Dental Separator Study

Purpose
To determine the effectiveness of Amalgam Separators used to remove Mercury from the environment.

Amalgam Separators were designed to remove amalgam from the environment and are effectively removing 99+% of the solid metal from the dental discharge. After an exhaustive study of dental office discharges at the street location (manholes), it became clear that very large quantities of mercury were still entering the environment (10 to 1600000 ng/L). These numbers indicated that there was still an issue with mercury entering the environment. In none of the separator studies performed by various states, academic and/or private companies is dissolved mercury examined. The ISO 11143 standard only examines physical separation. This type of separation assumes that the remaining 1-5% of amalgam (equal to 3400 pounds of dissolved mercury annually) discharging into the environment is not an issue or a hazard. The data below may change that assumption.

Purves Environmental Inc. sampled several separators in various offices only to find that the level of total mercury discharging to the environment at the separators ranged from 65,600 ng/L to 17,500,000 ng/L. This data is not addressed by the Dental community or the separator manufacturers. Separator designs were first established under the false assumption that the mercury remaining in the discharge was not an issue and that it remained in a solid form that could easily be removed at a waste water treatment plant. The other assumption that is now applied is; the discharge flow from a dental office is so small that the high levels of mercury would be diluted when mixed with the influents from other discharges. The premise of this study and research was to accumulate data from operating systems and determine the best separation systems now employed to handle the mercury discharge. It is focused primarily on dissolved mercury.

Dissolved mercury is far more dangerous to humans and wildlife than mercury which is bound to solid particles. Dissolved mercury is more readily absorbed by humans and aquatic organisms than mercury bound to solids. Dissolved mercury is converted into Methyl Mercury in the body through normal biological processes. The Methyl Mercury formed is far more dangerous than elemental mercury to humans because it attacks the Central Nervous system and causes a Parkinson's like syndrome. In aquatic life (primarily fish) this process occurs in the same manner. Since fish is a food source for humans, the Methyl Mercury in the fish is even more readily absorbed by humans and can become a danger to human consumption. This is the primary reason that the consumption of fish in the Great Lakes and many rivers and streams is limited by EPA and many state natural resource departments. For this reason the mercury discharge limit concentration was reduced to 12 ng/L and 1.3 ng/L (Great Lakes) to protect both humans and wildlife.

Table 1 below provides a relationship between removing solid amalgam based upon the ISO standard and the remaining mercury that enters the environment.

.../2

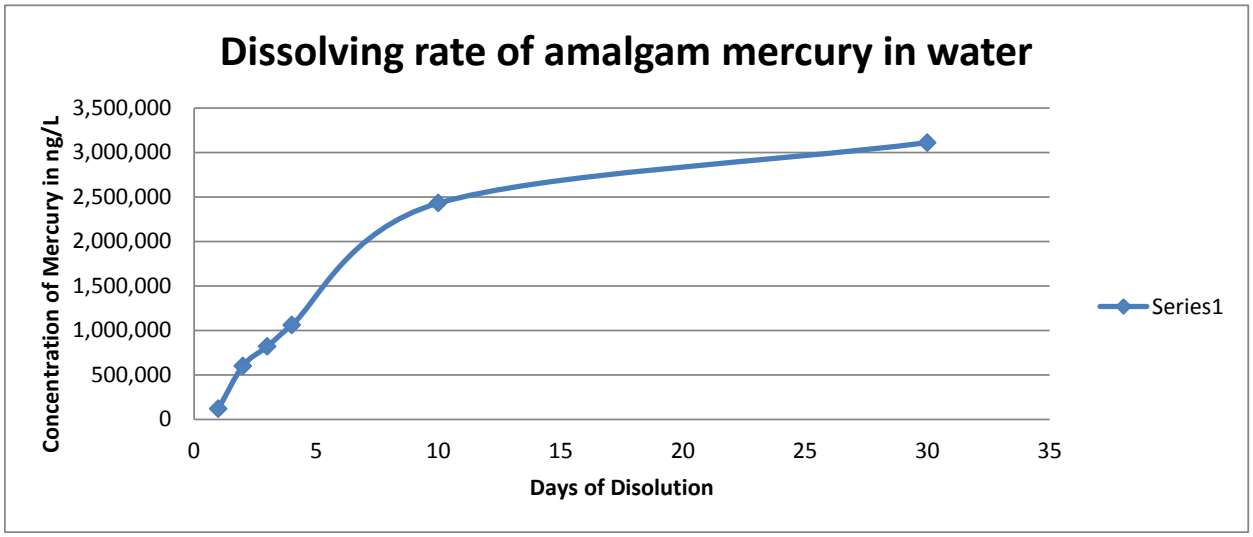
Table 1

% Removal of Amalgam from Separator	% of Amalgam entering the Environment	Amalgam Quantity entering the Environment based upon EPA limit in ng/Kg	Average quantity of Mercury entering the Environment based upon the EPA limit in ng/Kg
99%	1%	10,000,000,000	5,000,000,000
99.9%	0.1%	1,000,000,000	500,000,000
99.99%	0.01%	100,000,000	50,000,000
99.999%	0.001%	10,000,000	5,000,000
			EPA limit to the Environment 12 ng/Kg

