Institutet
För Kemisk Analys Norden AB

2007-06-25

Emission measurement of isocyanates during use of a rotating file from Safety Tools Allmet A/S

Hässleholm, Sweden
2007-06-25

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Summary

Emissions during the application of a rotating file used for rust and paint removal were tested in an emission chamber at the site of IFKAN, Hässleholm, Sweden. In this limited study, emissions were monitored during paint removal on 3 different metal parts. A comparison with the use of an angle grinder was made for one of the material samples. A total of 24 air samples of isocyanates together with continuous measurements of ultrafine particle concentration were taken during the tests. A surface coating sample from each of the used metal parts were tested in the lab for emissions of isocyanates during controlled heating.

No emitted isocyanates, except very low concentrations of isocyanic acid (ICA), were found when the rotating file was used for paint removal on the three different metal parts. It should be noted that the large amount of paint dust produced could be transported on clothes or otherwise to locations where sources of heat could thermally degrade the dust and provide a potential exposure source.

The emission of sub-micrometer particles (smoke) during application of a rotating file to a coated surface is much lower than when an angle grinder is used for paint and rust removal.

The technique where a rotating file is used for paint and rust removal from metal parts is promising and there is a strong indication of a reduced emission of isocyanates as compared to “hot methods” (angle grinder, IR-heaters etc.). However, for an exhaustive and complete evaluation of the method, further tests are recommended focusing on issues like wear of tools, coating type, material thickness, handling during use and comparisons with alternative methods. The design of a more detailed study could preferably be made in collaboration with users of the tools.

Contents

1. Abbreviations

Abbreviations	
2,4 - TDI	2,4–toluene diisocyanate
2,6 - TDI	2,6–toluene diisocyanate
4,4' - MDI	4,4'–methylenediphenyl diisocyanate
HDI	Hexametylene diisocyanate
IPDI	Isoforone diisocyanate
PhI	Phenylisocyanate
PIC	Propylisocyanate
EIC	Ethylisocyanate
MIC	Methylisocyanate
ICA	Isocyanic acid
MA	Maleic acid anhydride
PA	Phtalic acid anhydride
TA	Tetrahydrophtalic acid anydride
HA	*cis*-Hexahydrophtalic acid anhydride

2. Introduction

At the request of Safety Tools Allmet A/S, Institutet för Kemisk Analys Norden AB has performed measurements of isocyanates and ultrafine particles in air during removal of surface coating on metal parts using a rotating file.

Sampling date: 2007-06-15
Company: Safety Tools Allmet A/S
P.O. Box 69
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Contact: Kjetil Olsen
Samples: Provided by IFKAN
Measurements: Performed by Mårten Spanne and Jakob Dahlin

3. Methods

Emissions from the Safety Tools Allmet AS rust and paint removal device, model WC 25/25/30 was tested at the site of IFKAN AB. The used rotating file had a length of 30 mm and a diameter of 25 mm and was working at 3000 rpm (Figure 1). Emissions were monitored during paint removal on 3 different metal parts (Figures 2-4). The tests were performed in a 20 m^3 climate controlled room with an air exchange rate of 10 exchanges per hour. The temperature was 15 – 18°C and the relative humidity 50 % during the tests. A total of 23 impinger-filter air samples[1-7] were taken. The concentration of ultrafine particles was continuously monitored using a condensation particle counter (TSI Inc., Shoreview, MN, USA). Three surface coating samples were tested in the lab for emissions of isocyanates during heating (Table 1). The surface coating was mechanically removed from the tested metal parts[7].

Table 1. List of used material parts for the tests.

Object ID	Material type and description	Lab test method
1	Car door (material sample 1) Painted with a red polyurethane coating	Heating with hot air gun to about 300 - 400 ºC
2	Car bonnet (material sample 2) Painted with a black polyurethane coating	Heating with hot air gun to about 300 - 400 ºC
3	Pipe (material sample 3) 3.5 inch pipe with 5.5 mm walls, painted with a multilayer offshore coating.	Heating with hot air gun to about 300 - 400 ºC

Figure 1. Cold grinding tool with rotating file. File diameter: 25 mm, width: 30 mm.

