LIST

Kneading - Mixing - Drying

TDI Distillation Recovery Process:

Optimizing The Recovery of Residues in the Production of Polyurethane.

A White Paper | Summer 2019

TDI Residues Recovery Process

The recovery of undesired, hazardous and toxic TDI residues is a crucial aspect in the polyurethane production process. For almost fifty years, Swiss engineered LTAG technology is the worldwide standard in many industries.

Polyurethanes, similar to other polymer materials, are widely used across numerous industries such as construction, automotive industry, furniture, insulation, coatings, sealants, elastomers, adhesives and fibers. Toluene Diisocyante (TDI) in the composition of 2,4 and 2,6 isomers is widely used as monomer for the production of polyurethanes. Flexible polyurethane foams are the most common and largest application for TDI.

Since the first industrial production in 1950's the production of TDI has been steadily increased, resulting in new world-scale TDI plants with a production capacity of up to 300 ktpa. The industrial scale production of TDI is a very complex, challenging, multi-step process, including nitration, hydrogenation and phosgenation reactions with various thermal separation steps. In general the whole TDI process is divided in three production sections:

1. DNT (Dinitrotoluene)
2. TDA (Toluene Diamine)
3. TDI (Toluene-Diisocyanate)

A Broad Range of Undesired Distillation Residues.

During the course of production, undesired residues will be generated as by-products; some in the TDA step, the main part during the phosgenation step and the downstream TDI separation section. The undefined composition of the distillation residue can vary in a broad range, depending on the TDI Technology and the operating conditions (chemical reaction, catalyst, performance, temperature, pressure, residence time, vacuum leakage rate, etc.).

There is also an ongoing chemical reactivity of TDI and side-products, which increase also the amount of residue. Typical components are e.g. Urea, Biuret, Carbon-diimide or Isocyanurate.

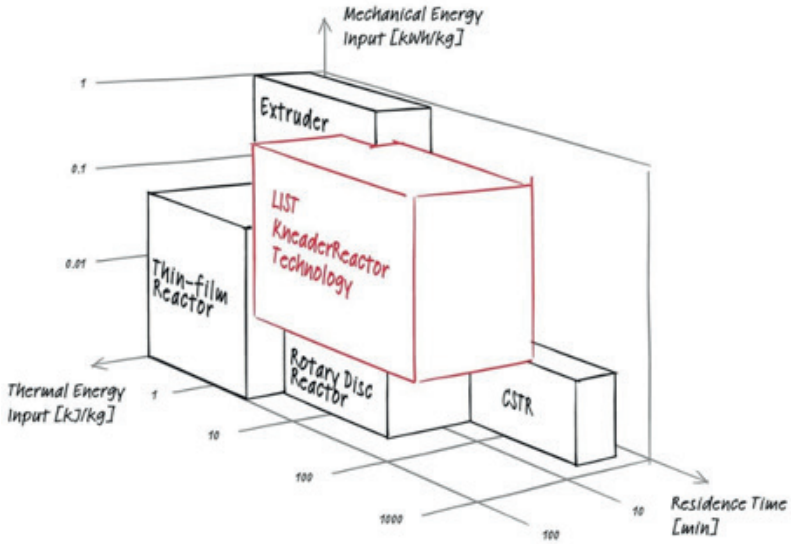
The high boiling by-products, also called Tars, must be removed in the last purification column in such condition that the column residue is still pumpable and can be conveyed into a thin-film evaporator or any other type of pre-concentrator.

Due to the ongoing chemical reaction and increasing viscosity, the residence time and the concentration of residues is limited with the risk of runaway chemical reactions and risk of explosion. Long-term storage, disposal or direct incineration of the concentrated distillation residue is hardly feasible, nor practicable in industrial scale (1'000 – 3'000 kg/h of distillation residue). Typically, the Tars concentration is in the range of 30 – 70 % at temperatures of 140 – 165 °C

Consequently there is a strong need to quickly process this hazardous, toxic distillation residue and at the same time recover the valuable TDI monomer.

- LIST has developed and optimized the TDI distillation recovery process for over 40 years.
- LIST has industrialized more than 40 operating production lines with LIST Technology of TDI Distillation Residue Recovery.
- LIST is the process leader worldwide for the recovery of TDI Distillation residues.

