MINAMATA CONVENTION ON MERCURY

Ref: MC/COP4/2021/27 2021 年 4 月 30 日

事由：供缔约方大会第四次会议审议的欧洲联盟关于修正《关于汞的水俣公约》附件 A 第一部分、附件 A 第二部分和附件 B 第一部分的提案

尊敬的女士/先生：

本函旨在向关于汞的水俣公约缔约方和签署方通报欧洲联盟提出的《公约》附件 A 和 B 修正案文。

对附件 A 第一部分，建议列入五个条目。
对附件 A 第二部分，建议列入补充案文。
对附件 B 第一部分，建议列入一个条目。

该提案将提交缔约方大会第四次会议审议，这次会议预定分两部分举行，分别为 2021 年 11 月 1 日至 5 日的在线部分以及 2022 年第一季度在印度尼西亚巴厘岛举行的现场续会部分。本函系根据第 26 条第 2 款发送，该款规定对《公约》提出的任何修正案文均应由秘书处在建议通过该项修正的会议举行之前至少提前 6 个月通报各缔约方。该提案将在 2022 年第一季度的现场续会部分审议。

本函附件一载列了欧洲联盟提出的《公约》附件 A 和 B 的修正提案。本函附件二根据第 4 条第 7 款和第 5 条第 9 款载列了关于拟议修正的解释性说明的案文。

为便于缔约方大会第四次会议进行讨论，缔约方不妨与欧洲联盟代表和秘书处交流关于修正提案的评论意见或问题。请将您的评论意见通过电子邮件发送至：

关于汞的水俣公约秘书处
电子邮件：mea-minamatasecretariat@un.org

以及

Ms. Jenny Green
Policy Officer
DG Environment
C4 Industrial Emissions and Safety
European Commission
电子邮件：Jenny-Johanna.GREEN@ec.europa.eu

UN environment programme

如需更多信息或澄清说明，请随时与秘书处联系。

执行秘书
Monika Stankiewicz

致：　关于汞的水俣公约国家联络人

关于汞的水俣公约签署方

抄：　各国政府（通过其与联合国环境规划署的官方沟通渠道）

常驻联合国环境规划署代表团和常驻联合国日内瓦办事处代表团

公约保存人、联合国法律事务厅

附件一

欧洲联盟关于修正《关于汞的水俣公约》附件 A 第一部分、附件 A 第二部分和附件 B 第一部分的提案

背景

根据《水俣公约》第 4 条第 7 款和第 5 条第 9 款，任何缔约方均可向秘书处提交关于将某种添汞产品列入附件 A、将生产工艺列入附件 B 的提议，其中应列有与该产品或工艺无汞替代品的可得性、技术和经济可行性以及环境与健康风险和惠益相关的信息。

此外，根据关于审查附件 A 和 B 的 MC-3/1 号决定，秘书处在 12 月 13 日的信（MC/COP3/2019/15）中要求缔约方在 2020 年 3 月 31 日之前提交材料，包括：

(a) 根据《公约》第 4 条第 4 款，提交关于添汞产品，以及关于添汞产品的无汞替代品的可得性、技术和经济可行性以及环境与健康风险和惠益的信息

(b) 根据《公约》第 5 条第 4 款，提交关于使用汞或汞化合物的工艺，以及关于使用汞或汞化合物的生产工艺的无汞替代工艺的可得性、技术和经济可行性以及环境与健康风险和惠益的信息

欧盟于 2020 年 3 月 31 日向公约秘书处传达了关于若干添汞产品和工艺及其在技术和经济上可行的现有无汞替代品的信息。传达的信息基于报告“收集关于添汞产品及其替代品的信息”，该报告已发表并在互联网上公布。这些信息体现在特设专家组关于闭会期间工作的报告中。欧盟还于 2020 年 8 月 31 日在根据缔约方大会第三次会议确定的有关程序提交的材料中，向公约秘书处传达了有关牙科汞合金技术和经济信息的资料。两份提交材料均可在水俣公约网站上查阅。

根据这两份提交材料中提供的关于无汞替代品、其可得性、技术和经济可行性及其对人类健康和环境相关惠益的信息，欧盟建议根据第 26 条，在缔约方大会第四次会议上通过本文件附件一所载的对附件 A 和 B 的修正。

附件二载有上述提交材料的相关摘录，内容涉及我们的修正提案所涵盖的汞用途。

欧洲联盟关于修正《关于汞的水俣公约》附件 A 第一部分的提案

欧洲联盟建议在附件 A 第一部分增加以下条目[1]：

添汞产品	开始禁止产品生产、进口或出口的时间（淘汰日期）
含汞量低于 2%的扣式锌氧化银电池以及含汞量低于 2%的扣式锌空气电池	2023 年
用于普通照明用途的卤磷酸盐荧光粉直管型荧光灯	2023 年
下列非电子测量装置： (a) 体积描记仪中使用的应变片； (b) 张力计	2023 年
下列电气和电子测量装置： (a) 熔体压力传感器、发射器和传感器； (b) 汞真空泵	2023 年
聚氨酯，包括用于使用聚氨酯的罐	2023 年

[1] 本表中关于聚氨酯的修正提案是对在附件 B 第一部分增加“使用含汞催化剂生产聚氨酯”条目这一提案的补充。拟议的附件 B 第一部分新增条目不会禁止进口含汞的聚氨酯罐。

欧洲联盟关于修正《关于汞的水俣公约》附件 A 第二部分的提案

欧洲联盟建议在附件 A 第二部分增加以下案文：

到 2024 年 1 月 1 日，缔约方应：

（一） 规定是牙科汞合金仅以预加药的胶囊形式[1]使用；

（二） 禁止牙科医生使用散装的汞；

（三） 确保使用牙科汞合金或移除牙科汞合金填充物或含有此类填充物的牙齿的牙科诊疗机构的经营者，为其设施配备保留效率为 95%的汞合金分离器[2]，以保留和收集汞合金颗粒，包括废水中所含的汞合金颗粒；

（四） 不再允许将牙科汞合金用于乳牙、15 岁以下儿童和孕妇或哺乳期妇女的牙科治疗，除非牙医根据患者的具体医疗需要认为绝对必要。

[1] 汞合金胶囊（如国际标准 ISO 13897:2018 和 ISO 24234:2015 中描述的汞合金胶囊）被认为适合牙科医生使用。

[2] 应根据相关国际标准（包括 ISO 11143:2008）判断汞合金分离器是否符合要求。

欧洲联盟关于修正《关于汞的水俣公约》附件 B 第一部分的提案

欧洲联盟建议在附件 B 第一部分增加以下条目：

使用汞或汞化合物的生产工艺	淘汰日期
使用含汞催化剂进行的聚氨酯生产	**2023 年**

Annex II

Further explanatory note from the European Union regarding the proposed amendments

TECHNICAL, ECONOMIC AND ENVIRONMENTAL INFORMATION IN ACCORDANCE WITH ARTICLES 4(7) AND 5(9) TO THE CONVENTION

I. SUBMISSION FROM THE EU ON MERCURY-ADDED PRODUCTS AND MANUFACTURING PROCESSES USING MERCURY OF MERCURY COMPOUNDS

Batteries (mercury-containing button cells)

Summary Overview

Button cells are small, thin energy cells commonly used in watches, hearing aids, and other electronic devices. Mercury-containing button cell batteries mainly fall into three types: zinc air, silver oxide and alkaline.

