Materials Characterization Paper
In Support of the
Advanced Notice of Proposed Rulemaking –
Identification of Nonhazardous Materials That Are Solid Waste

Spent Solvents and Related Materials

December 16, 2008

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1. Definition of Spent Solvents

A solvent is a material used to dissolve or dilute another substance. Examples of solvent use include degreasing, cleaning, and fabric scouring, use as diluents, extractants, and reaction and synthesis media. A spent solvent is a solvent that has been used at least once and cannot be used again for its original purpose without being processed, due to contamination during its use. This analysis addresses only solvents that: 1) have potential fuel value (i.e., organic solvents), and 2) are not considered hazardous under RCRA. Specifically, this paper targets non-hazardous, non-halogenated, solvents. Non-halogenated solvents include a variety of organic chemicals (hydrocarbons, alcohols, ketones, esters, etc).

2. Annual Quantities of Spent Solvents Generated and Used

(1) **Sectors that generate spent solvents:**

- A wide range of non-hazardous spent solvents are generated by a large number of industries. Generators of spent solvents can include industries that use solvents, industries that recycle or process spent solvents from other sources, and, in some cases, industries that manufacture solvents. Facilities in the following NAICS industry sectors focus specifically on the manufacture or management of solvents: 325998 – Recycling services for degreasing solvents (e.g., engine, machinery) manufacturing; 325132 – Solvent dyes manufacturing; 324110 – Solvents made in petroleum refineries; and 811111 – Automotive repair and replacement shops.
- Solvents are typically used in the following industries and applications: coatings, cleaners, inks, adhesives, pharmaceuticals, agricultural and food uses, personal care, automotive, microelectronics, and aerosol products (American Chemistry Council 2008).

(2) **Quantities and prices of spent solvents generated:**

- Due to the wide variety of solvents produced and used, it is difficult to characterize the quantity or prices of spent organic non-hazardous solvents generated in the U.S. Only a fraction of all solvents produced return to the market as spent solvents; many are recycled and reused on site by generators. Total annual production of solvents exceeds 10 billion pounds (5 million tons) per year (Paint and Coatings Industry 2006). This suggests that the total quantity of solvents that require replacement could also be roughly five million tons per year.

- The limited information available on markets for spent solvents focuses on hazardous solvents; these are commonly used as fuel, and they are "priced" to be less expensive to the generator than the avoided cost of hazardous waste disposal, which can range from $0.41 to $2.13 per gallon (Environmental Technology Council 2004).

(3) **Trends in generation of spent solvents:**

- Information on trends in generation of spent solvents is difficult to assemble given the range of products and management options. National demand for solvents is expected to rise by one percent a year to 12.5 billion pounds in 2010 (Paint and Coatings Industry 2006). However, as interest in recycling, reuse, and waste minimization increases, and the costs of reuse decrease, this projection may not hold.

3. Uses of Spent Solvents

(1) **Combustion uses of spent solvents:**

- Solvents with sufficient calorific value and minimal contamination can be readily used as fuel in a range of boilers, furnaces, and kilns. However, readily available information suggests that non-hazardous solvents do not represent a significant alternative fuel source.
- Portland Cement Association data indicated that the BTU value per pound of spent solvent varies due to the wide variety of solvent types (Portland Cement Association 2007).
- Solvents that are considered hazardous under RCRA frequently have fuel values that are similar to coal. Hazardous waste, as estimated by the Assessment of the Potential Costs, Benefits, & Other Impacts of the Hazardous Waste Combustion MACT Final Rule Standards, and the Economic Analysis for the Proposed Emission Comparable Fuel rule (based on the information contained in the hazardous waste constituent survey), has a heating value between 12,200 and 13,500 Btu per pound. In fact, a number of these solvents appear to meet the definition of hazardous waste because they are characteristic for ignitability, suggesting that there is a strong correlation between hazardous solvents and high fuel-value solvents. This may suggest that non-hazardous solvents are typically less valuable as a fuel source, but the variation among solvents makes it difficult to draw any specific conclusion.

