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PM abatement Technologies Applicable in EECCA Countries: Technical Paper

A Contribution to EGTEI

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Supported by IVL

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Rationale:

- IA emission and costs modeling results are aimed at redistribution of abatement costs between sectors/countries, assessment of attainability of Gothenburg Protocol emission limits.
- Uncertainties in IAM estimates (using GAINS and other models) affect policy.
- Level of accuracy of IAM estimates is different by region and for EECCA region is low
- So increase of emission/costs/impact assessment accuracy/reliability is necessary.
- Current IAM parametrisation is made using basically WE technologies data/BAT; limited data for EECCA.

Framework

Technical paper is prepared in the framework of project 'Validation of Belarus Air Pollution Data within the Convention on Long Range Transboundary Air Pollution – CLRTAP (IP 1001, BIP 19/4/2), Phase I', financed by the Swedish international development cooperation agency (SIDA) and integrate results of earlier studies.

Structure of Technical paper

Sources of information

- normative and technical regulative documents
- technical bulletins, reference data
- emission statistics
- sampling data for the large point sources of PM
- emission inventory materials of certain enterprises
- data from producers published on paper and on their web sites

PM control equipment standards

USSR

GOST 12.2.043-80. Dust equipment. Classification

GOST 25199-82. (CMEA Standard 2145-80) Dust equipment. Terms and definitions.

Purposes of use
- Air filter for forced ventilation
- Dust collector for emission

Types and subtypes
- Dry
  - Gravitational/inertial/filtration/electrostatic
- Wet
  - Gravitational/filtration/electrostatic

Dust abatement efficiency for particles of different size groups (I-V)

Belarus

«Rules of operation for gas treatment facilities»

- General types
- Inefficiency criteria

Classification of the equipment by operation principle

Rules of gas cleaning equipment operation, Order N60 (Belarus)

- Group C – dry mechanical cleaning from PM, operation principle based on particle sedimentation due to gravity, centrifugal force and changing gas flow speed;
- Group M – wet cleaning from PM as well as from wet and gas pollutants;
- Group F – filter-type devices;
- Group E – electrical filters;
- Group X – sorption-based cleaning of gases from gas pollutants (chemical and biological sorption);
- Group T – thermal, thermo-catalytic and catalytic deactivation of gas pollutants;
- Group D – other equipment.

PM control equipment classificatory (GOST 12.2.043-80) (extract)

Abatement type	Principal way of abatement	Subtype
Dry	gravitational	Hollow
		Bookshelf
	inertial	Chamber
		Louvred
		cyclone
		rotational
	filtration	fabric
		fibrous
		Granular
		mesh
		cancellous
	electrostatic	1 field
		2 fields
Wet	inertial	cyclone
		rotational
		scrubber
		impact
	filtration	mesh
		foam
	electrostatic	1 field
		2 fields

Efficiency classes of dust collecting equipment (GOST 12.2.043-80)

Class	Dust collecting efficiency by particle size, %				
	I	II	III	IV	V
1				>99	80-99
2			>99	80-99	
3		>99	80-99		
4	>99	80-99			
5	80-95				

Groups of filters by efficiency (GOST 51251-99)

Group of filter	Class of filters
Rough cleaning filters	G1
	G2
	G3
	G4
Fine cleaning filters	F5
	F6
	F7
	F8
	F9
High efficiency filters	H10
	H11
	H12
	H13
	H14
Ultra high efficiency filters	U15
	U16
	U17

Efficiency of common filters (GOST 51251-99)

Filter group	Filter class	Average efficiency, %	
		Ec*	Ea**
Rough cleaning method	G1	Ec < 65	
	G2	65≤ Ec < 80	
	G3	80≤ Ec < 90	
	G4	90 ≤ Ec	
Fine cleaning method	F5		40 ≤ Ea < 60
	F6		60 ≤ Ea < 80
	F7		80 ≤ Ea < 90
	F8		90 ≤ Ec < 95
	F9		95 ≤ Ea

*Ec – efficiency estimated for synthetic dust by weight method (via difference in mass concentrations before and after filter);
**Ea – efficiency estimated for atmospheric dust