Currently, the Minamata Convention provides an exemption to button zinc silver oxide and button zinc air batteries with a mercury content below 2%. This exemption was also active in the EU under Directive 2006/66/EC (Batteries Directive) until 2015, however since then, the placing of batteries containing more than 0.0005% of mercury on the market has been prohibited. In the USA, mercuric oxide button cell batteries have been banned since 1996.

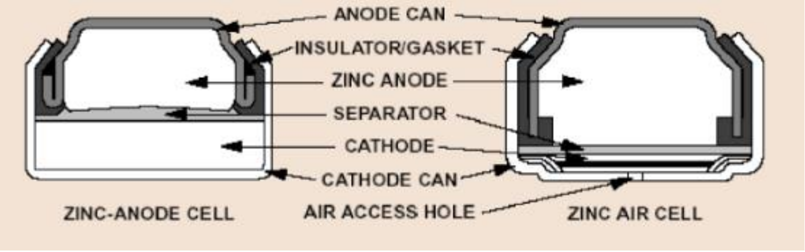
Mercury-free button cells are available, the most common being zinc air batteries, and are technically feasible for all applications. They cost approximately 10% more than mercury cells (BIO Intelligence, 2012). Mercury-free zinc air batteries mostly have similar performance regarding self-discharge, leak resistance and capacity (BIO Intelligence, 2012), but a reduction of their lifespan, by 2-10% can be observed. However, improvements in performance are expected (European Commission, 2014). There are also economic benefits to waste collectors and recyclers from mercury-free alternatives in the form of a 30-40% lower cost of recycling button cell waste (BIO Intelligence, 2012).

According to Lin et al. (2016), the production of mercury-containing zinc button cell batteries in China has gradually decreased from 8.8 billion units in 2005 to 5.5 billion units in 2014. In the EU, in 2010, the EU button cell market was 1.08 billion units containing an estimated 1.4 to 8.8 t Hg and displaying an upward trend (BIO Intelligence, 2012).

Technical Description

Currently, there are three types of button cell batteries that contain mercury: zinc air, silver oxide and alkaline. These batteries contain mercury in small amounts (typically 0.1-2%) (European Commission, 2014) and the purpose of mercury in the cell is to prevent the build-up of hydrogen gas. The mercury acts as a barrier to the production of hydrogen and as such prevents the cell swelling and becoming damaged.

Figure 1 – Cross Section of Zinc Anode Button Cell and Zinc Air Button Cell (European Commission, 2014)



Range of mercury content/consumption per unit product

0.1-2 weight-% (button cells with intentionally added mercury)

0.0005 weight-% (button cells without intentionally added mercury)

Availability of non-mercury alternatives

Main alternatives: Mercury-free zinc air batteries

Mercury-free versions are commercially available for all applications of the main types of button cells (lithium, silver oxide, alkaline and zinc air). The most frequently used types make use of zinc air technology (European Commission, 2014).

Since October 2015, mercury-containing button cell batteries have been prohibited in the EU following the expiry of the exemption granted under the Batteries Directive.

Technical feasibility of mercury-free alternatives

In the USA following a ban of mercury-containing button cells, there were initial issues relating to performance and usability of mercury-free alternatives however, these have now been overcome following technological developments.

Stakeholders have confirmed that performance parameters such as self-discharge, leak resistance, capacity and pulse capability of mercury-free button cells are comparable to traditional mercury-containing cells (BIO Intelligence, 2012).

Economic feasibility of non-mercury alternatives

Mercury-free alternatives currently cost approximately 10% more than mercury-containing cells to consumers (BIO Intelligence, 2012). There is a marginal cost to button cell manufacturers for investments in Research and Development (R&D) and assembly line adaptations and these costs are likely to be passed on by retailers to consumers which, is expected to be reflected in an increase in retail price by 5-10%.

The Lowell Centre for Sustainable Production in Massachusetts conducted a study in 2011 on the economics of converting to mercury-free products including button cell batteries, and found that maintenance of dual production capability between mercury and non-mercury products creates inefficiencies increasing the cost of production (Lowell Centre for Sustainable Products, 2011).

There are economic benefits to waste collectors and recyclers from mercury-free alternatives in the form of a 30-40% lower cost of recycling button cell waste (BIO Intelligence, 2012).

Health/Environmental Risks and benefits of non-mercury alternatives

In the EU, it was estimated that in 2009, 88% of button cell batteries were not collected for separate waste collection and as such would have been disposed in landfills or incinerated. This represented an estimated 4.5 tonnes of mercury going to disposal.

Due to the difficulty in increasing separate waste collection rates of batteries, substitution of mercury with alternatives is the most effective way of reducing this environmental impact.

A prohibition of mercury-containing button cell batteries would reduce exposure of global citizens to mercury introduced to the environment from this product.

Examples of regional or national restrictions

Mercury has already been eliminated from most batteries (e.g. mercuric oxide batteries) in the EU as a result of restrictions imposed by Directive 2006/66/EC on batteries and accumulators and waste batteries and accumulators (Batteries Directive), which prohibits the placing on the market of batteries and accumulators containing more than 0.0005% Hg by weight. This threshold intends to cover trace contamination and reflects current measurement limitations. Mercury-containing batteries are classified as hazardous waste but only a certain proportion are required to be separately collected for further recycling (45% since 2016) by the Directive.

In 1996, the USA introduced a national ban on mercury oxide batteries, after which a number of states implemented a ban on all types of mercury containing button cell batteries including Connecticut and Maine, Rhode Island, Louisiana, Wisconsin and Illinois (Lowell Centre for Sustainable Products, 2011).

In 2011, China issued 'Clean Production Guidelines' for the battery sector, including recommendations that companies actively promote mercury-free button cells. Mercury content of zinc button cell batteries produced in China has been 0.005 mg per battery (0.25%) since 2013 (Lin et al., 2016). In 2017, the Chinese Ministry of Environmental Protection issued a mercury regulation that states that from 2021 mercury-containing batteries are prohibited, but includes the Minamata exemption for zinc-silver oxide and zinc air batteries containing less than 2% mercury (CIRS-REACH, 2017).

