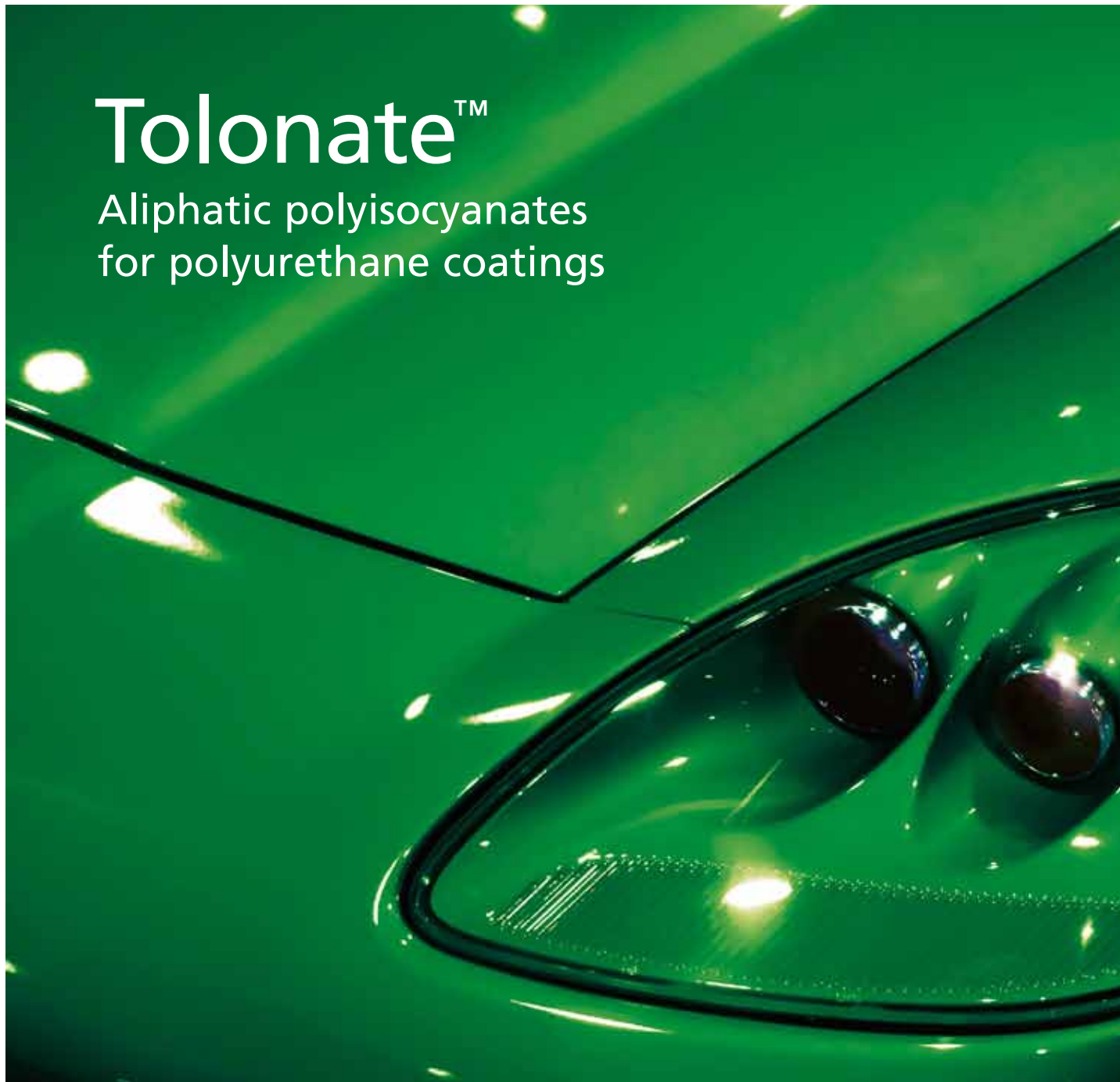


# Tolonate™

Aliphatic polyisocyanates  
for polyurethane coatings



## Our Tolonate™ aliphatic isocyanates

- Outstanding appearance
- Exceptional gloss retention
- Non-yellowing upon ageing
- High-solids, low-VOC options
- Fast drying possibilities

# The elements of success

You need a partner who can see the big picture when it comes to your products, your processes and your customers. Our experience and expertise in the special niches of organic chemistry, process technology and application development are at your service, providing you with a complete chain of solutions to enhance quality and profitability at every step.

