Methodical principles of emission assessment from transport

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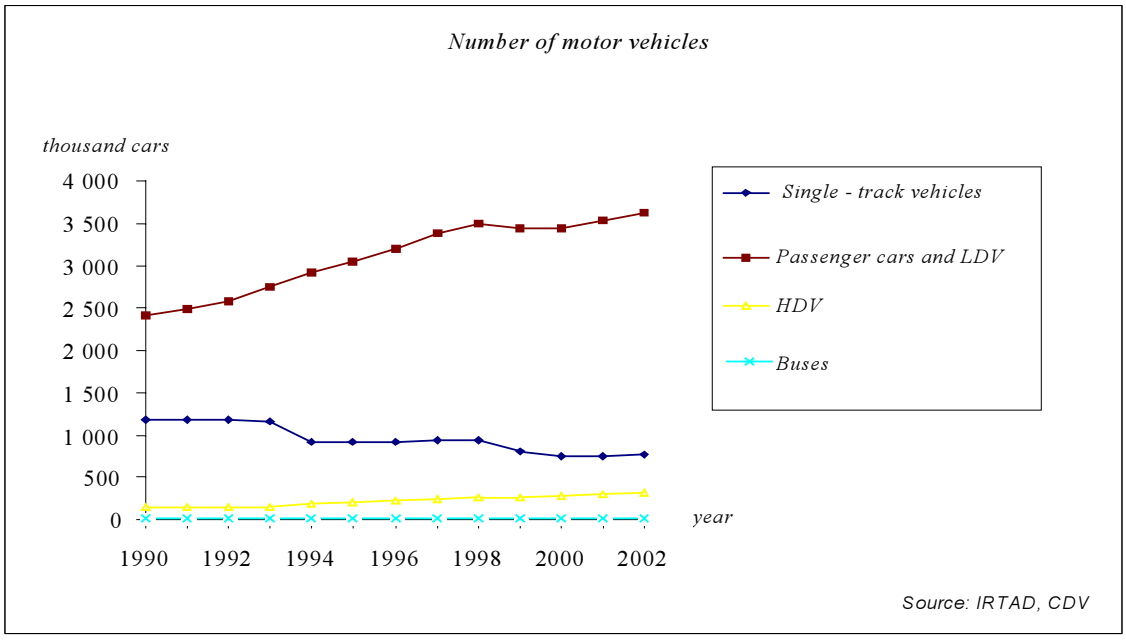
Abstrakt

The paper shows basic principles of specific emissions calculation methodology which was developed in the frame of the research project supported by Ministry of Transport. The methodology takes into account the “top down” approach and data availability in the Czech Republic (CR). Also, the emission factors are reviewed with a help of special tests at the most used Czech and foreign cars. The basic entry data are: measured emission factors, numbers of vehicles separated to a few categories, fuel consumption, fuel quality and properties (density, specific energy, Pb, S and benzene content, etc.). Emissions from the combustion of each fuel are calculated separately.

Introduction

Demands on traffic system resulting from fulfilling our individual needs and requirement for economic development, together with the process of integration into European union, are increasing. This fact entails many negative effects causing environmental and human risks. The most serious are among others emissions from fuel combustion in vehicle engines. The most significant mobile source of emissions are individual passenger transport and the road freight transport, mainly in large cities.

The methodology "Methodology of determination of air polluting emissions from transport" to calculate emissions from mobile sources was developed, considering composition of vehicles fleet in the CR, emission factors, annual mileages and fuel consumption.



The methodology of emissions calculation

The calculation of transport emissions is based on the methodology developed by our institution for the whole CR and also for regional and local level. The methodology includes only emissions from transport and does not include emissions from electricity production used by electricity vehicles. Furthermore it does not include emissions from engine of no-traffic machine and vehicles used for example in agriculture, building industry, army or in household.

