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Project Summary

Environmental Assessment of Shop Towel Usage in the Automotive and Printing Industries

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To further its research in Life Cycle Assessment (LCA) while assisting the EPA Office of Water evaluate the environmental impacts associated with woven shop towels, the National Risk Management Research Laboratory collected shop towel usage and emissions information using a streamlined life cycle approach. The assessment identified the environmental impacts and usage trends of shop towels in the printing and automotive repair industries. Four types of shop towels were evaluated: woven, nonwoven, paper, and rags. The resource requirements and emissions during the manufacture, usage and disposal of each shop towel were compared, with primary focus on the usage and disposal of shop towels. (The full report was submitted in fulfillment of Contract No. 68-C4-0020 by Lockheed Martin Environmental Systems and Technologies under the sponsorship of the United States Environmental Protection Agency. This report covers a period from June 1994 to May 1996 and the work was completed as of November 1996.)

This Project Summary was developed by EPA's National Risk Management Research Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

An environmental assessment using streamlined life cycle principles was conducted to identify the environmental impacts and usage trends of shop towels in the printing and automotive repair industries. The shop towels are used to clean equipment and to wipe up contaminants for a variety of operations. The four types of shop towels evaluated were woven, nonwoven, paper, and rags. Woven towels that become contaminated from usage are cleaned at industrial laundries and are a significant contributor to the contaminant loading of liquid discharges from the laundries. The cost of cleaning woven towels at industrial laundries is increasing as local regulations restrict the allowable contaminants in the liquid discharge. The printing industry continues to use woven towels rather than nonwoven and paper towels and may use alternative towel cleaning methods in the future. The automotive repair industry continues to use woven towels, but is slowly converting to nonwoven and paper towels due to their adequate capability and low cost.

Streamlining Process

The environmental assessment described here utilized the methodology for life cycle assessment (LCA) as described by the EPA (EPA, 1993), but a full LCA was not conducted. The limits of the assessment as conducted are given below:

- The assessment provided a brief analysis of the raw materials acquisition and manufacturing subsystems with a detailed analysis of the industrial usage and postusage subsystems.
- The assessment analyzed the energy and water inputs for all subsystems, but an analysis of emissions was conducted only for the industrial usage subsystem.

- The starting point of the raw material subsystem for this assessment was the materials used to produce the fibers for the shop towels.
- The assessment focused on the differences among the shop towels, therefore areas of similar energy and water usage among all shop towels were not examined in detail. For example, the energy for transportation of shop towels from the manufacture point to the user was considered similar for all shop towels and therefore was not quantified.
- The impact assessment was based on quantified pollutant emissions in the industrial usage subsystem, and estimated pollutant emissions in the raw materials, manufacturing, and the postusage subsystems. The shop towels analyzed were limited to the most common types currently used in the automotive and printing industries.

Inventory Assessment

The following shop towel categories were evaluated:

- Woven towels (cotton/polyester blend)
- Nonwoven towels (wood pulp/polyester blend and 100% polypropylene)
- Paper towels (wood pulp with binders)
- Rags (cotton/polyester blend, equivalent to woven towels)

Impact Assessment

The impact assessment was based on air emissions, liquid discharges, and solid wastes identified in the inventory assessment of the four types of shop towels. Potential environmental impacts for each subsystem were identified, but quantification of the impacts associated with these subsystems was not conducted. Potential environmental impacts and, to a limited extent, human health impacts were addressed in relation to general impact subcategories.

Results

Water Usage

Woven towels and paper towels require similar life cycle quantities of water (18,000 and 16,000 lb per 1,000 towels, respectively). Nonwoven towels require less than 3,500 lb of water per 1,000 towels. The raw material acquisition subsystem accounts for the majority of water usage for both woven towels and paper towels. Water usage for woven towels is dominated by the production of cotton. Water usage for paper towels is dominated by the manufacture of butadiene and styrene binders.

Energy Usage

The life cycle energy requirements are highest for paper towels (950,000 British thermal units [Btu] per 1,000 towels), followed by nonwoven towels (520,000 to 860,000 Btu per 1,000 towels; dependent on composition). Woven towels required the least amount of energy (72,000 Btu per 1,000 towels). Primary energy usage for all shop towels occurs in the raw material acquisition subsystem. Energy requirements for the nonwoven and paper towels are dominated by the processing of petroleum-based fabrics and binders. Although the energy required for a single woven towel usage cycle is roughly similar to the energy required for a single nonwoven and paper usage cycle, the net energy usage for woven towels is low due to their reuse.

Emissions

In the raw materials acquisition subsystem, the production of wood pulp is the primary source of environmental emissions for all shop towel categories analyzed, followed by petroleum product manufacturing and cotton production. However, emissions related to shop towels account for a very small percentage of total emissions from these industries. The wood pulp manufacturing process for the nonwoven and paper towel generates wastewater with biochemical oxygen demand (BOD) and total suspended solids (TSS) loading. Air emissions may include reduced sulfur compounds and volatile organics such as chloroform and methanol, depending on the process used to manufacture wood pulp. The manufacture of petroleum products that are used in woven, nonwoven, and paper towels produces airborne and waterborne organic emissions. Cotton production may result in fertilizers, herbicides, and pesticides in field runoff (liquid effluent).

The primary activities of fiber production, weaving, matting, and packaging result in relatively minor emissions from the shop towel manufacturing subsystem. The wet laid process to convert wood pulp to a fiber for nonwoven and paper towels generates wastewater with BOD and TSS loading.

