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USING MARKER PARAMETERS FOR SETTING AND ASSESSING BEST AVAILABLE TECHNIQUES EMISSION ASSOCIATED PERFORMANCE LEVELS

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ABSTRACT

In Russia, terms ‘marker substance’ or ‘marker parameter’ have been used in regulatory acts on Best Available Techniques (BATs). For BAT-related purposes it is needed to select most significant, marker (or indicator) parameters characterizing applied technologies and useful for setting BAT-associated emission limit values. When reliable environmental performance data are scarce and self-monitoring practices are not fully developed, marker parameters should be chosen by means of expert analysis.

Russian information and technical reference books on BATs have already been issued for over 20 industrial sectors. Each reference book contains a list of marker substances selected by experts and industry practitioners. Since 2019, according to the national Integrated Pollution Prevention and Control legislation, BAT-associated emission limit values for marker substances will be included in Integral Environmental Permits of major industries (about five to six thousand installations). Therefore, it is important to agree upon approaches towards selecting marker parameters and setting BAT-associated emission limit values to provide for well-substantiated and transparent decision-making.

To select marker parameters several criteria are suggested. Marker parameters have to be typical of technological processes (sometimes exclusive, ‘portrait’ of a particular process, but this is often difficult to imagine). Marker parameters may be single substances (as carbon monoxide or sulphur dioxide), groups of substances (as nitrogen oxides in stack gases or nitrogen compounds in wastewater) or integral and surrogate parameters (such as pH, colour, chemical or biological oxygen demand). Marker parameters have to be selected from pollutants emitted in significant quantities. Both physical mass (flow) and so called ‘adjusted’ mass (considering toxicity or Maximum Allowable Concentrations as environmental quality standards) can be used to describe emissions. The latter one is preferable since it allows evaluating environmental hazards of emissions and reflects risk-based approach in environmental self-monitoring.

Gradual implementation of BAT-based regulation and improvement of self-monitoring practices will allow to further substantiate selection of marker parameters and improve environmental performance of Russian industries.

Keywords: Best Available Techniques, marker parameters, environmental performance evaluation, BAT-associated performance levels.

INTRODUCTION

Approaches to setting BAT-associated emission limit values and environmental self-monitoring requirements have been formed in Russia since 2014. While national Integrated Pollution Prevention and Control Act was issued in 2014, and Information and Technical Reference Books on Best Available Techniques are gradually being developed, discussed and approved, methods of selecting most substantial parameters to be monitored (or even monitored continuously) and used for setting performance requirements remain rather vague.

Specialists with public health experience argue that for BAT-related regulation marker substances should be selected based on approaches widely spread in public health research, and look for close correlation between concentrations of markers and other substances present in emissions, as well as at environmental pollution patterns in vicinities of IPPC-regulated installations. Researchers and practitioners coming from environmental chemistry and technology circles agree with the necessity to consider environmental pollution but argue that expert judgement approach appears to be more logical and straight forward because it opens opportunities for well-substantiated compromise in the absence of reliable self-monitoring statistics (which is the case in Russia).

MARKER SUBSTANCES AND MARKER PARAMETERS AS TECHNOLOGY DESCRIBING CHARACTERISTICS

Best Available Techniques gradually become an essential reference element in the establishment of permit conditions for industrial installations in the Russian Federation. The overall idea of BAT-associated environmental regulation has been developed in Russia since at least late 1990s when pilot projects were implemented in metallurgy, manufacture of glass, food and textile industry [1]. In 2014, the national Integrated Pollution Prevention and Control (IPPC) Act was passed and Russian BAT Bureau established [2].

Learning lessons available from European IPPC and Industrial Emissions Directives [3], Russian decision-makers suggested organising an exchange of information on industrial emissions between BAT Bureau, major IPPC industries, research institutions, and non-governmental organisations promoting environmental protection in order to facilitate the drawing up of Information and Technical Reference Books on Best Available Techniques (ITRBs). Information exchange is in progress, and over 20 ITRBs have already been prepared, discussed and officially issued by the Federal Service for Technical Regulation (Russian Standardisation Body) [4].

Instead of issuing ‘BAT conclusions’ as separate documents, Russian BAT Bureau decided to include concise explanations of sectoral BATs into ITRBs as the elements of BAT reference documents laying down the conclusions on Best Available Techniques, their short descriptions and emission levels associated with BATs. For Russian industries conditions of these chapters of ITRBs are obligatory to comply with. In all ITRBs sector specific emission levels are listed mainly for so-called ‘marker substances’, and it is assumed that these substances should be covered by environmental self-monitoring programmes of industrial installations [5].