Underlying principles of the methodology are:
- categorization of vehicles
- measured emission factors
- distribution of fuel consumption between individual transport modes
- annual mileages in selected vehicle categories

Table 1 Vehicle categories for calculation of transport emissions

No. of category	Labelling	Description of category
1	ID.B1	individual transport, gasoline passenger single-track vehicles
2	ID.B2	individual transport, gasoline passenger dual-track vehicles without catalytic convert system
3	ID.B3	individual transport, gasoline passenger dual-track vehicles with catalytic convert system
4	ID.N	individual transport, diesel passenger dual-track vehicles
5	ID.LPG	individual transport, LPG passenger vehicles
6	ID.CNG	individual transport, CNG passenger vehicles
7	ID.SN	individual transport, bio-diesel passenger vehicles
8	AD.B	public transport, gasoline vehicles
9	AD.N	public transport, diesel vehicles
10	AD.LPG	public transport, LPG vehicles
11	AD.CNG	public transport, CNG vehicles
12	AD.SN	public transport, bio-diesel vehicles
13	ND.B	gasoline, goods vehicles
14	ND.LDV	diesel, goods vehicles under 3,5 t
15	ND.HDV	diesel, goods vehicles over 3,5 t
16	ND.LPG	LPG goods vehicles
17	ND.CNG	CNG goods vehicles
18	ND.SN.	bio-diesel goods vehicles
19	ŽD.N	rail, diesel traction
20	ŽD.SN	rail, bio-diesel traction
21	VD.N	diesel boats
22	LD.LB	aviation gasoline aircraft
23	LD.LP	kerosine aircraft

The methodology is base on distribution of vehicles into 23 categories using following criteria: transport mode, fuel, weight of vehicles (in road freight traffic) and equipment with effective catalytic convert system (cars). Every category has attached emission factors of CO_2, CO, NO_X, N_2O, CH_4, NM VOC, SO_2, Pb and PM, according to available measurements. Emission factors are put in $g.kg^{-1}$ of fuel and are processed in MS Access database.

For distribution of fuel consumption two parallel approaches are used:
"top - down", i.e. allocating total fuel consumption according to transport performances and vehicle numbers, and "bottom - up", i.e. from annual mileages and average consumption at $l.100km^{-1}$. This consumption is distributed into 5 categories, earmarked from the 23 categories mentioned above, which show largest difference in annual mileages ($km.year^{-1}$).

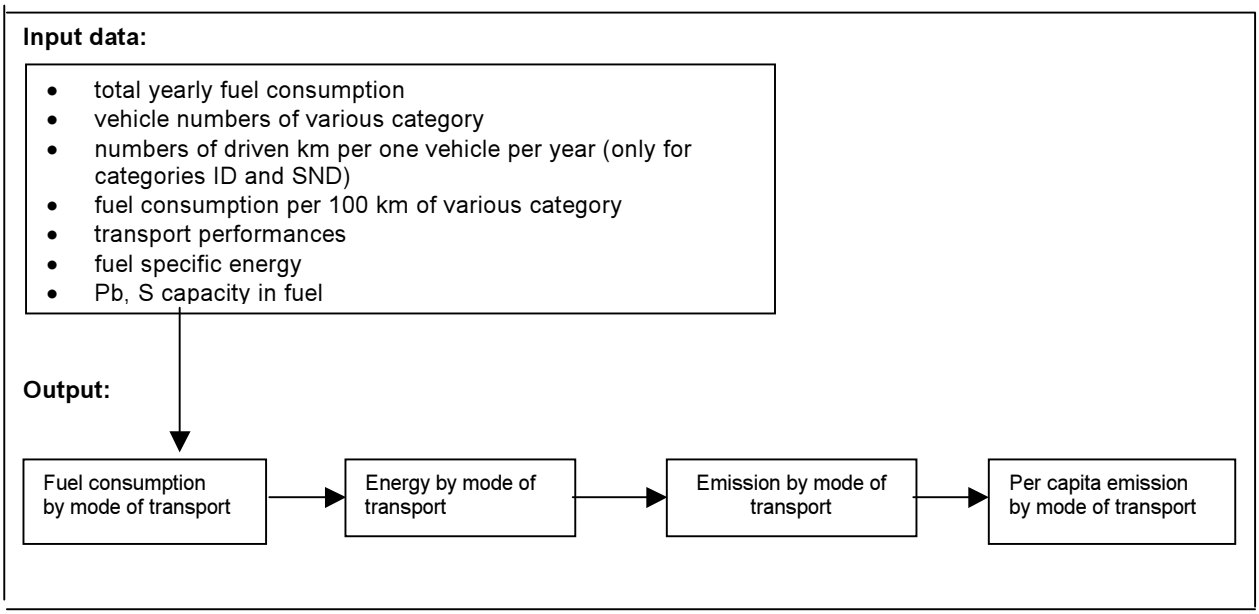
Table 2 Categories with deferent annual mileages:

