On-Road Mobile

All mobile sources are combustion sources, and their pollution comes from small inefficient engines. Incomplete combustion is caused by lack of oxygen to the fuel source.

Method for Determining Emissions

EPA's *Procedures for Emissions Inventory Preparation, Vol. IV: Mobile Sources* should be used to determine emissions for onroad vehicles. This method is the accepted methodology therefore, there will be no discussion of alternate methods of determining vehicle emission estimation methods for this report.

Estimating emissions of toxics is a two step process. The basic steps are:

I. Vehicle Miles Traveled (VMT): determine an estimate of miles traveled in the area of concern, and
II. MOBILE5.0ah: Calculate emission factors for total organic gases using MOBILE5.0ah,
III. apply appropriate total oganic gas (TOG) speciation profiles to estimate toxic emissions.

Inventories can be made more accurate by using as specific information as possible in each of the three steps.

A general statewide inventory was performed using the three steps above and is detailed below. Inventories for state implementation plans, special studies, or other purposes would require more specific information about travel, season, control programs and other parameters.

1994 Inventory

As stated above, this inventory is based upon generalizations. Emissions were calculated for areas with and without inspection and maintenance (I/M) programs, and with and without oxygenated fuel programs. Puget Sound I/M parameters were used for all areas with I/M programs (Puget Sound, Spokane, Vancouver). A start date of 1982 was assumed for the original program and 1993 for the expansion areas. Oxygenated fuels were assumed to be used for four months in the winter. Half of the year was assumed to fall under average summer conditions, and half under average winter conditions.

Vehicle Miles Traveled

1994 Highway Performance Monitoring System (HPMS) data was used to estimate vehicle miles traveled (VMT). The WA State Dept. of Transportation (WSDOT) works with local metropolitan planning organizations to collect the traffic count data which is reported to HPMS. Detail about HPMS is beyond the scope of this report. WSDOT follows the procedures in SPECIATE.

HPMS data are collected for several different roadway classifications. Urban classifications are: Interstate, Other Freeway/Expressway, Principal Arterial, Minor Arterial, Collectors and Local. Rural classifications are: Interstate, Principal Arterial, Minor Arterial, Major Collector, Minor Collector, and Local. Volume on the Local functional system is not specifically counted, but is an assumed percentage of the other functional classifications.

The HPMS data is collected in twelve sample areas. Ten are specific urban areas. Of the other two, one is all rural, and one is all small urban. Average daily VMT (ADVMT) was 130,613,000; annual VMT was estimated by multiplying ADVMT by 365. According to MOBILE5.0ah for 1994, light duty gas cars and trucks (LDG) make up about 90% of the ADVMT and 88% of the total organic gases (TOG).

For this inventory, the Puget Sound Regional Council's 1995 roadway link file was used to dissaggregate VMT into I/M areas in the Seattle-Everett and Tacoma urban areas. Sixty nine percent of the Seattle-Everett urban area VMT and 100% of the Spokane urban area VMT were counted as under the original I/M program. The expansion area VMT was counted using 31% of the Seattle-Everett urban area and 100% of both the Tacoma and Vancouver urban areas. All other travel assumed no I/M program. Oxygenated fuels were assumed for all VMT in the urban areas of Seattle-Everett, Spokane, Tacoma, and Vancouver.

Emission Factors - MOBILE5.0a

EPA's model MOBILE5.0ah was used to generate emission factors. Inputs were as follow:

- Calendar year of Evaluation: 1994
- Month of Evaluation: July (to be more representative of 1994 VMT).
- HCFLAG: 2 (hydrocarbon components - exhaust, evaporative, running, resting)
- NMHFLG: 4 (Total Organic Gases) (also run for VOC)
- PRTFLG: 4 (all pollutants)
- RVP: 12.8, winter, 8.7 summer
- Oxygenated Fuels: 99.9% alcohol blend, 2.7% oxygen content
- Model Year Registration Distribution: 1995 Washington distribution
- Speed: an average network speed of 30 mph was used for all runs
- Average summer temperatures (Sand Point): 58 min, 72 max
- Average winter temperatures (Sea-Tac CO SIP): 34 min, 50 max
- I/M program: Puget Sound parameters, start date 1982, 1993 (expansion area)

Speciation of TOG

EPA's Speciate database profiles were used to used to speciate the M5.0a components (pollutant codes in parentheses) of TOG: profile 1305 total evaporative (V), profile 1308 running (T) and profile 1313 exhaust (X) TOG. There was no profile for the resting loss TOG. The profiles were for light duty gas vehicles (LDGV) and were given a quality rating of B. While the profile was for LDGV, it was applied to light duty gas trucks 1 and 2 (LDGT1, LDGT2) as well. Together these three vehicle types made up 88% of the TOG from mobile sources.