Our versatile intermediates, an essential element of your winning formula, are specifically designed to add value and enhance end-product performance. Your solution to meeting the increasing demands for safer, lighter, more durable and environmentally friendly end-user products, begins here.

## Innovation in everything we do

Innovation distinguishes every aspect of our business process. Developing smarter and safer solutions creates real value in new chemical applications. Focused innovation instills leadership and purpose in our business activities, improves internal processes and increases application and product competitiveness.

## Delivering our promises globally

Our global presence provides you with reliable solutions and processes, consistent high quality, security of production and supply and delivery with precision. This commitment also means rapid response when product or application support is required and the very best in technical support.

## Putting the care into chemicals

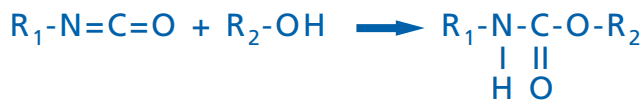
We take our responsibilities to heart and are committed to attentive, sustainable business practices. We minimize risks for our customers, our employees and the environment by working proactively to ensure safe products and processes.



# Leveraging the performance of polyurethane coatings

## Polyurethane coating technology

Polyurethane coatings are based on binders formed by the reaction between a (poly)isocyanate (-NCO) and another polymer containing hydroxyl groups (-OH), commonly called a polyol.



Polyurethane formation

The choice of raw materials, both polyols and (poly)isocyanates, is very large, enabling many combinations with a wide variety of properties. Polyurethanes based on aliphatic polyisocyanates are well known for their outstanding properties, especially for their exceptional resistance to weathering.

The main applications where the Perstorp Tolonate™ range is ideal for polyurethane formulations are:

- ➔ Automotive primers and clearcoats (both OEM and refinish)
- ➔ Transportation coatings for buses, trucks, railway carriages and aerospace
- ➔ Marine & protective coatings
- ➔ Plastic coatings
- ➔ General industrial coatings on metal and glass
- ➔ Wood coatings
- ➔ Can & coil coatings
- ➔ Concrete coatings

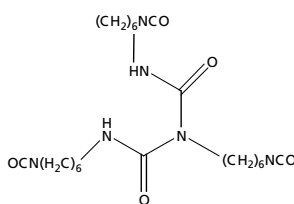


Figure 1. Tolonate™ HDB

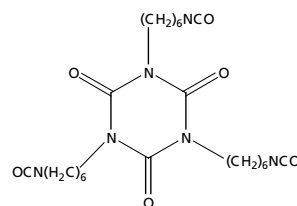


Figure 2. Tolonate™ HDT

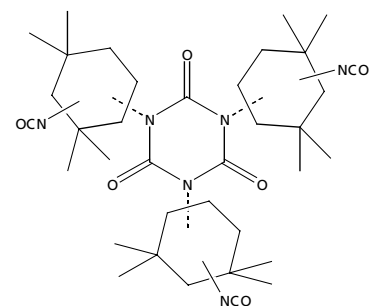


Figure 3. Tolonate™ IDT

## Our Tolonate™ range

### Tolonate™ HDB series

Due to internal hydrogen bonds (see figure 1), Tolonate™ HDB series are more polar than the other HDI derivatives. As a result, they exhibit:

- ➔ good compatibility with a wide range of resins (especially polyester polyols and alkyds)
- ➔ very good adhesion to a lot of substrates