Figure 2. Metal part 1: Car door.

Figure 3. Metal part 2: Car bonnet.

Figure 4. Metal part 3: 3½ inch pipe. The wall thickness is 5.5 mm.

3.1. Air sampling

Air measurements were performed using sampling devices placed in the breathing zone of the worker (personal sampling) and close to the tool used. The sampling equipment consists of SKC pumps calibrated to a flow rate of 1.0 litres per minute connected to impinger flasks containing 10 ml reagent solution containing 0.01 M di-n-butylamine (DBA) dissolved in toluene. During sampling DBA reacts instantaneously with isocyanates to protect them from reacting with other compounds. The SKC pumps are protected from solvent vapours by the use of a tube filled with active coal connected in line with and between the SKC pumps and the impinger flask. A cassette containing a glass fibre filter was connected to the impinger flask. After sampling the filter was transferred to a test tube containing the reagent solution from the impinger flask. The sampling time was between 3 to 5 minutes. Duplicate air samples were collected in each experiment.

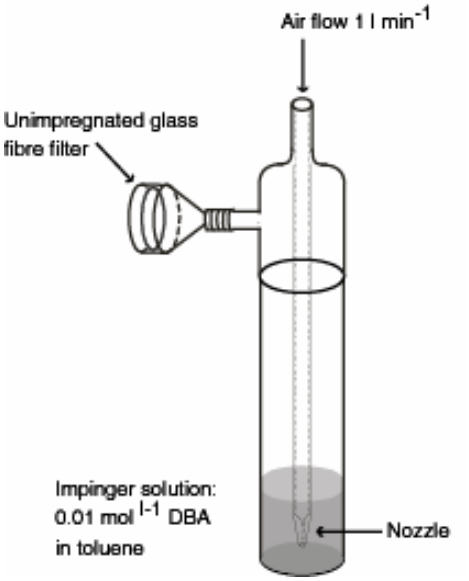
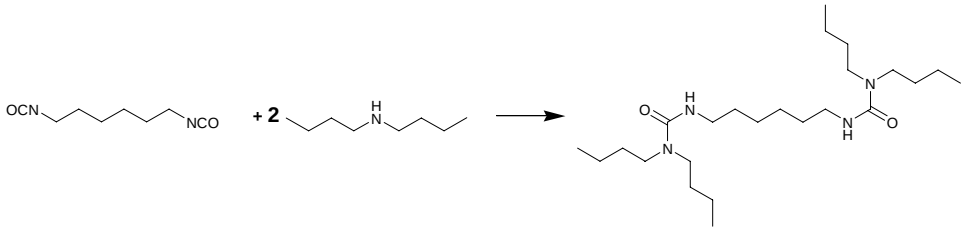


Figure 5. The impinger-filter sampling device.



Derivatisation reaction (example) for 1,6-hexametylenediisocyanate (HDI) with DBA.

3.2. Material samples

About 10 mg of the surface coating sample was introduced into a glass tube that was subsequently heated from the outside to 300 – 400°C using a hot air gun. Air was drawn through the glass tube to an impinger-filter sampler as described in the section above. The samples were heated for 2 minutes and the impinger solution and filter was analysed by LC-MS. The result is qualitative, showing only what types of isocyanates are emitted.

3.3. Particle measurements

Airborne particles were monitored by a condensation particle counter, detecting particles larger than 0.01 µm (CPC 3007, TSI Inc.). Data from the instrument could be fitted to video clips of performed work operations.

3.4. Chemical Analysis methods

Isocyanates were analyzed as DBA derivatives (urea derivatives). Derivatives were formed instantly during sampling.