Greatest PM emission control equipment manufacturers in EECCA

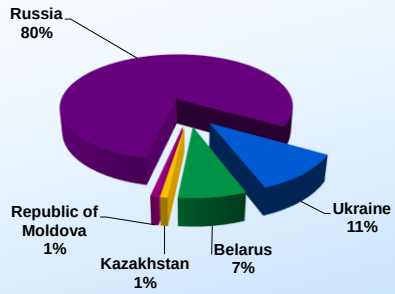
Russia
- FINGO ENGINEERING, CJSC *(all types)*
- «Folter», SPE *(cyclones, filters)*
- IRIMEX, JSC *(all types)*
- «Giprogazoochistka» OJSC *(all types)*
- «Rankom-Energo», EPC *(filters, electrostatic precipitators)*
- STC «Zenith», Ltd. *(cyclones, scrubbers)*
- «SPA «Talnakh», JSC *(cyclones, scrubbers, filters)*
- «Siberian association of energy engineering», Ltd. *(cyclones)*
- «ALYUMATEK», GC *(all types)*

Belarus
- «BELKOTLOMASH», SPE LLC *(cyclones)*
- «Belenergoremnaladka», JSC *(filters, electrostatic precipitators)*

Ukraine
- «Berdichev Machine Building Plant «Progress», TH *(cyclones, filters, electrostatic precipitators)*
- ARTEMOVSKIY MASHINOSTRAITELINYY PLANT«PROMMASH», Ltd. *(cyclones)*
- «Gas Cleaning Equipment Plant» Ltd. *(cyclones, scrubbers, filters)*

The largest producers of PM abatement equipment in EECCA are located in Russia (80% fro the total amount of producers), the Ukraine (11%), Belarus (7%), Kazakhstan (1%), Moldove (1%)

Distribution of emission control equipment manufacturers in EECCA



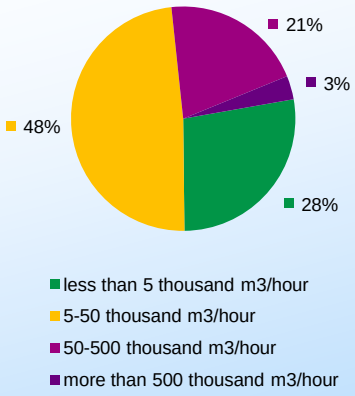
Small-scale production and implementation of projects under the order

Produced in USSR since 1925

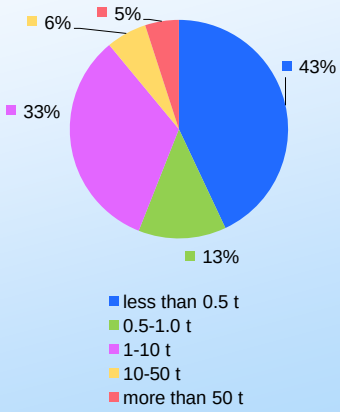
Over 150 manufacturers

Technical characteristics of the PM abatement equipment

Distribution by equipment capacity



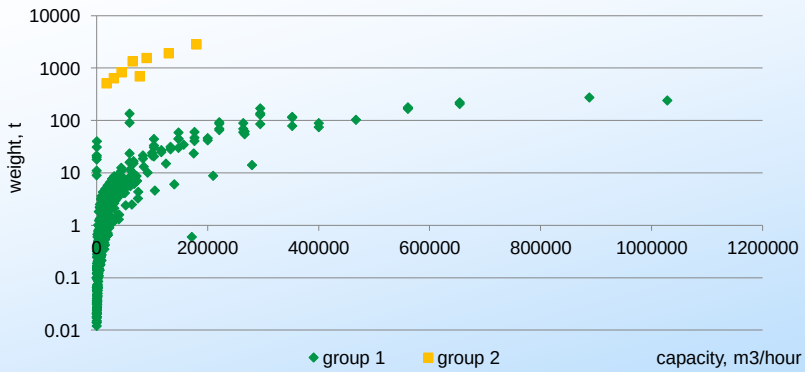
Distribution by equipment weight



About a half of PM equipment are characterized with capacity from 5 to 50 thousand m^3/hour

