Report of the NJDEP-Science Advisory Board

Management of Waste Wallboard

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Charge

NJDEP Commissioner Martin requested that the NJDEP Science Advisory Board (SAB) evaluate and recommend practices that would provide for management of Waste Wallboard that would eliminate the production of Hydrogen Sulfide (H_2S) as a result of the disposal.

Response to the Charge

The SAB appointed a sub-committee to respond to the charge. The members of the sub-committee are:

- John Gannon, Ph.D.
- Peter Lederman, Ph.D., P.E.
- Lily Young, Ph.D.

The group was chosen because of their extensive industrial, waste management, and environmental microbiology experience.

Executive Summary

Disposal of gypsum wallboard is currently not regulated in the State of New Jersey and can result in the formation of H_2S as a result of bacterial activity in the anaerobic, moist environment found in landfills. There are many interested parties in the efficacious disposal of wallboard with widely divergent interests. At present the disposal of wallboard in landfills is economically attractive. However, if the real long-term costs are considered that may not be the case. The potential hazards of H_2S release from the landfill presents very costly challenges.

There are a number of intermediate alternatives to managing wallboard disposal presented in this paper. This report addresses the potential solution options that may be considered. Although the ultimate solution to resolving the wallboard in landfill issues would be to prohibit landfilling of wallboards, this recommendation or a specific alternative option recommendation will not be made until the results of a recommended detailed economic life-cycle analysis are analyzed.

The potential options include:

- Wallboard wastes from a construction site:
  1. Develop recycling options for clean wallboard wastes from construction sites.
  2. After recycling operations are established, wallboard construction wastes can be managed at the construction site by requiring separation of wallboard into separate dumpsters which would be sent to a recycling plant.
- Wallboard wastes from demolition:
  1. It will not be economically feasible to recycle gypsum from demolition wastes.
  2. It may not be practical to completely ban gypsum demolition wastes from a landfill.
     a. The efficiency of separation and the quality of the mixed wastes may make it less desirable for recycling.
     b. Furthermore, a ban without practical, economically feasible options would decrease the ability to effectively enforce a restriction of this type in NJ.
     c. Alternative options, which would allow for demolition wastes to go into the landfill, are discussed in this review. The waste wallboard management options may include: a) limit disposal to specially constructed "dry" cells in the existing NJ landfills; b) create a new C&D landfill, which would be located remotely (away from housing) and managed to handle the challenges of C&D wastes – including wallboard demolition wastes; c) Require addition of SRB inhibitors to wallboard waste to be landfilled.

Achieving any of these goals will take a number of years and the cooperation of all the interested groups. They need to be involved in developing the ultimate solution along with a detailed economic life-cycle analysis.

Background

Wallboard is used extensively in construction providing the interior walls of most housing and office units. It is made of sheets of ground up gypsum covered with heavy paper on both sides. Gypsum is one of the common names for Calcium Sulfate Anhydrous ($CaSO_4$). The wallboard is non-toxic and stable in its manufactured form. The Material Safety Data Sheets (MSDS) which are provided by the various manufactures of the wallboard state uniformly that the only hazard is from inhalation of dust. The dust that is produced when the wallboard is cut during use in construction or while the board is manufactured. No mention is made of any degradation products. The MSDS state that disposal is to be carried out according to "state and local regulations".

Current Disposal Practices and Issues Arising

Wallboard trimmings produced during the manufacture of the wallboard are typically recycled at the manufacturing facility and are therefore not considered in this evaluation.

Waste wallboard resulting during construction or demolition is typically part of a mixed waste stream. Construction and Demolition waste (C&D) is typically about 20% wallboard in addition to wood, metal, insulation and glass. This waste stream may be dry or wet. It may also have a soil component depending of the source of the waste.

Unfortunately the MSDS for wallboard and $CaSO_4$ do not take into account the typical conditions at disposal sites. Typically, the landfill is anaerobic and moist. In addition, biological material such as wood or other organic wastes are present. Landfills more often than not are acidic. The presence of anaerobic conditions, moisture, biological material and an acid-neutral environment are ideal for the sulfate-reducing bacteria to thrive. The product of sulfate reduction is H_2S. Aerobic conditions would prevent the generation of H_2S as the sulfate reducing bacterial are strict anaerobes.

Several studies have shown that there are different ways to reduce the production of the sulfate reducing bacteria (SRBs). They include the use of nitrates to inhibit the SRB production and hence the production of H_2S (1). SRBs thrive best in a neutral anaerobic environment; hence increasing the alkalinity (pH) of the material in the area of the dry wall also inhibits the growth of SRBs (2). SRBs will not thrive in a moisture free environment. Also, adding ground-up concrete to the C&D mix can reduce or eliminate the formation of H_2S. This is the result of the H_2S reacting with the concrete. (3). While these processes have been demonstrated at laboratory-scale, more work is required to demonstrate them at a larger scale.

An additional issue which may arise is that with the input of large amounts of wallboard into a landfill, it may reduce the production of methane as the sulfate will compete for electrons that also are needed to produce the methane in the anaerobic microbial respiration process. This can affect the amount of methane if it is being collected as an energy source.

