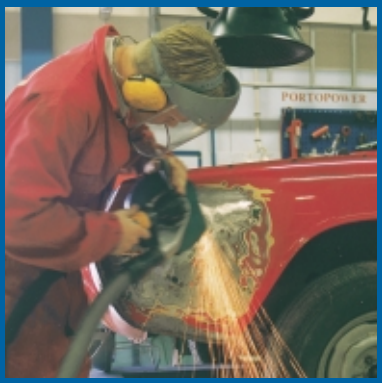
Isocyanates at work

AN ACTION PROGRAMME FROM THE SWEDISH TRADE UNION CONFEDERATION



Programme Group

The environmental and working life committee of the Swedish Trade Union Confederation (LO) decided, following a request from the Metal Workers' Union, to appoint a programme group with the assignment of drafting a common union action programme for the area of isocyanates and similar plastics. The programme group has worked in close collaboration with the LO working group for Chemicals.

The LO Chemicals Group has the following permanent members:

Kjell Johansson	*Building workers' Union*
Sigurd Holmqvist	*Graphic Trades Union*
Stefan Eriksson	*Retail Employees' Union*
Ulf Lavenius	*Industry Union (programme group)*
Pia Bellhagen	*Council Workers' Union*
Mats Hansson	*Farm Workers' Union*
Lars-Erik Folkesson	*Metal Workers' Union (programme group)*
Stefan Wiberg	*Painters' Union (programme group)*
Mikael Jansson	*Paper Industry Workers' Union*
Göran Hansson	*SEKO*
Bo-Ingemar Johansson	*Forestry and Woodworkers' Union (programme group)*
Sven Bergström	*LO, chairman (programme group)*
Sven Nyberg	*LO, secretary*
Bo Tengberg	*LO*

During the latter part of the programme group work, Ulf Lavenius was replaced by Kenneth Strandh. In addition, Rolf Ählberg, Metal Workers' Union, was a member of the programme group until he retired.

The attached plan of action was approved by the LO executive council on 22 November 1999.

ISOCYANATES AT WORK

The Swedish Trade Union Confederation
Action Programme for the area of isocyanates and similar plastics.

Isocyanates at work – Isocyanater på jobbet
Swedish Trade Union Confederation – SE 105 53 Stockholm, Sweden
Translation: Stockholms Språkcentrum
Tryck: EO Print AB, Stockholm
LO 2000.07
Art.nr 566-1709-7

Contents

LO demands – see the inside back cover

Preface

The working life of an individual and his work itself are in a state of constant change. Technical progress gives new products, production methods and forms of organisation, which can entail new risks. One of the main tasks of the trade union movement is to track developments with great attention, with the aim of preventing damage to the environment and personal injury.

Problems associated with isocyanates in the plastics manufacturing industry were discovered as far back as 1951. Since then, the use of isocyanates has grown considerably and applications are found in just about all fields of work these days.

New knowledge shows that symptoms such as asthma and allergies can be explained by exposure to isocyanates at the workplace. Deficient methods of measurement have concealed the correlation between poor health and work until the present time.

Little knowledge exists about what happens when products containing plastics are heated, and incomplete product information means that many workers are now exposed to isocyanates in their working environments. The lack of knowledge means that many are affected, and have to leave the workforce before their time. Many do this without acknowledgement that one of the reasons could be exposure at work. For this reason, greater awareness and preventive measures are needed in Sweden, the EU and internationally.

One great unfairness is found in the conditions of working life of the individual. Less than half of LO members (the blue-collar workforce) are able to continue working until retirement age. In the age group of 55 – 59 years, the risk of premature retirement is 5 times higher for blue-collar workers than for white-collar staff. Female LO members run the greatest risk of being affected.

The unfairness of these working conditions must be corrected. Better health for LO members is now on the agenda, through extension of systematic environmental work. Knowledge at local levels in companies must be improved through education and better adherence to

rules. When necessary, there must be access to external expert help for qualified measurements etc.

Central knowledge acquisition is needed to support good preventive environmental work at the local level. This requires not only sufficient resources for research and supervision, but also fair industrial injury statistics. It is also necessary that correlations between poor health and environmental factors are not suppressed, and that the responsible authorities are informed.

Wanja Lundby-Wedin

Some Personal cases


Lennart Nilsson.

1. Moulding of mineral wool
Lennart had not worked with making various insulation products for long before he began to experience problems. His work consisted of pressing various forms of mineral wool at high temperature. After doing this job for one year, Lennart fainted on his way home after a night shift. His breathing passages had contracted so much that Lennart could not get air. At the hospital, they found hyperactivity in his lungs. They did tests for several years, but never found the reason for the problems.

Thanks to the help of the regional safety representative, who also works as an insurance advisor, Lennart was finally able to get a clear picture of what caused the problems. The explanation could be determined after a number of articles appeared in the press about the way that isocyanates could be released when mineral wool is heated. After measurements were done at Lennart's workplace, the Social Insurance Office approved the industrial injury, and acknowledged that the problems were related to isocyanate exposure. Lennart has managed to find a job these days, where he does not have to put up with exposure to strong odors or chemicals.


Lola Ottosson.

2. Sub-contract manufacture of car components
Lola's work was making interior trim components for cars. Part of the job involved bonding plastic components together. Hot air guns were used to make the adhesive, which contained isocyanates, to harden quickly. Lola was affected by various kinds of oversensitivity. In addition to problems with her breathing passages, her skin became bright red, and she suffered from sensitivity in her face. Several of her colleagues were also affected by various kinds of allergic reactions, tiredness and asthma.

Lola has not managed to get her problems approved as an

industrial injury. She has had problems in getting support for the view that her over-sensitivity could be due to exposure to isocyanates at work. The presence of isocyanates at her workplace is well known and documented, however.

3. Car repairs

Göran, aged 36, has worked as a car body repairman for 18–20 years. His problems became worse during the last six or seven years. The days often started with his nose bleeding. Then he had nose bleeds several times a day. In addition, he had difficulties in swallowing and breathing. He was very tired when he got home in the evenings and fell asleep early. One of Göran's colleagues has been affected with the same type of symptoms, with nose bleeds and problems with breathing.

Göran Falk.