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Linear Fluorescent Lamps (LFLs)

Excerpt of the EU submission regarding halophosphate lamps

Summary Overview

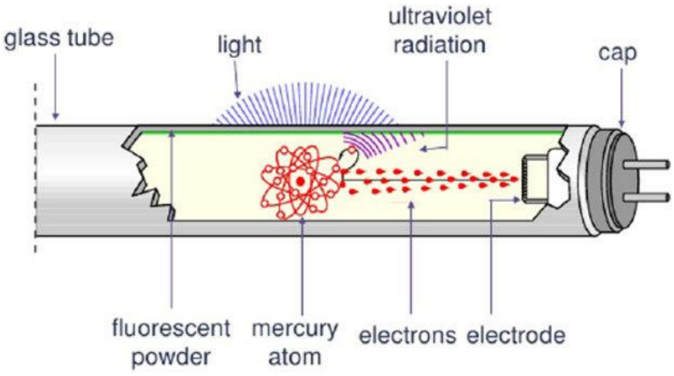
Linear Fluorescent Lamps (LFLs) are functionally identical to compact fluorescent lamps (CFLs). They are denoted as linear due to their shape and are used in a range of applications from domestic use to professional and industrial buildings. In 2016, LFLs were reported to be used in hundreds of millions of lighting installations (Gensch, et al., 2016).

Under the Minamata Convention, LFLs for general lighting purposes are restricted to 5 mg per lamp for triband phosphor lamps below 60 watts, with a phase-out date of 2020 for all lamps above the mercury limits. Halophosphate LFLs under 40 watts for general lighting purposes are restricted to 10 mg per lamp, with a phase-out date of 2020 for all lamps above these mercury limits. In Europe, halophosphate lamps have been phased out, although there is evidence they are still being produced and exported from the EU (COWI & ICF, 2017).

LEDs are the most suitable alternative to LFLs, with increasing levels of usage and development. With the exception of long-life LFLs, LEDs have environmental benefits of increased product lifetime to LFLs. In addition to substitution with non-mercury LEDs, halophoslate lamps can be replaced with triband phosphor LFLs, which have a lower mercury content.

Technical Description

Figure 2 – Linear Fluorescent Lamp (Sethurajan et al., 2019)



In LFLs, ultraviolet light is generated by driving an electric current through a tube, which contains argon and mercury. This then stimulates the phosphor coating to produce visible light. LFLs are categorised based on the type of phosphor used. Triband phosphor lamps utilise three combined materials with peaks at blue green and orange lights to create an overall white hue. They are a technical successor of halophosphate lamps.

Range of mercury content/consumption per unit product

The average mercury content of a halophosphate LFL is 8-10 mg (COWI&ICF, 2017)

Availability of non-mercury alternatives

Main alternatives: Tubular LED lamps based on Light emitting diodes (LEDs)

Halophosphate lamps can be replaced by triband phosphor lamps with a lower mercury content in cases where mercury-free alternatives are not yet feasible. Triband phosphor LFLs are subject to more stringent mercury concentration restrictions of 3-5mg depending on bulb size, while halophosphate lamps, now phased out in Europe, previously had limits set at 10mg.

Technical feasibility of mercury-free alternatives

Mercury levels in triband phosphor LFLs that can replace halophosphate LFLs are restricted to levels lower than that of Minamata. This indicates that there are no technical feasibility issues associated with reducing mercury content to these levels (see Examples of regional or national restrictions).

Economic feasibility of non-mercury alternatives

If fluorescent lamps would not be available and there would be no plug-in alternative, then the need to replace luminaires, control gears, or complete lighting systems etc. would result in high investment costs for businesses (Gensch, et al., 2016). The socio-economic impact report, published recently by the EU Commission, states that the related costs are substantial: 130-250 Billion € (European Commission, 2019). The sectors involved with the replacement (lamp producers, lighting installation contractors, etc.) would have benefits. However, from an overall economic perspective, premature replacement means a loss of capital and generation of 1-6 Million tonnes of waste (EU commission 2019). Therefore, a phase-out that replaces lamps at their natural end-of-life would avoid these impacts.

Health/Environmental Risks and benefits of non-mercury alternatives

The phase-out of halophosphate LFLs in the EU (in favour of tri-band phosphor lamps) resulted in a 53% decrease in mercury per lamp (Lighting Europe, 2015).

Examples of regional or national restrictions

Russia and the Eurasian Economic Union (Technical Rule EAEU 037/2016) as well as India (G.S.R338(E) E-Waste (Management) Rules, 2016) set lower limits on triband phosphor LFLs than required by Minamata. Limits set are the same as those prescribed by the EU RoHS Directive, as outlined above. There are a number of other countries that have also adopted RoHS-like restrictions setting the same limits on triband phosphor LFLs.

In Europe, placing on the market of halophosphate LFLs has been effectively prohibited since 2012 when the exemption under Directive 2011/65/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS Directive) expired.

Many nations have implemented RoHS-like legislation, which bans mercury-containing LFLs. In Russia and the Eurasian Economic Union (EAEU), Technical Rule EAEU 037/2016 on the restriction of the use of hazardous substances in electrical and radio electronic products are some such examples, and India, Singapore, Thailand, Ukraine, Jordan, Turkey, UAE, Saudi Arabia, Vietnam, South Korea and Japan are examples of other nations implementing RoHS-like legislation which bans mercury-containing halophosphates.

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Melt pressure transducers, transmitters and sensors using a capillary system

Summary overview

Melt pressure transducers, transmitters and sensors are used to control and measure melt pressure during extrusion, a process used to create objects of a fixed cross-sectional profile. Transducers maintain dimensional stability, to ensure that the products being extruded align to specific design requirements (Dynisco, 2016). They are used in processes for food and beverage packaging, piping, medical product manufacturing and recycling.

Melt pressure products entered the market in the 1950s, initially protected by a patent, which influenced their supply and market prices. Only recently have melt pressure transducers become more openly available on the market, produced by multiple manufacturers (Bagsik, 2019). However, industry data suggests that only 50% of extruders are fitted with melt pressure measuring equipment (Dynisco, 2016).

Currently, melt pressure products are not covered by the Minamata Convention.

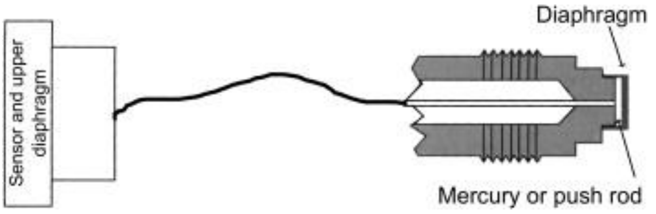
Sodium-potassium alloy and silicon oil are technically-viable alternatives to mercury, which are available internationally. Although neither of these substances operate with the same effect under high temperatures, silicon oil offers a suitable alternative to mercury in food, medical and pharmaceutical applications. Sodium-potassium alloy (NaK) offers a suitable alternative to mercury in plastics manufacturing. These alternatives are already commercially available, with mercury-free transducers manufactured in and exported from Europe, Asia and North America. They also have limited impact on health and the environment relative to mercury. The EU is the only jurisdiction to implement a limit on mercury content in melt pressure transducers (0,1 %). In the US, under the Federal Food, Drug, and Cosmetic Act, substances must be deemed Generally Regarded as Safe (GRAS) if they are used for specific food, medical or pharmaceutical applications. Mercury-free alternatives, silicon oil and NaK are GRAS.

