Источники выбросов тяжелых металлов в Беларуси

Sources of Heavy Metals Emission in Belarus

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Outline of the presentation:

1. Current state of accounting of emissions of heavy metals;
2. Major sources and trends of emissions of heavy metals in Belarus;
3. General characteristics of large facilities – sources of emissions of heavy metals; emissions treatment technologies;
4. Analysis of possibilities for meeting obligations under the Protocol on Heavy Metals by Belarus in the area of emission ceiling and emission reductions;
5. Possibilities for implementation of standards on concentrations of heavy metals and particulate matter in emissions into air (Annex V):
   - Stationary Combustion
   - Secondary iron and steel production
   - Cement Industry
   - Glass production
To date, much has been done to justify the accession to the Protocol on Heavy Metals:

- sufficiently detailed inventory of emissions of heavy metals developed; main sources of heavy metals emissions identified;
- trends of heavy metal emissions developed and characterized;
- research conducted (including contribution to the EMEP program, expert assessments, the assessment of critical loads)
1. Accounting of emissions of heavy metals in Belarus

Emissions of heavy metals into the atmosphere in Belarus in 2009, according to the National Statistics Committee

<table>
<thead>
<tr>
<th>Категория источника</th>
<th>As</th>
<th>Cd</th>
<th>Cr</th>
<th>Cu</th>
<th>Ni</th>
<th>Pb</th>
<th>Zn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial sources (total)</td>
<td>0.142</td>
<td>0.002</td>
<td>2.727</td>
<td>1.335</td>
<td>0.655</td>
<td>3.202</td>
<td>20.604</td>
</tr>
<tr>
<td>Power generation</td>
<td>-</td>
<td>-</td>
<td>0.005</td>
<td>0.011</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Fuel production</td>
<td>-</td>
<td>-</td>
<td>0.077</td>
<td>0.029</td>
<td>0.049</td>
<td>0.002</td>
<td>-</td>
</tr>
<tr>
<td>Ferrous metallurgy</td>
<td>0.001</td>
<td>-</td>
<td>0.021</td>
<td>0.09</td>
<td>0.03</td>
<td>-</td>
<td>0.147</td>
</tr>
<tr>
<td>Non-ferrous metallurgy</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.053</td>
</tr>
<tr>
<td>Chemical and petrochemical industry</td>
<td>0.131</td>
<td>-</td>
<td>0.358</td>
<td>0.033</td>
<td>0.013</td>
<td>0.01</td>
<td>11.838</td>
</tr>
<tr>
<td>Machinery and metalworking</td>
<td>-</td>
<td>0.002</td>
<td>1.956</td>
<td>1.166</td>
<td>0.363</td>
<td>0.139</td>
<td>7.57</td>
</tr>
<tr>
<td>Timber, woodworking and pulp and paper industry</td>
<td>-</td>
<td>-</td>
<td>0.004</td>
<td>0.004</td>
<td>-</td>
<td>0.001</td>
<td>0.003</td>
</tr>
<tr>
<td>Construction Materials Industry</td>
<td>-</td>
<td>-</td>
<td>0.014</td>
<td>-</td>
<td>0.001</td>
<td>0.004</td>
<td>0.137</td>
</tr>
<tr>
<td>Glass and porcelain industry</td>
<td>0.01</td>
<td>-</td>
<td>0.185</td>
<td>-</td>
<td>0.148</td>
<td>2.977</td>
<td>0.844</td>
</tr>
<tr>
<td>Other</td>
<td>-</td>
<td>-</td>
<td>0.517</td>
<td>0.014</td>
<td>0.055</td>
<td>0.056</td>
<td>0.089</td>
</tr>
<tr>
<td>TOTAL</td>
<td>0.14</td>
<td>0.002</td>
<td>3.2</td>
<td>1.4</td>
<td>0.7</td>
<td>3.2</td>
<td>20.6</td>
</tr>
</tbody>
</table>
Basic principles of the emission inventory management in Belarus within the framework of reporting to the EMEP programme

- Analysis of the completeness and quality of statistical data on emissions;
- On the substances and categories of sources of emissions for which are sufficiently complete, information is grouped according to the required reporting nomenclature (NFR);
- At those positions where the information is incomplete, additional emission calculations are conducted and the data are summarized with the available statistical data;
- At those positions where the information is completely absent, the resulting data are based entirely on calculations.
### Inventory of emissions in the reporting to the EMEP programme

