white paper

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RENEGADE PLASTICS textiles emit no volatile organic compounds during hot air welding

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Renegade Plastics®

RENEGADE PLASTICS TEXTILES EMIT NO VOLATILE ORGANIC COMPOUNDS DURING HOT AIR WELDING

By Katheryn Kolesar, PhD

Renegade Plastics (Renegade) proudly makes a plastic-coated textile that is better for the environment compared to textiles coated with polyvinyl chloride (PVC). In early 2025, we conducted testing on the extent to which Renegade's products release volatile organic compounds (VOCs) during thermal welding, specifically hot air welding. We found that, unlike PVC-coated textiles, the Renegade textiles emitted no detectable VOCs during hot air welding. The lack of VOCs helps to create a better working environment for textile fabricators.

INTRODUCTION

Thermal welding is a common method of fabrication for thermoplastic-coated textiles such as polyvinyl chloride (PVC) and thermoplastic polyurethane (TPU). Thermal welding can also be used for fabrication with Renegade's polypropylene-based textiles. Thermal welding can be done using hot air, a hot wedge, or a hot impulse bar. Thermal welding is ideal for many applications as it creates a flexible bond between two different pieces of coated textiles without leaving holes. Therefore, the weld is airtight, waterproof, and strong. PVC-coated textile welding typically occurs above 500˚C (Celsius) and welding with Renegade textiles is around 465˚C. In contrast to its benefits, thermal welding is known in fabrication settings to produce VOCs.

VOCs are carbon-containing compounds that evaporate from solid or liquid forms typically at or near ambient temperatures. There are a wide range of VOCs from a variety of sources. Some VOCs are considered innocuous such as natural emissions of VOCs from pine trees and the compound released from ripe bananas. These examples are VOCs that you can smell at low concentrations. There are a variety of other VOCs that have a high concentration threshold for scent detection and can be harmful to human health. Some examples of these include benzene, toluene, formaldehyde, tetrachloroethylene, methyl chloride, and vinyl chloride. A number of these, such as tetrachloroethylene, methyl chloride, and vinyl chloride, are only found in industrial settings.

Exposure to VOCs can cause immediate irritation to the eyes, nose, and throat. Breathing VOCs can cause damage to the liver, kidneys, lungs, and nervous system. Some effects are acute whereas prolonged exposure to some VOCs has been shown to cause cancer. There are several standards that can be used to determine safe levels of exposure to individual VOCs. The Occupational Safety and Health Administration (OSHA) publishes permissible exposure limits (PELs)[1], while the National Institute for Occupational Safety and Health (NIOSH) publishes Recommended Exposure Limits (RELs)[2]. RELs are

1 https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.1000TABLEZ1
2 https://www.cdc.gov/niosh/npg/

intended to limit exposure to hazardous substances in workplace air to protect worker health. NIOSH and OSHA regulations are the main focus for textile fabricator operations.

Additionally, this study will reference the California Office of Environmental Health and Hazard Assessment (OEHHA) exposure levels[3] associated with acute, 8-hour, and chronic exposure designed to protect the most sensitive individuals in the population by the inclusion of factors that account for uncertainties as well as individual differences in human susceptibility to chemical exposures. These levels are the concentration level at or below which no adverse non-cancer health effects are anticipated for the specified exposure duration. This information is useful in a work setting to determine if there are any adverse health effects that may affect worker well-being and long-term health.

Renegade makes a polypropylene-based plastic-coated textile that has minimal additives. As such, we are confident that thermal welding our products do not release VOCs, which helps to protect worker health. However, we wanted to provide data to back up this claim and also to quantify and identify VOCs released from thermal welding PVC-coated textiles. We conducted a study to measure the total amount of VOCs and also to quantify amounts of specific VOCs generated by hot welding Renegade textiles and also PVC-coated textiles.

MATERIALS

A common hot air welder from a U.S.-based manufacturer that was less than ten years old was used for all welding in this study. The machine was set to a hot air temperature of 465˚C and a roller speed of 12 meters per minute. Note that machine settings can vary widely between locations as welding quality can be affected by factors like ambient temperature and relative humidity, among other variables.

The textiles tested included one textile from Renegade, specifically the Renegade PPI-270 textile in black with matte finish, and two different PVC-coated textiles (PVC 1 and PVC 2). Both PVC-coated textiles were actually laminate fabrics, whereby PVC film is adhered to a woven polyester substrate using an adhesive. Both PVC-textiles in the study where classic white color with added flame retardancy. To provide sufficient material for continuous welding during the study, the team prepared 4- to 6-inch-wide strips, hundreds of yards long, of all three textiles prior to the study. The hot air welder was used to add an overlap hem to the long strips, therefore ensuring almost continuous welding for the duration of the three textile study-periods.

3 https://oehha.ca.gov/air/general-info/oehha-acute-8-hour-and-chronic-reference-exposure-level-rel-summary

METHODS

We measured the concentration of total VOCs while hot air welding. Each type of textile was welded consistently for one hour and no ventilation was used during welding. Note that during normal fabrication, a fan is used to ventilate the work area, so the concentrations of VOCs measured during this study are likely elevated in the immediate work area compared to normal operation. Workers for the test were outfitted with proper personal protective equipment (PPE) to avoid exposure to potentially elevated VOC concentrations, and the test was conducted outside of normal business hours to avoid influence from other fabrication operations.