For oxygenated fuels runs (winter), profiles 1301, 1304, and 1314 were used respectively.

Final Emissions Inventory

The inventory applied to light-duty gasoline vehicles only. Reliable and complete speciation profiles did not exist for the other vehicle types. Emissions were calculated as tons per year. Final speciated TOG results for those toxics greater than 100 tons per year are shown in Figure 1.

Criteria Pollutant Inventory

Emissions were also calculated under the same conditions for the criteria pollutants, only for all vehicle types. The results were 1,294,171 tons CO, 177,575 tons NOx, and 146,297 tons VOC. VOC was about 94% of TOG for light-duty gasoline. It should be noted that this doesn't quite agree with the speciation profile, where VOC TOG is a lower percentage, about 87%.

Related Studies

Hydrocarbon sampling was done at several sites in the greater Puget Sound region on Tuesdays and Thursdays during the summer of 1995. Samples taken at urban areas during morning rush hour traffic (6-9am) seem to agree well with the EPA speciation profile data.

References

1990/1995 Base and Projected Year CO/O3 SIP Emission Inventories for Seattle-Tacoma, Vancouver and Spokane.

National Oceanic and Atmospheric Administration, Climatological Data, Washington, average monthly temperatures.

Puget Sound Regional Council, 1995 VMT projections by link.

Raymond, John, *Fuel and I/M Program Data*, Department of Ecology, 360-407-6856.

SPECIATE database, downloaded from the CHIEFS bulletin board 4/94.

Standard Specification for Automotive Gasoline, Annual Book of ASTM Standards.

Temperature data from meteorological station at Sand Point.

U.S. Dept. of Transportation, *Highway Performance Monitoring System Field Manual*, December 1987 and Updates, FHWA Order M 5600.1A. Office of Highway Information Management, Federal Highway Administration.

U.S. Environmental Protection Agency, *Compilation of Air Pollutant Emissions Factors Volume 1: Stationary Point and Area Sources,* Fifth Edition with Supplements, January 1995, Document No. AP-42. (Page 13.2.1-5 (default paved road silt loading), January 1995) (available by section on Internet at http://www.epa.gov/ttn/chief/ap42.html)

U.S. Environmental Protection Agency, *Draft Temperature Guidance (for 1991(2) release of Procedures for Emission Inventory Preparation, Vol. IV: Mobile Sources*, EPA-450/4-81-026d.

U.S. Environmental Protection Agency, *Final Temperature and RVP Guidance (for 1991(2) release of Procedures for Emission Inventory Preparation, Vol. IV: Mobile Sources*, EPA-450/4-81-026d.

U.S. Environmental Protection Agency, *MOBILE5.0ah, User's Guide and Model*, March 1993. Office of Mobile Sources.

U.S. Environmental Protection Agency, *PART5. Model and User's Guide,* February 1995. Office of Mobile Sources.

U.S. Environmental Protection Agency, *Procedures for Emission Inventory Preparation: Volume IV: Mobile Sources*, 1992, EPA-450/4-81-026d.

Washington State Department of Transportation, *HPMS Mileage and Daily Travel Summary*, 1994.