**Emissions of heavy metals in Belarus in 2009 by source category of NFR, t**

<table>
<thead>
<tr>
<th>NFR</th>
<th>Source category</th>
<th>Pb</th>
<th>Cd</th>
<th>Hg</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A1a</td>
<td>Energy use and heat production</td>
<td>7,276</td>
<td>0,506</td>
<td>0,128</td>
</tr>
<tr>
<td>1A2</td>
<td>Manufacturing industries and construction</td>
<td>34,718</td>
<td>1,58</td>
<td>0,762</td>
</tr>
<tr>
<td>1A3a</td>
<td>Civil aviation</td>
<td>0,07</td>
<td>0,001</td>
<td>NE</td>
</tr>
<tr>
<td>1A3b</td>
<td>Automobile transport</td>
<td>2,195</td>
<td>0,022</td>
<td>NE</td>
</tr>
<tr>
<td>1A3c</td>
<td>Railroads</td>
<td>0,188</td>
<td>0,002</td>
<td>NE</td>
</tr>
<tr>
<td>1A4a</td>
<td>Commercial / Institutional Sector</td>
<td>0,104</td>
<td>0,01</td>
<td>0,001</td>
</tr>
<tr>
<td>1A4b</td>
<td>Residential sector</td>
<td>0,301</td>
<td>0,039</td>
<td>0,003</td>
</tr>
<tr>
<td>1A4c</td>
<td>Agriculture / Forestry / Fishing</td>
<td>0,591</td>
<td>0,006</td>
<td>IE</td>
</tr>
<tr>
<td>1B2</td>
<td>Oil and gas production</td>
<td>0,031</td>
<td>NE</td>
<td>NE</td>
</tr>
<tr>
<td>2B</td>
<td>Chemical industry</td>
<td>0,01</td>
<td>0,027</td>
<td></td>
</tr>
<tr>
<td>2C</td>
<td>Production of metals</td>
<td>20,081</td>
<td>0,81</td>
<td>0,017</td>
</tr>
<tr>
<td>2D</td>
<td>Other types of production</td>
<td>0,017</td>
<td>NE</td>
<td>NE</td>
</tr>
<tr>
<td>6C</td>
<td>Waste Incineration</td>
<td>0,262</td>
<td>0,022</td>
<td>0,003</td>
</tr>
<tr>
<td>7</td>
<td>Other</td>
<td>0,009</td>
<td>0,001</td>
<td>-</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td>65,853</td>
<td>3,026</td>
<td>0,914</td>
</tr>
</tbody>
</table>
2. Structure of lead (a) and mercury (b) emissions in Belarus (2009)

- **Pb**
  - Manufacturing industries and construction: 30%
  - Energy use and heat production: 11%
  - Metallurgy: 54%
  - Automobile transport: 2%
  - Other (<1%)

- **Hg**
  - Manufacturing industries and construction: 14%
  - Energy use and heat production: 29%
  - Metallurgy: 1%
  - Automobile transport: 83%
  - Other (<1%)
The most significant changes in emissions of lead occurred in the first half of the 1990s: in 1996 compared to 1990, lead emissions have decreased by factor 17. Primarily this is due to phase out of leaded gasoline. Since 1999 began a slight increase in emissions of lead but levels are still well below 1990 baseline.
Mercury emissions decreased from 1.1 tons in 1990 to 0.3 tons in 1996. However, later they began to grow again and by 2009 they had almost reached the 1990 level (0.9 t).
Trends of cadmium and mercury emissions are similar: up to 1996 they were decreasing; during the 1996-2000 period emissions stabilized, but than increased. In 2005 emissions of cadmium reached the 1990 level, in 2006 – exceeded the 1990 level. In 2009 emissions of cadmium were 3.03 t.
Large point sources of lead emissions include three cement plants, two plants of glass industry, and a metallurgical plant (together they are accountable for >80% of lead emissions).