3.4.1. Isocyanates

The collected air samples were prepared and then analysed by liquid chromatograph–tandem mass spectrometry (LC–MS/MS). Under the experimental conditions, the quantification limit for TDI, MDI, IPDI and HDI is 0.005 µg. For a five-minute air sample, this corresponds to approximately 1/100 of the Swedish occupational exposure limits (OELs).The quantification limit for EIC, PIC and PhI is 0.01 µg. For MIC it is 0.05 µg. For a five-minute air sample, this corresponds to approximately 1/10 of the OELs.

4. Results

A complete analysis report is attached in Appendix I. Below are pictures of the four tests performed.

Figure 6. Pictures showing (1) rotating file on car door, (2) angle grinder on car door, (3) rotating file on car bonnet and (4) rotating file on 3½ inch pipe.

4.1. Isocyanates in material samples

Coatings from the three metal parts were analysed in the lab by identification of the degradation products after heating the samples to about 300-400°C.

Table 2. The table shows occurrence of isocyanates in heated material samples (surface coating).

Object ID	ICA	MIC	EIC	PIC	PhI	HDI	2,6-TDI	2,4-TDI	IPDI (1)	IPDI (2)	MDI
1 (car door)	+	+	+	+	+	+	+	+	+	+	+
2 (car bonnet)	+	+	+	+	+	-	+	+	-	-	+
3 (pipe)	+	+	-	-	-	-	-	-	-	-	-

(x = detected isocyanate, - = no measurable occurrence)

The result show that the car door (sample 1) was painted with a coating based mainly on aliphatic isocyanates (emission of HDI and IPDI) but there are traces of several aromatic isocyanates also. Emissions from sample 2 (car bonnet) contain MDI and some monoisocyanates, indicating that the coating is mainly MDI-based. In sample 3 (pipe) there were no types of isocyanates emitted that typically arise from degradation of polyurethane paint. All samples emitted isocyanic acid (ICA) and methyl isocyanate (MIC).

4.2. Air samples

No emitted isocyanates, except very low concentrations of isocyanic acid (ICA), were found when the rotating file was used for paint removal on the three different metal parts, as can be seen in tables 3, 5 and 6.

When an angle grinder was used for removing paint (Test 2, Table 4) there was a clear emission of several types of isocyanates. The emission of MDI in this test does probably originate from the binder in the grinding wheel. The isocyanate concentration for each compound was below the Norwegian occupational exposure limit (OEL), except for ICA, but the combined exposure was well above the OEL. There is clear evidence that a rotating file will under all reasonable circumstances provide a lower emission of isocyanates than an angle grinder.

In Tables 3 – 6, results from the air samples are presented. Sampling position A is in the breathing zone of the worker and B is in the working zone close to the tool while it is being used. Sampling position C is stationary sampling in the room by the metal part, starting directly after the work operation was finished.

Table 3. Paint removal using rotating file. Test object 1: car door.

			Isocyanate air concentrations (µg m^{-3})										
Sample	Sampling time (min)	Sampling position	ICA	MIC	EIC	PIC	PhI	HDI	2,6-TDI	2,4-TDI	IPDI (1)	IPDI (2)	MDI
1	6.5	A	2.2	-	-	-	-	-	-	-	-	-	-
2	6.5		1.8	-	-	-	-	-	-	-	-	-	-
3	6.5	B	2.2	-	-	-	-	-	-	-	-	-	-
4	6.5		2.5	-	-	-	-	-	-	-	-	-	-
5	5	C	2.4	-	-	-	-	-	-	-	-	-	-
6	5		2.4	-	-	-	-	-	-	-	-	-	-

Table 4. Paint removal using angle grinder. Test object 1: car door.

