AEM

Proposed RoHS Additional Substances Consultation – Diantimony Trioxide

Submitted by:

John Wagner

Director of Materials Management

Association of Equipment Manufacturers

Email: jwagner@aem.org

Tel: 001 414 298 4164

Background and issues caused by substitution

AEM is a US trade association representing manufacturers of industrial equipment including products in the construction and agricultural sectors. Some of AEM members' products are in scope of the RoHS directive although many are excluded as types of professional Non-Road Mobile Machinery (as defined by RoHS) or as equipment that is specifically designed to be installed in excluded types of equipment. Products that are in scope are believed to be mainly in RoHS category 11 with some in categories 6 and 9.

Most AEM members' products are complex products designed for long lifetimes and high reliability. They must comply with other legislation apart from RoHS, such as the Non-Road Mobile Machinery (NRMM) Emissions Regulation that necessitates gaining approval in the EU from a Notified Body after any changes are made to product design such as would result from new RoHS restrictions. The NRMM Regulation requires engines to meet strict emissions limits, have proven reliability and long lifetimes and manufacturers must test engines to obtain this data before approval can be granted.

Another issue for AEM's members is that most of their products have niche uses and are not made in large numbers. However many of the component parts used are obtained from suppliers whose main markets are types of products that are excluded from RoHS, such as in heavy goods vehicles. AEM members may buy less than 1% of the total sales of a type of part from a component supplier and so have no influence over if or when the supplier develops an alternative RoHS-compliant version without the newly restricted substance. Suppliers will be reluctant to make changes if most of their customers do not want changes made as they will not want to have to gain re-approval for their products. As a result, it can take AEM's members many years to identify substitute parts, assess them, test them in engines, test in finished equipment and finally apply for EU approval before these can be sold. This can take 10 years or longer if sourcing substitute parts is especially difficult. The use of less reliable or lower performance parts is not an option as EU NRMM Emissions Regulation approval would not be granted. This 10 year timescale assumes that no new restrictions are adopted part way through, because if so, new components would need to identified and tested before finished equipment testing has to be re-started (this takes typically two years), which would extend the overall timescale required significantly.

Due to the considerable difficulties in achieving compliance, along with the uncertainties caused by the exemption request process (e.g. the time taken between submission and publication is now much longer than previously), some AEM members may consider withdrawing products from the EU market. If the next recast review results in the removal of some of the RoHS scope exclusions there could be more EU market withdrawal of products, especially if the list of RoHS restricted substances were to increase from the current 10. This would have a significant negative socio-economic impact on the EU.

The usage of RoHS substances in these products is limited to very small quantities comparing to the overall materials embedded in the finished product, which are nearly always collected for materials recycling or for refurbishment at end of life.

Supply chain RoHS data collection has been a significant challenge for our members due to the complexity of the impacted products and their supply chains. There can be up to 14 companies involved between raw material producer and AEM member manufacturer and this makes obtaining substance data difficult and time consuming. Some suppliers have been able to provide data on the proposed 7 additional RoHS substances, but most do not have this information and it will take some at least a year to obtain this information.

Some AEM members have identified needs for several RoHS exemptions for their products which have been requested in recent years via EUROMOT. Because of the safety, durability, and reliability requirement in our industry, alternative materials for restricted RoHS substances may not be available or feasible for machinery/equipment products that AEM members offer on the EU market The restriction of one or more of the proposed 7 new substances under RoHS is likely to result in need for additional exemption requests from our members. Due to the sophisticated material technologies embedded in the products our members offer, it is likely to take several years to just confirm the need for exemption requests.

AEM members have pointed out that it would be very beneficial across the industrial equipment industry, if any future restrictions were to be application specific, as is the approach used for REACH Annex XVII restrictions, or to exclude types of equipment that are unlikely to enter the EU waste stream due to manufacturers operating within the circular economy and so collect end of life equipment and ensure that it is safely recycled or refurbished for reuse, as is the case with most industrial equipment.

Answers to questions.

1. Applications in which diantimony trioxide is in use

Several AEM members have surveyed their suppliers to determine where diantimony trioxide is used. Due to long supply chains, it has been possible to obtain data from only some suppliers, but this has shown that of the substances proposed for restriction by RoHS, diantimony trioxide is the most widely used occurring in many more types of parts than any other of the substances.

A primary use is as a flame retardant synergist in the following types of components:

- As a flame retardant synergist in
    - PCB Epoxy Laminates
    - Electrical component load mounting epoxy resins
    - Cable insulation

  - Electronic component insulation, such as diodes, connectors, voltage suppressors and regulators, transformers, displays, Integrated circuits, transistors, inductors, capacitors, resistors, inverters, temperature and other sensors and valves. Huge numbers of electronic components used by AEM members contain this substance.
  - Complex sub-assemblies such as sensors, alternators, compressor, etc.
  - Plastic housings and enclosures
  - Rubber and plastic gaskets, hoses and tubes used in engines and in other types of equipment
- As a catalyst for PBT and other plastic (e.g. used for connectors)
- To manufacture glass, however glasses do not contain the substance "diantimony trioxide".

