Für Mensch & Umwelt

Umwelt Bundesamt

Emissions from fireworks

- New measured EFs for PM10 and PM2.5

- New method for calculation

05.05.2021

Emissions from fireworks - topics

- **BACKGROUND - WHY NEW EFS AND CALCULATION METHODS FOR FIREWORKS**

- **HOW THE DATA WAS GATHERED**

- **CALCULATION METHOD FOR THE NEW DATA**

- **RESULTS FOR THE EF AND CALCULATION OF EMISSIONS FOR PM10 AND PM2.5**

- **PROPOSAL FOR THE IMPLEMENTATION INTO THE EMEP GUIDEBOOK**

Background - Why new EFs and calculation methods for fireworks

IN GERMANY AN NGO IS SINCE SEVERAL YEARS REQUESTING THAT THE USE OF FIREWORKS SHALL BE FORBIDDEN. THE MAIN ARGUMENT ARE THE HIGH REPORTED PM10 EMISSIONS.

THE GERMAN ASSOCIATION OF THE PYROTECHNICAL INDUSTRY (VPI – VERBAND DER PYROTECHNISCHEN INDUSTRIE) ASSUMED THAT THE EFS WERE TO HIGH AND HAS INITIATED AND CONDUCTED MEASUREMENTS OF DIFFERENT TYPICAL FIREWORKS.

IN 2020 THE VPI REPRESENTED THE RESULTS AND THE NEWLY DEVELOPED EFS TO THE UBA.

IN AUTUMN 2020 GERMANY THEN IMPLEMENTED THE NEW EFS AND METHOD INTO THE INVENTORY

How the data of PM2.5 and PM10 was gathered

- A TEST LABORATORY MADE THE MEASUREMENT IN A CONTAINER WITH A VOLUM OF 33M³

- 7 DIFFERENT FIREWORKS WERE TESTED: BATTERIES (ONE WITH BOMBETTES, ONE WITH COMETS), ROCKETS, FOUNTAINS AND BANGER

- UP TO THREE TIMES

- FOR EACH BURNED FIREWORK TWO SAMPLES AT DIFFERENT TIME POINTS WERE TAKEN (T1 AND T2)

- FROM THESE AN AVERAGE VALUE FOR THE EF WAS DEVELOPED FOR EACH ARTICLE

- UNLIKE THE TRADITIONAL APPROACH, WHICH CALCULATES THE EMISSIONS FROM FIREWORKS FROM THE GROSS MASS, THE NEC (NET EXPLOSIVE CONCENTRATION) WAS USED HERE TO DETERMINE THE EMISSIONS. THIS IS DUE TO THE FACT THAT PACKAGING AND NON-COMBUSTIBLE, INERT COMPONENTS ARE NOT RELEVANT TO EMISSIONS.

FOR DETAILS SEE:

HTTPS://THG.THUENEN.DE/IIR-DE/SECTOR/IPPU/OTHER_PRODUCT_USE/FIREWORKS/START
HTTPS://ONLINELIBRARY.WILEY.COM/DOI/EPDF/10.1002/PREP.202000292

Calculation method for the new data in Germany

SO FAR:

- **AD = PRODUCTION + IMPORT − EXPORT**
- **EM = AD*EF$_{\text{TOTAL MASS OF PRODUCT}}$**

NEW METHOD:

ACTIVITY DATA

- **AD$_{\text{TOTAL}}$ = PRODUCTION + IMPORT − EXPORT − DISPOSAL + RETURN(T-1) − RETURN(T)**
- **AD$_{\text{NEW YEAR´S EVE}}$ = AD$_{\text{TOTAL}}$ − AD$_{\text{DURING YEAR}}$**

EMISSIONS:

- **NEW YEAR´S EVE:**
  EM = AD * EF_NEC$_{\text{NEWYEAR}}$ * FRACTION_NEC(T)

- **DURING THE YEAR:**
  EM = AD * EF_NEC$_{\text{DURINGYEAR}}$ * FRACTION_NEC$_{\text{AVERAGE}}$

Results of PM10 and PM2.5 for the EF and calculation of EM

Article	EF_{PM10}	$EF_{PM2.5}$
	g PM_{10} / kg NEC	g $PM_{2,5}$ / kg NEC
Battery	325	281
Rocket	298	231
Fountain	200	168
Banger	213	134
Average value	253	200

Comparison of EFs and Emissions

	EF_during year		EF_weighted_2019_new years eve		EMEP Guidebook 2019
	kg/t NEC	kg/t total mass	kg/t NEC	kg/t total mass	kg/t total mass
PM10	253	63,2	286,2	48,1	99,9
PM2.5	200	49,9	238,3	40,0	51,9

Pollutant	Source	2018
		[t]
Subm2020	PM10	4408
Subm2021		2187
Difference		-2220
Subm2020	PM2.5	2291
Subm2021		1799
Difference		-491

For the EF during the year Germany chose the lower „average value". But the higher fraction as during the year fireworks of all kinds (e.g. Professional, theatrical and consumer) are used.

For EF new years eve Germany weighted the EFs of the articles according the sold amounts and a higher EF resulted. But the fraction of new years eve is smaller as the products are for consumer use.

Proposal for the implementation into the EMEP guidebook

TIER 2

- **KEEP THE METHOD**
- **NEW EF: TAKE BIGGEST EF "BATTERY" WITH BIGGEST FRACTION "DURING YEAR" – 325KG/T*28,5% = 92,6 KG/T**

NEW TIER 3 METHOD

Calculation method:
Tier 3a – During the year
- $EF\_NEC(t) = sum(EF\_NEC\_article * sold~NEC~amount(t))/number~of~articles$
- $AD_{total} = production + import - export - disposal + return(t-1) - return(t)$
- $EM = AD * EF\_NEC(t) * fraction\_NEC_{during~year}$

Tier 3b – During the year + F2 dominated special events (New year´s EVE, national celebrity, holy celebrity, …)

- $AD\_{F2~dominated} = AD\_total - AD\_{during~year}$
- $EM\_{F2~dominated} = AD * EF\_NEC(t) * fraction\_NEC\_F2$

Default EFs		
Article	EF_{PM10}	$EF_{PM2,5}$
	g PM_{10} / kg NEC	g $PM_{2,5}$ / kg NEC
Battery	325	281
Rocket	298	231
Fountain	200	168
Banger	213	134

Default fraction NEC	
NEC fraction_during year	Max 28,5%
NEC fraction F2 dominated	Max 19%

Thank you very much for your attention!

Federal Environment Agency of Germany

Section V 1.6 Emissions situation

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