SNAP CODE: **040511**

SOURCE ACTIVITY TITLE: **PROCESSES IN ORGANIC CHEMICAL INDUSTRIES (BULK PRODUCTION)**
Polystyrene

NOSE CODE: **105.09.84**

NFR CODE: **2 B 5**

1 ACTIVITIES INCLUDED

Polystyrene is made by polymerizing styrene monomer. Most polystyrene is produced by free-radical polymerization.

2 CONTRIBUTION TO TOTAL EMISSIONS

The NMVOC emission of polystyrene plants contributes on average 0.01% to the total NMVOC emission in a country.

Table 2.1: Contribution to total emissions of the CORINAIR90 inventory (*28 countries*)

Source-activity	SNAP-code	Contribution to total emissions [%]							
		SO_2	NO_x	NMVOC	CH_4	CO	CO_2	N_2O	NH_3
Polystyrene	040511	-	-	0	-	-	-	-	-

0 = emissions are reported, but the exact value is below the rounding limit (0.1 per cent)
- = no emissions are reported

This activity is not believed to be a significant source of $PM_{2.5}$ (as of December 2006).

3 GENERAL

3.1 Description

Polystyrene can be polymerized via several mechanism: free-radical, anionic and cationic and with Ziegler-Natta catalyst. Commercially free-radical polymerization is most important.

Styrene acts as its own free-radical initiator, when heated. A commonly used temperature is 100 °C.

The process has a high yield; the product a high purity, because no additions are needed.

The key-problems are: heat removal and pumping the highly viscous solutions.

3.2 Definitions

3.3 Techniques

See section 3.1.

3.4 Emissions

The major emissions to air are: styrene and other hydrocarbons.

For the Netherlands, the VOC emission due to the polystyrene production is 342.3 ton/y. This emission is related to a production of 131.4 kton/y and a capacity of 194 kton/y (data for 1992).

The VOC emission can be subdivided as follows:

Emission source	**[1]**
leakage losses from appendages, pumps, etc.	94.5%
flaring, disruptions	0 %
losses due to storage and handling	5.5%
combustion emissions	0 %
other process emissions	0 %

3.5 Controls

The losses due to leakage can be limited by use of certain types of seals and application of double seals near pumps.

4 SIMPLER METHODOLOGY

Use of an overall emission factor for the polystyrene production to estimate total emissions. The amount of emitted VOC is then directly related to the polystyrene production.

5 DETAILED METHODOLOGY

A more detailed methodology is used by the United States EPA.
Instead of one emission factor for the whole plant, emission factors for each piece of equipment, like valves, flanges, etc., can be used. Each type of equipment has its own emission factor. The total emission factor for the plant can be calculated by multiplying each equipment emission factor by the number of pieces of that type of equipment. So, for this method it is necessary to know how many pieces of each type of equipment are present in the plant.

6 RELEVANT ACTIVITY STATISTICS

Tables 6.1 and 6.2 list relevant capacities and production data for several countries and regions for 1990.

Table 6.1: Polystyrene capacity in some countries

Country or Region	kton/y	source	year
Latin America	590	EurChemNews //92	1991
Indonesia	27.5	EurChemNews //92	1990?

Table 6.2: Polystyrene production in some countries and regions for 1990

Country or Region	**kton/y**	**source**
France	542	Chem&EngNews 29/6/92
Italy	353	Chem&EngNews 29/6/92
Canada	215	Chem&EngNews 29/6/92
U.S.A.	2280	Chem&EngNews 29/6/92
Japan	2097	Chem&EngNews 29/6/92
Korea, South	592	Chem&EngNews 29/6/92
U.S.S.R.	515	Chem&EngNews 13/4/92

7 POINT SOURCE CRITERIA

Polystyrene production plants can be considered as point sources if plant specific data are available.

8 EMISSION FACTORS, QUALITY CODES AND REFERENCES

Table 8.1: Emission factors for polystyrene

Source	**factor (kg/ton)**	**Quality Code**
TNO Emission Registration 1992 [1]	2.6	C
EPA [2]	0.6 - 2.5 batch	C/D
EPA [2]	0.2 - 3.3 cont.	C/D
EPA [2]	5.4 expandable	C/D

9 SPECIES PROFILES

Tables 9.1 and 9.2 list the VOC profile respectively for the different sources and the overall profile.

Table 9.1: The composition of the VOC emissions for the different sources is [1]:

	methane	ethylene	styrene	HCFC's	other HC's
leakage loss	0%	0%	>2%	0%	<98%
flaring and disruptions	-	-	-	-	-
storage and handling loss	0%	0%	>17%	0%	<83%
combustion	-	-	-	-	-
other process emissions	-	-	-	-	-

Table 9.2: The overall VOC emission profile for polystyrene plants

	TNO ER [1]	EPA [3]
methane	0%	-
ethylene	0%	-
ethylbenzene	-	10%
styrene	>3%	90%
other HC's	<97%	-

10 UNCERTAINTY ESTIMATES

11 WEAKEST ASPECTS/PRIORITY AREAS FOR IMPROVEMENT IN CURRENT METHODOLOGY

12 SPATIAL DISAGGREGATION CRITERIA FOR AREA SOURCES

National emission estimates can be disaggregated on the basis of production, population or employment statistics.

13 TEMPORAL DISAGGREGATION CRITERIA

The plants are operated in continuous flow, thus no variation in emissions diurnally or seasonally is expected to occur.

14 ADDITIONAL COMMENTS

15 SUPPLEMENTARY DOCUMENTS

- Kirk-Othmer, Encyclopedia of chemical technology, Volume 23, third edition (1983).
- Winnacker-Küchler, Chemische Technologie, Organische Technologie II, Band 6 4. Auflage (1982) (in German).

16 VERIFICATION PROCEDURES

Verification of the emissions can be done by comparing with measurements in the individual plant or by setting up a mass balance over the entire plant.

17 REFERENCES

1 TNO Emission Registration, 1992
2 EPA, AP-42
3 EPA, Airchief, 1991

18 BIBLIOGRAPHY

19 RELEASE VERSION, DATE AND SOURCE

Version : 1.2

Date : October 1995

Source : J J M Berdowski, W J Jonker & J P J Bloos
TNO
The Netherlands

Updated with particulate matter details by:
Mike Woodfield
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20 POINT OF ENQUIRY

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