Technical Description

Melt pressure transducers, transmitters and sensors enable accurate pressure measurements to be made, enhancing product quality and limiting damage to equipment (Dynisco, 2016). In melt pressure transducers, pressure transmission occurs in a closed capillary system filled with a transmission medium (i.e. mercury). The system is designed to transfer the pressure exerted on the diaphragm, pictured in Figure 3, to the transduction feature (i.e. upper diaphragm with the strain gauge). The strain gauge then converts the physical pressure into an electric signal (Gefran, 2017). In cases of excess pressure during extrusion, this process enables transducers to ensure safety, by switching off extruder driving systems when defined pressure limits have been exceeded (Bagsik, 2019).

In melt pressure transducers, mercury was traditionally used as the transmission medium, due to its capacity to transmit pressure readings at high temperatures. However, there is potential risk of mercury leakage during the manufacturing process.The EU through Directive 2011/65/EC (RoHS Directive) has required the use of inert mercury-free alternatives, such as silicon oil and sodium potassium alloy (NaK) (Industry Search, 2019). Despite the absence of regulation in other countries, many countries outside the EU also manufacture mercury-free alternatives, appealing to international customers.

Figure 3 – Melt pressure transducer cross-section (Wagner, et al., 2014)



Range of mercury content/consumption per unit product

The mercury content in melt pressure transducers varies depending on the model. Dynisco states that their pressure transducer 420/460 model contains 7mm^3 of mercury as the transmission medium. However, models released by other companies display a mercury filling volume of 30mm^3 – 40mm^3 (Gefran, 2014). In addition, Dynisco have provided another estimate of the mercury fill being approximately 0.003 cubic inches per transducer (~50mm^3) (Dynisco, 2016).

Availability of non-mercury alternatives

Main alternatives: sodium-potassium alloy, silicon oil

Although mercury devices are still on the market, a number of alternative transmission mediums exist. It is essential that alternatives meet certain requirements to ensure that they are suitable for extrusion processes. For example, products must be capable of withstanding high temperatures (up to 700°F) and high pressures (up to 30,000 psi), as well as being able to function in potentially corrosive settings (Dynisco, 2016). In addition, it is essential that the substances replacing mercury are capable of transferring pressure in a similar fashion.

The two key alternatives to the use of mercury as a transmission medium are silicon oil and sodium-potassium alloy (NaK). The latter is capable of transferring pressure with comparable quality to mercury (Gräff, 2015). However, Gräff (2015) states that silicon oil is not always an appropriate alternative to mercury, due to the disparity in its capacity to transfer pressure in a comparable manner to mercury. However, the silicon oil substitute is commonly used in food and medical applications, where lower temperatures are required.

Some companies have also developed sensors which do not require a transmission fluid. Instead, pressure is transferred to a silicon element through a diaphragm (Gefran, 2017).

Technical feasibility of mercury-free alternatives

Mercury-free alternatives are technically feasible and already commercially available. Through the use of advanced production processes, melt pressure products can be produced without the mercury filling and still provide an accurate reading (Müller, 2019). Sodium-potassium alloy is an alternative used by multiple manufacturers, due to its ability to mimic the characteristics of mercury. Sodium-potassium alloy alternatives can withstand temperatures of 400°C and according to Gräff (2015, p. 4), their mercury-free alterative is '100% market-compatible with all common manufacturers'. Due to its capacity to function under high temperatures, NaK is an ideal alternative for the plastics manufacturing industry (Industry Search, 2019).

In addition, the majority of manufacturers also produce melt pressure transducers which use silicon oil as an alternative transmission medium. Although these products have limits on the temperature which they can withstand, their use is ideal in food, medical and pharmaceutical applications.

Economic feasibility of non-mercury alternatives

Due to increasing pressure from the US Food and Drug Administration (FDA) and the EU Restriction of Hazardous Substances (RoHS) Directive, several manufacturers already produce mercury-free alternatives (Gräff, 2015). As these alternatives are readily available on the market, manufacturers will not face the additional cost of having to invest in research and development to create mercury-free alternatives (Gefran, 2010). All European manufacturers comply with the RoHS Directive and manufacturers based in China already produce mercury-free alternatives.

Health/Environmental Risks and benefits of non-mercury alternatives

The primary risk of mercury transducers, transmitters and sensors is the exposure to mercury during manufacturing processes. In addition, the use of mercury is particularly concerning in processes concerning food packaging, due to the direct link to human consumption (Dynisco, 2016). The silicon oil and NaK alternatives are considered safe by the US FDA, with neither of these alternatives containing hazardous substances. However, NaK is known to react strongly with water to produce highly-flammable hydrogen. NaK also reacts with CO_2 to produce methane (Chemwatch, 2009). However, the significance of this reactivity depends on the volume of NaK present. With the relatively low volume of transmission medium fill ($7mm^3$-$50mm^3$) for melt pressure transducers, the effect is likely to be minimal.

Examples of regional or national restrictions

In Europe, the RoHS Directive is the only regulation which governs the use of mercury in melt pressure transducers, transmitters and sensors. Although transducers using mercury are still available in the EU, all EU manufacturers fully comply with the RoHS.

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Devices using mercury to measure volume change of part of a body (strain gauge to be used with plethysmographs)

Summary Overview

Mercury is used in strain gauge plethysmography to measure blood flow and blood pressure. This is used to diagnose arteriosclerosis, a disease affecting arterial walls and resulting in reduced blood circulation.

Mercury usage in plethysmography is low in comparison to some other medical applications such as sphygmomanometers. Mercury-containing strain gauges are now rare. It is estimated that, for example, in Sweden only 200 strain gauges are used per year, and one major global producer of strain gauges consumed 946 grams of mercury in 2004 (ECHA, 2011). It is estimated that 0.014 t Hg was placed on the EU market in 2010.

Currently, strain gauges along with other measuring devices have been exempted from Annex A of the Minamata Convention in the absence of a feasible mercury-free alternative.

It is now the case that feasible mercury-free alternatives are available for all applications of strain gauges with the exception of certain research applications where reference gathered over decades using mercury-containing strain gauges is relied upon. The most prominent alternative is indium-gallium strain gauges, which are compatible with expensive wider electrical equipment that mercury strain gauges function with.

