# 07
# Road transport

*Process description*

Covered here are the emissions associated with the operation of passenger cars and light and heavy duty vehicles. The combustion process taking place in the gasoline and diesel engine will not be explained in detail here since it is assumed to be well known; however, with respect to possible emissions of PCDD/F some important characteristics should be noticed:

- halogen compounds (mainly chlorine and bromine) may enter the process with the fuel (especially in leaded fuel containing tetraethyllead and so-called brominated „scavenger compounds“) and with the combustion air which is taken from the ambient. To some extent lubricating oils may serve as a further source of halogens.

- during vehicle operation the combustion process is considerably varying with time. Emissions might be different during different phases like start-up, transient conditions , steady state condition etc.

*Abatement technologies:*

During the recent years catalytic devices have been implemented in the engines to reduce the emissions of CO and $NO_X$. These devices, which are operated together with electronic fuel injection and combustion controling facilities may also influence the emissions of dioxins and furans. Concerning diesel engines trials are made to develop efficient soot filters; if such filters will become available on a broad scale the emissions of all compounds bound to diesel soot particles would decrease.

*Plant data/European situation*

Considerable differences exist in the European countries concerning the degree of motorisation, the annual mileage per vehicle or per capita ( see 07—Table 1) and the types of fuel being used. While in some countries the use of leaded fuels continues to decline or has been banned yet remarkable amounts of leaded gasoline are consumed in others.

| **country** | **number per 1000 capita [1])** | **$10^9$ vehicle-km [2])** |
|---|---|---|
| **A** | 432 | nr |
| **B** | 408 | 61 |
| **CH** | 449 | nr |
| **D** | 419 | 463 |
| **Dk** | 323 | 29,5 |
| **E 1992** | 335 | 140 |
| **F** | 422 | 292 |
| **GR** | 189 | 25,5 |
| **I 1991** | 496 | 238 |
| **IRL** | 253 | 16 |
| **L** | 543 | 2,7 |
| **N** | 378 | nr |
| **NL** | 375 | nr |
| **P** | 224 | 19,2 |
| **S** | 410 | nr |
| **SF** | 369 | nr |
| **UK** | 362 | 443 |

**07—Table 1 Data on number and use of passenger cars**

[1]) according to intern. Statistics;

[2]) as reported to Corinair ‘90;

nr = not reported

*Activity data*

Data on fuel consumption being available from the national dioxin reports and from international statistics are shown 07—Table 5

*Emission factors*

There have been a few measurement programs in Europe ‹ 1 - 5› and in the United States ‹ 6› concerning probable PCDD/F emissions in vehicle exhaust. For the European countries the data given in the national dioxin reports are listed in 07—Table 4. The emission factors used in the Belgian report were chosen (07—Table 2) for the re-estimation of emissions since they were based on test stand measurement (German study) in combination with tunnel experiments (Belgian study),

| | **leaded gasoline** | **unleaded gasoline** | **diesel** |
|---|---|---|---|
| **Emission factor [ng I-TEQ/$t_{fuel}$]** | 2200 | 104 | 43 |

**07—Table 2 Emission factors chosen for of PCDD/F emissions from road transport**

*Emission estimation*

From the statistical data and chosen emission factors the following annual emission estimates were derived:

| | **leaded gasoline** | **unleaded gasoline** | **diesel** |
|---|---|---|---|
| **annual emission [g I-TEQ/a]** | 97.8 | 7.8 | 5.5 |

**07—Table 3 PCDD/F air emissions from road traffic**

*Conclusion/recommendation*

Only the use of leaded fuels may contribute to the European total emissions of dioxins and furans to a certain extent, while the emissions from combustion of unleaded and diesel are almost negligible. However, there are considerable uncertainties concerning emission from heavy duty diesel trucks which are suspected to be a more serious emission source in the United States ‹ 7, 8› . Since the only measurement results being available especially for this type of vehicles were obtained in the US one decade ago , some additional investigations may be useful to get information about the European

situation. Preliminary experiments in this direction are currently performed at the North-Rhine Westfalia State Environment Agency in Essen, Germany.

