

## Uses and Applications of Isocyanates

Isocyanates are widely used in manufacturing materials like polyurethane foams, rubbers, plastics, varnishes, adhesives and paints. A list of the most widely used industrial organic isocyanates and their main uses is in Table 1.

**Table 1** Isocyanate compounds

Name	Form	Main uses
Toluene diisocyanate (TDI)	Liquid (mix of 2,4- and 2,6-isomers)	Flexible polyurethane foam production
Methylene diphenyl diisocyanate (MDI)	Low-melting point solid	Rigid polyurethane foam production
Hexamethylene diisocyanate (HDI)	Liquid	Spray paints, lacquers and car re-finishing
Napthalene diisocyanate (NDI)	Solid	Elastomers and synthetic rubbers
Methyl isocyanate (MIC)	Liquid (highly volatile)	Intermediate in the production of some pesticides
Isophorone diisocyanate (IPDI)	Liquid	Manufacture of coating and adhesive polymers and polyurethane foams

. Isocyanates can also be generated from thermal decomposition of polyurethane materials including coated metals.

### Workers at greatest risk from exposure to isocyanates

The most common work activities and situations in which workers may be exposed to isocyanates are summarised in Table 2.

**Table 2** Isocyanate exposure to workers

Work activity	Source of exposure
<b>Spraying operations</b> e.g. spray painting and spraying of resins, lacquers and adhesives containing isocyanates	<ul style="list-style-type: none"> <li>Unreacted or partially cured isocyanates may be present during or after spraying. These may potentially be inhaled or come into contact with skin.</li> <li>Workplaces where two-pack mix isocyanate substances are sprayed. This can include vehicle repairers (paint), furniture and cabinet makers (paints, lacquers, adhesives and vinyl wrapping) and spa manufacturers (application of insulating foam and resins).</li> <li>Spray painters who use two-pack mix polyurethane paints are at high risk of exposure. The repair and refinishing of cars usually involves the spraying of isocyanate-containing coatings. Isocyanates like HDI used in paints are often also present as pre-polymers and polymeric</li> </ul>

## SAFETY IN NUMBERS – SUPPLEMENTAL INFORMATION

Work activity	Source of exposure
	isocyanates. Pre-polymers and polymeric isocyanates have the same health effects as free isocyanates when sprayed due to the generation of aerosols and overspray that may be inhaled.
<b>Manufacturing operations</b> e.g. polyurethane foams, synthetic rubbers, plastics production, insulation making, furniture making and cores for foundry castings	<ul style="list-style-type: none"> <li>• Foaming operations involving the formation of gases or a blowing agent. This can enhance the release of isocyanate vapour or aerosols.</li> <li>• Heating isocyanates before mixing with resins. This can increase the volatility of isocyanates.</li> <li>• Inhaling isocyanates during storage of product while they are still curing. There may be unreacted isocyanates which can evaporate creating an unsafe atmosphere.</li> <li>• Hot wire-cutting of polyurethane foams. In this situation isocyanate vapours can be released.</li> <li>• High temperature bonding involving polyurethane based sealers.</li> </ul>
<b>General transportation and storage</b>	<ul style="list-style-type: none"> <li>• Incorrect storage or transportation e.g. where water entry is allowed or where spillages occur and control measures are not in place to eliminate or minimise the risk of exposure.</li> <li>• Storage of newly made polyurethane products while they are still curing and emitting isocyanate fumes.</li> </ul>
<b>Welding of pipe work</b>	<ul style="list-style-type: none"> <li>• Hot welding of pipe work lagged with polyurethane foams. This can cause the foam to break down and release isocyanates.</li> </ul>
<b>Varnishes</b> e.g. in timber floor finishing	<ul style="list-style-type: none"> <li>• Varnishes that are not fully cured. Some varnishes contain isocyanates which may continue to be released until the varnish is fully cured.</li> <li>• Hot removal of varnish. This may result in the release of isocyanates.</li> </ul>
<b>Mining</b> e.g. filling tyres with two-pack mix polyurethane foam (flat proofing), spraying ground and strata surfaces and injecting voids to make them stable for mining operations	<ul style="list-style-type: none"> <li>• Mixing a two-pack mix material in tyre fitting workshops and injecting it into tyre voids.</li> <li>• Isocyanates being released from tyres filled with polyurethane foam if the tyres are damaged or catch fire during use or maintenance.</li> <li>• Transferring isocyanates and polyol by hose over distances underground and mixing isocyanates and polyol in underground restricted spaces and ventilated areas.</li> <li>• Polyurethane resins being sprayed or injected by workers. This can also affect others nearby.</li> </ul>
	<ul style="list-style-type: none"> <li>• Polyurethane used in ground or strata control for coal mines may act as an insulator and increase the risk of spontaneous combustion. Polyurethane should not be used where coal is prone to spontaneous combustion.</li> <li>• Polyurethane and toxic gases are released e.g. hydrogen cyanide (HCN). This can promote the spread of fires.</li> <li>• Welding sparks ignite polyurethane foam and create a fire underground.</li> </ul>