No. of category	Labelling	Description of category
1	ID.B1	individual transport, gasoline passenger single-track vehicles
2	ID.B2	individual transport, gasoline passenger dual-track vehicles without catalytic convert system
3	ID.B3	individual transport, gasoline passenger dual-track vehicles with catalytic convert system
4	ND.LDV	diesel, goods vehicles under 3,5 t
5	ND.HDV	diesel, goods vehicles over 3,5 t

Mileages are inputted in such a manner, that sum of fuel consumption of categories 1 - 3 calculated using "bottom - up" method is identical with fuel consumption in individual transport calculated using "top - down" method. Similar approach is taken in the road freight transport. Also relation of mileages set up must be in line with relations of above mentioned categories in real situation. These are derived from transport census.

With respect to separate calculation of all emissions weights for each fuel direct dependence of results on formerly used fuel coefficient is avoided. Categorization of vehicles enables the separated calculation of the production of N_2O from the total amount of NO_X. The VOC are divided into CH_4 (it contributes to the greenhouse effect) and nonmethane VOC. It eliminates the direct dependence of the relationship of transport performances given in passenger kilometres (passenger transport) or tonne kilometres (goods transport). The basis is total fuel consumption in appropriate transport modes. Transport performances are used to derive relative fuel consumption of individual transport modes. Fuel consumption in other sectors than transport is deducted from the total consumption, based on quantification of fuel consumption in agriculture and estimation of fuel consumption in other sectors.

Procedure of setting of annual emission



The methodology utilisation

The methodology is suitable above all for assessment of emissions on national level. However it is possible to use it also on regional level and local level. Emissions on regional level are taken by partition of total emission calculated by this methodology. In road transport results of national traffic census are used, added up with traffic intensities in Prague and also non-census traffic on intravilan network Using traffic model of Brno-city it was estimated that this non-census traffic amounts to c. 30 % of total traffic. This figure is meanwhile extrapolated for all large cities in the CR. Emissions of railway transport are distributed on regions according to the share of non-electrified tracks. Emissions from inland waterway transport are distributed according to the length of navigable rivers. Emissions of air transport (LTO cycles) are distributed according to airport performances, emissions from cruise are distributed evenly among regions, according to the total area.

The methodology also allows for emissions prognosis. They are based directly on different scenarios of transport development. Scenarios are projected into relevant indicators. These indicators, i.e. transport volumes and performances, fuel consumption and number and composition of vehicles fleet in the CR are at the same time input data of the methodology. Different scenarios of fuel consumption show possibile directions of development of transport sector as a whole. Scenarios are applied according to OECD standards, i.e. BAU - business as usual scenario, which suppose intensive increase in transport sector, and EST scenario, which aims to sustainable development. Prognosis of transport volumes show, how distribution among transport modes will look like. The methodology enables answering the question, what parameters, volumes and energy balance would transport sector in the CR have to achieve chosen emission level. With regard to this issue the methodology was already used to set national emission limits, which are now legally binding for the CR.

Conclusion

The methodology is finished with respect to calculation formulas, but not in the case of input data. It is concerning mainly emission factors, which are very inhomogeneous. The reason is that emission factors are from several source, which are provide large variance. Statistical processing of these data in a database is the main issue of further research on the topic with the aim of avoiding the largest variances.

Literature

[1] Dufek, J., Huzlík, J., Adamec, V. Methodology of determination of air polluting emissions from transport in the Czech Republic. CDV, Brno, 2002. 22 s.; (http://www.cdv.cz).

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