The company doctor sent Göran to the Industrial and Environmental Medicine Clinic. The chief doctor studied the product information brochures for several of the paints, which Göran used. His conclusion was that since the product brochures did not specify the inclusion of isocyanates, that could not be the reason for Göran's symptoms. But by referring to Göran's health and general working conditions, he specified better ventilation and the use of a compressed air mask at work.

Thanks to the union, Göran managed to get his problems approved as being work-related. The correlation was not related to isocyanate exposure, but to welding work in general. Göran has now been unemployed for a long time.

Where Isocyanates are found

Isocyanates are a group of chemicals, which have been used in industry for about 50 years, mainly in the manufacture of polyurethane plastics (PUR). Use of PUR has widened considerably as time has passed. From the beginning, it was mainly used for mattresses and foam rubber, but is now used in many different fields. The reason is that PUR offers several technical advantages. The properties of materials can be modified thanks to various additives. PUR is found in foam plastics, thermoplastics, fibres and adhesives and also in paints, foils and insulation materials.

Application of car window glue.

The widened use of PUR in various products means that many workers do not understand the risk of being exposed. Without knowledge

of the risks, you can also have difficulties in seeing the correlation between poor health and working conditions.

Isocyanates occur as more or less viscous fluids and in powder form. There are a large number of different isocyanates. The following three types comprise more than 90 percent of all isocyanates made industrially:

TDI, toluene diisocyanate

MDI, methylene bisphenylisocyanate

HDI, hexamethylene diisocyanate

When material or surfaces containing PUR are heated

The risk of exposure to isocyanates does not only occur when handling chemical products, which contain isocyanates. Developments in measurement methods in recent years have shown that many people who heat material containing PUR are also exposed to high levels of isocyanates and other substances. This is common when surfaces treated with paints or varnishes containing PUR are heated. For example, various types of copper products are varnished, such as water pipes and electrical wiring, to retain their gloss.

Soldering of a PUR lacquer circuit board.

Welding in PUR insulated steel pipe.

Grinding in PUR painted car.

Another example is PUR varnished floors, which are commonly found in garages and workshops. When flame cutting or other work makes red-hot sparks fly and hit the floor, the varnish suffers from chemical breakdown. Measurements have shown that this can cause severe exposure, far above the relevant hygienic limits.

Example:
When 1 gramme of PUR is heated to about 250°C, the break-down products must be diluted in 5000 m^3 of air to prevent the break-down products from exceeding the hygienic limit.

When binders are heated

High temperature treatment of mineral wool.

Even if isocyanates or PUR are not initially found in a product from the beginning, they can be released during heating. In recent years, it has been found that new domestic ovens give off isocyanates. The reason is that the insulation around the oven has been treated with a binder, not to give off dust. The binder contains three chemicals, formaldehyde, phenol and urea. These components can form methyl isocyanate (MIC) and isocyanic acid (ICA) if the material is heated. The temperature needed to form MIC is about 150°C. Toxicity is very high. The accident in Bhopal in India in 1984 is often used as an

example of this in the literature. 2.000 people died there because of the high toxicity, and 170.000 were injured when MIC leaked from the factory. Other effects reported were reproductive dysfunction and spontaneous abortions.

The corresponding problem is found in the foundry industry, where a similar binder is used to hold casting cores and shell sand together. Another product, which contains equivalent components, is Bakelite. Similar products are commonly found in electronic equipment, such as circuit cards. Exposure is worsened if the cards are PUR varnished. The cores of grinding and cutting disks often consist of materials similar to Bakelite.

Examples of activities/industries where isocyanates occur

Activity/industry	Source	On heating
Motor industry, ships, aircraft & trains	filler, paint, sealants, windscreen assembly, bonding, composites	cutting, welding, grinding, windscreen removal, removal of underseal
Building	sealing, bonding, painting, caulking, floor and wall coverings	mineral wool, mat welding, copper pies, paint removal, district heating pipes
Fire extinguishing		mineral wool, polyurethane in furniture and interior fittings
Electrical & electronics	packaging, adhesives, casting	circuit cards, optical fibres, varnished wires, cable insulation, Bakelite
Paint industry	manufacture	repairs
Foundry	cold-box	hot-box, casting cores and shell sand
Graphic trades	printing inks, lamination	
Foodstuffs	can varnishes	conveyors, repairs packaging materials
Painting & varnishing	car & industrial painting	removal of paints & varnishes with heat
Plastics industry	manufacture of foam mattresses, car interior fittings	
Tunnelling	Sealants	self-ignition occurs
Wood and furniture	adhesives, varnish, upholstery padding, painting	removal of paints & varnishes with hot air gun
Engineering	adhesives, elastomers, paint, insulation, fixatives	repairs and removal of polyurethane materials with heat
White goods industry	manufacture PUR insulation, painting	repairs
Medical care	bandages, castings, fillings, equipment	

How am I Affected?

Over-sensitivity

The most critical effect of isocyanate exposure is that you can develop isocyanate asthma. Excess sensitivity can develop in parallel with it, which means that you can not go near your old workplace. After sensitisation, many people also are adversely affected by other odours, such as perfume, car exhausts or tobacco smoke. This type of symptom means that people often can not continue to participate in the workforce.

Another serious effect is reduced lung function, which the affected person frequently does not discover until it is too late. Not infrequently, the problem is experienced as a considerable loss of fitness. Various types of skin reactions spread across various parts of the body, even when no direct skin exposure has occurred. There are frequent reports that people have been affected by nosebleeds in conjunction with "hot work".

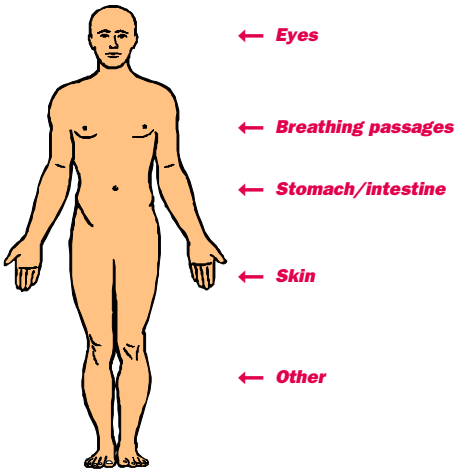


Figure 1: Isocyanate exposure can take place in several ways. In addition to breathing, which is the main exposure route, isocyanates can also enter the body in other ways. The importance of skin exposure for asthma symptoms is discussed in the literature. Knowledge of the importance of absorption via stomach and intestines is currently limited. Another route could be via various kinds of implants.