			Isocyanate air concentrations (µg m^{-3})										
Sample	Sampling time (min)	Sampling position	ICA	MIC	EIC	PIC	PhI	HDI	2,6-TDI	2,4-TDI	IPDI (1)	IPDI (2)	MDI
7	3.47	A	30.5	1.2	-	-	1.2	4.6	-	-	4.6	-	17.3
8	3.47		28.8	1.2	-	-	1.2	5.8	-	-	4.6	-	16.1
9	3.47	B	21.3	0.6	-	-	-	4.6	-	-	3.5	-	7.5
10	3.47		20.7	0.6	-	-	1.2	3.5	-	-	2.3	-	8.1
11	5.5	C	14.5	0.7	-	-	0.7	2.5	-	-	1.5	-	0.7
12	5.5		12.4	0.7	-	-	0.7	3.3	-	-	1.8	-	1.8

Table 5. Paint removal using rotating file. Test object 2: bonnet.

			Isocyanate air concentrations (µg m^{-3})										
Sample	Sampling time (min)	Sampling position	ICA	MIC	EIC	PIC	PhI	HDI	2,6-TDI	2,4-TDI	IPDI (1)	IPDI (2)	MDI
13	5.37	A	2.6	-	-	-	-	-	-	-	-	-	-
14	Pump failure												
15	5.37	B	2.2	-	-	-	-	-	-	-	-	-	-
16	5.37		2.6	-	-	-	-	-	-	-	-	-	-
17	5	C	2.4	-	-	-	-	-	-	-	-	-	-
18	5		2.8	-	-	-	-	-	-	-	-	-	-

Table 6. Paint removal using rotating file. Test object 3: pipe.

			Isocyanate air concentrations (µg m^{-3})										
Sample	Sampling time (min)	Sampling position	ICA	MIC	EIC	PIC	PhI	HDI	2,6-TDI	2,4-TDI	IPDI (1)	IPDI (2)	MDI
19	4	A	1.5	-	-	-	-	-	-	-	-	-	-
20	4		1.0	-	-	-	-	-	-	-	-	-	-
21	4	B	1.0	-	-	-	-	-	-	-	-	-	-
22	4		0.5	-	-	-	-	-	-	-	-	-	-
23	5	C	0.8	-	-	-	-	-	-	-	-	-	-
24	5		0.8	-	-	-	-	-	-	-	-	-	-

It could be noted that grinding and cutting in a thin metal sheet such as a car door could be considered as a worst case situation as the metal will heat more rapidly than a thicker material such as the pipe in the last test. However, it should also be noted that the large amount of paint dust produced could be transported on clothes or otherwise to locations where sources of heat could thermally degrade the dust and provide a potential exposure source.

4.3. Particle measurements

Airborne ultrafine particles (0.01 – about 1 µm) was monitored as an indicator of thermal degradation products from the heating operation. The particle concentration varied considerably between the two different tools used. The grinding wheel produced particles in a concentration above the range for the instrument (500000 particles/cm^3)

