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EMISSION ESTIMATES OF ORGANIC COMPOUNDS AND NITROGEN OXIDES FOR OSLO AND SOUTHERN TELEMARK

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SUMMARY

Emission estimates of organic compounds and nitrogen oxides are given for Oslo (500.000 inhabitants) and southern Telemark (100.000 inhabitants). The organic compounds are specified in reactivity classes, represented by the following seven compounds: "non-reactive", aldehydes, n-butane, n-hexane, ethylene, xylene and propylene. The nitrogen oxides are specified as nitric oxide and nitrogen dioxide.

For organic compounds, the emission categories are gasoline exhaust, diesel exhaust, oil combustion, solvent use, handling and storage of oil products, dry cleaning and petrochemical industry. For nitrogen oxides, the emission categories are gasoline exhaust, diesel exhaust, oil combustion and high level industrial emissions.

The total emissions of organic compounds (as carbon) are estimated to 23500 kg/day for Oslo and 12200 kg/day for southern Telemark. The total emissions of nitrogen oxides (as nitrogen) are estimated to 4100 kg/day for Oslo and 7400 kg/day for southern Telemark.

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EMISSION ESTIMATES OF ORGANIC COMPOUNDS AND NITROGEN OXIDES FOR OSLO AND SOUTHERN TELEMARK

1 INTRODUCTION

In 1980 a study was performed using the "EKMA Model" to calculate the effect of emission control on the ambient ozone levels in two areas in Norway (Schjoldager, 1980).

The EKMA Model (Empirical Kinetic Modeling Approach) is a photochemical box model for predicting the changes in maximum ozone concentration downwind of an urban area, as a result of changes of various factors influencing the ozone level, such as precursor emissions, transported ozone, mixing height etc. The EKMA Model has been developed by the U.S. Environmental Protection Agency (EPA) and is offered as a tool for studying photochemical oxidant abatement strategies (EPA, 1977; Whitten and Hogo, 1978).

The results from the use of the EKMA Model in Norway were discussed at the "Second Workshop on Oxidant Control Strategies", held at the Organisation for Economic Co-operation and Development (OECD) in Paris in June 1980, together with the results of model calculations from other areas in Europe and North America (OECD, 1980). At the workshop it was agreed that further calculations should be carried out, either with the EKMA Model or with other available models, and that emission inventories of organic compounds and oxides of nitrogen should be made for the areas under consideration. The format of such emission inventories was outlined at the workshop. In order to make possible the use of more sophisticated models, the emission inventories of organic compounds were specified in more detail than required for the application of the EKMA Model.

The two areas in Norway, for which the calculations were performed, were Oslo and southern Telemark. In this report, emission estimates of organic compounds and oxides of nitrogen are given for these two areas. The emissions from Oslo are based on data from 1979, while most of the data for southern Telemark are from 1977. Oslo and southern Telemark have approximately 500.000 and 100.000 inhabitants, respectively.

2 BASIS FOR THE CALCULATIONS

The following emission categories were specified at the workshop:

Mobile emissions
Low level fugitive emissions
High level emissions (nitrogen oxides only)
Domestic heating

In order to make use of earlier emission estimates (Gram et al., 1980) the emission categories were divided into subcategories:

Mobile emissions:	Gasoline exhaust, Diesel exhaust.
Low level fugitive emissions:	Solvent use, Handling and storage of oil products, Dry cleaning, Petrochemical industry.

2.1 Emission factors

The emission factors given here are on a weight basis, calculated as carbon (C) or nitrogen (N).

For mobile emissions the following factors were used (Grønskei, 1981):

Diesel exhaust	:	Organic compounds (C)	: 0.75 g/km
		Nitrogen oxides (N)	: 1.52 g/km
Gasoline exhaust	:	Organic compounds (C)	: 1.52 g/km
		Nitrogen oxides (N)	: 0.47 g/km

For solvents, an average per capita emission of organic compounds of 25 g/day was used. This is somewhat lower than previously used by the OECD (1978), but the value corresponds to the estimates made for southern Telemark in 1977.

The organic emissions were divided in reactivity categories, represented by the following components:

Non-reactive
Aldehydes
n-butane
n-hexane
Ethylene
Xylene
Propylene

The division of the emissions into the various components was somewhat arbitrary, due to lack of reliable information. The emission fractions chosen were similar to those of earlier studies (Gram et al., 1980). The emission fractions are given in Table 1 and should be interpreted as representing reactivity categories rather than the accurate composition of the given components.

