Short Communication

Composition of Fumes Evolving from Hot-Melt Glues

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Key words: Hot-melt glues, Fumes, Composition, Asthma

Hot-melt glues have gained increasing use with many products because they are solvent-free and environmentally friendly. They are mainly used in the paper, package, hygienic, printing and book-binding industries. In Finland the annual usage of hot-melt glues was about 4,000–5,000 tonnes in 1992. Complaints of respiratory irritation from exposure to fumes from hot-melt fumes are relatively common, even though very few cases of occupational disease (asthma) are related to such exposure. There are several types of hot-melt glues. A typical example would be a glue composed of: 1) a polymer, typically a copolymer such as ethene-vinyl acetate (EVA) or styrene-isoprene-styrene (SIS), 2) a resin used as a tackifier (e.g. pine rosin ester or synthetic C_5-alkyl polymer), 3) a wax (e.g. paraffin or microx wax) and 4) an antioxidant (e.g. BHT [butylated hydroxytoluene] or an alklyphenol derivative). In addition, hot-melt glues may contain mineral oils and inorganic fillers. Colophony resin fume is a known respiratory sensitizer and the resin itself is also a skin-sensitizer. Some resin hot-melt glues contain pine resin and therefore the same compounds as found in studies dealing with colophony resin in solder flux would also be expected to evolve from these hot-melt glues, but hot melt glues contain resin in a chemically modified form (resin acid ester), and they are used at temperatures lower than in soldering. A typical application temperature range is 150–210°C. This study was initiated due to an occupational asthma found in a book-binding company using hot-melt glues. We have found only a few reports on the health hazards or composition of the fumes from hot-melt glues. The aim of this study was to further characterize their composition.

Materials and Methods

Hot-melt glue samples: The hot-melt glues analysed in this study were obtained from Finnish factories in which they are used; they are listed in Table 1.

Weight loss tests: Weight loss of hot-melt glues due to the loss of volatile components was studied by keeping 1 g of each glue in a heat chamber (Termaks) for 1 hr at their recommended usage temperatures (155–210°C) and weighing the sample before and after the heat exposure. The tests were carried out at the recommended application temperatures. The temperature of the cabinet was measured by means of an accurate laboratory thermometer (Labotherm, GDR) in addition to its own thermometer.

Results

The one-hour weight losses of the four hot-melt glues (%) per hour) were as follows: Ecomelt 1.7% (155°C), Instant-Lok 0.5%, Rakoll S 1.2% (210°C) and Emutherm 0.6% (170°C). The results are averages of duplicate determinations at the application temperatures. The accuracy of the test is about ± 5%.

A typical gas chromatogram of a hot-melt glue (Instant-Lok 7652, a polyolefine-based hot-melt glue) is shown in Fig. 1, and Table 1 provides summary of the main volatile components of the glues studied.

The resin acid content of the fumes was 0.0003 mg/m³ for Emutherm and 0.001 mg/m³ for Ecomelt. The aldehyde content of the fumes was under 0.05 mg/m³. The main aldehyde found in all the glues was acetaldehyde (highest concentration 0.4 mg/m³ in the fume of Ecomelt), and only small amounts of formaldehyde aldehydes appeared. Traces of acetone (<0.1 mg/m³) were also found in the fumes.
In this study the fumes from hot-melt glue were obviously formed mainly through evaporation rather than degradation due to the relatively low temperatures used. The small amounts of low molecular weight aldehydes in the fumes also lead to the same conclusion. Obviously some degradation also takes place during the heating of the glue. The low content of resin acids can possibly be explained by the fact that an esterified form of resin is used in the studied hot-melt glues.

The following conclusions can be drawn on the basis of this study. Fumes from the selection of hot-melt glues studied are mainly composed of various aliphatic ($C_{8-14}$ octane–octadecane) and aromatic (e.g. alpha-methylstyrene) hydrocarbons, which obviously evaporate from the wax or polymer component of the glue. Indene was also found in the fumes of the glue containing coumarone-indene resin. Aldehydes (mainly acetaldehyde) were found in the fumes, but only in low concentrations. Antioxidants such as alkylated phenols (e.g: butylated hydroxytoluene (BHT)) and Irganox 1010 (Ciba-Geigy) or their degradation products were also prominent in the fume chromatograms, obviously due to their relatively higher volatility. Common respiratory sensitizers, such as aldehydes and abietic acid or its derivatives, were not found in high concentrations in the fumes of the studied hot-melt glues. When our results are compared with those of a brief Danish study, it seems that aldehydes and terpenes were less prominent in the present study. This is obviously due to the fact that resin acids/copalophy was used only in one of the glues studied.

**Acknowledgments:** This work was financially supported by the Finnish Board of Labour Protection. The authors thank Ms. Marja-Liisa Äijälä, for her skilful technical assistance in the chemical analyses and Ms. Maj-Len Henriks-Eckerman, Phil.Lic., from Turku Regional Institute of Occupational Health, for the resin acid analyses. The authors are also gratified to Mr. Markku Nelke and Mr. Bertel Waenerberg of Emutherm Ltd. for their useful comments on the study.

**References**


**Table 1.** Main volatile components found in fumes evolving from the glues studied

<table>
<thead>
<tr>
<th>Hot-melt glue (type)</th>
<th>Temp. °C</th>
<th>Major components in fumes</th>
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<tbody>
<tr>
<td>Ecomelt L3EX412 (Styrene-isoprene-butene-based hot-melt glue, contains esterified tall oil resin)</td>
<td>155</td>
<td>C10 Hydrocarbons (decane isomers) C13-C15 Hydrocarbons, partly oxidized Butylated hydroxytoluene (BHT) Cyclopentane, substituted</td>
</tr>
<tr>
<td>Istant-Lok 7652 (Polyolefine-based hot-melt glue)</td>
<td>175</td>
<td>C12 Hydrocarbon (dodecane isomers) C8 Hydrocarbon (octane) Alkylphenol derivative (degradation product of an antioxidant) C13-C16 Hydrocarbons</td>
</tr>
<tr>
<td>Rakoll S2120 (Ethene-vinyl acetate based glue, contains coumarone-indene resin)</td>
<td>210</td>
<td>Alkylphenol derivates 1H-indene Methyl-1H-indene alpha-Methylstyrene C12 Hydrocarbon (dodecane)</td>
</tr>
<tr>
<td>Emutherm 20-123 (Ethene-vinyl acetate-based glue, contains also alpha-methylstyrene resin)</td>
<td>170</td>
<td>C12 Hydrocarbon (dodecane isomer) alpha-Methylstyrene C18 Hydrocarbon C8 Hydrocarbon Alkylphenol derivative</td>
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</table>

**Fig. 1.** Chromatogram (total ion current) of the fumes from a polyolefine-based hot-melt glue (Instant-Lok 7652) sampled by the charcoal tube method. The gas chromatographic conditions: Injector and detector temp. 250°C, a 50 m HP-5 capillary column; temp. program: 30°C for 7 min, 10°C/min, 250°C for 10 min. Split ratio 1:25.