Wallboard has been recycled successfully, but on a limited scale. This has been with “clean” wall board. It is necessary to develop a supply chain structure from the producer of the waste, through the collector, to the pre-treatment facility that removes the paper, and to the final user of the recycled waste. The economics of recycling the “clean” waste wallboard does not appear to be favorable under present conditions and cost of landfilling. However, if one considers the cost of actively capturing and treating the H_2S emitted from a landfill, then the economics may change significantly. It will also be necessary to evaluate the effect of wallboard that comes from mixed C&D or is in other ways contaminated such as salt residue from wallboard that has been exposed to storm surge.

Waste wallboard is also “recycled” as feed to cement kilns. Currently, most cement manufacturers opt to buy virgin gypsum. Here, again, past practice and economics must be considered and overcome for this to be a consistent receptor of the waste.

Waste Wallboard Management Options

There a number of waste management options for wallboard. These include:

- Prohibit disposal of clean and used wallboard
- Limit disposal to specially constructed "dry" cells
- Require addition of SBR inhibitors to wallboard waste to be landfilled
- Create a C&D landfill, which would be managed to mitigate wallboard concerns.
- Recycling options include but are not limited to:
  - Recycle material to cement kilns
  - Recycle waste to wallboard manufacturers.
  - Use as cover material at landfills exposed to aerobic conditions
  - Use as stabilizing material on road construction and road banks

Each of these options will be discussed below.

Prohibit disposal of clean and used wallboard

The prohibition of landfilling wallboard waste into landfills is not practical under current operating and economic constraints. However it should be the ultimate aim of any program. Massachusetts has such a prohibition. It was put in place after much consultation with all stakeholders and implemented over a number of years.

Limit disposal to specially constructed "dry" cells

This would require separation of the wallboard from the C&D waste so that the volume that required this special handling would be significantly reduced. Maintenance of these cells in a dry environment also presents a challenge.

Require addition of SBR inhibitors to wallboard waste to be landfilled

Requiring the addition of materials that inhibit the SRB biogenesis needs further evaluation at a scale which better simulates landfill conditions. The materials include nitrates and materials that make the disposal environment more alkaline. Ground concrete also fits into this group of materials. It limits H_2S release by adsorbing the H_2S and reacting it with concrete to form stable Calcium Sulfate.

Create a C&D landfill, which would be managed to mitigate wallboard concerns

This could be a capital intensive project, so the detailed economic life-cycle analysis would be of utmost importance. The longer term mitigation management of this issue may be easier in a designated C&D landfill versus implementing mitigation management options across all landfills in the state. However, the difficulty of separating out wallboard in a demolition waste stream may result in very high volumes of demolition wastes, which would make this option less practical or less sustainable than other options (i.e., volume may require need for multiple C&D landfill sites).

Recycling Options

- Recycle material to cement kilns

  Crushed wall board is already being used as a feed stock in the manufacture of cement. The wallboard has to be separated from the rest of the C&D material. It competes at present with virgin gypsum.

- Recycle waste to wallboard manufacturers.

  Recycle waste wallboard to wallboard manufacturer. This would require developing a fully integrated processing train to separate the wallboard from the C&D, pretreat (remove the paper from the gypsum) and grind the wallboard so that is an acceptable feedstock.

- Use as cover material at landfills exposed to aerobic conditions

  The gypsum should be mixed with other cover materials to limit potential H_2S production if the landfill conditions were to change to an anaerobic environment.

- Use as stabilizing material on road construction and road banks

  The gypsum should be mixed with other stabilizing materials to limit the potential for dusting of the gypsum.

Economics of Wallboard Waste Management

It is not the charge of this sub-committee to develop the economics of wallboard reuse and recycle. However this is a critical element for evaluation of any reuse and recycle program. At the present time, landfilling C&D waste without separation is thought to be the most economical disposal method. However, it is the considered opinion of the committee that the economics currently cited are based on dumping fees and do not consider potentially very significant costs of mitigating problems that can be caused by formation and release of H_2S emissions.

Recommendations

For the present, waste wallboard will have to continue to be disposed of in landfills. However this should be done under carefully controlled conditions. It is also recommended that a user group with representatives of all interested parties be formed to:

- Further develop the alternatives
- Develop an action plan to that sets goals for significantly reducing the quantity of gypsum sent to landfills
- Develop mitigation management initiatives for the gypsum wastes that are sent to landfills.

The State of Massachusetts has implemented a program that prohibits, except in very limited cases, the disposal of wallboard in landfills. The State of New Jersey should contact their colleagues in Massachusetts to learn about their efforts to develop the regulatory process to prohibit landfilling of wallboard in Massachusetts. However, although the ultimate solution to resolving the wallboard in landfill issues would be to prohibit landfilling of wallboards, this recommendation or a specific alternative option recommendation are pending until a detailed economic life-cycle analysis of options is completed and field demonstrations of desired alternatives are demonstrated.

References

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