Technical characteristics of PM abatement equipment

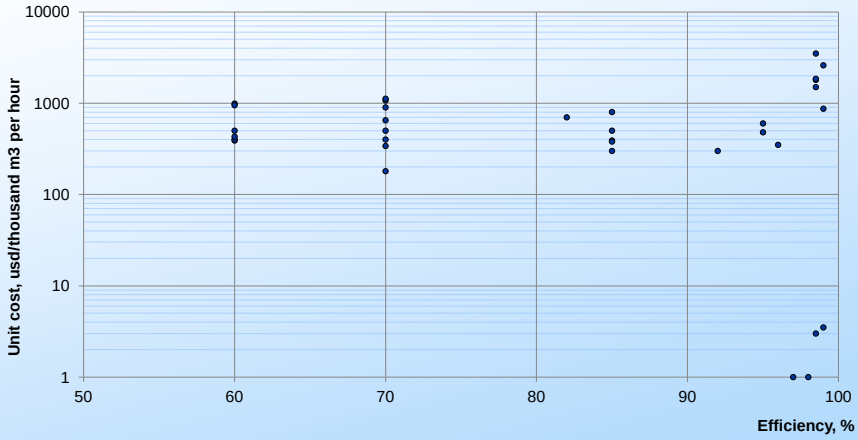
weight – capacity dependence



Group 1 – a unit weight higher than 1 t/thousand m^3/h, rapid weight increase with capacity increase (14.57 t / thousand m^3/h)
Group 2 – a unit weight up to 1 t/thousand m^3/h, slow increase of weight with capacity increase (0.28 t / thousand m^3/h);

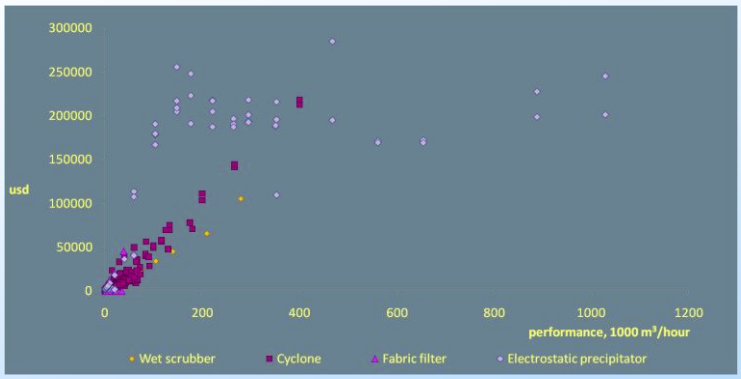
This kind of grouping is not directly related to construction features of the equipment; however, to group 1 belong only certain types of ESP and wet-based technologies.

Relation between average unit costs and efficiency of PM abatement equipment



No clear dependences of relative specific efficiencies and type of equipment

Relation between average unit costs and performance of PM abatement equipment



Cost of equipment vary from <1 Euro/unit to 285 thous. Euro/unit
Specific cost – from 23 Euro to 6,29 thous. Euro

Applicability of main groups of abatement equipment by industry sectors

Type	Brand	Common	Building materials	Ferrous	Non-ferrous	Energy	Chemical and petrochemical	Metal cutting	Wood processing
Scrubber	ГВПВ	■							
	КЦТ	■							
	СИОТ	■							
	СПВПК	■							
Multicyclone	4БЦШ								
	БЦ-2					■			
	БЦ-259					■			
	БЦ-512					■			
Cyclone	ЛИОТ	■							
	РИСИ	■							■
	СДК-ЦН-33	■							
	СДК-ЦН-34	■							
	СИОТ	■							
	СЦН-40		■						
	ЦН-11	■							
	ЦН-15								
	ЦН-15М		■	■	■	■	■		
	ЦН-24		■	■	■	■	■		
	ЦН-24Ц		■	■	■	■	■		
	ЦОК							■	
	ЦОЛ	■							
	ЦРк	■							
Fabric filter	ФРИА				■				
	ФРИП		■	■	■		■		■
	ФРКИ		■	■	■	■	■		■
	ФРКИЦ	■							
	ФРМИ		■	■	■	■	■		
Electrostatic precipitator	УГ		■	■	■	■	■		
	ЭГА			■	■	■			
	ЭФВА		■	■	■	■			

