SNAP CODES: **040506**
040507

SOURCE ACTIVITY TITLES: **PROCESSES IN ORGANIC CHEMICAL INDUSTRIES (BULK PRODUCTION)**
Polyethylene Low Density
Polyethylene High Density

NOSE CODE: **105.09.80**
105.09.81

NFR CODE: **2 B 5**

1 ACTIVITIES INCLUDED

This section includes the manufacture of polyethylene. Three types are produced; low density polyethylene (LDPE), linear low density polyethylene (LLDPE) and high density polyethylene (HDPE).

This section includes all emissions during the processing of chemical feed-stocks to produce polyethylene, including process and fugitive emissions. Emissions from storage of feed-stocks, intermediates and products are not included.

Note. 'Polyethylene' and 'Polythene' are synonymous and the terms may be used interchangeably.

2 CONTRIBUTION TO TOTAL EMISSIONS

The CORINAIR 1985 inventory gives emission estimates for LDPE and HDPE production (Eurostat, 1992). Emissions are total hydrocarbon. LDPE production typically represents 0 to 1% of a countries national emission of VOCs (including methane), whereas HDPE production typically represents 0 to 0.3%. No data are available for LLDPE production.

3 GENERAL

3.1 Description

Polyethylene is a polymer of ethylene and has the general empirical formula $(-CH_2CH_2-)_n$. The manufacturing process used depends upon the type of polymer produced.

3.2 Definitions

LDPE is a tough waxy polymer, with approximately 2% branching between polymer chains and has a density of about 0.92t/m^3.

LLDPE is a crystalline polymer with no chain branching and a density comparable to that of LDPE.

HDPE is a crystalline polymer with no chain branching and a density of about 0.96t/m^3.

3.3 Techniques

LDPE
LDPE is generally produced by high pressure and high temperature catalytic polymerisation of ethylene in a tubular or autoclave reactor.

LLDPE
A low pressure method is generally used in which ethylene and a co-monomer such as butene or hexene are catalytically polymerised.

HDPE
HDPE is produced by low pressure polymerisation of ethylene in a reactor containing a liquid hydrocarbon diluent and in the presence of Ziegler catalysts. The polymer produces a slurry as it forms and is filtered from the solvent.

3.4 Emissions/Controls

The major emissions to air are NMVOC - un-reacted monomer (i.e. ethylene), some partially reacted monomer (alkenes and alkane) together with small amounts of additives.

NMVOCs are emitted primarily through leakages, and may be production time dependent rather than production dependent.

Control techniques are primarily through replacement of leaking valves etc, and regular maintenance.

4 SIMPLER METHODOLOGY

The simpler methodology relies on the use of an emission factor for each type of polyethylene production combined with national activity statistics.

5 DETAILED METHODOLOGY

The detailed methodology involves the use of several emission factors for different types of emission sources combined with activity statistics relating to individual plants.

The assessment of individual plants may be verified through measurements.

6 RELEVANT ACTIVITY STATISTICS

For the simpler methodology, the national annual production of each of the three types of polyethylene is required.

For the more detailed methodology, data on the throughput of individual plant is required.

7 POINT SOURCE CRITERIA

Polyethylene production is carried out at a limited number of sites throughout Europe (for example three production sites have been identified in the UK). These sites should therefore all be considered point sources, regardless of the size of the emission.

For the simpler methodology, if the production from each site is not known, then the national emission estimate may be proportioned according to the relative production capacities of each plant.

8 EMISSION FACTORS, QUALITY CODES AND REFERENCES

8.1 Simpler Methodology

Emission factors are in kgVOC/t polyethylene produced and are tabulated below:

Process	Emission factor	Quality Code	Reference
PE manufacture	2 kg/t (new plant)	D	UN ECE, 1990
	10 kg/t (old plant)	D	UN ECE, 1990
LDPE manufacture:	3 kg/t	D	UN ECE, 1990
	2 kg/t	D	ChemInform, 1993
LLDPE manufacture	2 kg/t	D	ChemInform, 1993
HDPE manufacture:	6.4 kg/t	D	UN ECE, 1990
	5 kg/t	D	ChemInform, 1993

8.2 Detailed Methodology

Emission factors for the detailed approach are based on the USEPA Protocol for Generating Unit Specific Emission Estimates for Equipment leaks of VOC and VHAP. For example one of the protocols involves the use of the Synthetic Organic Chemical Manufacturing Industry (SOCMI) average emission factor model. SOCMI factors are combined with component counts to give an overall fugitive emissions from a plant. The SOCMI average emission factor method does not involve on-site monitoring whereas the other approaches considered by the USEPA protocol do require on-site monitoring.

Further information may be obtained from the USEPA, Research Triangle Park, Rayleigh, North Carolina, United States.

9 SPECIES PROFILES

Species present will depend upon the process used and the stage of the process. No detailed speciation has been found. In the absence of further information, it may is assumed that the NMVOC emission is 100% ethene.

10 UNCERTAINTY ESTIMATES

For the simpler methodology, the range of emission factors between old and new plant and the relatively low data quality suggest that the potential uncertainty in emission estimates is large i.e more than factor 2.

For the detailed methodology, the uncertainty is not known. However in a study by Environment Canada, use of SOCMI average factors tended to give considerably higher emission estimates than were obtained using other more detailed methods in the USEPA protocol referred to above (Edwards 1990).

11 WEAKEST ASPECTS/PRIORITY AREAS FOR IMPROVEMENT IN CURRENT METHODOLOGY

The weakest aspect of the methodology is the use of general emission factors whose accuracy needs to be confirmed through measurement.

In addition the emission factors do not distinguish between methane and non methane VOCs. No speciated data appears to be available for the emission from these plants. Various organic compounds may be present including methane.

The priority areas for improvement are suitable measurement programme to assess emissions from whole plants and thus enable accurate comparison between the different methodologies used for estimating VOC emissions. Such a programme should also establish the speciated profile of emissions from polyethylene production plants.

12 SPATIAL DISAGGREGATION CRITERIA FOR AREA SOURCES

All sources should be considered point sources.

13 TEMPORAL DISAGGREGATION CRITERIA

In the absence of better information, it may be assumed that Polyethylene production is carried out as a continuous process. No temporal variation is considered, except for shutdowns of plants for maintenance. Where available, monthly production statistics should be used to establish any possible temporal variations.

14 ADDITIONAL COMMENTS

15 SUPPLEMENTARY DOCUMENTS

USEPA Protocol for Generating Unit Specific Emission Estimates for Equipment Leaks of VOC and VHAP.

16 VERIFICATION PROCEDURES

Verification is through comparison with emission estimates from other countries together with a measurement programme for selected sites.

17 REFERENCES

Eurostat (Statistical Office of the European Communities), Environment Statistics, Luxembourg, 1992

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20 POINT OF ENQUIRY

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