The greatest threats to health are absorption through breathing gases and particles. A further form, which is frequently distinguished, is aerosols (fine drops of fluid) which are formed in spray painting etc. Isocyanates also affect eyes and can be absorbed via the skin. Knowledge about absorption via stomach and intestines is still limited.

The serious effects of isocyanates on health have justified very low hygienic limits. The average concentration in air in the breathing zone during a working day must not exceed 0.005 ppm (ppm = parts per million). This converts to no more than 0,00004 g TDI in each cubic metre of air. The peak exposure limit for a 5-minute period must not exceed 0,01 ppm.

Research in recent years has shown that it is possible to develop asthma from isolated, very brief but concentrated exposure peaks. All isocyanates are marked as sensitising in the limit value list. At present, only TDI is marked as carcinogenous.

The odour threshold for the most common isocyanates is around 0.4 ppm, i.e. considerably above the current hygienic limits. The absence of odour at a workplace is thus no guarantee whatsoever that you have not been subjected to exposure which far exceeds the current limits.

The scientific literature on the health effects of isocyanates distinguishes between irritating, sensitising and cancer.

Irritation

Isocyanates are hazardous to your lungs and irritate eyes and skin. Breathing vapours and mist can cause pain and "pins and needles" sensations in air passages, coughing, nausea and vomiting. Influenza-like problems can occur, with symptoms such as a runny or stuffed-up nose, sore throat, and chest pains. Other symptoms are coughing, fever, shivering, joint pains, muscle pains and headaches. Asthma-like problems of wheezing, or shortness of breath, can also occur. At high exposure levels, there is a risk of lung oedema (water on the lung).

Sensitisation

Isocyanates cause allergies, and the person who has become sensitive can be affected by breathing problems at very low levels, far beneath

hygienic levels. The onset of problems is frequently delayed, and may take several hours to develop. It is not unusual that problems do not occur until the evening, or night, when you are at home. This situation means that it may take a long time before you connect your problems with the worksituation. A long period of exposure may also lead to reduced lung function. The exposure needed to trigger chronic problems varies considerably between individuals. Some can suffer from asthma-like symptoms after only one, or a few exposures.

Both allergic and non-allergic contact eczema can be caused by skin exposure to isocyanates.

Cancer

The only isocyanate, which is classified as carcinogenic in the Swedish hygienic limit list, is TDI. In animal tests, TDI exposure has caused an increased frequency of various kinds of tumours and IARC (International Agency For Research on Cancer, WHO) believes that there is "sufficient evidence" for stating that TDI is carcinogenous for animals. On the other hand, they believe that there is "insufficient evidence" to state that it causes cancer to people. Both TDI and MDI are regarded as mutagens (affecting genes), however.

sensitising = develops over-sensitivity

lung oedema = water on the lung

mutagen = affects genes and inheritance

If you are already affected

If you work with isocyanates and have already noticed problems with your health, your exposure to isocyanates must stop. There are people who, in the tough-working climate of the nineties, have kept their health problem secret, to avoid loosing their jobs. There are even people who use asthma medicines to be able to go on working. The result can be a chronic injury, which makes it impossible to work for the rest of your life.

Action must be taken early, as soon as you experience the first symptom of a runny nose for example. Ask for help and support from your safety representative. If you belong to the company health care system, they should help you with preventive measures and rehabilita-

tion work. The basic requirement for connecting your health problems with exposure at the workplace is that industrial hygiene measurements must have been done. Without these measurements, it is difficult to relate your problems to your exposure. This is often a requirement for having your poor health classified as an industrial injury.

Measurements are also a basic requirement for deciding the need for action to be taken at the workplace. Follow-up measurements should also be done to check that the measures taken have been sufficient.

It is thus of vital importance that these measurements should be done. If there is a company health care facility, they should have the competence and resources to help out. If not, other expertise should be brought in from the Industrial Medicine Clinic, etc.

If you have problems in gaining understanding of your employer, for the need to do the measurements, you should contact your industrial safety representative if there is one. If necessary, the Labour Inspectorate can demand it from your employer.

Report your problems as being an industrial injury to the Social Insurance Office. If there are isocyanate exposure measurements, your chances of getting the industrial injury approved are better.

Risks and Exposure

When discussing the health effects of manufacturing polyurethane plastics and other hard setting plastics, such as epoxy, ester and acrylic plastics, one talks about the free monomers. Monomers are small, independent molecules, which are highly reactive. The health effects of isocyanates or other hard setting plastics are related to the occurrence of these free monomers. This is why manufacturers of hard setting plastics have endeavoured to limit the occurrence of free monomers in the atmosphere as far as possible.

Monomers and other substances are released when hard setting plastic products are heated, together with other additives used in manufacture. One of the additives whose effects has been the subject of a lot of discussion is flame retarders.

Manufacture of PUR

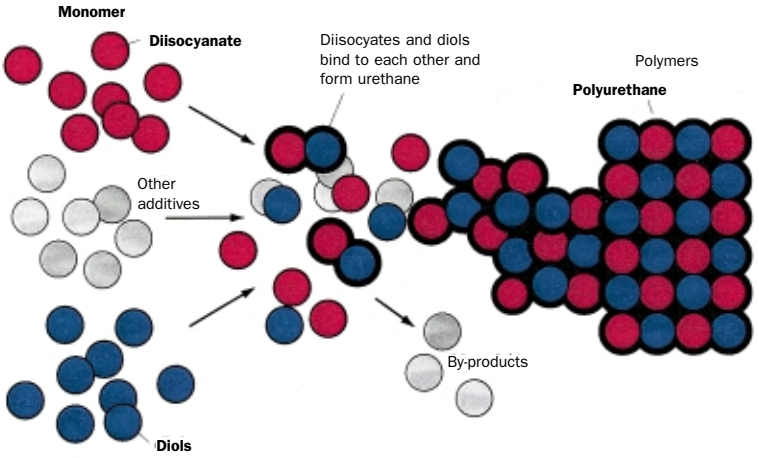


Figure 2. The highly reactive diisocyanate monomer is mixed with a diol, and the stable hard setting plastic product, polyurethane plastic, is formed in the polymerisation reactions.