While biomarkers are widely used in biomedical research, chemical and biological indicators (sometimes also called markers) are applied to analyse changes that occur in ecosystems. Indicators are defined as species or substances whose presence indicates certain environmental conditions. Organisation for Economic Co-operation and Development runs several projects aimed at assessing and disseminating information on environmental pollution indicators as essential tools for tracking environmental progress, supporting policy evaluation and informing the public [6].

Thus, the initial idea for introducing marker substances in BAT-associated regulation was similar to selecting indicators in environmental chemistry and trying to assess harmful impacts of industrial activities. It would be logical to suppose that to select marker substances these should be chosen to describe technological processes and used to set environmental performance requirements. It is nearly the case but medical nature of the term ('marker') turned researchers to studying correlations between various pollutants emitted to the environment. In BAT-related standards marker substance became determined as 'the most significant representative of a group of substances within which a strong correlation relationship exists' [7]. Such a correlation may exist (like between nitrogen and carbon oxides in emissions of gas combustion plants) and may not (like between nitrogen, sulphur and carbon oxides in emissions of cement or glass plants). In other words, 'marker substance' (or marker) term is borrowed from public health standards and regulations [8], and being both important and widely used in one area (for example, using genetic epidemiology approaches to identify new environmental exposures) appeared confusing in another (selecting most significant BAT parameters for setting conditions of Integrated Environmental Permits).

To harmonise views of BAT experts tending to be more public health oriented and more concerned about technological aspects of IPPC regulation, it is needed to find a consensus between two groups of researchers (and two approaches) and to suggest clear methodology for setting BAT-associated emission performance (limit) values.

EXPERT APPROACH TO SELECTING MARKER PARAMETERS

Back in 2000, Rojer Dijkmans described a transparent and proven methodology for selection of Best Available Techniques at the sector level by guided expert judgement [9]. Many authors have been referring to this article but arguing also that more better substantiated approaches to setting BAT-associated Emission Limit Values.

It is necessary to emphasise that in European BAT practice marker parameters are never discussed, substances listed in BREFs and BAT Conclusions can be called 'key emissions characteristics', 'most significant emissions' [10], 'certain air pollutants' [11], 'main air-polluting substances' [12], etc. In contrary, Russian regulators and researchers discussing most significant emissions argue that it is necessary to develop methodologies for selecting marker substances [2, 13].

It is likely that for the first time marker substances appeared in Russian BAT-related documents in the federal IPPC Act [2]. Article 67 of this Act states, "While running environmental self-monitoring programmes, operators shall ensure that measurements are conducted first of all for pollutants characterising technological processes and peculiarities of production processes (marker substances)". Two assumptions can be derived from this obligation, namely: (1) marker substances are those typical, characteristic for technological processes and significant for the environmental performance assessment and (2) marker substances are those compulsory to measure in emissions. Moreover, developing requirements to continuous self-monitoring regulators

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often mention marker substances as those to be included in the lists of continuous self-monitoring parameters. This is why Russian BAT-related regulation stakeholders cross swords defending their positions.

To begin looking for compromise, one should remember that it is far too late to alter wording: marker substances (or parameters) are listed in all sector IRTBs issued in Russia [4], and addressed in the national IPPC act [2]. What is still possible is altering the definition and making it more precise. The following explanation can be suggested:

> "Marker parameters are **individual or integral parameters** (including substances), **characteristic of applied technological processes**, reflecting peculiarities of these processes and **significant for assessing production environmental performance and resource efficiency** Marker parameters have to be selected using clear criteria and justified for each IPPC-regulated production process".

Thereby we've not only keep the term, but make certain progress towards allowing using such parameters as pH, biological and chemical oxygen demand, total phosphorus or nitrogen, suspended solids, total hydrocarbons, etc. as emission markers. We hope also that Russian experts will agree that surrogate parameters as temperature, conductivity, colour addressed in Reference Report on Monitoring of emissions from IED-installations [14] can also be included into lists of BAT markers.

Here we come to the selection of characteristic, typical pollutants or surrogate parameters (Fig.1).