Diantimony trioxide is used as:

Flame retardant synergist usually used with halogenated materials such as PVC or with brominated or chlorinated flame retardants. In combination with halides, it is a very effective fire retardant able to achieve the highest fire retardancy standards such as UL94 VO. Diantimony trioxide alone and halogenated flame retardants alone are very inferior to their use in combination.

High levels of fire retardancy performance is often required by EU safety standards for electrical equipment and it is difficult and sometimes impossible to achieve this performance without diantimony trioxide in several types of polymer. A study published by the Danish Ministry of the Environment in 2006 showed that HIPS, ABS can be effectively flame retarded only with diantimony trioxide as a synergist. It is also essential in flexible PVC.

Alternative types of polymers (that do not need diantimony trioxide) and alternative flame retardants to diantimony trioxide can rarely be used as drop in replacements as each polymer type and the types of additives used will give materials with different flexibility, hardness, impact strength, chemical resistance, etc. as well as fire resistance, so that finding a replacement for diantimony trioxide can be extremely difficult and may in many cases be impossible.

Electrical fires kill and injure many people in the EU annually and so it is not advisable to discourage manufacturers from using the most effective fire retardants.

In the UK, for example[1], in the year 2016 / 2017, 261 people died in fires of which 231 were in homes and 4% of these were caused by faulty electrical appliances (other than cooking appliances) and 5% were due to faulty electrical distribution, which in total (9%) was equivalent to 21 deaths in the UK. Danish research showed a similar statistic with 4% of fatal fires being caused by technical faults to electrical equipment[2]. In the EU as a whole, there are many hundreds of deaths caused by faulty electrical equipment each year but it seems likely that a restriction of diantimony trioxide could encourage manufacturers to use less effective fire retardants or more flammable plastics, this could significantly increase the number of deaths and injuries from electrical fires each year. This clearly should be avoided.

[1] Detailed analysis of fires attended by fire and rescue services, England, April 2016 to March 2017, Statistical Bulletin 16/17, 12 October 2017, published by the UK Home Office ISBN: 978-1-78655-572-4

[2] https://www.ifv.nl/kennisplein/Documents/09-06-24_rapport_consumer_fire_safety_pdf1.pdf

Polymerisation catalyst used for polymers such as PET and PBT typically at 0.015 – 0.02% of homogeneous materials. Most PET (about 75% is used to make plastic bottles which are outside of the scope of RoHS[3]). Sb2O3 is trapped within the polymer matrix and does not leach out.

To make glass. Originally used to replace very toxic arsenic oxide to remove colour from glass. The glass does not contain the specific compound Sb_2O_3, as glass is a complex non-stoichiometric mixed oxide.

Occurrence in secondary materials that might be used

The EU's Circular Economy Action Plan[4] seeks to encourage reuse and recycling of secondary materials and this should include reuse of recovered plastics. Recovered plastics will contain diantimony trioxide as the use of diantimony trioxide is very common because it is such an effective and useful flame retardant synergist, occurrence in secondary materials is very likely.

2. Quantities and ranges in which diantimony trioxide is in use

Quantity used: AEM members do not make or import diantimony trioxide so cannot provide data on annual EU consumption of this compound. One manufacturer has calculated that a typical engine weighing 50 – 200kg might contain 1 to 2 grams of diantimony trioxide, but the amount will be very variable and another manufacturer has determined that an engine system (including hoses, cables, control electronics, etc.) might contain 400 grams of diantimony trioxide.

Substitution trends: Diantimony trioxide is the most effective flame retardant synergist and as the EU risk assessment published in 2008 and the US assessment from 2014 (see Q 6 below) showed that it causes no harm to human health or to the environment, there has been no need to find replacements.

3. Potential emissions in the waste stream

This was considered by the EU impact assessment and the US impact assessment described in section 6 below. Both showed that antimony oxide in electrical equipment waste causes no harm to human health and the environment.

4. Substitution

Which applications are substitution not practicable or reliable and why?

Many of AEM members' products must have proven long term reliability to be permitted to be placed on the EU market. This is especially the situation with equipment that contains engines where EU emissions legislation is applicable. There are many types of professional equipment that is in scope of the RoHS Directive (i.e. that is not a form of transport or professional non-road mobile machinery as defined by RoHS) which is also in scope of the Non-Road Mobile Machinery (NRMM) Regulation (this uses a different definition to that used by RoHS).