Large point sources of cadmium emissions include three cement plants and a metallurgical plant (together they are accountable for >80% of cadmium emissions).
3. Cement Industry

Wet method (75% of national production)
Rotary clinker kilns
Main source of heavy metals - pyrite cinders.
Fuel – gas, tires (up to 10% on one of the kilns).
Flue gas cleaning equipment for the main process - ESP, Lurgi, EGBM, ESG, HS, fabric filters EFR, computerized emissions control system.
Particulate matter treatment efficiency - 98,8-99,5%

Dry method (25% of national production)
Rotary clinker kiln
Main source of heavy metals - dust from metallurgical production.
Fuel – natural gas, tires
Flue gas cleaning equipment of the main process - ESP, EGBM, and cyclones

Programmes for the sector development:
State comprehensive programme for development of logistics in the construction industry for the 2006-2010 period (Council of Ministers of Belarus, № 1118, 2006)
Increase in cement production by a factor of 2 (up to 2015);
Construction of cement plants - dry method cement production.
Fuel – coal (peat).
**Glass industry**

**Crystal glass**
Continuous tank furnaces (gas-flame and electric); reconstruction in 2006 and 2008, due to low capacity production units are not covered by the Protocol. Flue gas cleaning equipment of the main process - heat exchanger (efficiency 83%), fabric filters (efficiency 99.2%).

**Glass used in construction**
Continuous gas-flame glass furnaces, put into operation in 1996 and 2010. New furnace is equipped with a three-tier system for flue gas treatment (efficiency of 85%).

**Programme for development of the sector:**
Glass production sector development programme of Belarus for 2006-2010. (Presidential Decree № 351, 2006)
- A gas-flame furnace for the production of crystal glass decommissioned
- Construction of an electric furnace
- Production of curved automobile glass, the increase in production of construction glass
**Metallurgy industry**

**Steel production (electric arc furnace)**
Bulk of steel is produced in electric arc furnaces (capacity of 100 tons)
Modernization to increase energy efficiency
Flue gas treatment is carried out with Lurgi, Scheuch and KE bag filters (efficiency of 99%).

**Cast iron**
Open cold blast cupola (furnace) (provides ca.85% of the production of cast iron). Average age - 20 years old
In the last years the use of induction furnaces has expanded.
Emissions from the cupola (furnace) are treated with wet scrubbers of various design and removal efficiency of 50-92%, in some cases there is no flue gas treatment in place.

**Programme for development of the sector:**
Programme of technical retrofitting and modernization of the foundry, thermal, electrochemical, and other energy-intensive industries for 2007-2010. Decree of the Council of Ministers of Belarus № 1421 (2007);
Increase in proportion of cast iron in induction and electric furnaces.
4. Analysis of possibilities for meeting obligations under the Protocol on Heavy Metals by Belarus

**Emission ceilings**

Draft revised text of the Protocol calls for emission reductions in relation to the base year levels (1990 or an alternative year between 1985 and 1995); for countries with economies in transition - an alternative year from 1985 to the year of entry into force of the Protocol for the Party. The Party specifies the base year at the time of ratification, acceptance, approval or accession.

Analysis shows possible difficulties in achieving future emission ceilings of heavy metals without specific measures. It is expected that with respect to emissions of lead there will not be difficulties if 1990 or another year in the 1985-1990 interval will be selected as a base year. However, due to the outlined trend of growth in emissions of cadmium and mercury it may be difficult to achieve reduction in relation to 1990, especially for cadmium.
5. Actual levels of heavy metals and particulate matter emissions and values proposed by the Heavy Metals Protocol

**Sources of information**

- results of emission inventory development at machine building, metallurgy, cement and glass production plants;
- Measurements of particulate matter in exhaust gases;
- Measurements of lead in the production of crystal glass;
- Published data on the content of heavy metals in the dust;
- Results of experimental studies of heavy metals in the dust;
- Calculated values of heavy metal content in flue gases (based on the content of heavy metals in the dust (captured), and the dust concentration in flue gases)
Fuel combustion in boilers

Power generating plants are accountable for about 2% of emissions of dust, and 3% of emissions of lead, 4% of cadmium, 9.6% of mercury. Main fuel - natural gas, reserve - fuel oil. Share of solid fuels - 4% of all fuels consumed. There is a number of small power plants and boilers that use wood, waste, peat and fuel briquettes as fuel.