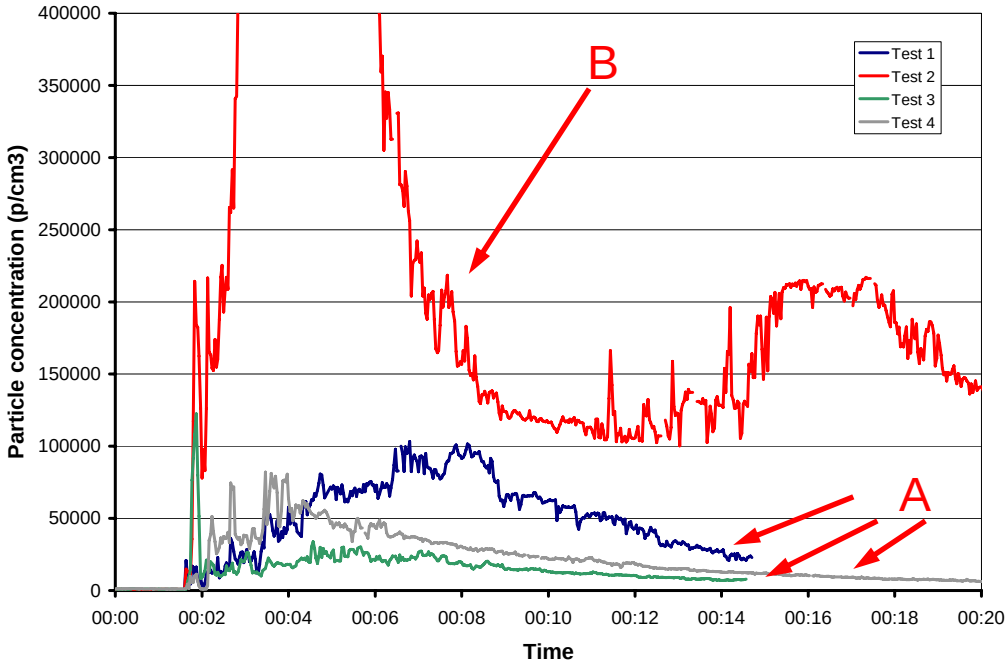


Figure 7. Comparison of particle concentration profiles during paint removal on metal parts. A: rotating file model WC 25/25/30. B: angle grinder.

Emissions of other compounds than isocyanates have not been performed in this study. The direct reading instrument detecting ultrafine particles showed increased air levels during the application of the rotating file. Further measurements are needed to investigate the chemical composition of these particles.

5. Conclusions

No emitted isocyanates, except very low concentrations of isocyanic acid (ICA), were found when the rotating file was used for paint removal on the three different metal parts. It should be noted that the large amount of paint dust produced could be transported on clothes or by other means to locations where sources of heat could thermally degrade the dust and provide a potential exposure source.

The emission of sub-micrometer particles (smoke) during application of rotating file to a coated surface is much lower than when a grinding wheel is used for paint and rust removal.

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The technique where a rotating file is used for paint and rust removal from metal parts is promising and there is a strong indication of a reduced emission of isocyanates as compared to “hot methods” (angle grinder, IR-heaters etc.). However, for an exhaustive and complete evaluation of the method, further tests are recommended, focusing on issues like wear of tools, coating type, material thickness, handling during use and comparisons with alternative methods. The design of a more detailed study could preferably be made in collaboration with users of the tools.

6. References

1. Arbete och Hälsa 2000:23. Jan-Olof Levin (red). Principer och metoder för provtagning och analys av ämnen på listan över hygieniska gränsvärden. (Work and Health 2000:23. Jan-Olof Levin (ed). Principles and methods for the sampling and analysis of substances in the list of hygienic values)

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3. Tinnerberg H, Spanne M, Dalene M and Skarping G (1996). Determination of complex mixtures of airborne isocyanates and amines. Part 2. Toluene diisocyanate and aminoisocyanate and toluenediamine after thermal degradation of a toluene diisocyanate-polyurethane. Analyst 121:1101-1106.

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Appendix I. Isocyanate analysis protocol

Institutet för Kemisk Analys Norden AB

21/6 2007

Analyssvar

Kjetil Olsen
Safety Tools Allmet A/S

Analys av isocyanater i luft

Beställnings ID: 9354126

2007-06-14

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Institutet för Kemisk Analys Norden AB 21/6 2007

Beställnings ID: 9354126

Ankomstdatum: 2007-06-14 **Klart datum:** 2007-06-21 **Luftprover - provförteckning**

Prov ID	Provtyp	Provtagningstid (min)	Luftflöde (L / min)	Provtagningsplats
1	Filter + reagens	6.50	1.0	Personburen provtagning vid färgborttagning med roterande fil. Impingerprover i andningszonen på filoperatören. Provmaterial: PUR-lackerad bildörr.
2	Filter + reagens	6.50	1.0	Personburen provtagning vid färgborttagning med roterande fil. Impingerprover i andningszonen på filoperatören. Provmaterial: PUR-lackerad bildörr.
3	Filter + reagens	6.50	1.0	Provtagning i färgsprutet efter roterande fil, provtagarna följde verktyget rörelser vid arbetet. Provmaterial: PUR-lackerad bildörr.
4	Filter + reagens	6.50	1.0	Provtagning i färgsprutet efter roterande fil, provtagarna följde verktyget rörelser vid arbetet. Provmaterial: PUR-lackerad bildörr.
5	Filter + reagens	5.00	1.0	Stationär provtagning i kammaren kort efter avslutad färgborttagning. Provmaterial: PUR-lackerad bildörr.