### Tolonate™ HDT series

Thanks to their aliphatic nature and to their isocyanurate ring structure (see figure 2), Tolonate™ HDT series exhibit:

- ➔ exceptional UV and weathering resistance (non-yellowing and very high gloss retention)
- ➔ chemical and solvent resistance
- ➔ ideal balance between high functionality and low viscosity, which explains their increasing usage in low-VOC systems (high solids and solvent-free formulations)

### Tolonate™ IDT series

Due to their cyclo-aliphatic structure (see figure 3), Tolonate™ IDT series:

- ➔ facilitate fast drying and improve initial and final hardness
- ➔ produce coatings with improved resistance to acids and solvents



# Tolonate™ key benefits

## Outstanding appearance

Thanks to their high transparency and very low color, Tolonate™ polyisocyanates are ideal for producing polyurethane clearcoats and topcoats when the aesthetic and durability of the coatings are critical.

## Exceptional gloss retention and non-yellowing properties

Polyurethane coatings with Tolonate™ exhibit exceptional gloss retention and non-yellowing properties upon ageing (see graph 1).

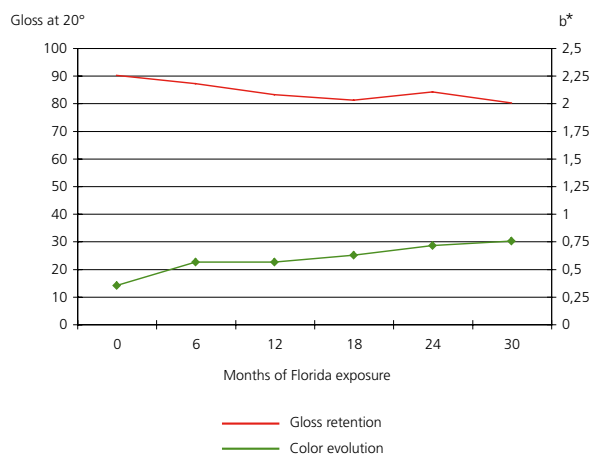
## High-solids, low-VOC options

We have implemented a special process for Tolonate™ low-viscosity LV grades (see graph 2). These 100% solids products are particularly well adapted for low-VOC formulations.

## Fast drying possibilities

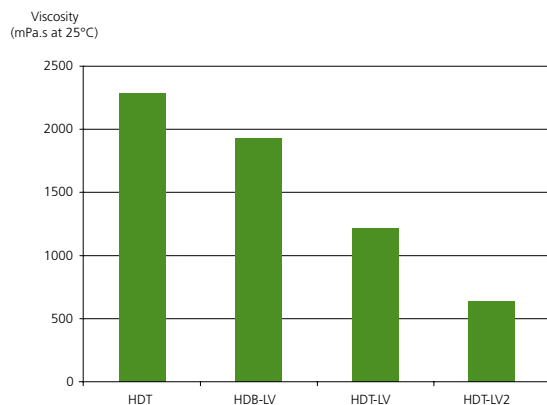
We offer special grades, like the Tolonate™ IDT series, which reduce the drying time of coatings, improving painting productivity.

Graph 1: Gloss retention and color evolution



Gloss and color evaluations of a Tolonate™-based clearcoat over a waterborne metallic basecoat applied on steel panels during months of ageing in Florida.

Graph 2: Viscosity of 100% solids Tolonate™ grades



# Formulating recommendations

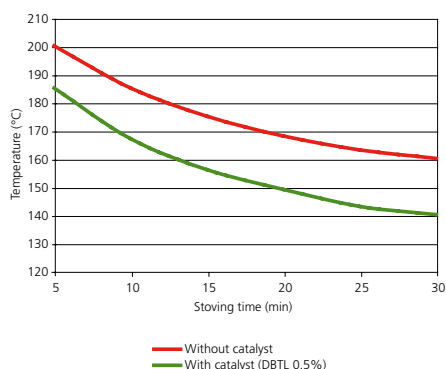
## 1K formulations with Tolonate™ D2

Tolonate™ D2 is used as a crosslinker of one-pack heat-activated coatings (as the only crosslinker or in conjunction with amino resins).