Actual concentrations: PM concentrations (from solid fuel burning) 60-115 mg/m3
Concentration of heavy metals does not exceed ELVs (estimates)

PM concentrations in flue gases (from solid fuel burning):
Comparison of ELVs set in Belarus and in the Protocol (mg/m3)

<table>
<thead>
<tr>
<th>Unit type and capacity</th>
<th>Domestic legislation</th>
<th>ELV proposed by the Protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>50-100 MW</td>
<td></td>
<td></td>
</tr>
<tr>
<td>New</td>
<td>50</td>
<td>10/20/50</td>
</tr>
<tr>
<td>Existing</td>
<td>150</td>
<td>15/30/50</td>
</tr>
</tbody>
</table>
Electric arc furnaces

ELVs for PM in accordance with the Protocol: for existing - 10/15/20 mg/m3; for new – 5/5/20 mg/m3
In Belarus: for major sources - 60 mg/m3, for others - 80 mg/m3

For the steel plant, which provides the bulk of the steel, calculated concentration of heavy metal emissions does not exceed the limits under the Protocol. However, concentrations of lead and cadmium are close to respective limit values. The mercury concentration is much lower.
Cast iron production

ELVs for PM in accordance with the Protocol for all plants - 10/20/50 mg/m3

In Belarus, the average concentration of PM in flue gases of open cupola (furnace) is estimated to be 675 mg/m3, for induction furnaces - 30 mg/m3. Concentrations of heavy metals in emissions (at levels of 85% to 90% treatment efficiency) does not exceed the limit values

Taking into account fundamental differences between installations for cast iron production (open and closed cupola (furnaces), induction furnaces, electric furnaces), it would be practical to consider a wider range of ELVs for this source category.
Cement clinker kilns

According to the Protocol, ELVs for PM are: 15 mg/m³ (option 1), 20 mg/m³ (option 2) and 50 mg/m³ (option 3); for cadmium: 0.05 mg/m³, for lead: 1 mg/m³, and for mercury: 0.05 mg/m³.

In Belarus, the levels of dust concentrations in the cement kiln emissions significantly exceed the standards established by the Protocol (factor 2.5-3). There are two exceptions: two kilns at a plant operate with 30 mg/m³ dust concentrations in emissions (after upgrading electrostatic precipitators).

Calculated concentrations of heavy metals (with an efficiency of 99.5%): for lead - 0.04 mg/m³, for cadmium - 0.0004 mg/m³, for mercury - 0.00002 mg/m³.
ELVs recommended by the Protocol: Cd - 0.05 mg/m3 (the production of glass containers - 0.8 mg/m3); Pb - 0.5 mg/m3 (the production of glass with the use of cullet - 0.8 mg/m3), manufacture of glass, where lead is added to ensure the required quality of products: Hg - 0.05 mg/m3.

In Belarus the dust concentration in flue gases varies in the range of 15-70 mg/m3, concentration of lead (according to the measurements - 20 mg/m3, according to calculations - 12 mg/m3).

This means that the lead content during production of lead-added crystal glass is much higher than the established limit values for lead - 3 mg/m3. Calculated concentrations of cadmium and mercury are considerably below the limits of the Protocol.

For other types of glass production (construction, special, containers), heavy metals content in the dust is negligible.
A list of major sources of emissions of heavy metals in Belarus is rather limited, and includes the production of cement, steel, cast iron, and lead—added crystal glass.

No complications are expected to achieve emission ceilings for lead, if the year 1990 or another year in the interval 1985-1990 will be selected as a base year, but due to the outlined growth trends it can be difficult to decrease emissions of mercury and cadmium in relation to their 1990 levels. In this regard, 2009 or 2010 can be set as the base for cadmium.
With regard to achieving ELVs for particulate matter there may be problems with solid-fuel boilers, cement production and iron smelters.

It is expected that for most sectors NO significant challenges with achieving ELVs for heavy metals in emissions should arise (except for the production of lead-added crystal glass).

It should be noted that the limit values of heavy metals in emissions under the Protocol are assumed to be the same for most processes, including combustion and metallurgical processes, which is hardly justified, given the very different levels of heavy metals in dust emissions from these processes.
• to achieve the standards of the Protocol on particulate matter for new stationary sources there is a need to bring into compliance with national standards on concentrations of particulate matter emissions from fuel combustion in installations over 50 MW;
• establish emission standards for PM for other sources covered by the Protocol.
• the most important issues is to take measures to reduce dust concentration in flue gases (by increasing PM capture efficiency of existing facilities, upgrading of production processes). These activities will also help to reduce the concentration of heavy metals (particularly lead and cadmium), which are emitted predominantly in aerosol form.
Priority sources for implementation of mitigation measures are: rotary kilns in cement and lime production, fertilizer production, cast iron furnaces, cupola furnaces and to a lesser extent, electric arc furnaces.
Спасибо за внимание!