Ovanstående tabell utgör en förteckning över erhållna luftprover.

Provtagningsteknik:

Prov på: luft, i syfte att analysera isocyanater alternativt isocyanatrelaterade ämnen.

Provinsamlingskärl: Som standard användes impingerflaska med monterat filter.

Reagenslösning: 0.01 M Dibutylamin löst i toluen.

Luftflöde: 1.0 liter / minut rekommenderas.

Analysteknik:

Analysen utförs med: Vätskekromatografi - Masspektrometri - Masspektrometri (LC - MS - MS - ES+).

För ytterligare upplysningar om provtagningsteknik och analysteknik: Se referens 1 - 7.

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Beställnings ID: 9354126

Ankomstdatum: 2007-06-14 **Klart datum:** 2007-06-21 **Luftprover - provförteckning**

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7	Filter + reagens	3.47	1.0	Personburen provtagning vid färgborttagning med vinkelslip. Impingerprover i andningszonen på filoperatören. Provmaterial: PUR-lackerad bildörr.
8	Filter + reagens	3.47	1.0	Personburen provtagning vid färgborttagning med vinkelslip. Impingerprover i andningszonen på filoperatören. Provmaterial: PUR-lackerad bildörr.
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Provinsamlingskärl: Som standard användes impingerflaska med monterat filter.

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Luftflöde: 1.0 liter / minut rekommenderas.

Analysteknik:

Analysen utförs med: Vätskekromatografi - Masspektrometri - Masspektrometri (LC - MS - MS - ES+).

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13	Filter + reagens	5.37	1.0	Personburen provtagning vid färgborttagning med roterande fil. Impingerprover i andningszonen på filoperatören. Provmaterial: PUR-lackerad motorhuv.
14	Filter + reagens	Pump stannade	1.0	Personburen provtagning vid färgborttagning med roterande fil. Impingerprover i andningszonen på filoperatören. Provmaterial: PUR-lackerad motorhuv.
15	Filter + reagens	5.37	1.0	i färgsprutet efter roterande fil, provtagarna följde verktyget rörelser vid arbetet. Provmaterial: PUR-lackerad motorhuv.

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Provinsamlingskärl: Som standard användes impingerflaska med monterat filter.

Reagenslösning: 0.01 M Dibutylamin löst i toluen.

Luftflöde: 1.0 liter / minut rekommenderas.

Analysteknik:

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21	Filter + reagens	4.00	1.0	Provtagning i färgsprutet efter roterande fil, provtagarna följde verktyget rörelser vid arbetet. Provmaterial: Målat rör från oljeplattform, färgtyp okänd.
22	Filter + reagens	4.00	1.0	Provtagning i färgsprutet efter roterande fil, provtagarna följde verktyget rörelser vid arbetet. Provmaterial: Målat rör från oljeplattform, färgtyp okänd.
23	Filter + reagens	4.00	1.0	Stationär provtagning i kammaren kort efter avslutad färgborttagning. Provmaterial: Målat rör från oljeplattform, färgtyp okänd.
24	Filter + reagens	5.00	1.0	Stationär provtagning i kammaren kort efter avslutad färgborttagning. Provmaterial: Målat rör från oljeplattform, färgtyp okänd.

Ovanstående tabell utgör en förteckning över erhållna luftprover.

Provtagningsteknik:

Prov på: luft, i syfte att analysera isocyanater alternativt isocyanatrelaterade ämnen.

Provinsamlingskärl: Som standard användes impingerflaska med monterat filter.