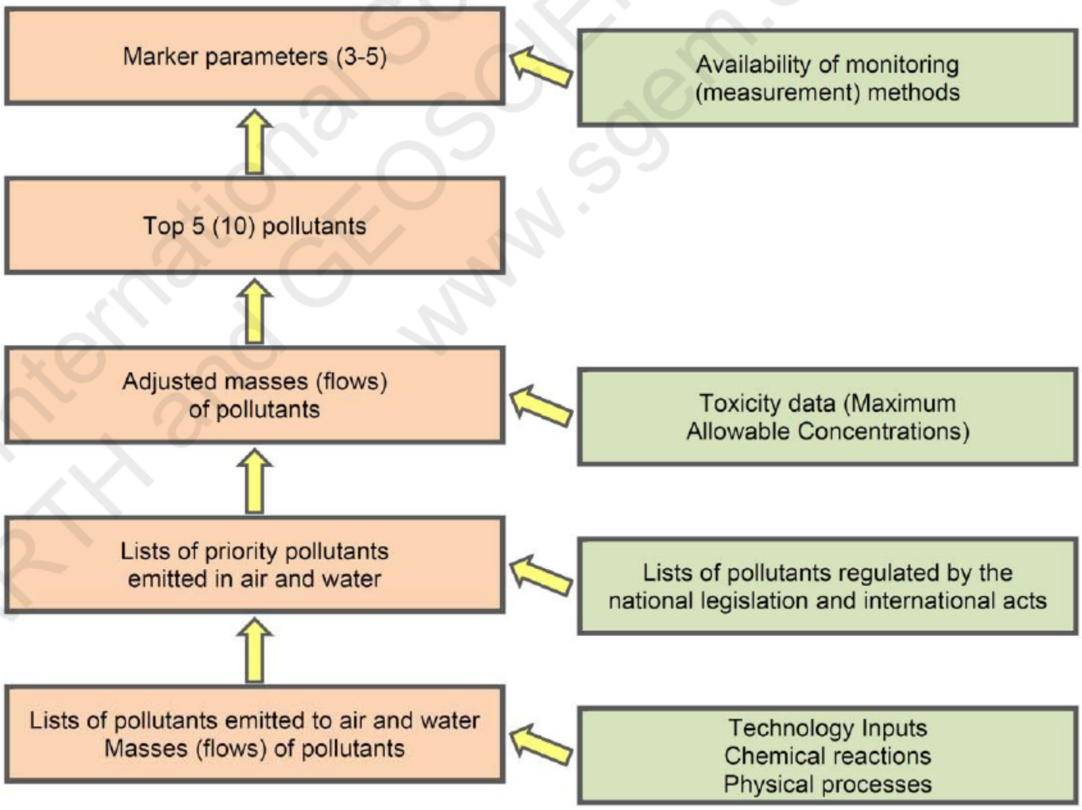

Fig. 1. Step-by-step selection of significant (marker) parameters

Common sense approach is simple: check your inputs, consider raw materials, their composition, possible admixtures, and chemical reactions that occur in the technological processes. In fact, currently each installation functioning in Russia operates in accordance with single-medium permits, and both industrialists and regulators know very well which pollutants are emitted into air, water and soil. Therefore, whatever we start with we'll come up with **technology specific lists of pollutants**. At this point it is necessary to make sure that priority pollutants included in Global Environmental Monitoring Programmes (GEMS) and Pollutant Release Registers are not forgotten while compiling technology specific lists. In Russia, the list of regulated (controlled) air pollutants amounts 254 substances, while GEMS list of priority pollutants for impact areas includes only sulphur dioxide, nitrogen oxides, carbon monoxide, ozone, and asbestos. The truth is somewhere in between, but from the practical standpoint it should be closer to GEMS priority pollutants (5-7 substances) than to the Russian list of regulated substances.

Returning to single-medium permits and pollution charges we find references to the 'adjusted mass' term. Adjusted mass allows comparing emissions not only by amounts of pollutants released but also by their hazard. For this purpose, a special hazard coefficients are used. To get a coefficient for substance **i**, its toxicity expressed in Maximum Allowable Concentrations (MPC) is compared to the toxicity of reference substances such as carbon for air emissions and glycerol for water discharges:

$$M_i = m_i \cdot \sqrt{\frac{MAC_{da\ CO}}{MAC_{da\ i}} \cdot \frac{MAC_{wa\ CO}}{MAC_{wa\ i}}}$$

M_i – 'adjusted mass' of pollutant **i**, conventional tonnes (per year);

m – mass of pollutant **i**, tonnes (per year);

$MAC_{wa\ CO}$ – Maximum Allowable Concentration of CO, daily average, mg/m^3;

$MAC_{da\ I}$ – Maximum Allowable Concentration of substance **i**, daily average, mg/m^3;

$MAC_{wa\ CO}$ –Maximum Allowable Concentration of CO, working area, mg/m^3

$MAC_{wa\ I}$ – Maximum Allowable Concentration of substance **i**, working area, mg/m^3.

Such 'adjustment' allows to better prioritise pollutants attracting attention of regulators and regulatees to the necessity to minimise, monitor and control emissions of most significant substances (Table 1). Since both in legislative acts and in research articles we find arguments that marker substances are those causing significant environmental impacts, 'adjusted' mass becomes even more reasonable: we take into account air (or water) quality standards set to protect – if not the environment then human beings forming an essential part of environment.