The Non-Road Mobile Machinery Regulation requires that engines are extensively tested after any change is made, such as would occur if diantimony trioxide were restricted, to prove that

[3] http://www.antimony.com/files/cms1/publications/safe-use-of-antimony-catalysts-in-pet--june-2014-final.pdf
[4] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52015DC0614

substitution does not negatively affect lifetime or reliability and also that the EU's emissions limits are still met. This type of redesign work and testing takes at least eight years after all substitute parts and components have been identified and assessed for suitability. At present, the efficacy and reliability of substitutes is not known and due to the operating temperatures and environmental conditions close to engines, there is a high likelihood that no substitutes will be found for many applications.

Which alternatives are available?

At present no alternatives are known to AEM that meet all of the technical and legal requirements for its products.

Constraints on substitution

Fire retardancy of the alternative flame retarded polymer must be at least as good as the polymers that contain diantimony trioxide. Also, all physical and chemical properties of the substitute polymer formulation must meet multiple requirements. Engine components are often exposed to harsh environments including dust and chemicals, high temperatures, severe vibration, engine fluids such as lubricants and coolants. They must also maintain these properties for the lifetime of the engine which can be 25 – 40 years for some types of industrial equipment.

Flexibility, impact strength and other physical properties are very dependent on the type of flame retardant used and it may be impossible to achieve all of the required properties. Some alternative flame retardants are unsuitable in flexible cables, such as mineral types, because they make the polymer too hard and rigid so that the insulation fractures. Some types cannot achieve the level of fire retardancy that is required by safety standards. There are several phosphorous-based flame retardants available that can achieve UL94V0, but some of these are classified as hazardous materials (some are REACH SVHCs) and the global supply of phosphorous minerals that are used to make these materials is very limited and these are classified by the EU as "Critical Raw Materials".

5. Socio economic impact of a possible restriction

If a restriction were to be adopted, even though we believe that this is unnecessary, it will be important to allow manufacturers sufficient time to identify, test and gain approvals for substitutes. From past experience of AEM members with phthalate substitution, this can take up to 10 years or longer if some substitute parts are not available from component suppliers. Note that many components are made primarily for sectors outside of the scope of RoHS and so manufacturers have no incentive to develop substitutes. If research shows that no substitutes exist, AEM could apply for exemptions, but this would not be possible until the research had been completed with negative results available to justify the exemption.

In addition, past experience has shown that it can take more than 3 years (>4 years in recent years) from submission of an exemption request to the exemption being published in the EU Official Journal. Based on experience with phthalate substitution, a 10 year transition period appears reasonable, but as there are so many types of part that contain antimony oxide, the time needed is likely to considerably longer.

If diantimony trioxide were to be restricted before fully RoHS compliant equipment can be tested and gain NRMM Emissions Regulation approval from a Notified Body, many types of equipment could not be sold in the EU. For example, EU hospitals could not buy emergency generators, with potentially disastrous implications, construction equipment would not be available so that new buildings could not be constructed, and some farm machinery will not be available in the EU therefore affecting food production.

6. Further information and comments

A comprehensive EU risk assessment for antimony oxide was carried out by the Swedish Chemical Inspectorate and published in 2008 in accordance with Council Regulation (EEC) 793/931 on the evaluation and control of the risks of "existing" substances[5]. This comprehensive study considered published literature on health and environmental hazards, sources of exposure, levels of exposure to humans and the environment from emissions in all life cycle phases including exposure to unusually high levels of "local exposure" such as might occur close to production or waste sites.

The study concluded that for all environmental and human impacts "**There is at present no need for further information and/or testing and no need for risk reduction measures beyond those which are being applied already**".

This study, (which considered all sources of exposure to antimony, not only from diantimony trioxide in EEE) showed that EU restrictions are not needed to protect human health or the environment and therefore a RoHS restriction would also not be necessary. Since 2008, the hazard classification of diantimony trioxide as a category 2 carcinogen has not been changed, which indicates that the risk assessment's conclusions are still valid.

A more recent risk assessment by the US EPA (published in 2014) concluded that antimony oxide poses a minimal risk to the environment[6] and this study also concluded that antimony oxide does not pose a significant risk to the general population or to workers.

Diantimony trioxide is included in CoRAP for assessment in 2018 with the objective to clarify toxicological properties, exposure and physio-chemical properties. The results of this study should be considered before deciding on the most appropriate regulatory action.

---

[5] Diantimony Trioxide Risk Assessment, May 2008, Swedish Chemicals Agency. Downloaded from the https://echa.europa.eu/... Website May 2018

[6] https://www.epa.gov/sites/production/files/2015-09/documents/ato_ra_8-28-14_final.pdf