Reagenslösning: 0.01 M Dibutylamin löst i toluen.

Luftflöde: 1.0 liter / minut rekommenderas.

Analysteknik:

Analysen utförs med: Vätskekromatografi - Masspektrometri - Masspektrometri (LC - MS - MS - ES+).

För ytterligare upplysningar om provtagningsteknik och analysteknik: Se referens 1 - 7.

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Beställnings ID: 9354126

Ankomstdatum: 2007-06-14 **Klart datum:** 2007-06-21 **Isocyanater i luft - rutinanalyser**

Prov ID	2.4 - TDI	2.6 - TDI	4.4' - MDI	HDI	PHI	MIC	EIC	PIC	IPDI	ICA	Haltenhet
1	-	-	-	-	-	-	-	-	-	2.2	µg/m³
2	-	-	-	-	-	-	-	-	-	1.8	µg/m³
3	-	-	-	-	-	-	-	-	-	2.2	µg/m³
4	-	-	-	-	-	-	-	-	-	2.5	µg/m³
5	-	-	-	-	-	-	-	-	-	2.4	µg/m³
6	-	-	-	-	-	-	-	-	-	2.4	µg/m³
7	-	-	17.3	4.6	1.2	1.2	-	-	4.6	30.5	µg/m³
8	-	-	16.1	5.8	1.2	1.2	-	-	4.6	28.8	µg/m³
9	-	-	7.5	4.6	0.0	0.6	-	-	3.5	21.3	µg/m³

Tabellen visar isocyanathalter i luft. (- = halt under kvantifieringsgränsen)

Kvantifieringsgränser:

TDI, MDI, HDI och IPDI: 0.005 µg. PHI, MIC, EIC och PIC: 0.01 µg. ICA: 0.05 µg.

Förkortningar:

2.4 - TDI	2.4 - Toluendiisocyanat	PHI	Phenylisocyanat	IPDI	Isoforondiisocyanat
2.6 - TDI	2.6 - Toluendiisocyanat	MIC	Metylisocyanat	ICA	Isocyanatsyra
4.4' - MDI	4.4' - Metylendifenyldiisocyanat	EIC	Etylisocyanat		
HDI	Hexametylendiisocyanat	PIC	Propylisocyanat		

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Beställnings ID: 9354126

Ankomstdatum: 2007-06-14 **Klart datum:** 2007-06-21 **Isocyanater i luft - rutinanalyser**

Prov ID	2.4 - TDI	2.6 - TDI	4.4' - MDI	HDI	PHI	MIC	EIC	PIC	IPDI	ICA	Haltenhet
10	-	-	8.1	3.5	1.2	0.6	-	-	2.3	20.7	µg/m³
11	-	-	0.7	2.6	0.7	0.7	-	-	1.5	14.5	µg/m³
12	-	-	1.8	3.3	0.7	0.7	-	-	1.8	12.4	µg/m³
13	-	-	-	-	-	-	-	-	-	2.6	µg/m³
14	-	-	-	-	-	-	-	-	-	-	µg/m³
15	-	-	-	-	-	-	-	-	-	2.2	µg/m³
16	-	-	-	-	-	-	-	-	-	2.6	µg/m³
17	-	-	-	-	-	-	-	-	-	2.4	µg/m³
18	-	-	-	-	-	-	-	-	-	2.8	µg/m³

Tabellen visar isocyanathalter i luft. (- = halt under kvantifieringsgränsen)

Kvantifieringsgränser:

TDI, MDI, HDI och IPDI: 0.005 µg. PHI, MIC, EIC och PIC: 0.01 µg. ICA: 0.05 µg.

