Pollutant Type: Gaseous Pollutants

Pollutant Name: Nitrogen Dioxide (NO2)

Description of the metric

Nitrogen dioxide (NO2) is an important gaseous air pollutant as it is directly linked with a number of adverse effects on human health (see below). In addition, NO2 plays an important role in the formation of tropospheric ozone (O3) and is a precursor of nitrates which contribute to atmospheric fine particulate matter. As other N-compounds it contributes also to the eutrophication of soils and waters.

NO2 is directly emitted from various sources but also formed in the atmosphere from reaction of nitrogen monoxide (NO) with O3. NO2 can on the other hand photolyse to form NO and ozone, resulting in a cycling between NO and NO2 in the troposphere during daytime at time scales of minutes (Jacob, 1999). Consequently, current European legislative standards control the emissions of nitrogen oxides (NOx, the sum of NO and NO2) rather than of NO2.

The most important emission sector for NOx in Europe is transportation followed by combustion in power plants and industry. Commercial, residential and other stationary combustion sources and agricultural activities are other important sources of NOx (see EMEP emission data, available from http://www.emep-emissions.at/emissiondata-webdab).

Concentrations of NO2 are usually reported in µg/m³ using the respective molar masses of 46 g/mol. Concentrations are reported with reference to standard pressure of 101,3kPa and standard temperature of 293 K.

Health Relevance

Adverse health effects of ambient NO2 have been reported through many epidemiological studies. Many studies reported short-term respiratory effects including the increase of respiratory symptoms, asthma exacerbations in children and adults, and increases in related emergency visits and admissions as well as respiratory mortality (Anderson et al. 1997; Anderson et al. 1998; Sunyer et al. 1997; Katsouyanni et al. 2001; Stieb et al. 2002; Galan et al. 2003; Peel et al. 2005; Samoli et al. 2006; Chiusolo et al. 2011; Tramuto et al. 2011; Mann et al. 2010). There is evidence that NO2 exposure increases symptoms and affects the infection defense mechanism among asthmatics (Mortimer et al. 2002). There are also reports on the effects on the cardiovascular system and increases in cardiovascular admissions and mortality (Burnett et al. 1999; Metzger et al. 2004; Samoli et al. 2006; Chiusolo et al. 2011; Felber Dietrich et al. 2008), but not all evidence is consistent (Schwartz et al. 1997; Roemer et al. 1998). Recently there have been reports from Spanish cohorts associating prenatal exposure with decreased fetal growth (Estarlich et al. 2010; Estarlich et al. 2011). Several long-term studies assessed the effects of NO2 and reported effects on asthma incidence in children (Simons et al. 2011), lung function decrements in children (Gauderman et al. 2004) and adults (Schindler et al. 1998), cardiac autonomic dysfunction (Felber Dietrich et al. 2008) and mortality (Hoek et al. 2002; Nafstad et al. 2004; Filleul et al. 2005) but the results across studies are not consistent (Forastiere et al. 2006).

In spite of the evidence, there is skepticism on whether the NO2 health effects are causal or are reflecting effects from other traffic related pollutants and in particular particles with which NO2 concentrations are highly correlated in time and space. NO2 results have been more inconsistent compared with the ones reported for particles and are also more dependent on the lag times examined as well as the susceptibility of the population. Evidence from toxicological studies suggests that there are NO2 effects in animals concerning lung metabolism, emphysema like structural changes, lung function, airway inflammation, bronchial hyperresponsiveness and decrease in host defense against pulmonary infections (Becker & Soukup 1999; Pathmanathan et al. 2003; Forastiere et al. 2006; Hodgkins et al. 2010;). There is some evidence that NO2 acts synergistically with ozone or PM from controlled exposure human studies (Gong et al. 2005). These can be considered in favour of independent NO2 effects but most have detected effects at higher than ambient level concentrations. However Koehler et al. 2011 demonstrated genotoxicity and DNA alterations at NO2 exposure of 200µg/m3 on nasal epithelial cells.

Compound	*Toxicological Information*	*References*	*Epidemiological information*	*References*
NO2	Effects on lung metabolism, emphysema like structural changes, lung function, airway inflammation, bronchial hyperresponsiveness and decrease in host defense against pulmonary infections	Becker & Soukup 1999; Hodgkins et al. 2010; Forastiere et al. 2006	Short-term increase in respiratory symptoms, asthma exacerbations in children and adults, increases in related emergency visits and admissions and respiratory mortality. Short-term increase in cardiovascular admissions and mortality	Anderson et al. 1997; Sunyer et al. 1997; Katsouyanni et al. 2001; Stieb et al. 2002; Peel et al. 2005; Samoli et al. 2006; Chiusolo et al. 2011
	Genotoxicity and DNA alterations in human nasal epithelium	Koehler et al. 2011	Emergency room visits for acute respiratory symptoms, asthma exacerbation in children	Anderson et al. 1998; Galan et al. 2003; Tramuto et al. 2011; Mann et al. 2010; Weinmayr et al. 2010
			Prenatal exposure affects fetal growth	Estarlich et al. 2010, Estarlich et al. 2011
			Long-term effects on asthma incidence in children, lung function decrements in children and adults; cardiac autonomic dysfunction in susceptible groups and mortality	Schindler et al. 1998; Hoek et al. 2002; Nafstad et al. 2004; Gauderman et al. 2004; Filleul et al. 2005; Forastiere et al. 2006; Felber Dietrich et al. 2008; Simons et al. 2011

EC legislation, limit values (EU Directive 2008/50/EC)

Averaging period	Limit value	Date by which limit value is to be met
One hour	200 µg/m^3 (not to be exceeded more than 18 times in a calendar year)	1 January 2010
Calendar year	40 µg/m^3	1 January 2010

Reference method for determination of the metric

The reference method for NO2 is based on the catalytic conversion of NO2 into NO and subsequent determination of NO by the chemiluminescence signal resulting from the reaction of nitrogen monoxide with ozone(EN14211:2005 “Ambient air quality — Standard method for the measurement of the concentration of nitrogen dioxide and nitrogen monoxide by chemiluminescence”). The method is described in detail in the AirMonTech Technology Description File for NO2.

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