Monomer	= small, free, highly reactive molecule such as diisocyanate or diol.
Polymer	= molecules which have been bound to each other in great numbers (plastics).
Polymerisation	= chemical reaction where small molecules are linked together to form a polymer.

Hard setting plastic products containing isocyanates can be of the two-component or single component types. The single-component types use the humidity of the atmosphere to harden.

Various measures have been taken to attempt to reduce the risks associated with monomers. One method used is to replace the more volatile isocyanates TDI and HDI with the less-volatile MDI. This can reduce the concentration of isocyanates as a gas in the atmosphere. Other methods are pre-polymerisation and blocking.

Pre-polymerised isocyanates

Pre-polymerised isocyanates are formed by letting the monomers react to a small extent in advance. This reduces the amount of free monomers, and also reduces volatility. A hardener is then added to promote final hardening. This procedure has sometimes been used by some manufacturers, to claim in the product information brochure, that there are no isocyanates in a product.

Blocked isocyanates

Another method used to reduce the health effects is blocking of the isocyanates. The method is intended to reduce the amount of free isocyanates, which can float freely in the air breathed in. The isocyanate monomers are bound by means of the blocker. Heat is frequently needed to release the isocyanate monomers and start the hardening process. Blocking of isocyanates is used in paint manufacture, for example. Unfortunately, blocking has also been used by many manufacturers to claim in the product information brochure that there are no isocyanates in a product.

The finished PUR product

Depending on the mixing ratios, free isocyanate groups can be found in the finished product. Isocyanates can also react with high humidity

in the air to form amines, which can be found in the finished PUR product. The aromatic amines, which can be formed, include MOCA, TDA and MDA. These substances are included in the National Board of Occupational Safety and Health hygienic limit list under group B since they cause cancer. Substance in-group B may only be handled in industry if permission is granted by the Labour Inspectorate (YI). Permission is normally granted only if absorption in the body can be prevented.

One problem with the current rules for these amines, found on the B list, is that permission is only required when the products are purchased. There are no rules for amines formed at the workplace, since there are no hygienic limits for substances on the B list. The National Board of Occupational Safety and Health has ordered criterion documents however, to allow hygienic limits to be set for these substances as well.

In the glass ware industry, products are placed on fibreglass sheets containing PUR. Upon heating the PUR is decomposed and isocyanates are released.

Amines are also frequently added to control and facilitate the polymerisation process. Depending on the properties required in the finished product, diols can be replaced by diamines. There have been discussions about the levels found in materials such as mattresses, cushions, earplugs and other light foam products used close to the skin, on account of the negative health effects of aromatic amines.

Aromatic	= Unsaturated molecule, often ring shaped – to be compared with
Aliphatic	= Saturated molecule, frequently straight in shape
Amines	= A type of molecule which contains nitrogen
MOCA, TDA, MDA	= Aromatic amines

Applying heat to PUR

When the PUR is thermally decomposed many different isocyanates are formed. In addition different amines such as MOCA, TDA and MDA may be formed. Detail information of many of the formed compounds are sparse.

The decomposition products are to be found in both gas and particle phase and the composition depend on the formulation of the actual polyurethane polymer.

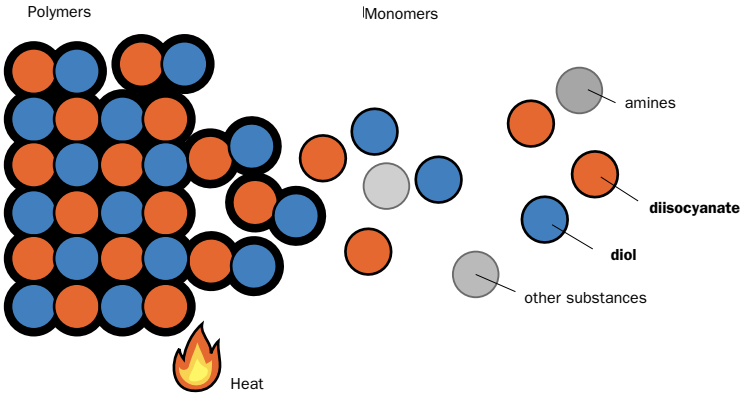


Figure 3. When polyurethane is heated, it breaks down, and free monomers and other substances are formed.

Additives

A large number of additives are used in making PUR and other plastics materials, to give products the desired properties. Some examples of these are pigments, anti-static compounds, flame retards and biocides. Many of the chemicals used for this are also extremely controversial because of their effects on both the working environment and the external environment.

The fire retards used which are most in focus are the chlorate or bromide organic compounds (halogenated). These compounds cause cancer, are difficult to break down and are accumulated in living organisms. Chlorate and bromide compounds have begun to be replaced by phosphate esters, which have similar properties. Knowledge of the effects of these substances is deficient, although many people are exposed. Personnel who work with electronic equipment or other flame-protected products such as textiles, furniture and cars are exposed. The considerable increase in the levels of bromided flame retards in mother's milk gives an illustration of the severity of the risks associated with these substances.

Our ability to track product use in the global chemical industry and to analyse the new substances which occur is far too limited. The strategy for chemicals, which Sweden has initiated in the EU, demands better chemical analyses and that the most dangerous chemicals should be phased out.

biocides	= additive to stop biological breakdown
phosphate esters	= organic compound containing phosphorous
chlorated compounds	= organic substances containing chlorine
bromided compounds	= organic substances containing bromine
halogenated	= organic substances containing chlorine, fluorine, bromine or iodine
pyrolysis	= thermal breakdown

LO believes that a ban on the most dangerous flame retards such as those containing halogens, should be introduced to speed up developments towards non-hazardous flame retards.

Further research needed

We see these days that isocyanates have serious effects on health. People are expelled from the working force because they have developed oversensitivity and asthma. The current situation with the strong cutbacks in resources for research in chemicals makes the situation serious. Constant changes in workplace, with the use of new substances and production methods puts constant new demands on research capacity.

PUR for just about every link in the industrial hygiene chain knowledge is still incomplete regarding the industrial use of PUR. Only sketchy information exists regarding hot work in PUR and heating of products similar to Bakelite, containing formaldehyde, phenol and urea.