Förkortningar:

2.4 - TDI	2.4 - Toluendiisocyanat	PHI	Phenylisocyanat	IPDI	Isoforondiisocyanat
2.6 - TDI	2.6 - Toluendiisocyanat	MIC	Metylisocyanat	ICA	Isocyanatsyra
4.4' - MDI	4.4' - Metylendifenyldiisocyanat	EIC	Etylisocyanat		
HDI	Hexametylendiisocyanat	PIC	Propylisocyanat		

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Beställnings ID: 9354126

Ankomstdatum: 2007-06-14 **Klart datum:** 2007-06-21 **Isocyanater i luft - rutinanalyser**

Prov ID	2.4 - TDI	2.6 - TDI	4.4' - MDI	HDI	PHI	MIC	EIC	PIC	IPDI	ICA	Haltenhet
19	-	-	-	-	-	-	-	-	-	1.5	µg/m³
20	-	-	-	-	-	-	-	-	-	1	µg/m³
21	-	-	-	-	-	-	-	-	-	1	µg/m³
22	-	-	-	-	-	-	-	-	-	0.5	µg/m³
23	-	-	-	-	-	-	-	-	-	0.8	µg/m³
24	-	-	-	-	-	-	-	-	-	0.8	µg/m³

Tabellen visar isocyanathalter i luft. (- = halt under kvantifieringsgränsen)

Kvantifieringsgränser:

TDI, MDI, HDI och IPDI: 0.005 µg. PHI, MIC, EIC och PIC: 0.01 µg. ICA: 0.05 µg.

Förkortningar:

2.4 - TDI	2.4 - Toluendiisocyanat	PHI	Phenylisocyanat	IPDI	Isoforondiisocyanat
2.6 - TDI	2.6 - Toluendiisocyanat	MIC	Metylisocyanat	ICA	Isocyanatsyra
4.4' - MDI	4.4' - Metylendifenyldiisocyanat	EIC	Etylisocyanat		
HDI	Hexametylendiisocyanat	PIC	Propylisocyanat		

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Isocyanater i luft - diskussion

Gränsvärdesangivelser:
Se Arbetsmiljöverkets författningssamling, AFS 2005:17. Hygieniska gränsvärden och åtgärder mot luftföroreningar, för gällande gränsvärden.

Provtagningsstrategi:
Vad gäller provtagning och mätresultat vilka skall sättas i relation till gränsvärden är att provtagningen självklart skall ske genom personburen provtagning. För att illustrera riskerna kan det ibland vara lämpligt att studera situationer av typen "värsta tänkbara fall av exponering". Det är naturligtvis angeläget att säkerställa skyddsutrustningens effektivitet om sådan normalt användes. I de fall då i produktionen olika typer av material och batch-visa variationer av material förekommer kan lufthalterna och exponeringen variera.

Exponeringsbedömning:
Denna typ av undersökning kan betraktas som en stickprovsundersökning. För att göra en bedömning av exponeringen vid arbetsplatsen i sin helhet måste prover tas så att representativiteten kan säkerställas. Man kan inte utgå ifrån att alla arbetsmoment och olika individers arbetsvanor åskådliggörs genom ett alltför begränsat antal mätningar. Särskilt viktigt är det att klarlägga huruvida andra moment såsom reparation av verktyg, rengöring av pumpar eller dylikt förekommer. Detta kan innebära att andra arbetstagare än de som huvudsakligen är inblandade i produktionen, såsom reparatörer med flera, också kan vara exponerade.

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Isocyanater i luft - referenser

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6. Karlsson D, Dalene M and Skarping G (1998). Determination of complex mixtures of airborne isocyanates and amines. Part 5. Determination of low molecular weight aliphatic isocyanates as dibutylamine derivatives. Analyst 123:1507-1512.

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8. Arbetsmiljöverkets författningssamling, AFS 2005:17. Hygieniska gränsvärden.
(Ordinances of the National Board of Occupational Safety and Health, AFS 2005:17. Hygienic limit values)

9. Arbetsmiljöverkets författningssamling, AFS 2005:18. Härdplaster.
(Ordinances of the National Board of Occupational Safety and Health, AFS 2005:18. Thermosetting plastics).