Technical Description

The mercury strain gauge consists of a fine rubber tube filled with mercury which is placed around the body in the area where blood pressure is to be measured.

Range of mercury content/ consumption per unit product

1.25g elemental mercury per strain gauge (ECHA, 2011).

Availability of non-mercury alternatives

Main alternatives: **Strain gauges with indium-gallium, photo cell/laser-Doppler techniques**

There are technically and economically feasible mercury-free alternatives available (ECHA, 2011). Indium-gallium strain gauges are the main alternative to mercury strain gauges.

Photo cell and Doppler techniques are typically used for measurements in fingers and toes, for which indium-gallium gauges are not suitable (COWI, 2008). The photo cell technique registers changes in tissue colour at different pressures. The Doppler technique measures the velocity of red blood cells to determine blood flow. Ultrasonic devices are used for larger applications, and laser devices are used for measuring smaller volumes.

The world leading manufacturer is D.E. Hokanson, Inc., in the USA where both mercury and indium-gallium strain gauges are produced for export (COWI & ICF, 2017). No mercury strain gauges have been sold in Europe since 2014 and according to NEWMOA, mercury-filled strain gauges are rarely used (NEWMOA, 2016).

Technical feasibility of mercury-free alternatives

According to COWI (2008) photo cell and laser-Doppler technique or gallium/indium strain gauges are capable of identifying a variety of diagnosis offered by mercury-containing equipment. Indium-gallium strain gauges can be used with existing plethysmographs for the same application as mercury strain gauges (ECHA, 2011).

In the area of research however, there is no alternative to mercury-containing plethysmographs where absolute blood flow in arms and legs is measured. This is due to the body of research and reference materials built up over decades of use. Indium-gallium gauges have a higher freezing point and lower resistance and so cannot be used for some applications, specifically Raynaud's disease or small digit tests, or cold water immersion studies (Hokanson, 2019) (COWI & ICF, 2017).

Economic feasibility of non-mercury alternatives

The driving factor for ongoing use of mercury-containing strain gauges is economic as mercury-containing tubes are inexpensive. However they are designed to work with complex electronic equipment costing in excess of EUR 20,000 and with life spans of 10-15 years. As such, clinics are hesitant to replace the complete system other than in the case of technical failure (COWI, 2008). It is possible to retrofit indium-gallium gauges with Hokanson plethysmographs with a few exceptions (COWI & ICF, 2017).

The prices of indium-gallium strain gauges are approximately 40% higher than mercury gauges according to a major supplier (COWI & ICF, 2017). However, ECHA (2011) judged that indium-gallium gauges are economically feasible and estimated the cost of compliance in the EU for restrictions on mercury-containing strain gauges at EUR 2.6 million in the period of 2015-2034. A major producer of mercury strain gauge claimed that indium-gallium is also more difficult to handle during production, requiring more assembly time.

Health/Environmental Risks and benefits of non-mercury alternatives

Gallium is reported to cause skin, eye and respiratory irritation and may cause bone marrow abnormalities with damage to blood forming tissues (ECHA, 2011). There is less information on the toxicological properties of indium. However, due to the clear evidence on the hazardous properties and risk of mercury the usage of indium-gallium strain agues is considered to reduce overall risk to environment and health.

Examples of regional or national restrictions

The export, import and manufacturing of mercury-containing strain gauges to be used with plethysmographs is prohibited in the EU from 31 December 2020 by Regulation (EU) 2017/852 on Mercury.

There are some exemptions to the restriction, notably:

Non-electronic measuring devices installed in large-scale equipment or those used for high precision measurement where no suitable mercury-free alternative is available;

Measuring devices more than 50 years old on 3 October 2007

Measuring devices which are to be displayed in public exhibitions for cultural and historical purposes

Strain gauges to be used with plethysmographs intended for industrial and professional uses were restricted from being placed on the market from 10 April 2014. The restriction also applies to devices which are placed on the market empty if intended to be filled with mercury.

In the USA, mercury strain-gauges are prohibited from sale in the states of Maine, Louisiana, Connecticut and Rhode Island.

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Mercury Vacuum Pump

Summary Overview

A vacuum pump is a device that removes gas from a sealed space to produce a partial vacuum.

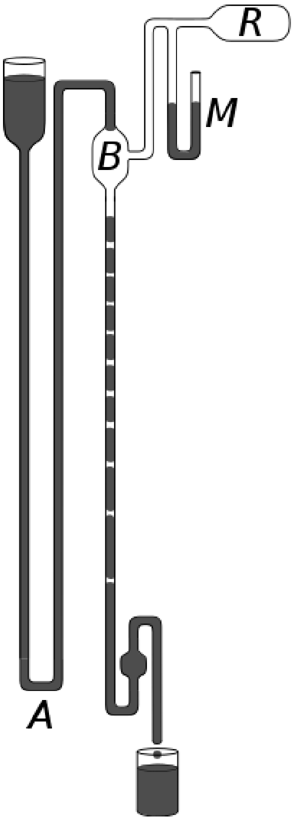
It was reported in 2008 that mercury vacuum pumps were still in operation but not sold (COWI, 2008).

Mercury-free alternatives exist and are widely in use. Positive displacement pumps are used to create low vacuums and momentum transfer pumps are used to create high vacuums (Atta & Hablanian, 1991).

Technical Description

The Sprengel pump is a form of vacuum pump that uses drops of mercury falling through a small-bore capillary tube in order to trap air. Mercury is contained in the reservoir and flows into bulb B, where it forms drops which fall leaving air entrapped in bulb B. Mercury is collected and restored to the left reservoir. In this way almost all air can be removed from bulb B and by extension vessel R.

Figure 4 – Mercury-containing vacuum pump (Beach & Chandler, 1914)



Range of mercury content/ consumption per unit product

3.4 kg mercury (COWI, 2008).

Availability of non-mercury alternatives

Main alternatives: **Positive displacement pumps, momentum transfer pump**

Positive displacement pumps use a mechanism to expand a cavity, causing gases to flow in from the chamber that is to be extracted, after which the chamber is sealed and gases are exhausted. This can be repeated indefinitely to create an increasing vacuum. Momentum transfer pumps (molecular pumps) use dense fluid or high speed blades to knock gas molecules out of the chamber.

Technical feasibility of mercury-free alternatives

There are technically feasible alternatives to mercury pumps available and widely used.

Positive displacement pumps are most effective for the creation of low vacuums, while momentum transfer pumps are used to create high vacuums.

The KALPUREX process for removing helium from exhaust gases in a planned fusion demonstration power plant (DEMO, potential successor of the ITER) employs two mercury vacuum pumps. Mercury is used as a working fluid because of its very good compatibility with radioactive tritium (Giegerich & Day, 2014). The concept was chosen as the most suitable option on the basis of a Strength, Weakness, Opportunity and Threat (SWOT) analysis (Giegerich & Day, 2014).