Deficient methods of measurement have given an incorrect picture of exposure, especially as regards hot work. No consideration has ever been given in assessments to particles containing isocyanates.

This situation has meant that research on the medical effects has not been able to interpret correlations correctly. Many of the past surveys, using incorrect exposure measurements, are only of limited value these days.

The following questions are the most urgent:

- How poisonous are various types of isocyanates and amines commonly found in industry?
- How poisonous are the various types of additives used?
- What importance does skin absorption has for the development of asthma?
- Is a single high-level exposure enough to give chronic injury and asthma?
- What level of importance does exposure to particles, aerosols and gases have?
- What is the correlation between exposure and biological levels?

- What should an acceptable diagnosis method for isocyanate related illness look like?

What do alternative, less hazardous systems look like?

Measurement of Isocyanates

Measurement of isocyanates is a complicated task. There are many different varieties, the levels are very low and they are very reactive. The method used in Sweden in the 70s and 80s was based on use of a so-called impinger flask.

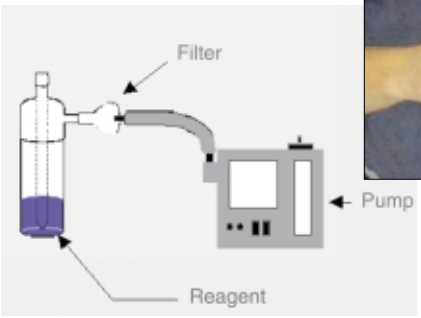


Figure 4. The figure shows an impinger flask connected to a glass fibre filter. An air-sampling pump is used to give precise airflows and volumes. Isocyanates in the gas phase and large particles are collected in the impinger-flask where as small particles are collected on the glas fibre filter.

The flask contains a reagent (a fluid) which the isocyanates are bound to. The reagent used at that time was methylaminomethylanthracene, commonly referred to as MAMA.

Suspicions arose in the mid 90s that the method did not work well in all situations. It was Dr. Gunnar Skarping and his research team in Lund who found from biological testing that personnel who had the typical symptoms of isocyanate-related problems had also been subjected to exposure, although atmospheric measurements had shown very low values. It was found that exposures could be seriously under-

estimated by MAMA measurements in the more complex chemical environments. In some cases, no levels at all were found, and in other cases the results could be thousands of times lower than the true values.

This was very serious, since the MAMA method was the method used to check that hygienic limits were not exceeded. It was also used when the reasons for poor health were investigated. There are certainly many who have been affected, but who have never been able to obtain confirmation that their problems were caused by isocyanates at work.

Many companies have also been granted exemptions from doing further measurements in their working environments, on the basis of measurements with this misleading method. LO believes that these exemptions should be withdrawn.

Gunnar Skarping and his colleagues have developed the methods of measurement. Their first act was to replace the reagent in the impinger flask with dibutylamine (DBA). DBA requires that analyses should be done with a mass spectrometer however.

The method has been further refined after measurements in car workshops. The reason is that the impinger flask does not trap the smallest particles in the air. A filter has therefore supplemented the impinger flask. Figure 5 below shows the results from measurement at car workshops using this method. The results show that exposure to the small particles can add a considerable quantity of isocyanates to the environment. The figure also shows that exposure via particles also includes less volatile isocyanates, such as MDI etc. Developments continue, and measurements in the near future may use a dry method, without an impinger flask.

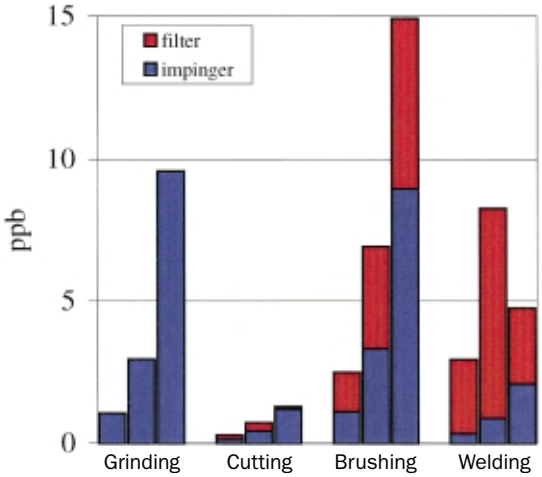


Figure 5. The figure shows air concentrations of isocyanates during cutting in pained car metal sheets. Three different air samples were taken and gas and particle phase isocyanates were determined. It can be observed that the most volatile isocyanates (MIC) is only present in gas phase where as the much less volatile isocyanate MDI is predominantly in the particle phase.

Various direct-reading instruments are commercially available, such as the Isolog. This instrument is not reliable in establishing absolute levels, but is excellent for use as an indicator. The instrument is very valuable for use in preventive measures, since it gives direct information about the tasks, which give high levels of isocyanates.

Isolog	= a direct indication instrument for isocyanates
Mass spectrometry method	= an advanced, highly sensitive method for determining the type and levels of organic contamination which occurs

Exposure measurement for isocyanates

Risk evaluations through exposure measurements at the workplace must be sufficiently comprehensive that they give a clear picture of the substances and levels to which a worker is exposed. Regulation also stipulates that the results of measurements should be documented and saved.

The safety representative shall participate in planning and setting up measurements. Measurements shall be done by persons who have sufficient competence for the task. Measurements should normally be done by industrial hygienists or industrial safety engineers, who have received further training in industrial hygiene measurement, and also have training in isocyanate measurement.

Simultaneous monitoring of isocyanates using impinger-filter sampling and a continuous monitoring device.

Air passages and lungs are injured by high concentrations of isocyanates. There are suspicions that single, short exposures to high concentrations can be enough to cause injury, even if they only occur on isolated occasions. Average measurements of hygienic levels are thus not enough. Nor can the peak limit exposure on the average of a 5-minute exposure be regarded as sufficient. In some cases, a direct indication instrument such as the Isolog can be used.

Measurements shall be done with the DBA method, supplemented by a filter, or with another method which is developed and has corresponding performance or better. The results of all analyses should be documented, given the background of our incomplete knowledge about exposure and effects, including levels of isocyanic acid and amines where found.