Close attention of regulatees and regulators to the selection of marker parameters is explained by the fact that the legislation requires monitoring these parameters [2]. It shifts logic of risk-based approach to environmental self-monitoring: most significant (and hazardous) pollutants emitted in large quantities need to be measured and controlled at the first instance. In Russia, it is also assumed that it is the group of marker parameters that has to be monitored continuously which is also quite logical [15].

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Table 1. Most significant pollutants in ceramic industry

Pollutants	Air emissions in brick production		Air emissions in tile production	
	Specific mass of emissions, kg / tonne of product	Specific 'adjusted' mass of emissions, conventional kg / tonne of product	Specific mass of emissions, kg / tonne of product	Specific 'adjusted' mass of emissions, conventional kg / tonne of product
NO_2	0.01 – 0.70	0.27 - 19.00	0.06 – 0.60	1.62 – 16.20
NO	0.01 – 0.08	2.10 - 17.00	0.02 – 0.20	0.42 – 4.20
SO_2	≤ 1.3	≤ 14	≤ 0.1	≤ 1.1
CO	0.12 – 7.00	0.12 – 7.00	0.11 – 3.50	0.11 – 3.50

Therefore, we come to the third major criterion for selecting marker parameters for setting and assessing BAT-associated environmental performance requirements: substances (or parameters) selected have to be measurable – directly (preferably) or indirectly.

Data quality is the most critical aspect of self-monitoring. Reliable data are needed for assessing and comparing the performances of emission (and even consumption) control techniques, for decision-making concerning allowable levels of emissions, and for the prevention of accidents, etc. Thus, quality assurance is essential for the whole data production chain and for the selection of marker parameters (parameters to be monitored).

In Russia, stakeholders argue that the key point for selecting between continuous and periodic self-monitoring is the availability and reliability of continuous measurement equipment, depending also on the industrial sector or on a specific emission source. Under certain flue-gas conditions such as high humidity content, the presence of aerosols or precipitation of particles at the sampling equipment continuous measurements might not be feasible.

It is expected that Russian IPPC regulators will come up with lists of sector-oriented emission sources (first of all – air emission sources) to be monitored continuously. A new act has to be issued in autumn 2017 allowing operators extra four years for developing projects, selecting and purchasing continuous self-monitoring equipment, installing, calibrating devices and preparing for reporting data to environmental authorities. In general, this approach is similar to that applied in the European Union, but since there is no freedom in selecting emission sources operators strive to substantiate selection of measurable marker parameters and (no surprise) to minimize lists of these parameters for each IPPC-regulated sector.

CONCLUSION

To set and monitor BAT-assessed performance levels (emission limit values) most significant parameters have to be selected for each IPPC-regulated sector. In Russia, these parameters are called markers. There markers can be individual substances or integral parameters characterizing technological processes applied at IPPC installations.

It is suggested that marker parameters have to be selected at the sector level by guided expert judgement. Major criteria for this judgement include:

- significance of marker substances/parameters for the technological process (processes) applied at IPPC installation in question (marker parameters have to be characteristic and if possible specific, ‘portrait’ for the technology);
- large emissions of marker substances assessed in mass flows or in ‘adjusted mass’ flows considering both quantity and toxicity expressed by environmental quality standards;
- measurability in terms of self-monitoring conditions and opportunities for providing reliable data quality.

The third criterion forms a basis for selecting both individual substances and integral (or surrogate) parameters, some of which can be used for setting BAT-associated emission limit values (as Biological Oxygen Demand) while others play a role of specific conditions (as pH, conductivity, temperature, etc.). Current uncertainties of environmental legislation in the Russian Federation allow stakeholders to assume that a new and stringent requirement for continuously monitoring marker parameters will be issued in 2017.

The first generation of Russian Informational and Technical Reference Books on Best Available Techniques consisting of 51 ITRBs is nearly ready. All issued sector books include lists of BATs and correspondent technological parameters and marker (significant) substances. These substances were selected by experts using data submitted by Russian IPPC-regulated industries to Technical Working Groups developing ITRBs. Though draft lists of technological parameters and marker substances were widely discussed with stakeholders in 2015-2016, regulatees are only now coming to understanding risks and opportunities of setting BAT-associated emission limit values and environmental self-monitoring performance requirements for marker substances.

Possibilities for revising lists of marker parameters and officially setting requirements to expert judgement approach still exist: first Integral Environmental Permitting procedures for major polluters will be implemented only in 2019, and national standards in the field of Integrated Pollution Prevention and Control can easily be developed based on the logic suggested in this paper.

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