(2) **Non-combustion uses of spent solvents:**

- Most spent solvents can be reprocessed and recycled for use again in their original form. Facilities that produce spent solvents may choose to install recycling equipment in an effort to cut costs on virgin solvent purchases (see, for example, Ohio EPA 2004; and NSBDCBEP). It is difficult to estimate the quantities of non-hazardous spent solvents disposed or kept in storage because they originate in many locations, and are likely managed in a number of different ways. It appears, however, that recycling is a viable option for a significant percentage of non-hazardous solvents.

4. Management and Combustion processes

(1) Types of units using spent solvents

- It is possible that some non-hazardous, organic, solvents may have Btu values that would give them value as a fuel source. Hazardous solvents, whose generation and management is tracked in the Biennial report, are burned as fuel in a variety of liquid-fuel industrial boilers and cement kilns.

- One limitation concerning burning solvents may be the design of combustion equipment. Bullard (2007) notes that boiler and burner manufacturers and other companies that support commercial and industrial boilers have only limited experience with burning hazardous or non-hazardous waste solvents. These boiler/burner supportive industries are more familiar and more interested in working on projects involving traditional fuels like natural gas and distillate, since this is the fuel overwhelmingly in use in industry (Bullard 2007).

- Cement kilns are experienced at burning hazardous waste solvents, along with a range of other liquid wastes. However, an industry contact noted that EPA's introduction of the exclusion rules in the 1990s that removed materials with high Btu values, when used as fuels, from the definition of solid waste, have resulted in more energy recovery from solvents on-site at manufacturers; as a result, solvents have diminished as a fuel source in the cement industry (Guerra 2008).

- An EPA document source concerning industry impact information of boilers suggests that some nonhazardous waste burning cement kilns use, among various other secondary fuels, spent lubricants and solvents (EPA 2008). These data are not sufficiently broken down to attribute any energy savings information to spent solvents specifically.

(2) Sourcing of spent solvents:

Spent solvents originate in many locations, and a national-level collection and distribution system does not exist for all types of solvents. However, census data indicates that recycling of solvents is widespread. Recycling services for degreasing solvents (e.g., engine, machinery) manufacturing includes 1,188 facilities that are involved in the management of secondary solvents. This does not address the on-site recycling and fuel recovery activities that take place at generators.

(3) Processing of spent solvents:

In some cases, only minimal processing is required to reuse spent solvent on site, since it is not always necessary to have 100 percent purity (Ohio EPA 2004). Alternatively, some types of solvents may not be suitable for reuse even after significant processing (including physical and chemical processes to remove impurities) and therefore must be managed through an alternate method, including being used in a different process or sold to another company for use.

(4) **State regulatory status of spent solvents use as ingredient:**
At this stage, we have not identified any states that have specifically granted a beneficial use designation for the use of spent solvents as fuel, but we have not performed an exhaustive investigation of state activities and regulations.

5. Commodity Composition and Impacts

(1) **Composition of spent solvents:**
The composition of spent solvents can vary widely depending on the original chemical structure and the solvent, and the substance with which it was first used. To be useful as a non-hazardous fuel source, solvents must have carbon (i.e., be organic). However, other constituents are difficult to characterize because they are based largely on the specific process (e.g., cleaning production equipment) in which the solvent was originally used.

(2) **Impacts of spent solvents use:**

- Data from the Portland Cement Association notes that the Btu value per pound of spent solvent varies (Portland Cement Association 2007), but when it can be used as an alternative fuel, it offsets use of primary fuels.
- Benefits associated with use of spent solvents as fuel include avoided risks associated with disposal, cost savings associated with avoided disposal and recovery of energy, and the avoided environmental impacts associated with production of energy from "virgin" non-renewable sources when solvents are used instead.
- The specific lifecycle impacts of spent solvents used as a fuel are not evaluated here because of uncertainties in lifecycle scenario development. For example, it is difficult to identify the fuel (Btu) value and emissions factors associated with a "typical" non-hazardous organic solvent that is suitable for fuel. In addition, spent solvents may substitute for a variety of fuels; the choice of fuel often depends on location specific-factors such as the location of the combustor in relation to fuel supplies, and on the design of the specific combustion unit. Avoided upstream impacts depend heavily on the specific fuel being displaced in the lifecycle scenario.

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