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Draft annotated outline of the study report on mercury from oil and gas for consideration by the Global Mercury Partnership Advisory Group at its eleventh meeting

Note by the secretariat

1. At its tenth meeting held in Geneva on 23 November 2019, the UNEP Global Mercury Partnership Advisory Group (PAG) decided to initiate work on the issue of mercury from oil and gas, identified as a cross-cutting topic amongst different Partnership Areas[1]. The PAG requested the Secretariat of the Partnership to convene targeted discussions with interested Partnership Area leads, partners as well as other relevant stakeholders, to identify the needs and challenges, the information currently available as well as the possible aspects where the Partnership may have a useful contribution and move the issue forward.

2. In response to this request, expert consultations were launched through an online meeting held on 23 April 2020[2], with the overall objective to identify potential useful contributions from the Partnership, within the context of its mission and its existing areas of work. Participants were invited to attend in their expert capacity, to share views and ideas, and any useful background information.

3. Interested Partnership Area leads subsequently agreed to guide a process for developing a study report on the topic. As per their guidance, the report should be concise, i.e. not exceed 40 to 50 pages, with the aim to better understand potential releases of mercury, as well as possibly how wastes are treated and accounted for and may be entering the market for other uses. The guidance further indicated that the report could distinguish the key differences between oil and natural gas related information, and therefore address them separately. The report could also identify the differences in the presence and management of mercury in the respective sectors. The guidance further indicated that the report could include:

- a review of existing knowledge and gaps in understanding mercury content, emissions and releases; relative geographic mercury concentrations; waste flows and treatment during the respective stages of the oil and gas processes, including decommissioning of their infrastructures of both offshore and onshore sites; and available information on the potential avenues through which mercury from the sector may be entering the market for other uses;

[1] The report of the tenth meeting of the Partnership Advisory Group (document UNEP/ Hg/PAG.10/5) is available at: https://web.unep.org/globalmercurypartnership/partnership-advisory-group-meeting-10

[2] Further information, including summary of main discussion points, may be found at: https://web.unep.org/globalmercurypartnership/expert-consultations-“mercury-oil-and-gas”

- if available, information related to quantities of mercury that are possibly entering the market;
- information related to how mercury is present in new techniques such as non-conventional gas (fracking, shale gas), and how it is extracted;
- a review of the different methods used, highlighting best practices for mercury releases reduction and waste treatment (including the treatment at dismantling yards for the decommissioned infrastructures that may contain mercury), and for detecting or monitoring mercury releases;
- initial ideas for further research and cooperation.

4. A draft annotated outline of the study report on mercury from oil and gas is annexed to the present note for consideration and further discussion by the PAG at its eleventh meeting. Together with the information collected, the finalized annotated outline will be used as a basis to develop the study report during the first half of 2021.

5. When considering the draft annotated outline, the PAG may wish to provide feedback on the proposed flow of the report, its chapters and sections; consider the suitability of the identified dimensions and topics as per the guidance received by the Partnership Area leads; highlight topics meriting further elaboration; and propose key references to be used and cited in drafting the document. The PAG may also wish to discuss next steps, including further consultations with relevant stakeholders and dissemination of the reports.

Annex

Draft annotated outline of the study report on mercury from oil and gas for consideration by the Global Mercury Partnership Advisory Group at its eleventh meeting

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1. Introduction

Initiated in 2005 by a decision of the United Nations Environment Programme (UNEP) Governing Council, the UNEP Global Mercury Partnership (hereinafter referred to the "Partnership") aims to protect human health and the environment from the release of mercury and its compounds to air, water and land. With over 200 partners to date from Governments, intergovernmental and non-governmental organizations, industry and academia, the Partnership focuses on supporting timely and effective implementation of the Minamata Convention on Mercury, providing state of the art knowledge and science and raising awareness towards global action on mercury.

At its tenth meeting (Geneva, 23 November 2019), the UNEP Global Mercury Partnership Advisory Group (PAG) requested the Secretariat of the Partnership to convene targeted discussions with interested partners and stakeholders on the topic of mercury from oil and gas

In response to this request, expert consultations were launched on 23 April 2020, with the overall objective to identify potential useful contributions from the Partnership, within the context of its mission and its existing areas of work.

Interested Partnership Area leads subsequently agreed to guide a process for developing a concise report on mercury from oil and gas with the aim to better understand potential releases of mercury from oil and gas, how wastes are treated and accounted for, and how they may be entering the market for other uses.