The washwater effluent from woven towel laundering is the only significant liquid discharge in the industrial usage subsystem. Woven towels account for a small fraction of the articles cleaned in a typical industrial laundry, but are responsible for the majority of the contaminant loading (organics, inorganics, and metals) in the wastewater effluent. Treatment of the effluent to remove contaminants may occur at the industrial laundry or at a publicly-owned treatment works (POTW). The capability for contaminant removal at the industrial laundry or the POTW is dependent on local regulations, and is highly variable throughout the United States.

Air emissions in the industrial usage subsystem are primarily from evaporation of volatile contaminants collected on the shop towel. Volatile organic compound (VOC) emissions can occur during handling and storage of all types of contaminated shop towels and during the washing of woven towels. Solvent washing of woven towels results in a minor increase in VOC emissions compared to water washing. (Herod, 1995)

Disposal of shop towels and sludge occurs in the postusage subsystem. The weight of sludge from washing woven towels (88 lb per 1,000 towels) is similar to the weight of contaminated single-use towels (68-74 lb per 1,000 towels) entering the landfill. The sludge from woven towel washing contains an average of 22% water. Single-use towels (nonwoven, paper, and rags) do not contain the water associated with woven towel sludge, but the shop towel enters the landfill along with the contaminants. Rags have the greatest disposal weight (110 lb per 1,000 towels) due to single-use and higher towel density compared to nonwoven and paper towels.

Sludge generated from the water washing of woven towels is commonly sent to municipal landfills, while the sludge generated from solvent washing of woven towels is incinerated. Single-use shop towels, along with the contaminants, are sent directly from the automotive or printing shops to landfills. Incineration of single-use shop towels is uncommon due to higher costs as compared to landfills, and is conducted only when the shop towels cannot be land filled because of regulatory restrictions.

Impacts

Air quality impacts were relatively minor for all shop towels. VOC emissions could result in minor smog generation impacts. A small amount of acid rain precursor emissions are generated during the production of wood pulp.

Adverse water quality impacts occur in the production of wood pulp, production of petroleum-based intermediate materials, and woven towel laundering. Common impact areas for all shop towels include aquatic life, oxygen depletion, and chemical/biological content. Aquifer contamination could occur from field runoff during

cotton production. Alterations of water pH in localized areas may occur due to wood pulp production and cotton cloth production.

Adverse human health impacts occur primarily through inhalation or ingestion of contaminants. Irritant/sensitizer effects and respiratory effects resulting from airborne pollutants are the most common impact areas. Dermal contact of pesticides and herbicides during cotton production has the potential for gastrointestinal and reproductive effects. The variety of organic compounds (cleaners, lubricants, etc.) associated with all shop towel usage may result in exposure to potential carcinogens that will affect the liver, kidneys, and central nervous system.

Conclusions

The following conclusions have been reached through the evaluation of the shop towel life cycle and offer a "snapshot" of current shop towel usage.

Inputs

The total water requirements were similar for woven and paper towels, and were about ten times greater than for nonwoven towels. Laundering woven towels is usually regarded as a large water consumption process, but the wet laid process for manufacturing paper towels consumes more water than the laundering process for woven towels. Woven towels have the lowest relative energy requirement due to their capacity for reuse.

Outputs

Woven, nonwoven, and paper towel wastes generated from the industrial usage and postusage subsystems were similar in total weight. However, the volume occupied in the landfill is variable because woven towel waste is primarily in the form of sludge, while nonwoven and paper towel waste consists of the towel and contaminants.

Liquid discharges to the environment are generated during woven towel washing because the effluent treatment process at the laundry or the POTW is not 100% efficient in removing contaminants.

Impacts

Environmental impacts from woven towel usage are greatest in the industrial usage subsystem, which is consistent for reusable materials. Water quality impacts occur because processes for treating laundry effluent do not remove all contaminants from the water prior to discharge.

Environmental impacts from nonwoven towel usage occur primarily in the raw material acquisition and manufacturing subsystems, which is consistent for single usage materials. Impacts associated with nonwoven towels are dependent on the materials used to manufacture the towel. The manufacturing process for nonwoven towels that contain petroleum-based materials generates air emissions composed of organic compounds. The manufacture of nonwoven towels that contain wood-based materials generates air and water emissions that could contain sulfur and chlorine compounds.

The environmental impacts from paper towel usage occur primarily in the raw material acquisition and manufacturing subsystems, again consistent for single usage materials. The conversion of wood to cellulose acetate is responsible for the majority of air and water quality impacts associated with paper towel usage.

Environmental impacts attributable to the postusage subsystem are similar for all shop towels. The contaminants generated from the woven towel usage are divided between sludge that enters the landfill (>90%) and liquid discharge that enters the environment (<10%). All contaminants on the single-use towels will usually enter the landfill with the towel. The primary difference between disposal of sludge that is generated from woven towel laundering and disposal of single-use towels with their associated contaminants is the volume occupied in the landfill. The single-use towel/contaminant combination has a lower density than the woven towel sludge and will occupy a larger volume in the landfill.

The use of solvent washing for woven towels has the potential to significantly reduce the amount of sludge sent to the landfill since the sludge from solvent washing is usually incinerated. However, the incineration of solvent washing sludge will result in a small increase in air emissions.

There were no distinct human health impact differences noted among the shop towels. The by-products of shop towel production and use have towel-dependent impacts, but it is not feasible in this assessment to determine a clear distinction of the impact differences for the shop towels.

The fuill report was submitted in fulfillment of Contract No. 68-C4-0020 by Lockheed Martin Environmental Systems and Technologies under the sponsorship of the U.S. Environmental Protection Agency.

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The complete report, entitled "Environmental Assessment of Shop Towel Usage in the Automotive and Printing Industries," (Order No. PB97-133698; Cost: $25.00, subject to change) will be available only from:
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