Toluene diisocyanate (TDI) CH₃C₆H₃(NCO)₂ is an organic compound where two of the six possible isomers - 2,4-TDI and 2,6-TDI - are used in the commercial production of an extensive range of materials. These include flexible polyurethane foams (the largest market for TDI products); rigid foams, which use polymeric MDI as the isocyanate component; and in adhesives, sealants, surface coatings and elastomers, which TDI is used principally in urethane alkyds, reactive two - component systems and moisture-curing pre-polymers.

TDI synthesis is a complex, three-stage process which first require the production of toluene diamine and phosgene (COCl₂), which are then combined and distilled to create TDI, with hydrochloric acid as a by-product. The process, which involves combining a range of toxic materials including hydrogen, chlorine and carbon monoxide, requires high levels of gas analysis for both process control and product purity throughout all three processes.

Servomex is an expert in the supply of analyzers and systems designed to meet all requirements of the TDI process. Offering an industry-leading range of analyzer technologies, we offer a turnkey solution for TDI gas analysis that overcomes common process problems including gas cross sensitivity, the highly toxic nature of the process and detecting low levels of Chlorine within the TDI product.

Supported by a global network of Service and Support, our expertise in TDI analysis enables us to consult, design and build systems that are safe, reliable, highly efficient and highly productive.
Toluene Diisocyanate Process Application Map

1. TDA Production
Hydrogen from the HyCO process is used for the Hydrogenation of dinitrotoluene (DNT) and the next step is the catalytic reduction of dinitrotoluene under hydrogen pressure which is subsequently undertaken to produce toluene diamine (TDA). There are a number of measurements to ensure the quality of the CO using the SERVOPRO MultiExact 5400 (1), SERVOPRO 4210 (2), SERVOTOUGH OxyExact 2200 (3) and SERVOTOUGH LaserSP 2900 (4), which measure hydrogen, methane, oxygen and water impurities respectively. The purity of the hydrogen is also measured, with the MultiExact (5) measuring percent hydrogen and 4210 (6) measuring ppm carbon monoxide. Hydrogen is also measured as an offgas (7).

2. Phosgene Manufacture
Phosgene is made using the carbon monoxide from the HyCO process and chlorine from the electrolysis of brine. The SERVOTOUGH SpectraExact 2500 (8) provides a critical purity measurement for the supplied CO while the SERVOTOUGH LaserSP (9) monitors for ppm moisture levels in the chlorine feed.
The TDA is then treated with the phosgene under controlled temperature and pressure conditions, with quality ppm measurements of Cl\(_2\) and CO\(_2\). This results in a TDI isomer mixture in solution, together with traces of phosgene and HCl. These traces are subsequently separated and recycled.

During the phosgenation stages the orthodichlorobenzene solvent is monitored for moisture and NCO (cyanate groups). The phosgene quality is also measured by the SpectraExact for purity and also for impurities including HCl, CO\(_2\) and moisture.

The TDI isomer mixture is then purified by distillation. There is no change to the 80:20 isomer composition during this step. During the distillation process the HCl by-product is monitored for impurities such as phosgene and solvents by the SpectraExact and 4210. Phosgene emission in the stack and CO emissions are measured by the SpectraExact (20) and 4210 (21) respectively.