2. Objective of the report

The objective of the report is to analyze the life cycle of mercury in the oil and natural gas value chains and understand how this heavy metal, naturally present in oil and natural gas, may be released to the environment at different stages of the process, including the decommissioning of oil and gas infrastructure. It further aims to identify how mercury waste from the sector is treated and whether it may be entering the market for other uses.

3. The problem of mercury in oil and natural gas

- Crude oil and natural gas contain heavy metals, including mercury, in concentrations that vary significantly depending on the nature of the geological formation of the basin of the extraction.

- The presence of mercury in crude oil and natural gas may impact the processing operations, and represent a risk for human health, in particular through operational exposure, and the environment. A significant fraction of the mercury present may hence be captured for operational, health and environmental reasons, and subsequently treated as waste.

- Available information appears to be limited as to potential mercury emissions and releases from the different processes and uses of crude oil and natural gas all along the extraction/production chain; to mercury or mercury containing waste from extraction or processing; and to human exposure, in particular of workers.

- Due to its persistence, mercury emissions, even the lowest ones, do not dilute in the environment but rather contribute to increasing the environmental pool of mercury. Mercury is considered by WHO as one of the top ten chemicals or groups of chemicals of major public health concern. Exposure to mercury can result in adverse impacts on the nervous, digestive and immune systems, lungs, and kidneys, in particular during the first stages of development (since conception), where it affects neurodevelopment and contributes to reproductive negative effects, among other important toxic effects.

- Worker's Exposure: Mercury may accumulate in certain equipment at different stages of the processes and may lead to occupational exposure, especially during maintenance work and inspection activities in the petroleum industry. As conclusive symptomatic diagnosis of neuralgic impairment is usually at an advanced stage, it is important to work on awareness, prevention and access to information.

- The report will include a case study on The Campana refinery in Argentina: South America is the second region with the highest concentrations of mercury in crude oil. The Campana refinery, in Argentina, has been aware of the potential presence of mercury in crude oil since 2009. Since then, mercury average concentrations increased up to 25 ppb (from 15 ppb originally). The refinery informed that mercury has a high occurrence in lighter cuts (like LPG and naphtha) and gave a strong recommendation to systematically study mercury levels to prevent workers and environmental exposure.

4. Mercury content in oil and gas deposits

- Different forms of mercury in oil and gas deposits: Almost all mercury is present as elemental mercury in natural gas and different forms in crude oil and condensates, mainly elemental and inorganic forms (sulphide, chloride and selenide).

- Presence of mercury in crude oil and natural gas in the different regions: The amounts of mercury can vary significantly depending on the origin of the crude oil or natural gas. There are numerous ways of estimating the regional averages of mercury in crude oil and natural gas by region, which give different results.

- Mercury concentration differences between oil and gas in deposits: Natural gas and crude oil share the same mercury concentrations regional distribution (when mercury concentration is higher in oil so is in gas). There are discrepancies in the information: according to IPIECA[3], natural gas presents a slightly lower concentration of mercury compared to oil, and Qa3 informed (and provides some examples) that mercury concentrations in gas are typically higher than in crude oil from the same source[4].

- Regional content of mercury in crude oil and natural gas as an indicator: Importance of considering the way crude oil and natural gas are commercialized when using regional averages as indicators. Regional average concentrations cannot be used as indicators to understand local problems, given the different concentration of mercury between deposits.

5. Mass of mercury in crude oil

Mercury may be found and released at different stages of the crude oil value chain, including:

[3] IPIECA. Mercury management in petroleum refining An IPIECA Good Practice Guide. 2015.
[4] See the document with supplementary information sent by Qa3.

- Extraction: "Produced water" is obtained during the extraction of crude oil, and this wastewater may contain mercury and other heavy metals, even the concentration of mercury found in the produced water is lower compared to crude oil and natural gas.

- Transport: There is a risk of accumulation of sludges with high mercury concentration in crude oil storage tanks, especially in tankers that have been used for several years. These sludges with high concentration of mercury may be released to the environment during the decommissioning of tankers or accidental spillages.

- Processing: Mercury enters the processing facility dissolved or suspended in the crude oil and can exit it dissolved in the products, the wastewater, the air, the solid waste or be accumulated in the systems.

    - The water treatment, designed to capture salts dissolved in crude oil, can generate mercury-containing wastewater.

    - Some processing facilities may use adsorbent materials to remove mercury from volatile fractions, which generates mercury-containing solid waste.