Since Tolonate™ D2 is temporarily blocked, these 1K formulations show no reactions to humidity and do not have a limited pot-life during application. They are ready-to-use (the end-user does not have to add a hardener in precise quantity prior to use).

Typical curing conditions are 20-40 minutes at 140-150°C (280-300°F). Higher temperatures result in shorter curing times. Therefore, 1K formulations based on Tolonate™ D2 can only be used on metal or glass substrates. Tin catalysts can be used to reduce baking temperatures or time (see graph).

Curing conditions of 1K formulations with Tolonate™ D2



## 2K formulations with other Tolonate™ grades

Except Tolonate™ D2, the other Tolonate™ grades are used as crosslinkers of two-pack (2K) polyurethane formulations. The paint applicators have two separated components. The pot containing the polyol is usually called part A, while the the hardener based on Tolonate™ is called part B.

Just prior to use, end-users have to mix the two parts in a specified ratio (see processing recommendations, page 8). As soon as the two packs are mixed, the NCO groups of the polyisocyanate start to react with the OH groups of the polyol, leading to a slow, continuous and irreversible increase in viscosity. The time during which the coating can be used is called "pot-life". The end of the pot-life is usually reached once the initial viscosity of the ready-to-use coating has doubled.

Since the NCO + OH reaction takes place at room temperature, the 2K polyurethanes are used on all the substrates which are sensitive to heat (like wood and plastics) and on all the objects which are too big to be stoved (airplanes, bridges, railway carriage, etc.).

2K polyurethane coatings are either cured at room temperature or forced-dried at 50 to 80°C or even baked at 140°C, depending on the final applications and paint line equipment.



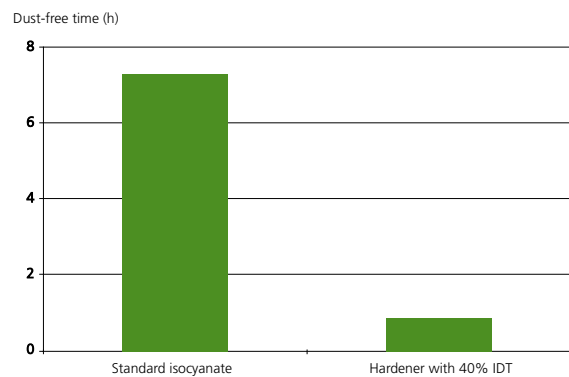


### Fast-drying 2K formulations

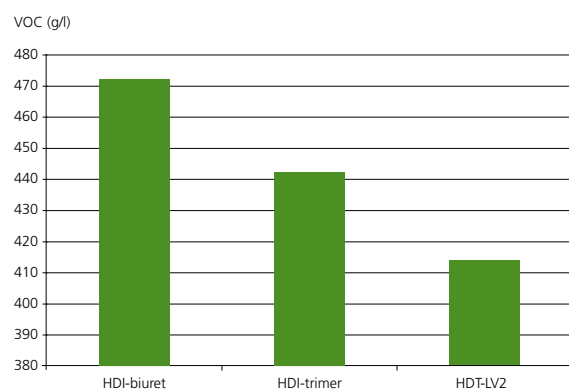
Fast drying is a key parameter to increase paint productivity and to minimize dust issues. Physical drying time can be strongly reduced and the rate of hardness development increased by using Tolonate™ IDT 70 series (see graph). In order to keep an acceptable level of coating flexibility, Tolonate™ IDT 70 series should be used in blends with Tolonate™ HDT or HDB grades.

