adsorption, to obtain the desired purity level of the product.

Generally, the temperature is kept below the boiling point of MMA (around 101°C at atmospheric pressure) to prevent decomposition and side reactions.

Overall:

- Temperature - 240°C
- Pressure - 1 MPa
- Reaction time - 4 hours
- Yield - 90%

**References:** <https://patents.google.com/patent/US20020188151A1/en>

<https://patents.google.com/patent/EP0941984A2/en> [EP0941984A2](#)

#### List the contributions of each author:

SHORYA TAMRAKAR (210993) carried out the literature search and find the reaction steps, and product yield as well as found necessary separation steps to achieve desired product purity for preparation of MMA from method one.

AVNI GOUR (210240) carried out the literature search and found the reaction steps, and product yield as well as found necessary separation steps to manufacture MMA from method two.

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