

Mercury recovery in situ of four different dental amalgam separators

Lars D. Hylander^{a,*}, Anders Lindvall^b, Roland Uhrberg^c,
Lars Gahnberg^d, Ulf Lindh^b

^a Department of Earth Sciences, Air and Water Science, Uppsala University, Villavägen 16, S-752 36 Uppsala, Sweden

^b Foundation for Metal Biology, Öfre Slottsgatan 16A, S-753 12 Uppsala, Sweden

^c MeAna Konsult, Ekeby 10 A7, S-752 63 Uppsala, Sweden

^d Public Dental Health Service, County of Uppsala, Ulleråkersvägen 21, S-750 17 Uppsala, Sweden

Received 23 March 2005; received in revised form 5 July 2005; accepted 8 July 2005

Available online 21 September 2005

Abstract

Amalgam separators are used to physically remove dental amalgam from waste water in dental clinics. They are thereby supposed to reduce mercury (Hg) emissions to the municipal waste water system to acceptable levels. We here present results from a comparative study in situ of three amalgam separators available on the market, all with a claimed efficiency of 99% according to Danish and ISO protocols, and using sedimentation as the principle of separation. We also present corresponding data for an investigational prototype of an improved separator.

The obtained efficiency of the three commercial separators is far below what is stated by the manufacturer and by authorities assumed to be the efficiency in clinical conditions. They reduced Hg emissions by 79 – 91%, leaving an average Hg content in outgoing waste water of 1.5 mg L^{-1} . However, the prototype separator participating in this study retained 99.9% of the waste water Hg emissions, leaving an average Hg content in outgoing waste water of 0.004 mg L^{-1} . Physical restrictions prohibit sedimentary type separators to recover the Hg fractions causing the largest damages in wastewater treatment plants. This fraction is not considered in the ISO protocol for testing amalgam separators, which therefore needs to be revised.

Abolishing the use of dental amalgam and cleaning the tubing systems is the most efficient long-term solution to reduce Hg emissions from dental clinics. Until then, Hg emissions originating from placing, polishing or removing existing amalgam fillings, should be counteracted by the use of low-emission amalgam separators, already on the market or presently being developed for use alone or together with sedimentary type amalgam separators.

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Keywords: Amalgam separator device; Mercury pollution; Mercury traps; Prevention; Recovery efficiency

* Corresponding author. Tel.: +46 18 471 22 65; fax: +46 18 55 11 24.

E-mail addresses: Lars.Hylander@hyd.uu.se (L.D. Hylander), Anders.Lindvall@spray.se (A. Lindvall).

1. Introduction

The Commission of the European Communities has acknowledged that dental amalgam will become the major source of intentionally used Hg in EU since the chlor-alkali industry is now phasing out mercury cells (EU, 2005). Dental amalgam contains about 50% Hg by weight and is used for filling dental cavities, resulting in an annual Hg consumption of about 70 tonnes Hg in the EU (15 states; Maxson, 2004). It is therefore appropriate to re-examine the scope for substitution, especially as the coverage of dental amalgam, under the medical devices directive, limits the scope for restrictive national measures (EU, 2005). Further, the Commission realizes that dental amalgam is a significant source of mercury pollution, and will in 2005 review Member States' implementation of Community requirements on the treatment of dental amalgam waste material (EU, 2005).

There is an estimate of 1 300 – 2 200 tons of Hg placed in dental fillings in the population of EU (15 states) and EFTA states (Hylander, 2002; EU, 2004). This Hg is at risk of entering air, soil and water due to abrasion from everyday chewing, waste material generated in dental clinics, and vapor emissions from crematoriums (Hylander and Meili, 2005; EU, 2004).

Amalgam separators, also called ASD (amalgam separator devices), mercury traps, or MRU (mercury recovery unit), have been introduced to minimize the quantities of mercury (Hg) emitted via waste water from dental clinics. These emissions will continue also after a transition to Hg free dental materials, due to repair, polishing and removal of existing amalgam fillings, and because of the emission of particles from sediments already deposited in tubing systems.

This contamination is expected to be dealt with in amendments to the water directive from EU as a part of the strategies towards a sustainable management of water resources (EC, 2001). Since 1985, amalgam separators have been installed in all dental clinics in Sweden, in accordance with an agreement between the Swedish Environmental Protection Agency, the Swedish Dental Association, the Federation of Swedish County Councils (FCC), and the Swedish Dental Trade Association (Statens Naturvårdsverk, 1979). A number of other European countries have also installed amalgam separators. They are presently used in most dental clinics in Austria, Denmark, Fin-

land, France, Germany, the Netherlands, Norway, and Switzerland (Christensen et al., 2004; FINLEX, 1997; OSPAR, 1997; Sosial- og helsedirektoratet, 2002). They are also required in Canada and in two US states (Maine and Connecticut), and by many local governments (e.g. The City of San Francisco and King County, Washington), while the use of amalgam separators are under consideration in other locations—Massachusetts, Minnesota, Montana, New Hampshire, New York, and Vermont (Reindl, 2005; pers. comm. Charles G. Brown, Consumers for dental choice, Jan. 2005).

The amalgam separator is placed in the suction (vacuum) system designed as either a dry or a wet type system. A wet system is characterized by the transportation of air and fluid from the dental unit (dental chair) to a central tank, where the air is separated from fluid. The fluid then enters an amalgam separator before it is passed on. In the so-called dry system, air and liquid is separated within the dental unit, and the amalgam separator is, generally, integrated within the unit.

Amalgam separators based on sedimentation, sometimes combined with a filter, dominate the market and are used in wet suction systems and occasionally also in dry systems. The waste water enters at one end and passes out at the other, and high density particles form sediment on the bottom. Sometimes two separators are mounted in series to increase the efficiency of separation. They do not contain any moving parts, which can cause problems. However, they are sensitive to abrupt flow peaks, which may flush amalgam sediment from the separator into the waste water pipes. Therefore they are generally equipped with a buffer (equalizing) tank downstream the amalgam separator to accommodate the waste water during a working cycle. Thereby the waste water can continuously pass the separator in pace with its production at the dental chair/s, while the release from the buffer tank when vacuum is released, causing a high flow rate, does not pass the separator. Further details on relevant designs of suction systems are given in Hylander et al. (in press).

The nominal efficiency of Hg removal from dental effluent was for some earlier models claimed to be 95% according to the Danish and Swedish protocols, but for models presently sold it is claimed to be as high as 99% or more according to the Danish or ISO

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