| | Leaded | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Flue gas conc. [ng I-TEQ/m³] | | | Emission factors | | | Dimension (I-TEQ) | Remarks |
| | typ | min | max | typ | min | max | | |
| **B** | | | | 2200 | | | **[ng/t]** | EFs based on tunnel experiment in B and German study [Hagenmeier]; for 1995 45% of all vehicles assumed to be equipped with catalyst. |
| **D** | | | | 174.0 | 28.0 | 1080.0 | pg/l fuel | |
| **F** | | | | 0.74 | | | ng/t | |
| **NL** | | | | 1080 | | | pg/l fuel | |
| **S** | | | | 103.92 | 10 | 1080 | pg/l fuel | |
| **Uk** | | | | | 1.1 | 220 | pg/km | incl. petrol used in heavy duty vehicles |
| | | | | **2200** | | | **ng/t** | **Chosen value** |
| | **Unleaded** | | | | | | | |
| **B** | | | | 104 | | | ng/t | EFs based on tunnel experiment in B and German study [Hagenmeier]; for 1995 45% of all vehicles assumed to be equipped with catalyst. |
| **D** | | | | 43.0 | 20.0 | 90.0 | pg/l fuel | |
| **F** | | | | | 0.02 | 0.09 | ng/t | |
| **NL** | | | | 18.9 | 7 | 51 | pg/l fuel | |
| **S** | | | | 17.75 | 3.5 | 90 | pg/l fuel | |
| **Uk** | | | | | 0.36 | 21 | pg/km | incl. mopeds and motorcycles |
| | | | | **104** | | | **ng/t** | **chosen value** |
| | **diesel** | | | | | | | |
| **B** | | | | 43 | | | **[ng/t]** | EFs based on tunnel experiment in B and german study [Hagenmeier]; for 1995 45% of all vehicles assumed to be equipped with catalyst. |
| **D** | | | | 48.0 | 23.6 | 97.5 | pg/l fuel | |
| **NL** | | | | 24 | | | pg/l fuel | |
| **S** | | | | 34.64 | 24 | 50 | pg/l fuel | |
| | | | | | 0.72 | 9.5 | ng/km | derived from measurements of tunnel air and assumptions on traffic mix ‹5› |
| **Uk** | | | | | 0.65 | 37 | pg/km | in UK report EFs are further diferentiated for type of vehicle and use of catalyst in case of unleaded fuel. |
| | | | | **43** | | | **ng/t** | **Chosen value** |

**07—Table 4 PCDD/F air emission factors for road transport from the national dioxin inventories**

| | **Activity rates [kt/a]** | | | | | |
|---|---|---|---|---|---|---|
| | from Inventories | | | from Eurostat (IEA), 1994 | | |
| | leaded | unleaded | diesel | leaded | unleaded | diesel |
| **A** | | | | 0 | 2408 | 2439 |
| **B** | 643 | 2246 | 4100 | 1001 | 1842 | 3979 |
| **CH** | | | | 993 | 2712 | nd |
| **D** | 2332 | 27935 | 25790 | 2332 | 27935 | 25790 |
| **Dk** | | | | 420 | 1474 | 1932 |
| **E** | | | | 4823 | 2032 | 10421 |
| **F** | | | | 7591 | 7579 | 21387 |
| **Gr** | | | | 1954 | 745 | 1978 |
| **I** | | | | 13088 | 3528 | 16182 |
| **Irl** | | | | 510 | 483 | 829 |
| **L** | | | | 133 | 411 | 616 |
| **N** | | | | 530 | 1153 | nd |
| **NL** | 1817 | 2703 | 5120 | 783 | 3129 | 4159 |
| **P** | | | | 1281 | 548 | 2190 |
| **S** | 715.36 | 3756 | 2438.4 | | 4174 | 2009 |
| **Sf** | | | | 116 | 1919 | 1486 |
| **Uk** | 183,9e9 km | 152,8e9 km | 73,5e9 km | 8898 | 13201 | 12777 |
| **TOTAL** | | | | 44453 | 72865 | 108174 |

**07—Table 5 Activity rates releated to road transport**

| | from Inventories | | | Re-estimated | | | Total |
|---|---|---|---|---|---|---|---|
| | leaded | unleaded | diesel | leaded | unleaded | diesel | |
| **A** | | | | 0.0 | 0.3 | 0.10 | **0.4** |
| **B** | 1.4 | 0.1 | 0.2 | 2.2 | 0.2 | 0.17 | **2.6** |
| **CH** | | | 0.848 | 2.2 | 0.3 | 0.848 | **3.3** |
| **D** | 0.5 | 1.6 | 1.7 | 5.1 | 2.9 | 1.11 | **9.1** |
| **Dk** | | 0.2 | | 0.9 | 0.2 | 0.08 | **1.2** |
| **E** | | | | 10.6 | 0.2 | 0.45 | **11.3** |
| **F** | | | | 16.7 | 0.8 | 0.92 | **18.4** |
| **Gr** | | | | 4.3 | 0.1 | 0.09 | **4.5** |
| **I** | | | | 28.8 | 0.4 | 0.70 | **29.9** |
| **Irl** | | | | 1.1 | 0.1 | 0.04 | **1.2** |
| **L** | | | | 0.3 | 0.0 | 0.03 | **0.4** |
| **N** | | | | 1.2 | 0.1 | nd | **1.3** |
| **NL** | 2.0 | 0.1 | 0.1 | 1.7 | 0.3 | 0.18 | **2.2** |
| **P** | | | | 2.8 | 0.1 | 0.09 | **3.0** |
| **S** | 0.1 | 0.4 | 0.1 | 0.0 | 0.4 | 0.09 | **0.5** |
| **Sf** | | 2.8 | 0.8 | 0.3 | 0.2 | 0.06 | **0.5** |
| **Uk** | 4.3 | 0.7 | 1.0 | 19.6 | 1.4 | 0.55 | **21.5** |
| Total | 8.4 | 5.9 | 3.9 | 97.8 | 7.8 | 5.55 | 111.1 |

**07—Table 6 Estimated annual PCDD/F emissions from road transport [g I-TEQ/a]; reference period: 1993-1995**

## References to 07

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