Characteristics by types of PM equipment

Cyclones

- More than 20 types;
- The most typical: ЦН-15, СЦН-40, СИОТ, СИОТ-М, СДК-ЦН-33, БЦ-512
- Capacity: 0.1 - 400 thous. m^3/h
- Average nominal efficiency – 60-70%
- Average cost – 11 thous. US $
- Specific cost - 550 US $ / thous. m^3/h
- Producers: >60 % of the total number of producers

СЦН-40 

СИОТ 

СДК-ЦН-33 

ЦН-15 

Wet scrubbers

- About 10 types
- The most typical: ПВМ, СВ-Кк, СИОТ, ЦВП
- Capacity: 0.05 - 280 thous. m^3/h
- Average nominal efficiency – 90–99%
- Average cost – 23.5 thous. US $
- Specific cost - 660 US $ / thous. m^3/h
- Producers: ~20% of the total number of producers

ПВМ

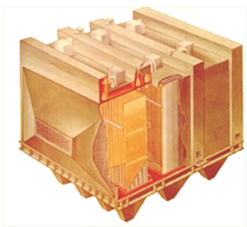
ЦВП

СИОТ

ESP

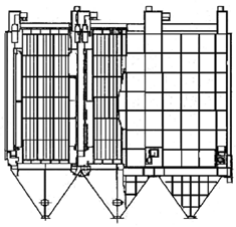
- About 10 types
- The most typical: ЭГА, ЭГАВ, ЭГСЭ
- Capacity: 30- 1000 thous. m^3/h
- Average nominal efficiency – 95–99%
- Average cost – 116 thous. US $
- Specific cost - 1000 US $ / thous. m^3/h
- Producers: ~ 10% of the total number of producers

ЭГА



ЭГАВ

ЭГСЭ



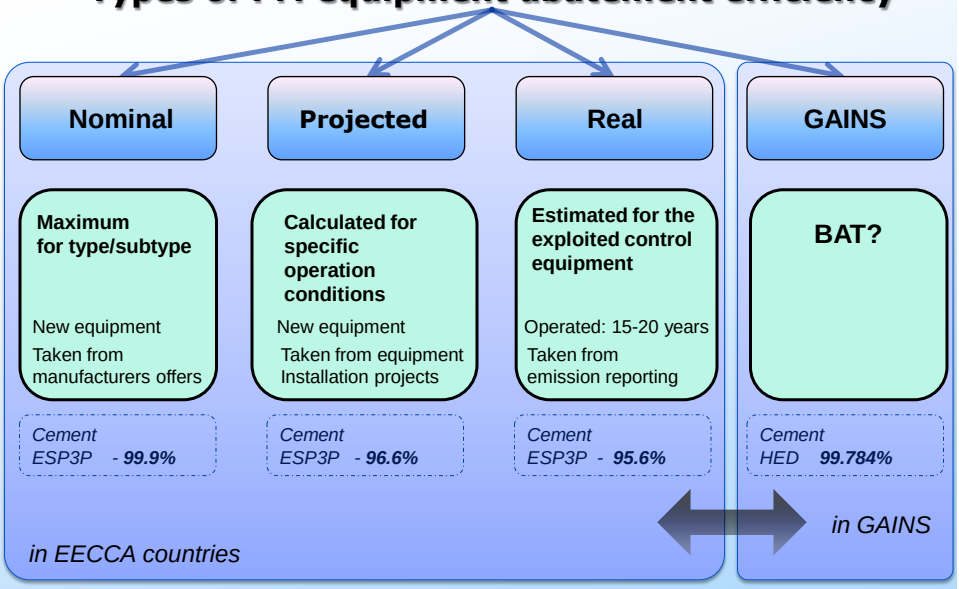
Fabric filters

- More than 20 types
- The most typical: ФРКИ, ФРИ, ФСВ, ФРИА, ФКГ, ФКИ
- Capacity: 0.3 - 1000 thous. m^3/h
- Average nominal efficiency – 96–99%
- Average cost – 5 thous. US $
- Specific cost - 10 US $ / thous. m^3/h
- Producers: ~ 45 % of the total number of producers

