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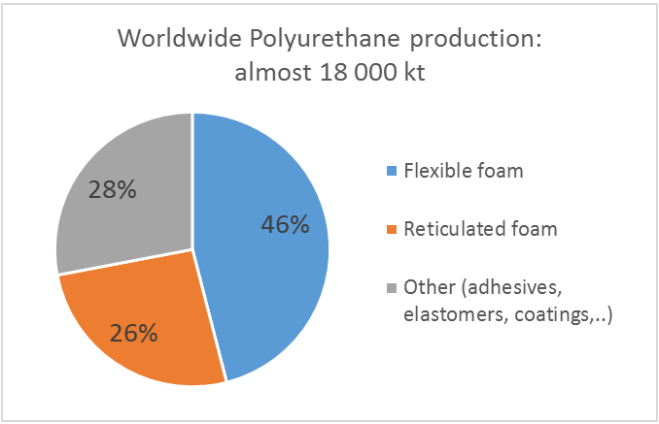
Inline control
Chemicals evaporation control

Application
MDI / TDI recovery
for polyurethane manufacturing: evaporation, distillation, polymerization

Targets: MDI and TDI manufacturers, Polyurethane manufacturers



Application

Polyurethane is one of the most polyvalent polymer. It appeared in the late 30s and is used as insulating material, coating, adhesive and solid plastic. Polyurethane can be produced in different shapes: **flexible foam and reticulated foam, elastomer, coating**, and is in high demand worldwide, especially in China.

Polyurethanes are produced by reacting an isocyanate, generally **TDI** (Toluene Diisocyanate) or **MDI** (Methylene Diphenyl Diisocyanate), as these two represent more than 95% of the world's diisocyanate production, and a polyol like PTMEG (Polytetramethylene Ether Glycol) or PPG (Polypropylene Ether Glycol) in a batch or continuous process.
During the reaction, raw materials are pumped from their storage tank to a pressurized, heated and agitated reactor while additives are incorporated according to a specific recipe to obtain the formulation specific to each manufacturer.

In 2014, the annual growth rate for these products was expected to be **over 6%** worldwide per year for the next 5 years.

"Crude" MDI or TDI is produced by reacting a diamine (MDA or TDA) with phosgene. The crude diisocyanates are then fractionated in a distillation column to produce purer blends of MDI or TDI isomers for use as raw material in polyurethane.
At the bottom of the column, a mixture of MDI or TDI and tar is sent for recovery through a drying/evaporation process in order to increase the unit output of MDI/TDI.

Viscosity is a crucial parameter in the evaporation of MDI/TDI and can also be beneficial in other processes of the MDI/TDI cycle. As a temperature-dependent physical characteristic of these chemicals, a precise control of viscosity and temperature can help, for example, monitoring accurately the residue content of the evaporator which will, in turn, give reliable information about the good operation of the process.

Challenges

One of the challenges in diisocyanates production is the recovery of MDI/TDI from the tar after the first distillation. Distillation residues contain a substantial quantity of free MDI/TDI ranging anywhere from 30% to 70% by weight, meaning that its recovery is of utmost importance in order to increase the process profitability. In the case of TDI, the evaporation causes the distillation residue to go through a rubbery viscous phase and then a pasty phase with a strong tendency to foam. Eventually, when the TDI content falls below 15%, this residue starts solidifying and forms a crust.

Important concerns during recovery by means of evaporation and drying are:

- **Solidification** and plugging of the entire process equipment
- Uncontrolled thermal **decomposition** reactions
- From a health standpoint, the **toxicity** of TDI requires efficient means of containment.

Solution

In the life cycle of diisocyanates, several applications exist for viscosity control, especially in a MDI/TDI recovery process:

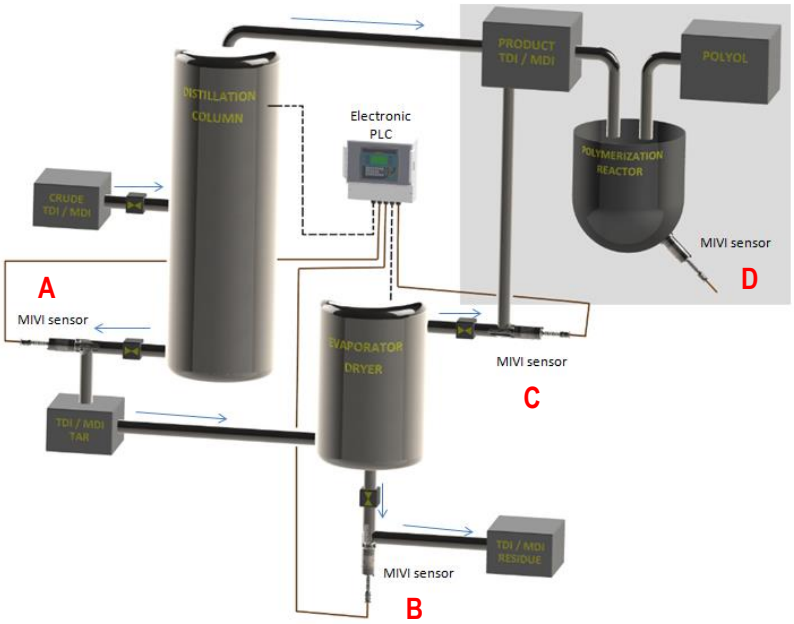
- **At the bottom of the main distillation column**, an inline MIVI viscometer will help monitor the tar quality in order to regulate evaporation parameters (A)
- **At the output of the evaporator/dryer:**
  - Either in the residue (B), a MIVI viscometer will allow the monitoring of the residue to ensure that sufficient product has been recovered
  - Or in the final product (C), a MIVI viscometer allows a precise monitoring of the viscosity of the recovered MDI or TDI, maximizing the MDI/TDI final product quantity.
- **During the polymerization process** of MDI or TDI with polyols and additives, a process viscometer installed in the reactor (D) will help control the polymerization process (please refer to application note – ref 299/o – addressing polymerization application)

Installation

MIVI A, B and C:
Easily mounted on a pipe angle coming out of the distillation tower or evaporator, the MIVI sensor monitors the viscosity of the recovered product. Connected to a simple electronic, or to a regulator, depending on the installation, the viscosity indication allows the adjustment of the drying parameters such as heat power or evaporation time and can divert products in the case of anomalies. This prevents contamination of the final MDI/TDI product used for polymerization.

MIVI D: directly mounted on reactor for polymerization control

MDI/TDI global operation diagram for MIVI sensors



Key product characteristics

- Good sensitivity
- Self cleaning
- Repeatable and reliable
- Easy to install with a wide variety of mountings and positions
- No maintenance, no wearing parts and no drift in time
- Ex-proof certifications
- Temperature probe
- Many different coatings for corrosive materials