### High-solids, low-VOC 2K formulations with Tolonate™ HDT-LV2

- ➔ In order to comply with new regulations, formulators have to offer low-VOC (Volatile Organic Compounds) formulations.
- ➔ We have developed a unique process leading to the low-viscosity, 100% solids HDI-trimer Tolonate™ HDT-LV2. Thanks to Tolonate™ HDT-LV2, high-solids, VOC-compliant coatings can be prepared (see graph). These formulations exhibit similar properties to the ones based on standard polyisocyanates.



Effect of Tolonate™ IDT 70 on dust free time



Comparison of VOC level of clearcoats based on various hardeners

# Dilutions of Tolonate™ with solvents in 2K formulations

In order to reduce the viscosity of Tolonate™ and obtain a simple mixing ratio between part A and part B, formulators usually dilute Tolonate™ using one or more solvents.

## Type of solvent(s)

Some of the most common solvents in the paint industry can be used to dilute Tolonate™, with the exception of those that may react with the polyisocyanate, such as alcohol or glycol monoethers. Besides, Tolonate™ is not fully soluble in aliphatic hydrocarbons (like white spirit), which should not be used.

The best solvents for Tolonate™ are esters (like butyl acetate) and ketones (like MIBK: methyl isobutyl ketone). Ether esters (like MPA: methoxy propyl acetate) and aromatic hydrocarbons (such as xylene or naphtha solvents) are also commonly used.

Dilutions using hydrophilic solvents, such as ketones, are more sensitive to atmospheric humidity than those produced with hydrophobic solvents such as aromatic hydrocarbons.

## Water content of the solvent(s) and impurities reacting with NCO

Like all isocyanates, Tolonate™ reacts with water. It is therefore essential to use solvents with a water content lower than

500 ppm (preferably lower than 300 ppm), which are referred to as "urethane grade solvents."

We also recommend carefully checking the quantity of impurities likely to react with NCO groups, such as butanol and/or acetic acid in butyl acetate.

## Dilution level

It is theoretically possible to dilute Tolonate™ to a high degree. However, the higher the quantity of solvent, the greater the risk that traces of water from the solvent may cause problems with the diluted polyisocyanate.

That is why it is recommended to go no lower than 35-40% solids by weight. Below this level, there is a higher risk of obtaining turbidity, precipitates and even gels.

It should be noted that trimers can generally withstand higher dilution levels than biurets.



# Processing recommendations

## NCO/OH ratio: calculation and impact on final properties

A polyurethane network is created by the reaction between the polyol and the hardener based on Tolonate™. In theory a stoichiometrical ratio should be used (NCO/OH = 1), i.e. an equal number of NCO groups of Tolonate™ should react with the OH groups of the polyol\*.

- ➔ But in practice the NCO/OH ratio varies, depending of the required end properties.

In the case of primer coats, NCO/OH is usually lower than 1 (0.7 to 0.9 for example), to obtain a better film flexibility and a better inter-coat adhesion with the topcoat.

In the case of topcoats, NCO/OH is usually higher than 1 (1.1 to 1.5 for example) in order to ensure a perfect crosslinking of the film, and thus durability and protection against UV light, humidity and chemicals.

- ➔ An easy way to calculate the quantities of each component (Tolonate™ and polyol) is obtained by using the so-called "equivalent weights". They are either indicated on the product technical data sheets or can be calculated from the NCO content (%) and OH content (%), as explained hereafter:

### Tolonate™

$EW_{NCO}$  = equivalent weight of NCO in grams =  $42 \times 100 / (\% \text{ NCO})$

### Polyol

$EW_{OH}$  = equivalent weight of OH in grams =  $17 \times 100 / (\% \text{ OH})$

Technical data sheets for polyols sometimes only mention the OH index ( $I_{OH}$  in mg KOH per gram of dry resin). OH content (%) can be calculated from this using the following formula:

$$\% \text{ OH} = I_{OH} / 32.94$$

- ➔ The ratio between the two components can then be obtained by using:
  - quantity of Tolonate™ (in grams) =  $NCO/OH \times EW_{NCO}$  (as supplied)
  - quantity of polyol (in grams) =  $EW_{OH}$  (as supplied) =  $EW_{OH} \text{ (on solids)} / \text{(solids content)}$