Economic feasibility of non-mercury alternatives

There are economically feasible alternatives to mercury using vacuum pumps, evidenced by the fact that no mercury using pumps were sold in the EU since before 2008 (COWI, 2008).

Health/Environmental Risks and benefits of non-mercury alternatives

There are no known environmental downsides to mercury free alternatives to mercury containing vacuum pumps (COWI, 2008).

Examples of regional or national restrictions

According to Directive 2011/65/EU, the RoHS Directive, Member States must ensure that all electrical and electronic equipment placed on the market shall not contain mercury beyond a maximum concentration of 0.1% by weight in homogenous material. There are however exemptions for medical devices and monitoring and control instruments, as well as research applications.

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Tensiometer

Summary Overview

Tensiometers measure the surface tension of liquids and are used in applications such as the determination of soil moisture tension, or for measuring tension in wire, fibres and beams (Committee for Risk Assessment and Committee for Socio-economic Analysis, 2011).

Mercury containing tensiometers are used for measuring the negative pressure of soil water (soil water potential). The potentially mercury-containing component of a tensiometer is a manometer, which is an instrument for measuring pressure.

In the Minamata Convention, there is no reference to tensiometers among measuring devices listed in Annex A.

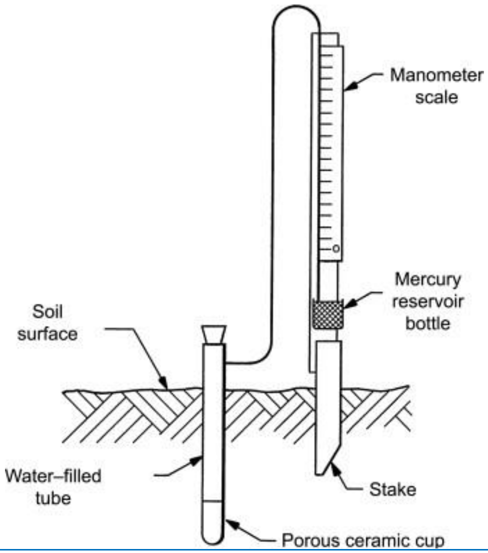
Alternatives exist for mercury containing tensiometers for all applications, and there are no significant health risks or technical feasibility restrictions associated with them. Mercury-free alternatives are usually cheaper than mercury manometers, with the exception of electronic manometers which are significantly more expensive, however provide additional functionality (Committee for Risk Assessment and Committee for Socio-economic Analysis, 2011).

Technical Description

The mercury containing component of a tensiometer is a manometer. Manometers consist of a U-shaped glass or plastic tube that contains a liquid (water, alcohol or mercury) such that the surface of liquid in one end of the U moves proportionately with the liquid in the other end. When pressure is applied, the liquid level in one arm rises and the other drops, enabling a reading to be taken.

A mercury tensiometer contains a capillary tubing linked to the mercury manometer. The capillary tubing is attached to porous cups which are inserted into the soil. Mercury manometers/tensiometers are shipped without mercury and filled with mercury by the user (Committee for Risk Assessment and Committee for Socio-economic Analysis, 2011). There may also be risk of release from breakage, but the highest risk of release is in the waste phase.

Figure 5 – Mercury tensiometer (Kirkham, 2005)



Range of mercury content/ consumption per unit product

70-140 g mercury per manometer.

There was roughly 4 t of mercury estimated to have been accumulated in manometers in the EU in 2011, and 0.04-0.4 t Hg per year placed on the market (ECHA, 2010).

Availability of non-mercury alternatives

Main alternatives: Liquid filled in tube manometers, mechanical alternatives/elastic pressure sensors, electric manometers, other devices

The mercury manometers used in tensiometers are usually replaced by elastic pressure sensors or electric manometers.

Elastic pressure sensors contain elements that are deformed or stretched when pressure is applied to them. The level of displacement is recorded. Common elastic pressure sensors include Bourdon tube manometers and pressure gauges with diaphragms. Bourdon tube manometers use a C-shape tube sealed at one end. Pressure is applied at the open end, causing pressure to be transferred to a gear and indicating needle. Pressure gauges with diaphragms can be mechanical or electric and contain a flexible two-sided membrane, with one side enclosed in a capsule containing a fluid such as air at a known pressure. Pressure is applied to the other side and the bending in the membrane is recorded.

Electric manometers use pressure transducers connected to an analogue to digital converter to transform the sensor response to an electrical signal.

Liquid filled tube manometers can contain liquids other than mercury e.g. water or alcohol.

There are also alternative methods to manometers to measure soil moisture. The gravimetric method determines the water content of soil by weighing it, drying it and measuring the difference in weight.

Technical feasibility of mercury-free alternatives

According to a European producer of mercury manometers, there was no application where mercury manometers cannot be replaced by other devices (Committee for Risk Assessment and Committee for Socio-economic Analysis, 2011).

Bourdon tube manometers are more robust than mercury manometers and suitable for measuring higher pressures (Committee for Risk Assessment and Committee for Socio-economic Analysis, 2011).

Pressure gauges with diaphragm are equally accurate as traditional mercury manometers.

Electronic manometers are widely used and have advantages compared to mercury manometers such as requiring less maintenance and less expertise to use.

The gravimetric method is time consuming and labour-intensive, however is accurate and low-cost.

Economic feasibility of non-mercury alternatives

Alternatives to mercury manometers are usually cheaper (Committee for Risk Assessment and Committee for Socio-economic Analysis, 2011). Mercury manometers costed around €108 in 2006. Prices for bourdon tube manometers ranged from €54 to €122, and prices for pressure gauges with diaphragms ranged from €30 to €76.

Electric manometers were the exception to this, costing 3-4 times more than mercury manometers for similar pressure ranges (Committee for Risk Assessment and Committee for Socio-economic Analysis, 2011).

Health/Environmental Risks and benefits of non-mercury alternatives

Mercury manometers/tensiometers are shipped without mercury and filled with mercury by the user (Committee for Risk Assessment and Committee for Socio-economic Analysis, 2011). There may also be risk of release from breakage, but the highest risk of release is in the waste phase.

There is no risk associated with the use of alternative liquids in manometers and the risks associated with electronic alternatives are not significant (Committee for Risk Assessment and Committee for Socio-economic Analysis, 2011).

Examples of regional or national restrictions

In Europe, tensiometers containing mercury intended for industrial and professional uses have been prohibited from being placed on the market from April 2014 according to the Regulation 1907/2007 on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH). This restriction also applies to tensiometers supplied to the market empty with the intention of being filled with mercury. Electronic manometers also fall under restriction of the RoHS Directive which prohibits maximum mercury concentration over 0.1% in electrical and electronic equipment placed on the market.