Biological sampling

Checks on exposure at the workplace should be based on estimates of the worker's environment in the first hand. Risk evaluations in the

form of industrial hygiene exposure measurements shall always be done if there is a risk of exposure, which could cause injury. Experience with isocyanates shows that these measurements do not always reflect the true exposure. Air measurements do not catch the exposure due to skin or stomach/intestines, whose importance in various kinds of effects is still uncertain. In other countries, such as Germany, biological test methods are used for isocyanates.

LO believes that each individual should be given the right to biological testing in cases of poor health or in conjunction with regular testing. If this right was available as an extra check when requested by the individual, mistakes in preventive environmental work could be discovered. The right to biological testing should be available for exposure to isocyanates for which analysis methods have been developed. These are TDI and MDI at present.

Training

The presence of various forms of isocyanates is very common in many industries and areas. In some cases, this is because products, which contain free isocyanate monomers such as paints, adhesives, joint sealers, varnishes etc. are handled. In other cases, it is because finished products containing PUR are heated, whereupon the compounds break down and form free isocyanates. Isocyanates are also formed when products containing formaldehyde, phenol and urea are heated, such as Bakelite, mineral wool, circuit boards etc.

LO believes that all persons who work with these substances or who heat material resulting in the generation of isocyanates should receive training. Awareness of the importance of preventing exposure is necessary for everybody. This also applies to people who have temporary or fixed time appointments, or are supplied by an agency.

Experience has shown that the hard setting plastic regulations are unknown in many cases. An example of adherence to rules can be taken from the Labour Inspectorate, who inspected industrial painting in Östergötland province. The companies visited worked with engineering, woodworking, sub-contract painting and other activities. 75 percent of the companies who used hard setting plastics did not know about the rules in the Hard setting plastic Regulations.

There is a strong need to improve knowledge. A good start is that basic knowledge of hard setting plastics is given in the relevant vocational training courses. It is necessary for the teachers to have the requisite competence, for this to occur. LO believes that the Schools Board should be responsible for ensuring that teachers get further training in working environment matters. The certification of competence in the hard setting plastic field can also take place.

The scope of the training needed can vary-, for the professional groups already out at work. The basic requirement is, however, a course equivalent to the Joint Industrial Safety Council hard setting plastic material, supplemented by knowledge of the relevant working situation. A one-day course is a minimum union requirement for all kinds of hard setting plastic work. Safety representatives and supervisors

should also have more comprehensive training. It is a good idea if the scope of training in each industry were regulated by general agreement between the various bodies in the labour market. The agreement should also stipulate the interval for refresher training in the hard setting plastic field.

Personal Protective Equipment

Personal protective equipment is the last resort for solving problems of exposure at the workplace. Measures to be used in the first hand have failed, such as replacing products containing isocyanates by less hazardous encapsulation or other technical measures. Many situations exist where personal protection equipment is the only way to protect yourself, such as in accidents, discharge, fires etc.

Breathing protection

The National Board of Occupational Safety and Health hard setting plastic regulations require that at least a half-mask and carbon filter must be used. This is no use, however, against methyl isocyanates of low molecular weight (MIC). The reason that the regulations do not consider MIC is that there was no knowledge about them at Swedish workplaces when the regulations were issued. MIC is formed when mineral wool and other products containing the three components of formaldehyde, phenol and urea are heated. A full mask supplied by compressed air should be used instead.

The use of fresh air respiratory protection device during grinding.

In discussions about personal protective equipment related to isocyanate work, it has been found that some makes of half masks do not provide the promised protection factor in practice, despite CE marking. The marking should indicate that the demands in the directive are complied with. The effect is that some of our members are subjected to exposure although they have taken the precautions and believe that they are protected. LO believes that it is serious if inadequate quality is commercially available. The National Board of Occupational Safety and Health should be responsible for ensuring that all commercially available masks are tested. Reports should be sent to manufacturers whose products do not meet the quality requirements. Changes to current standards may also be needed.

Given that carbon filters are of no use when workpieces are heated, and that the protection factor can frequently be dubious when a half mask is used, LO believes that compressed air supplied breathing protection should be used in all regular isocyanate work.

Protective gloves, protective clothing and eye protection

The pictures show the application of synthetic polyurethane casts. The polymer hardens after squeezing the PUR-impregnated bandage in water. Amines can be found in the water.

Isocyanates are highly irritating and sensitising for skin and eyes as well. This means that unprotected hands, which have been exposed to isocyanates, can contribute to the development of over-sensitivity, which can affect the skin and breathing passages. It is thus very important that you should protect yourself with gloves, goggles and other protective clothing if needed to prevent contact with isocyanates. Note that both isocyanates and amines quickly penetrate ordinary plastic gloves. The only safe glove commercially available is the 4H glove, which is relatively clumsy, however. Changes of clothes and good hygiene are necessary. If there is any risk of splashing, an emergency shower should be available nearby.

Plastic bandages are frequently used in the medical care sector these days, instead of plaster casts. The bandage hardens when wetted with water, at which point amines are released in the water. If an ordinary operation glove is used for this work, it does not take long until the skin is exposed to free amines.

Manufacturers and Suppliers

The basic philosophy behind our views on handling of hazardous chemicals is that they should be replaced by less hazardous ones (the so-called substitution principle). The principle should be applied to both the working environment and the outside environment. This concept has been applied for some time in Swedish regulations, and is now applied in EU regulations. This is the basic standpoint in the Chemicals Inspectorate and the National Board of Occupational Safety and Health regulations. This principle should of course be applied to isocyanates as well. One prerequisite for this to happen is that the information in the product information brochures must be accurate.

The Chemicals Inspectorate is the supervisory body for the chemical suppliers in Sweden. Since the LO chemicals group has been able to find deficiencies in companies' product information, the following letter was sent to the Inspectorate in 1998, see next page.

This note has not resulted in any major changes so far. A meeting with the personnel from the supervision unit at the Inspectorate has taken place, however. It was stated at the meeting that all supervision is done by only three people and that there is no realistic opportunity for carrying out more active supervision. The police reports made by the authority must be done on the basis of a visit to the company in question. The reports, which have been done with the current manpower, frequently do not lead to charges being brought or any noticeable punishment.

Workers' health and company's consideration for the external environment is completely dependent on knowledge of the content of chemical products and the effect of the chemical components. A decisive factor for ensuring that correct assessment is done at the workplace is that product marking and product information brochures contain the necessary information.