- ➔ Example:  
For a polyol with an OH% = 4% (on solids) and a solids content of 60% by weight:

$$EW_{OH} \text{ (on solids)} = 17 \times 100 / 4 = 425 \text{ g}$$

$$EW_{OH} \text{ (on delivery form)} = 425 / (60/100) = 708 \text{ g}$$

Quantity of Tolonate™ HDB 75 MX to be used to have NCO/OH = 1.1:

$$\begin{aligned} \text{As NCO}\% = 16.5\% \text{ then } EW_{NCO} \text{ (as supplied)} \\ = 42 \times 100 / 16.5 = 255 \text{ g} \end{aligned}$$

We therefore need  $255 \times 1.1 = 280 \text{ g}$  of Tolonate™ HDB 75 MX for 708 g of polyol, which means 39.6 g of Tolonate™ HDB 75 MX for 100 g of polyol.

\* Formulators have to make their own tests in order to define the best NCO/OH ratio depending of their formulation and final application.

# Performance you can trust

## Designed to enhance

The unique properties and the virtually endless design possibilities of polyurethanes have ensured widespread use in many applications.

## Coatings for automotive OEM and repair

Coatings for automotive applications serve to protect the substrates from the effects of corrosion and weathering. They also provide an attractive appearance and are considered as critical component.

Automotive requirements are very stringent and set high standards for gloss, appearance, acid etch and bird-dropping resistance, weathering and UV resistance. Thanks to their exceptional appearance and long durability, polyurethane coatings made from aliphatic polyisocyanates enable formulators to address these tough specifications.

## Industrial coatings

Industrial coatings cover a wide range of paint types (can and coil, aerospace, concrete flooring, plastic and wood coatings), which means a lot of different substrates and various end-user requirements are involved. They usually have to exhibit outstanding appearance (color, gloss and levelling) and bring long lasting protection (durability and chemical resistance). In addition, industrial coatings have to dry quickly, in order to follow the productivity requirements of the industry.

Polyurethane-based materials are widely used in industrial coatings because in the past 30 years they have proven their superiority in terms of durability (no yellowing and exceptional gloss retention upon weathering), mechanical properties (balance between hardness and flexibility) and chemical resistance.



## Product data summary

Tolonate™	Color <sup>(1)</sup>	Viscosity avg. mPa.s <sup>(2)</sup>	NCO avg. % <sup>(3)</sup>	Free monomer %	Solid content Avg. %	Solvent type	Bulk density kg/m <sup>3</sup> <sup>(2)</sup>	Flash point °C <sup>(4)</sup>	Equivalent weight g <sup>(3)</sup>	Refractive index <sup>(2)</sup>
<b>Biurets – polyesters compatibility</b>										
<b>Standard grades</b>										
HDB	≤ 40	9,000	22	< 0.3	100	-	1,120	> 120	191	1.505
HDB 75 B	≤ 40	150	16.5	< 0.3	75	B	1,150	35	255	1.4747
HDB 75 M	≤ 40	250	16.5	< 0.3	75	M	1,083	55	255	1.4761
HDB 75 MX	≤ 40	250	16.5	< 0.3	75	MX	1,067	38	255	1.4894
<b>Low viscosity</b>										
HDB-LV	≤ 40	2,000	23.5	< 0.3	100	-	1,120	> 120	179	1.5013
<b>Trimers – durability</b>										
<b>Standard grades</b>										
HDT	≤ 40	2,400	22	< 0.2	100	-	1,160	> 120	191	1.5039
HDT 90	≤ 40	500	19.8	< 0.2	90	SB	1,120	53	212	1.4988
HDT 90 B	≤ 40	450	20	< 0.2	90	B	1,132	48	210	1.4923
<b>Fast drying</b>										
X FD 90 B	≤ 60	2,000	17.4	< 0.5	90	B	1,130	48	240	1.4960 <sup>(5)</sup>
<b>Low viscosity</b>										
HDT-LV	≤ 40	1,200	23	< 0.2	100	-	1,160	> 120	183	1.5004
HDT-LV2	≤ 40	600	23	< 0.5	100	-	1,131	> 120	183	1.4986
<b>For thermosetting formulation (NCO-blocked)</b>										
D2	≤ 40	3,250	11.2	-	75	S	1,060	49	370	1.5103
<b>IPDI derivatives</b>										
IDT 70 S	≤ 60	1,830	12.3	< 0.5	70	S	1,040	45	342	1.5156
IDT 70 B	≤ 60	600	12.3	< 0.5	70	B	1,060	29	342	1.48
IDT 70 SB	≤ 60	1,000	12.3	< 0.5	70	SB	1,054	49	342	1.5038