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Production of polyurethane

Summary Overview

Polyurethane is a polymer comprised of a series of organic units, which are linked by urethane (ChemEurope, 2019). Polyurethane is available in a number of forms and densities, and is used in bedding, thermal insulation and in floorings (ibid). However, the primary use of mercury catalysts is in the production of polyurethane coatings, adhesives, sealants and elastomers (referred to as CASE applications). According to a major catalyst supplier, elastomers comprise approximately 90% of the mercury catalyst market (Norwegian Climate and Policy Agency, 2010).

Mercury catalysts are used for the manufacture of a number of polyurethane elastomers. In particular, mercury is used in the production of polyurethane elastomers that are cast into complex shapes, or sprayed onto a surface as insulation (i.e. corrosion protection). It is estimated that polyurethane elastomer castings and coatings comprise at least 90% of the total applications of polyurethane elastomers (COWI, 2008).

Under Annex B Part II of the Minamata Convention, a series of measures are outlined, to reduce the use of mercury catalysts and conduct research into the use of mercury-free alternatives. However, there is no prohibition of the use of mercury-containing catalysts in polyurethane production.

It is estimated that globally, mercury catalysts account for less than 5% of polyurethane production and that in 2008, 300-350 tonnes of mercury catalyst were used in the global production of polyurethane elastomers (COWI, 2008).

Bismuth and zinc carboxylates, and tertiary amines, are technically an economically viable alternatives to the use of mercury catalysts, which are already in use internationally. However, both of these alternatives require additional adjustments, to ensure that they reflect the characteristics of mercury. Relative to mercury, these alternatives have limited impact on health and the environment.

Use of mercury compounds in the production of polyurethane is completely prohibited within the EU since 1 January 2018.

Technical Description

In the formation of polyurethane, mercury catalysts are used in the reaction between a polyol and an isocyanate component. During the reaction, mercury catalysts enable a long induction period, followed by a rapid reaction for curing the product. The catalyst tends to be present in the polyol component. The mercury catalyst is integrated into the polymer and remains present in the final polyurethane product (Norwegian Climate and Policy Agency, 2010).

Organic mercury compounds provide the desired characteristics of catalysts for the majority of polyurethane applications. Mercury catalysts offer an initial induction period (pot life) where the reaction between polyurethane and the catalyst is slow or does not occur. This enables sufficient time for the mixture to be cast, following the addition of the catalyst. This provides the manufacturer with greater oversight of the polyurethane application (ibid).

Secondly, mercury catalysts engender a rapid reaction following the initial induction period, which enables the product to reach its final form and adopt the desired properties in relation to shape, density and malleability. In addition to allowing the product to take on its desired characteristics, the rapid reaction enables the production process to occur in a timely manner (COWI, 2008).

Range of mercury content/consumption per unit product

The mercury catalyst is typically added to the polyurethane systems at concentration levels of 0.2 % – 1 %. However, this depends on the specifications of the end product and the other components present (Norwegian Climate and Policy Agency, 2010).

Availability of non-mercury alternatives

Main alternatives: bismuth and zinc carboxylates, tertiary amines, organotin compounds

According to the European trade association for producers of diisocyanates and polyols (ISOPA) and the European Aliphatic Isocyanates Producers Association (ALIPA), using the polyurethane systems currently in place with a non-mercury catalyst does not enable the same level of performance as using these systems with mercury catalysts. Therefore, designing alternative polyurethane systems, which use alternative polyol or isocyanate components, with a non-mercury catalyst is preferable (ISOPA, 2009).

There is also the potential for the development of systems based on other polymers to replace mercury polyurethane systems. However, due to the wide range of applications required, finding suitable polymers is expected to be a complex task (Norwegian Climate and Policy Agency, 2010).

In contrast, non-mercury catalysts are available for the majority of applications, and are used as catalysts in over 95% of polyurethane elastomer applications (ChemEurope, 2019). Several non-mercury catalysts with distinct properties have been developed for polyurethane elastomers, as a 'one-size-fits-all' approach is not applicable in the case of replacing mercury catalysts for multiple applications (Norwegian Climate and Policy Agency, 2010).

Bismuth and zinc carboxylates have been used as alternatives to mercury catalysts since the 1980s. Bismuth and zirconium systems are also available on the market as mercury catalyst alternatives. In addition, tertiary amines and organotin compounds have also been used as substitutes to mercury catalysts in a range of applications (ibid).

Technical feasibility of mercury-free alternatives

Bismuth and zinc carboxylates have been adopted for many decades, and are designed to replace the use of mercury, lead and tin catalysts. These catalysts have displayed commercial success, despite their shortcomings relative to mercury (ChemEurope, 2019). For example, bismuth compounds require manufacturers to make adjustments to account for the differing reactivity of bismuth relative to mercury. In addition, bismuth compounds result in greater viscosity relative to mercury, as the reaction occurs. This produces polymers with different consistencies, relative to the polymers which a mercury catalyst produces. However, the use of a bismuth neodecanoate and zinc neodecanoate mixture enables users to adjust the concentration of the two metals, and hence adjust the behaviour of the gel (Norwegian Climate and Policy Agency, 2010).

Bismuth and zirconium systems are also used as mercury catalysts for the production of polyurethane elastomers. However, their sensitivity to moisture renders it difficult for these systems to act as catalysts in the presence of water.

Organotin compounds are not considered direct replacements for mercury catalysts, although they have been used to replace mercury in some applications. For example, organotin compounds are used in polyurethane systems to produce foams, coatings, adhesive and elastomers. However, these compounds cannot replace the use of mercury in all applications (ibid).

Tertiary amines have also been used as catalysts, producing a long pot life, followed by rapid reaction rate, two characteristics necessary for a suitable alternative to mercury catalysts. These can be used in adhesive, sealant and elastomer applications. However, the water content of polyurethane systems needs to be controlled, to ensure that foaming issues do not occur (ibid).

The aforementioned catalysts are all currently available on the market.

Economic feasibility of non-mercury alternatives

The cost of mercury-free catalysts is expected to be comparable with the cost of mercury catalysts. The cost of mercury catalysts has increased, and therefore, the price of alternatives is not expected to be a barrier (COWI, 2008). Broader research and development is expected to engender higher costs, as sourcing substitutes for a relatively simple polyurethane system is expected to require two months of research from one researcher (equivalent to €10,000 - €15,000). However, it is not expected that additional machinery costs will be incurred, as the same machinery can be used for both mercury and non-mercury systems (Norwegian Climate and Policy Agency, 2010).

Only non-mercury alternatives are used for manufacturing of polyurethane in the EU.

Health/Environmental Risks and benefits of non-mercury alternatives

All of the mercury catalyst used in polyurethane production remains in the product. This represents 0.2 to 1% of the polyurethane in products and several hundred tonnes of mercury catalyst globally. In most cases, polyurethane waste is subject to unspecific waste disposal and therefore represents significant risks of emissions and releases to the environment.