Table 1: Composition of organic emissions, given on a per cent basis, calculated as carbon.

Component / Category	Non-reactive	Alde-hydes	n-butane	n-hexane	Ethylene	Xylene	Propylene	Sum
Gasoline exhaust	18	2	15	5	20	20	20	100
Diesel exhaust	12	3	10	5	15	25	30	100
Oil combustion	70		5	5	10	5	5	100
Solvent use	17	3	5	5	15	50	5	100
Handling and storage	5		35	15	30	10	5	100
Dry cleaning	50		5	5	30	5	5	100
Petrochemical industry			15		55		30	100

The composition of nitrogen oxides, given as NO_2/NO_x volume ratio, was assumed to be:

Nitric acid production	0.5
Cement production	0.15
All combustion sources	0.05

2.2 Use of gasoline and diesel oil

Based on sales inventories from the oil companies, the fuel consumption in the two areas is given in Table 2.

Table 2: Consumption of gasoline and diesel oil. Unit: m^3/year.

	Oslo	Southern Telemark
Gasoline	214000	47600
Diesel oil	73000	18300

The weighted average of fuel consumption of the vehicles were estimated as follows:

Gasoline vehicles: 0.13 ℓ/km
Diesel vehicles : 0.32 ℓ/km

3 EMISSION ESTIMATES

3.1 Organic compounds

The total emissions (in kg carbon per day) are presented in Table 3. The numbers represent average values for the summer months.

Table 3: Emission of organic compounds.
Unit: kg/day (as carbon).

Category	Oslo	Southern Telemark
Gasoline exhaust	6860	1520
Diesel exhaust	470	120
Oil combustion	470	200
Solvent use	12500	2500
Handling and storage	2470	700
Dry cleaning	750	150
Petrochemical industry		7000
Sum	23520	12190

It is seen from Table 2 that more than 50% of the emissions are in the category "Solvent use". This result may seem erroncous, but is a direct result of the emission factors given in Section 2.

In order to calculate the emissions of the specific organic compounds, the total emission figures in Table 3 must be multiplied by the emission fractions from Table 1.

3.2 Nitrogen oxides

The total emissions are presented in Table 4, in kg nitrogen per day. The numbers represent average values for the summer months.

Table 4: Emissions of nitrogen oxides.
Unit: kg/day (as nitrogen).

Category	Oslo	Southern Telemark
Gasoline exhaust	2120	470
Diesel exhaust	950	240
Oil combustion	810	100
High level industrial emissions:		
Nitric acid production		2000
Cement production		2100
Petrochemical industry		880
Other industry		1560
Sum	4060	7350

4 CONCLUDING REMARKS

The emission factors for organic compounds in gasoline and diesel exhaust used in this report are lower than those employed earlier. The emissions result in total molar emission ratios between organic compounds and nitrogen oxides of 6.8 for Oslo and 1.9 for southern Telemark. The ratios used in the EKMA Model calculations were 9 and 6, respectively. This discrepancy is thus particularly large for southern Telemark. In the EKMA calculations, however, it was assumed that, due to the location the industries and topographical effects, most of the industrial emissions of nitrogen oxides were not directly influencing the photochemical reactions leading to the maximum ozone concentrations recorded on 6-7 June 1979 in southern Telemark.

It is felt that the changes in emission ratios do not significantly affect the main conclusions drawn from the EKMA Model calculations.

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OPPDRAGSGIVER
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3 STIKKORD (á maks.20 anslag)		
Utslipp	Organiske stoffer	Nitrogenoksyder

REFERAT (maks. 300 anslag, 5-10 linjer)

Utslipp av organiske stoffer og nitrogenoksyder er anslått for Oslo og nedre Telemark. Utslippene er gitt med tanke på fotokjemiske modellberegninger. Sju typer av organiske stoffer er spesifisert. Verdiene er middeltall for sommermånedene.

TITLE

ABSTRACT (max. 300 characters, 5-10 lines)

Emissions of organic compounds and nitrogen oxides are estimated for the two areas in Norway, Oslo and southern Telemark, for which photochemical model calculations (using the EKMA Model) were performed earlier. Seven classes of organic compounds are given. The numbers are average values for the summer months.

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