B = butyl acetate X = xylene M = methoxypropyl acetate S = aromatic hydrocarbon NM = not measured  
 (1) = Hazen or APHA (2) = at 25°C (3) = on delivery form (4) = in closed cup

## Influence of temperature on viscosity

Tolonate™		Viscosity (mPa.s) at various temperatures						
		-20°C	-10°C	0°C	10°C	20°C	40°C	60°C
HDI derivatives	<b>Biurets</b>							
	<b>Standard grades</b>							
	HDB	NM	NM	241,470	66,310	22,730	3,540	860
	HDB 75 B	4,440	1,810	800	390	210	80	35
	HDB 75 M	NM	NM	1,450	600	310	110	45
	HDB 75 MX	11,000	3,850	1,820	700	340	110	50
	<b>Low viscosity</b>							
	HDB-LV	NM	65,680	19,660	7,190	2,910	665	200
	<b>Trimers</b>							
	<b>Standard grades</b>							
	HDT	NM	75,400	26,680	8,530	3,410	770	250
	HDT 90	27,430	9,070	3,420	1,440	690	200	80
	HDT 90 B	NM	NM	2,700	1,090	570	180	75
	<b>Fast drying</b>							
	X FD 90 B	NM	36,700	12,550	6,470	2,950	1,470	NM
<b>Low viscosity</b>								
HDT-LV	NM	27,400	9,380	3,810	1,640	410	140	
HDT-LV2	NM	15,580	5,170	2,180	1,000	280	105	
<b>Blocked</b>								
D2	NM	NM	10,100	24,060	6,370	960	250	
IPDI derivatives	IDT 70 S	NM	NM	NM	10,300	3,260	310	150
	IDT 70 B	NM	NM	NM	2,320	820	160	76
	IDT 70 SB	NM	NM	NM	6,000	1,950	330	100



## Your winning formula

The Perstorp Group, a trusted world leader in specialty chemicals, places focused innovation at your fingertips. Our culture of performance builds on over 125 years of experience and represents a complete chain of solutions in organic chemistry, process technology and application development.

Matched to your business needs, our versatile intermediates enhance the quality, performance and profitability of your products and processes. Present in the aerospace, marine, coatings, chemicals, plastics, engineering and construction industries, they can also be found in automotive, agricultural, food, packaging, textile, paper and electronics applications.

Our chemistry is backed by reliable business practices and a global commitment to responsiveness and flexibility. Capacity and delivery security are ensured through strategic production plants in Asia, Europe and North and South America, as well as sales offices in all major markets. Likewise, we combine product and application assistance with the very best in technical support.

As we look to the future, we strive for the development of safer products and sustainable processes that reduce environmental impact. This principle of innovation and responsibility applies not only to our own business, but also to our work with yours. In fulfilling it, we partner with you to create a winning formula that benefits your business – as well as the people it serves.

Discover your winning formula at [www.perstorp.com](http://www.perstorp.com)