There are in some cases health concerns associated with non-mercury alternatives. For example, zinc neodecanoate is reported to cause potential irritation to skin and eyes. In addition, there are some adverse effects associated with ingestion of zinc and bismuth. However, bismuth and zirconium are not considered to be skin irritants (ibid).

One of the primary environmental concerns associated with the use of mercury in polyurethane elastomers is the contamination of municipal waste streams and waste incinerators. This contamination is likely to contribute towards atmospheric mercury releases (COWI, 2008), as well as being toxic to aquatic organisms (Norwegian Climate and Policy Agency, 2010). In contrast, mercury-free alternatives have minimal impact on the toxicity of aquatic organisms.

In relation to both health and environmental impacts, mercury-free alternatives have minimal impact relative to mercury.

Examples of regional or national restrictions

In the EU, Regulation (EC) No 2017/852 prohibits manufacturing processes in which mercury or mercury compounds are used as a catalyst from 1 January 2018.

Before Regulation (EC) No 2017/852 came into effect, national legislation in Norway exceeded EU-level restriction, prohibiting the production, use and sale of mercury compounds, which include polyurethane elastomers using mercury (COWI, 2008).

In 2017, Japan implemented the Mercury Pollution Prevention Act, which adopts measures in line with the Minamata Convention, as well as additional stricter measures. In the National Implementation plan, Japan states that ‘no manufacturing process using mercury catalysts has been found in the polyurethane production processes’ (Mercury Convention, 2017, p. 16).

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II. EU SUBMISSION ON DENTAL AMALGAM

The EU is pleased to share with the Minamata Convention Secretariat a study it has commissioned to gather information on the feasibility of phasing out dental amalgam. The final report[2] of the study provides the basis for the assessment of the technical and economic feasibility of a phase out of dental amalgam and documents its environmental implications.

The study collected information on the use of dental amalgam and mercury-free alternatives, implications for the organisation of health services in EU Member States and dental amalgam phase down plans established by Member States under Article 10(3) of Regulation 2017/852 on mercury[3].

Extensive data collection included the review of scientific articles and reports, EU-wide data collection through an online survey and interviews. A workshop gathering experts from EU Member States and stakeholders (dentistry organisations, NGOs) organised in January 2020 validated the preliminary findings of the study, and provided additional input to improve the modelling and conclusions.

Whilst the whole report may be of relevance to the Minamata intersessional process on dental amalgam, a short summary is provided below.

Trends of the use of dental amalgam

Dental amalgam has been used as a restorative material for centuries, in order to fill cavities caused by tooth decay and to repair tooth surfaces. It is an alloy of mercury and other metals (e.g. silver, tin, copper).

Dental amalgam is the largest remaining use of mercury in the EU. The estimated annual demand for dental amalgam (EU28) amounted to 27-58 t of mercury in 2018. This represents a significant decrease, by approximately 43%, compared to the previous estimate 55-95 t of mercury a year in 2010[4]. It is estimated that in 2018, approximately 372 million dental restorations were carried out in EU28. Of these, only between 10% and 19% would have used dental amalgam. This share however varies significantly among Member States.

Increasing consumer awareness of the environmental and associated indirect health effects of dental amalgam, as well as more desirable aesthetics of alternative materials, appear to be main drivers for the decreasing use of dental amalgam.

Dental amalgam use is expected to decrease by approximately 70% between 2018 and 2030. The use in 2030 would be approximately 8-17 t of mercury.

Economic feasibility

The progressive substitution of dental amalgam with mercury-free materials (such as e.g. composite resins, ceramics, and glass ionomer cements) is already taking place. The overwhelming majority of EU manufacturers (95%) produce mercury-free materials, which represent a major share of the market.

The difference between the prices of dental restorations per type of material is relatively small due to improvements in mercury-free restoration techniques. Furthermore, the price difference between dental amalgam and mercury-free materials has decreased.

Technical feasibility

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[2] Study on assessment of the feasibility of phasing out dental amalgam.

[3] Regulation (EU) 2017/852 of the European Parliament and of the Council of 17 May 2017 on mercury, and repealing Regulation (EC) No 1102/2008 (OJ L 137, 24.05.2017).

[4] Bio Intelligence Service (2012), Study on the potential for reducing mercury pollution from dental amalgam and batteries.

Given the high use of mercury-free materials across the EU, it can be assumed that the vast majority of dental facilities in the EU already have the equipment required for mercury-free restorations and that most, if not all dentists, master the necessary techniques.

Evidence has shown that mercury-free materials exhibit satisfactory mechanical properties, with a lower cavity preparation requirement for composites[5] as well as better aesthetics[6]. Four main factors influence the longevity of a filling: the material, the method of restoration, the dentist's skills and the patient's dental hygiene. Mercury free materials are nowadays of good quality, effective restoration methods are widely available and dental schools are increasingly teaching the necessary skills. Dental hygiene should continue improving thanks to public health communication. Hence, the longevity of restorations should further improve.

Dentist representative organisations have however expressed concerns regarding a lack of available information on mercury-free materials, as well as the safety profile and biocompatibility of certain materials, some of which contain Bisphenol A (BPA) and nano-sized particles (particles with a size from 1 to 100 nm). Due to a lack of comprehensive scientific evidence, the potential direct and indirect impacts of mercury-free materials remain uncertain. Available scientific reviews concluded that release of BPA from certain dental materials was associated with only negligible health risks[7] and exposure to BPA is within the Tolerable Daily Intake[8]. However, the 2015 BPA risk assessment by the European Food Safety Authority, which reduced the Tolerable Daily Intake for BPA from 50 to 4 µg/kg bw/day, is currently under review.

Environmental aspects

Dental amalgam causes significant emissions of mercury to air, water and soil.

Emissions to air were estimated[9] to be 19 t over the dental amalgam life cycle (2012, EU27[10]). Emissions to water[11] by dental clinics were estimated to be 3 t (2010, EU27), which will reduce as the Regulation mandates dental practices to be equipped with high level retention dental amalgam separators.

The presence of mercury in wastewaters is problematic for the residues (sludge) from urban wastewater treatment plants. Depending on the type of wastewater treatment, mercury may end up in sludge from wastewater plants. Mercury emissions from dental amalgam to soil, estimated at 8 t (2010, EU27), are primarily due to the spreading on land of such sludge.

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[9] BIO Intelligence Service (2012), Study on the potential for reducing mercury pollution from dental amalgam and batteries.

[10] Does not include Croatia that joined the EU in 2013.

[11] Mercury passes from the dental clinics through waste water treatment plants. Treatment technologies employed reach different removal efficiencies, and mercury, as other heavy metals tend not degrade but to adsorb in sludge. (Pistocchi et al. 2019; Hargraeves et al. 2016).