ФРКИ ФРИ ФКИ



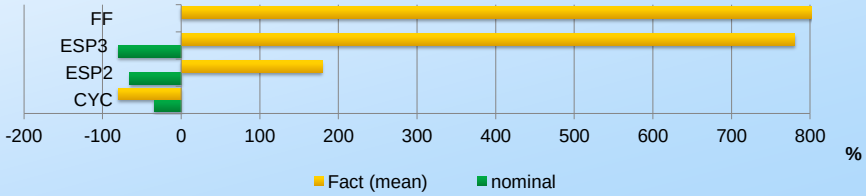
Types of PM equipment abatement efficiency



PM emission calculated using different types of abatement efficiency

Sector	Technology	Efficiency			PM emissions, kg/t*		
		Nominal	Real (mean)	GAINS	Nominal	Real (mean)	GAINS
Cement	CYC	70	90.7	54.6	39	12.09	59.02
	ESP2	99	91.9	97.1	1.3	10.53	3.77
	ESP3	99.9	95.6	99.5	0.13	5.72	0.65
	FF	99.5	95.2		0.65	6.24	

Deviation in emissions (per ton) from GAINS
using different values of the efficiency (nominal and real mean)*



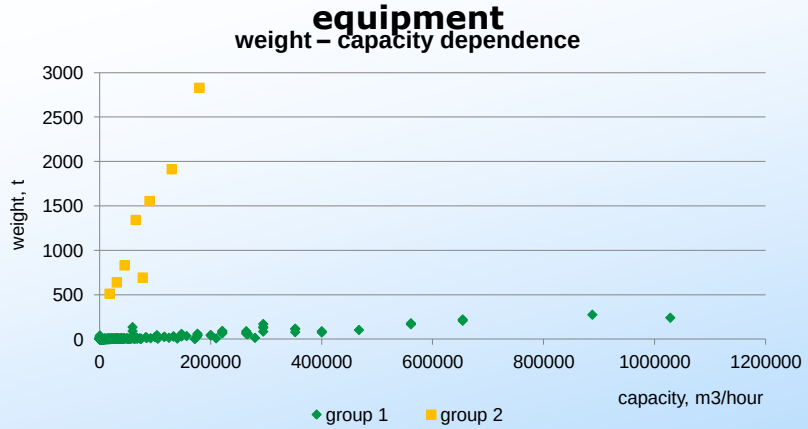
* for unabated TSP emission factor 130 kg/t

Thank you for your attention!

PM control equipment features and specific condition

		Design features	Specific conditions
Cyclone *Dry* *Inertial*		Angles Diameters Ratio between the elements	Abrasive dust Danger of explosion Working outdoors
Scrubber *Wet* *Inertial*		Angles Diameters Ratio between the elements	Abrasive dust Danger of explosion Working outdoors Solvents
Filter *Dry* *Filtration*		Regeneration Materials	Abrasive dust Danger of explosion Working outdoors
Electrostatic precipitator *Dry* *Electrostatic*		Number of fields Placement (horizontal/vertical)	Danger of explosion Working outdoors Productivity

Technical characteristics of PM abatement equipment



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Comparative cost of PM control equipment

Equipment	Unit investment costs, US$/ 1000 m^3/year	
	produced in the EECCA	produced in the U.S.A*
Cyclone	26.4	15.7
Wet scrubber	30.8	15.1
Fabric filter	82.8	49.3
Electrostatic precipitator	89.6	91.7

* Air Pollution Control Technology Fact Sheets (EPA-452/F-03-028; EPA-452/F-03-005)

Investment costs for ESP are close and very different for others types of equipment

Comparative PM removal efficiency by sector, %

Abatement technology	Sector			
	Cement production	Lime production	Iron and Steel foundries	Electric Arc Furnace
ESP (2 field)	91.9/97.1			
ESP (3 fields and more)	95.6/99.5	97.5/99.8		
Fabric filters	95.2/99.5	95.5/99.8	83.2/99.1	96.1/94.6
Cyclone	90.7/54.6		74.9/38.5	
Wet scrubber			86.6/80.0	