The Joint LO chemicals group has discussed several questions related to the current situation with product information brochures. Improvements to the current situation must be achieved by improved application of current legislation.

After discussions with representatives from the affiliated national unions, LO has found that there are three problems associated with current application.

1. *Companies who fail to follow the rules through intention or negligence do not risk any sanctions in practice.*
2. *Substances, which can give a negative effect on health, are not noted in the information, with the motivation that their content is less than 1%, for example. It also occurs that only some of the substances are specified, although various substances in the group may differ in their hazardous effects.*
3. *Harmful effects are possible from hazardous substances formed during thermal breakdown when the finished product is worked on, such as paints, adhesives, plastics etc.*

Given the background of current conditions, LO believes that a review of the application of current legislation should take place. LO affiliates and LO are available for further discussions and views.

The Swedish Trade Union Confederation

Wanja Lundby-Wedin

LO's letter and the environmental scandal in the railway tunnel under Hallandsåsen have started a debate on product information supplied by companies, however. Several organisations are interested in improved product information, both among chemical suppliers and employer organisations. Many improvements will likely be made voluntarily in various industries, but these probably will not be sufficient

LO believes that resources and knowledge must be available to public authorities and the public prosecution service, so that the sanction system in the law will also function and be applied when product information is not observed.

Regulations and Supervision

The National Board of Occupational Safety and Health is the central public authority which issues regulations where the demands on industrial environment work in companies is specified, under the Industrial Environment Act. The Labour Inspectorate maintains a regional presence throughout Sweden, and conducts inspections at workplaces. The cut-backs in recent years mean that the resources available to the Labour Inspectorate have been reduced so far that Sweden is clearly the lowest in the Nordic area for the number of workers per inspector.

Companies are not particularly inclined to observe the regulations issued by the National Board of Occupational Safety and Health. One of the main regulations requires employers'- to conduct inspections of industrial environmental work in companies. According to the National Board of Occupational Safety and Health own surveys, only about 42 percent had functional internal inspection, among companies with 5–49 employees. The figure was only 13 percent among the very smallest companies.

LO believes that the rules in the industrial environment field should be observed, and demands better resources for the Labour Inspectorate and the regional safety representatives.

The most important regulation related to isocyanates at the workplace is "Hard setting plastics". The regulation covers hard setting plastics in general, i.e. including epoxy, esters, acrylics, cyanoacrylates, amino plastics and phenolic plastics in addition to urethane plastics based on isocyanates.

One problem with the regulation is that various trades do not understand-, or know that they are affected by the regulation. How should a shoemaker who uses isocyanate adhesive or a repair worker who welds PUR coated material understand that he is affected by the Hard setting plastic Regulation? LO believes that the name of "Hard setting plastics" contributes to the fact that many trades do not understand that they are affected.

The Hard setting plastic Regulation includes the provisions that:

- Everybody who works with hard setting plastics should have training.
- Hard setting plastic components should be mixed in a closed system, or in a separate, well ventilated area.
- Hot work (such as welding, soldering, grinding) must not be done in such a way that the plastic is heated unless special measures have been taken to prevent exposure to air contamination.
- Workers must make sure that exposure measurement is done if hazardous air contamination could occur due to handling of hard setting plastic components.
- Measurements must be documented.
- Employees must go through a health check before any work with hard setting plastics is done.
- Enhanced medical checks shall be done if isocyanates, cyanoacrylate or organic acid anhydrides occur, including a test of lung function. A follow-up shall be done after 3–6 months, and then every second year.

Applicable paragraphs are found in their entirety in AFS 1996:4 Hard setting plastics.

Spirometry is used for the measurement of the lung capacity.

LO believes that a revision of The Hard setting plastic Regulation is necessary, given the background of the new knowledge which has arrived since 1996. The suspicion that a single, heavy exposure can cause permanent over-sensitivity must be given special attention, in respect to exposure at temporary workplaces. LO believes that a particularly high protection level must be maintained irrespective of whether a workplace is temporary or permanent.

In addition, a review of the following must be made:

- increased clarification of the jobs affected by the regulation
- clarification in relation to hot work and training
- heating of products containing formaldehyde, phenol and urea
- opportunity for workers to have a biological test of exposure
- rules for aromatic amines found on the B list which are formed in industrial processes
- rules and recommendations for personal protective equipment.

Measures at the Workplace

The general rule for chemicals at the workplace is substitution. The increased use of polyurethane plastics has mainly taken place in a time when measurement methods for isocyanates have been inadequate. This means that we have not been able to see the correlation between poor health and the working environment.

Windows are mounted using a non-isocyanates containing glue.

We now have methods for measuring more accurately-, and can state that some car paints contain more isocyanates than others. The same situation applies to adhesives etc. This new knowledge does not only allow us to see correlation between exposure and poor health; it also allows us to reject isocyanates if there are alternatives available

Well-functioning substitution work in companies is based on correct product information being available for the products used. The product information brochures must state whether isocyanates occur in products in any form. The health risks and the protection measures necessary should be easily understandable, from reading the product information brochures.

Even when product information brochures function well, exposure can still occur at workplaces. The reason is that material or products can be heated when a product information brochure would not be relevant, such as repair or maintenance work. Workers who are occupied with this type of task suffer a considerable risk of isocyanate exposure. Hard setting plastic training should therefore be obligatory for this category of workers.

If accidents at workplaces mean that employees are exposed to high levels, an investigation of the consequences must be done. Exposure checking by means of biological testing should be done and the results should be saved. Measures should also be taken to prevent a repetition.

There are various types of compounds available for isocyanate and amine decontamination in premises and equipment. There are also corresponding products for use on skin. There is also a cream, which reduces skin absorption.

A mobile booth can be used to isolate the ”isocyanates work” in the car repair shop.

If it is not possible to avoid products, which contain isocyanates, or if isocyanates are formed by heating, the following measures must be taken:

- Handing shall be isolated from other activities, in a separate area with lower atmospheric pressure than in adjacent premises.
- Workers who do the work must be provided with breathing protection with a compressed air supply.