Though the theoretical data above is the examination of the ISO standard and the quantity of mercury solids that continue to enter the environment, this study focuses on actual data taken from dental offices using various separators. To dispel the theory that all of the mercury that exits the separator is solid and non-hazardous, Table 2 below is a time study in which 4 grams of amalgam is placed in 125 milliliters of pure water neutral pH (6.9) and allowed to dissolve over a 30 day period in the same manner that it dissolves in a separator.

Table 2

Days in Water	Quantity of Mercury dissolved in ng/L
1	119,000 ng/L
2	600,000 ng/L
3	818,000 ng/L
4	1,060,000 ng/L
10	2,410,000 ng/L
30	3,110,000 ng/L
EPA Limit	12 ng/L



.../3

7484 Woodspring Lane, Hudson, OH 44236 Phone: 330-687-3360
e-mail: wpurves330@gmail.com

The rate of dissolution reduces over time as the water hits a saturation point. The change of pH from 7.0 will increase the dissolution rate. A pH less than 5 or greater than 9 may increase the dissolved mercury concentration substantially. The pH of the offices studied ranged in a pH of 6.8 to 8.0.

All of the separator manufacturers claim 6 months or more service life on the separator efficiency of 95% minimum. The samples taken for the study assumes that the separators and vacuum systems are maintained as recommended by the manufacturers. Most dental offices do not keep records regarding maintenance of their systems. In most cases they may know when the separator was last changed but system cleaning and maintenance is not available. In this small study, all of the dentist offices claimed the unit had been operating for at least 6 months. The following table is from 8 dental offices that had separators in use for more than 6 months. Offices 3 and 4 were "Green Dentists and do not place amalgams but only remove them.

Table 3

Office	Total Mercury from the Separator in ng/L	Dissolved Mercury from the Separator in ng/L*	Separator Type
1	17,500,000	7,500,000	Hg5
2	7,290,000	2,530,000	Hg5
3	660,000	452,000	Hg5
4	534,000	378,000	Hg5
5	1,250,000	811,000	Medentex
6	10,200,000	5,210,000	DRNA
7	65,600	36,600	M.A.R.S Biomed

*Dissolved mercury content based upon filtration of the discharge through a 0.7 um filter.

Impact on Waste Water Treatment Plants (PTOWs)

An exhaustive study was performed by the City of Elyria in Ohio that demonstrated a significant quantity of mercury is being discharged into their system by dental offices. When complying with EPA discharge requirements many PTOWs are having difficulty meeting their discharge limits. Based upon the data generated above, small PTOWs may have mercury issues that are directly attributed to dental office discharges.

Taking the actual data from a WWTP study and using the discharge rate from an office with 3 chairs at 50 ml/minute per chair, the following table demonstrates theoretically the impact of one dental office on a waste water treatment plant.

Table 4

Discharge at Street ng/L	Concentration /1000000 liters in ng	Concentration entering the PTOW ng/L	Number of Chairs	Has Separator	Separator Type
486000	4374000	4.37	3	X	Hg5

.../4

Conclusion

A visual examination of the water from each of the separators demonstrated that the discharge of the water was cloudy with particulate. The difference in the total to dissolved mercury content strongly demonstrates that not only do the separators not remove all mercury but a significant quantity of dissolved mercury is discharged to the environment. Under the proposed EPA Guidelines for separators, the problem of mercury entering the environment will not be solved. The separator in office #7 is the only unit that is capable of removing both solid and dissolved mercury from the environment. Their design provides the highest removal rate under normal operating parameters and treats both the total and dissolved mercury.

Source Data

This document is a partial accumulation of years of discharge data. Much of the data is from manholes near the dental offices. Table 3 data is from actual separators in dental offices. The office and names of dentists are not revealed for their privacy. The discharge data in table 4 is the average concentration taken from 7 street manholes near dental offices. The actual concentration from the separator was not taken for this table. Separator studies mentioned in paragraph 1 by various states, academia and private companies were found on the internet and state websites. An internet search regarding separators will reveal many of the facts stated in this document.

William W Purves
President
Purves Environmental Inc.