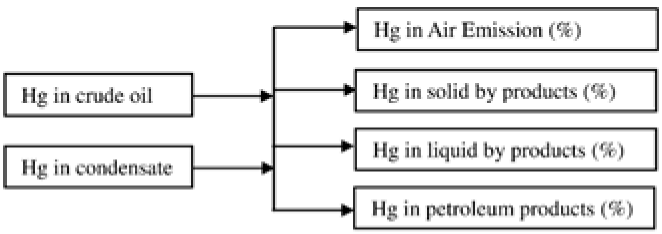
    - There is evidence of higher concentrations of atmospheric mercury in oil refineries and their surroundings.

    - Elemental mercury can be found in the products derived from volatile fractions of processed crude oil.

    - High amounts of mercury can be accumulated in the pipelines and systems of oil processing facilities.

  A detailed mass balance of mercury in processing facilities would be necessary to evaluate the extent of the issue.

Mercury mass balance in oil refineries



6. Mass of mercury in natural gas

- Extraction: The extraction of natural gas by hydraulic fracture (fracking) presents a risk of mercury releases into the environment unique to this technique due to the production of "flowback" water, which may contain mercury in high concentration.

- Transport: When natural gas is transported through long distances, an appreciable decrease in mercury concentration can be observed. This missing mercury is adsorbed by the pipelines, which must be treated as mercury-contaminated materials.

- Processing: Systems designed for the removal of water, hydrogen sulphide and carbon dioxide from natural gas can have a secondary effect of also capturing mercury, this mercury can end up dissolved in the wastewater or emitted to the atmosphere during regeneration of the removal systems or from flaring of waste gases Natural gas exiting the facilities for consumption may contain mercury in small concentrations and it is released during combustion.

7. Techniques used to remove mercury from crude oil and natural gas

- Presence of mercury in crude oil and natural gas in a refining plant: Even though mercury is present in crude oil and natural gas in trace levels, it can concentrate in the plant equipment and generate severe problems in refining plants.

- Mercury removal from crude oil: Whilst possible, it is not an easy process to remove mercury from crude oil and there are very few facilities operating this technology. During the refining process mercury partitions into the light fractions (predominantly the LPG) and on some refineries the mercury in the LPG is removed with “mercury removal units” (MRU) when needed. Once these adsorbents are saturated, they become mercury waste or mercury-containing waste and must be treated accordingly.

- Mercury mass balance in crude oil distilleries: Due to the chemical characteristics of mercury, and the accumulation processes, refineries have reported troubles in closing a mercury mass balance, obtaining uncertainties of at least 30%, however, this exercise is valuable and can identify where the mercury accumulates and where there is the greatest risk for worker exposure.

- Mercury removal from natural gas: Where cryogenic apparatus is installed on a gas processing facility, it is essential that a mercury removal process is deployed upstream of the cryogenic distillation as mercury can cause catastrophic failures of aluminum heat exchangers via two corrosion processes; liquid metal embrittlement and amalgam corrosion. The disposal of the collected mercury by the removal system (mercury waste) varies depending on the type of system used, but in every case should be considered hazardous waste.

8. Fate or possible fate in the environment of mercury generated from oil and gas activities

Based on literature review, one may highlight the following:

- There is little information about the fate of the sludge produced during the processing of crude oil and natural gas.

- There is very little information available about the fate of the solid waste with a high mercury content, which comprises saturated wastewater filters and saturated adsorbent from the mercury removal systems. This hazardous waste should be managed in an environmentally sound manner by third parties, specialized and certified in this activity.

- The mercury present in the different fuels will be released to the atmosphere as elemental mercury after its combustion in power generation plants, vehicles and heaters.

- The replacement of pipelines that may have accumulated mercury and the decommissioning of entire facilities and tankers generates mercury-containing waste that must be correctly disposed of, otherwise this mercury will be released to the environment.

9. Initial Ideas for further research and cooperation

- The necessity to monitor in a systematic, standardized, comparable and multicentric way the whole process as well as to complete mercury mass balances across oil refineries and natural gas separation and processing facilities in the most accurate way.

- Share information on the common areas within gas processing plants and oil refineries where mercury is known to be released to the environment.

- Share the information on the production and fate of mercury waste and mercury containing waste's flow, especially in crude oil and natural gas deposits and/or regions where mercury concentrations are higher (fate of the saturated adsorbent from mercury removal systems as well as from filters, pipeline pigging activities and others).

- Identify the available technology and the capacity of the facilities to process mercury and mercury containing waste and safely dispose of it in the different regions.

- Define mercury waste and mercury containing waste volumes and fate in order to implement the appropriate measures to reduce or eliminate mercury emissions.

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