Figure 1. 1994 Onroad Mobile Air Toxics Emissions Estimate - Washington State

Pollutant Name	Tons	%	Cumulative Tons	Cumulative %
methane	14,883	11	14,883	11
n-butane	12,188	9	27,071	20
toluene	11,759	9	38,831	29
isopentane	8,473	6	47,304	35
ethylene	5,630	4	52,934	40
2,2,4-trimethylpentane	4,998	4	57,932	43
m-xylene	4,837	4	62,769	47
benzene	4,757	4	67,527	51
n-pentane	3,331	2	70,857	53
acetylene	3,087	2	73,944	55
2,3,4-trimethylpentane	3,054	2	76,998	58
propene	2,349	2	79,347	59
ethane	2,208	2	81,555	61
1,2,4-trimethylbenzene	2,072	2	83,627	63
methylpentenes	2,025	2	85,652	64
3-methylpentane	1,869	1	87,521	65
2-methylpentane	1,844	1	89,365	67
1-methyl-3-ethylbenzene	1,823	1	91,189	68
o-xylene	1,753	1	92,941	70
ethylbenzene	1,698	1	94,639	71
2,3-dimethylbutane	1,482	1	96,121	72
ethyl alcohol	1,410	1	97,531	73
2,3-dimethylpentane	1,313	1	98,844	74
hexane	1,307	1	100,151	75
2-methyl-2-butene	1,269	1	101,420	76
formaldehyde	1,256	1	102,675	77
s-butylbenzene	1,153	1	103,828	78
methylpropene	1,095	1	104,923	78
3-methylhexane	1,038	1	105,961	79
2,4-dimethylpentane	1,017	1	106,978	80
unc peaks to CBM non-react	976	1	107,954	81
2-methylhexane	832	1	108,786	81
2,4-dimethylhexane	791	1	109,577	82
1,3,5-trimethylbenzene	750	1	110,328	83
methylcyclopentane	747	1	111,075	83
methylpropane	740	1	111,815	84
2,2-dimethylbutane	700	1	112,515	84
trans-2-pentene	642	0	113,157	85
2,4-dimethyloctane	632	0	113,789	85
acetaldehyde	629	0	114,418	86
butene	568	0	114,986	86
2,3-dimethylhexane	561	0	115,547	86
ethyltoluene	537	0	116,084	87
1,3-butadiene	537	0	116,622	87
2,2,5-trimethylhexane	534	0	117,155	88
n-propylbenzene	509	0	117,665	88

acetone	503	0	118,168	88
o-ethyltoluene	477	0	118,645	89
1-nonene	457	0	119,101	89
1-pentene	453	0	119,554	89
2,5-dimethylhexane	446	0	120,000	90
2-methyl-1-butene	445	0	120,445	90
n-undecane	428	0	120,873	90
1,2,3-trimethylbenzene	417	0	121,290	91
butylbenzene	412	0	121,701	91
4-methyloctane	406	0	122,108	91
cis-2-pentene	377	0	122,485	92
C6 olefins	376	0	122,861	92
dimethylhexanes	372	0	123,233	92
heptane	369	0	123,603	92
styrene	360	0	123,962	93
t-2-butene	320	0	124,283	93
dimethylcyclopentane	301	0	124,584	93
methylindans	296	0	124,880	93
2,4,4-trimethyl-1-pentene	290	0	125,170	94
methyl alcohol	286	0	125,456	94
methylhexenes	275	0	125,731	94
methylcyclopentene	272	0	126,003	94
cis-2-butene	259	0	126,263	94
octane	246	0	126,509	95
unc peaks to CBM paraffins	245	0	126,754	95
c5-alkylbenzenes	233	0	126,987	95
methylcyclohexane	223	0	127,210	95
napthalene	219	0	127,429	95
1-hexene	218	0	127,646	95
n-decane	206	0	127,852	96
3-methyl-t-2-pentene	205	0	128,057	96
2,2-dimethylhexane	198	0	128,255	96
isobutylene	193	0	128,449	96
dimethylcyclohexane	193	0	128,641	96
unc peaks to CBM xylene	192	0	128,833	96
4-methylheptane	185	0	129,018	96
propane	184	0	129,201	97
trimethylcyclopentane	183	0	129,384	97
methylethylketone	181	0	129,565	97
methylbutadiene	177	0	129,741	97
cyclopentane	170	0	129,911	97
cyclohexene	163	0	130,074	97
indane	154	0	130,229	97
p-tolualdehyde	147	0	130,376	98
dimethyloctanes	140	0	130,515	98
1,2,3,4-tetramethylbenzene	138	0	130,653	98
benzaldehyde	136	0	130,789	98
ethylcyclopentane	118	0	130,908	98
3-methyloctane	106	0	131,014	98
isomers of diethylbenzene	102	0	131,115	98