Union Check List

- ✓ The internal inspection regulation rules and other National Board of Occupational Safety and Health regulations must be applied. In addition to The Hard setting plastic Regulation there are rules for air contamination and hygienic limits, plus general rules about chemicals use at the workplace.
- ✓ The employer must do a risk evaluation, which shall be documented as regards chemicals at the workplace.
- ✓ If exposure occurs at the workplace, industrial hygiene measurements must be done so that the exposure pattern of the victims is clearly documented. The measurement reports must be saved.
- ✓ Plans shall be drafted for long term and short term corrective measures.
- ✓ There must be a collected register of all chemicals used by the company.
- ✓ Product information brochures should be evaluated before products are ordered. Choose the least hazardous product, which serves the purpose. A product, which lacks product information, should never be handled. A good rule is that products, which lack product information, should never come inside the gates. Change supplier if product information is poor or missing.
- ✓ Use the company medical service or other industrial hygiene expertise for choice of products, industrial hygiene measurement and for help in proposing corrective measures.
- ✓ Contribute to taking swift measures if anybody feels symptoms due to isocyanates. Even if a transfer has to be done, measures must be taken to reduce risks at the workplace, so that more workers are not affected. The company medical service is a resource for both measures at the workplace and in rehabilitating the affected persons.

Make sure that the rules in the Hard setting plastic Regulation are observed. Use a compressed air mask and other necessary protection equipment. Ask for help from the industrial safety representative, regional industrial safety representative, Labour Inspectorate or union branch if you suspect that working conditions are hazardous and the employer refuses to take measures. If you work aboard a ship, you can also ask for help from the National Administration of Shipping & Navigation. It is your health, and your workmates' health, which is in the balance.

Read More

Training material for *Hard setting plastics with associated OH package*

A series of brochures containing information about risks and measures to be taken:

Do you work in a car or truck workshop?	Part no. 5212
Do you work in the electronics industry?	Part no. 5213
Do you work with isocyanates or polyurethane?	Part no. 5214
Do you work with bonding or with bonded components or products?	Part no. 5215
Do you work with painting or varnishing, or with painted/varnished components?	Part no. 5216
Do you work with foam plastic or insulation foam?	Part no. 5217
Do you work with welding?	Part no. 5218
Do you work in the building trade?	Part no. 5219

This material can be ordered from the

Joint Industrial Safety Council,
Box 3208, S-103 64 Stockholm,
Phone 08-402 02 00, fax 08-21 01 52.

The series of brochures is free and is also available at *www.asn.se* under the heading of Support and service.

Hazardous substances (AFS 1994:2)

Hygienic limits (AFS 1996:2)

The Hard setting plastic Regulation (AFS 1996:4)

Internal inspection regulation (AFS 1996:6)

Order from the **National Board of Occupational Safety and Health publication service,**
Box 1300, S-171 25 SOLNA,
phone +46 8-730 97 00, fax +46 8-730 98 17
or downloaded from *www.arbsky.se*

ABBREVIATION

DBA	Dibuthylamin
HDI	Hexamethylene diisocyanate
ICA	Isocyanic acid
MAMA	Methylaminometylantracen
MDA	Methyldianilin, aromatic amin
MDI	Methylene bisphenylisocyanate
MIC	Methyl isocyanate
MOCA	Methylenbis(o-kloranilin), aromatic amin
TDA	Toulendiamin, aromatic amin
TDI	Toulene diisocyanate

GLOSSARY OF SELECTED TERMS

Aliphatic	Saturated molecule, frequently straight in shape
Amines	A type of molecule which contains nitrogen
Aromatic	Unsaturated molecule, often ring shaped – to e compared with aliphatic
Biocides	Additive to stop biological break-down
Bromided compounds	Organic substances containing bromine
Chlorated compounds	Organic substances containing chlorine
Halogeneted	Organic substances containing chlorine, fluroine, bromine or iodine
Isolog	A direct indication instrument for isocyanates
Lung oedema	Water on the lung
Mass spectrometry method	An advanced, highly sensitive method for determining the type and levels og organic contramination which occurs
Monomer	Small, free, highly reactive molecule such as diisocyanate or diol
Mutagen	Affects genes and inheritance

Phosphate esters	Organic compound containing phosphorous
Polymer	Molecules which have been bound to each other in great numbers (plastics)
Polymerisation	Chemical reaction where small molecules are linked together to form a polymer
Pyrolysis	Thermal breakdown
Sensitising	Develops over-sensitivity

LO demands

that public authorities, organisations and private companies should collaborate on the goal of creating greater awareness about the serious risks caused by isocyanates and of preventive measures in Sweden, the EU and internationally

that everybody who handles products and material which – in hot or cold work – can emit isocyanates should have at least one day's isocyanate training,

that all use of isocyanates is replaced by less hazardous substances,

that research resources in the industrial environment field in general, and the chemicals field in particular, are enhanced,

that the Chemicals Inspectorate is given more facilities to carry out supervision, so that the rules relating to product information are followed,

that developments towards the development of non-hazardous flame retarders is speed up by banning the hazardous ones,

that rules in workplace should be observed, which requires better resources for the Labour Inspectorate and the regional safety representatives,

that the Schools Board should take measures as soon as possible to improve the competence of teachers in all vocational training, as regards hard setting plastics and working environment regulations,

that exemptions based on measurement results using old measurement methods should immediately be withdrawn by the Labour Inspectorate,

that the National Board of Occupational Safety and Health should immediately revise the relevant regulations, on the basis of the new knowledge,

that biological testing should soon become a right for all workers exposed to isocyanates or amines,

that compressed air breathing protection should be used for all regular isocyanate work,

that risk evaluation in relation to chemicals exposure should contain documented industrial hygiene exposure measurement so that the exposure picture for the persons exposed becomes clearer.

One of the core tasks of a trade union is to monitor technical developments with great attention, with the goal of preventing injury to people and damage to the environment.

New knowledge shows that symptoms such as asthma and allergies can be explained by exposure to isocyanates at the workplace. However, poor methods of measurement have thus far concealed the correlation between poor health and work.

This brochure contains union demands for measures to reduce the risks to which workers are exposed, given the current level of knowledge.

The measures demanded contain improvements to:

- **Research**
- **Product information**
- **Training**
- **Rules and resources for supervision**
- **Measurement**

The union urges that public authorities, organisations and private companies collaborate in the goal of creating greater awareness about the serious risks caused by isocyanates, and of preventive measures in Sweden, the EU and internationally.

www.lo.se