Polyurethane *is present in our everyday's life*



The LIST TDI Distillation Residue Process. An Industrial Standard

The LIST TDI Distillation Residue Process is based on fast thermal separation of the concentrated residue stream and the continuous transition of the remaining residues into granular solid Tars. These solids can be stored, land-filled or incinerated for power/steam generation. Applying the LIST Process it is possible to recover almost 100% of the TDI from the distillation residue. The typical final free TDI content in Tars is less than 0.5 wt%.

During the TDI separation by evaporation, the liquid distillation residue passes through a rubbery, viscous, pasty phase with a strong tendency to foam, caused by decomposition and release of CO_2. When the TDI content is below 15%, the residue starts to solidify and forms a solid hard crust and after further drying turns into a solid granular material. All phases starting from low to medium to high viscous phases and subsequent granular phase can be handled in the same processor.

The LIST Twin Shaft Processor: Simply Best in Class.

The LIST TDI Distillation Residue Process is based on the LIST Twin Shaft Processor. The recovery is effected by continuous evaporation/drying under vacuum condition. The final residue is an odorless, low-toxic granular solid.

The LIST Twin Shaft Processor is characterized by its two parallel, inter-meshing agitator shafts in a horizontal housing. The main shaft carries disc elements with kneading bars. The cleaning shaft is fitted with kneading elements that mesh with, and clean, the main agitator disk elements and bars.

Intermeshing of the two sets of elements generates an intensive mixing/kneading action and achieves effective self-cleaning. The arrangement of the kneading bars and disk elements is designed to provide a gradual forward conveyance of product, coupled with intensive lateral intermixing.

The shell housing, agitator shafts and disk elements are heated by thermal oil circulation. The heat exchange surface is very large in relation to the volume. The intensive mixing and kneading action, coupled with the self-cleaning of the heat exchange surface, combines to break up of solid crust layers, agglomerates and lumps, a major requirement for the TDI process.

This ensures a high rate of product surface renewal for both heat and vapor transfer.

Highly Flexible and Adaptable.

To handle the required torque and power, these units operate with agitator shaft speeds between 4 and 30 rpm, and maximum available torques as high as 250 kNm. The arrangement of the kneading elements with screw angle imparts regular axial conveying, even at the highly viscous, pasty phase of TDI-residue mass in the process chamber. The LIST Twin Shaft Processing Technology is easily adaptable to changing feed rates, composition and different origin of residues. This ensures high operational flexibility even under extreme circumstances.

The LIST Twin Shaft Processor operates at fill levels in the range of 40 - 70% of total. That leaves adequate free volume for vapor disengagement. This is an important technical feature taking into account that the initial free TDI content in the distillation residue stream could be as high as 70% by weight, and that the process takes place under vacuum.

The main benefits of LIST TDI Recovery Technology:

- Reliable, industrially proven and low maintenance
- Processing the changing consistency of the residue in a safe, continuous mode of operation
- Closed design and TDI containment, environmental friendly operation
- High flexibility with respect to capacity and composition of the distillation residue, i. e. wide process/operation window
- Optimized design and operation
- Long life time with low abrasion due to low shaft speed
- Less dust formation and dust entrainment
- 40 years experience and know-how in TDI recovery process.
- Low energy and labor costs.

About: LIST Technology is a Swiss high tech company providing solutions for high viscosity mixing and processing. LIST is a niche company solving very unique, specific and complex rheology challenges with Swiss Engineered solutions, services and equipment. The LIST Competence & Test Center in Arisdorf, Switzerland and the LIST Team of specialists offer Clients the unique possibility of dealing, testing and scaling all features and phases of their specific project, from Process simplification to Large scale industrial intensification.

Note: For obvious confidentiality obligations, LIST Technology does not discard the Identity of its clients or details of its projects.

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focused

A Jakob Müller Company

LIST Technology AG - Berstelstrasse 23 - 4422 Arisdorf - Switzerland
+41 (0)61 815 30 00 - info@list.ch - www.list.ch

+LISTengineered