The testing protocol involved three sets of hot air welding times with background sampling before and after each hot air weld period. The schedule was:

1. Background sampling for 30 minutes.
2. Renegade-coated textile welding for 60 minutes.
3. Background sampling for 45 minutes. Ventilation of the station for the first 30 minutes.
4. PVC-coated textile welding for 60 minutes.
5. Background sampling for 45 minutes. Ventilation of the station for the first 30 minutes.
6. PVC-coated textile welding for 60 minutes.
7. Background sampling for 60 minutes. Ventilation of the station.

Figure 1. A Renegade Plastics employee outfitted with proper PPE hot air welding PVC.

The total VOC concentration was measured throughout the testing using an Aeroqual Ranger with VOC sensor head. The VOC attachment uses a 10.6 electron Volt (eV) ionization source to ionize gases drawn in through its inlet. Most VOCs, except for lighter compounds such as methane and formaldehyde, are ionized at 10.6 eV, so it provides a comprehensive measurement of the total amount in the ambient air. The ionized gases are detected with a photoionization detector with a range of 0 to 30 parts per million (ppm). The VOC sensor head measurements are calibrated to isobutylene. Measurements are reported as one-minute averages. The Aeroqual Ranger and hot air welder are shown in Figure 2.

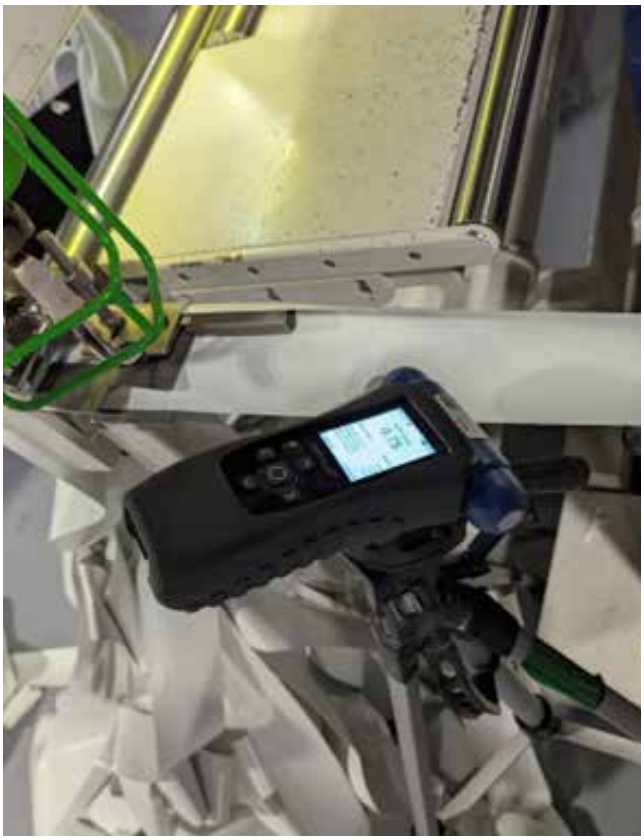

Figure 2. The Aeroqual Ranger with VOC sensor head is used to measure total VOCs during hot air welding.

Whole air samples for offline analysis were also taken during two background periods, while hot air welding with Renegade, and while hot air welding with PVC 1. These were analyzed by Eurofins US using the Environmental Protection Agency Compendium method for organics TO-15. Method TO-15 uses gas chromatography and mass spectrometry (GC/MS) to separate the gases collected in a whole air sample by size and charge followed by mass to charge ratio. The concentration of 97 distinct VOCs are determined by the integration of the area under the peak, which is then converted to concentration by a calibration curve for each species.

RESULTS

The results of the total VOC measurements are shown in Figure 2. During an hour of welding with Renegade, the average concentration of total VOCs (0.00061 ppm) was not statistically different compared to the average background measurements that were taken before and after sampling. On the other hand, the average concentrations measured during welding each of the two PVC textiles have a 0.2 to 0.4 ppm increase in total VOCs compared to their relevant background average concentrations. These averages are statistically different from the background averages at the 99.9% confidence interval.

The speciated VOC data from the TO-15 canister analysis provides an indication of what VOCs are being released during hot air welding. There are several compounds whose concentration increased by more than 50% during hot air welding of PVC 1 above the background concentration. These compounds, their observed concentration, the NIOSH REL standard, and the OEHHA public health limit are given in Table 1. All VOCs were lower than the NIOSH REL by a factor of 500 or more. In all cases, the NIOSH REL is less than or equal to the OSHA PEL. The trimethylbenzenes (1,2,4- and 1,3,5-trimethylbenzene) concentration is above the public health limit for chronic exposure from OEHHA, but less than their 8-hour public health limit. Note that whole air samples were only collected during PVC 1 hot air welding and not during PVC 2 hot air welding.

On the other hand, the speciated VOC data from the TO-15 canisters taken during Renegade welding only showed an increase of more than 50% for only carbon disulfide. The concentration observed was 1.5 micrograms/m3, which is more than 1000 times less than the NIOSH REL (3 milligrams/m3). It is also more than 500 times less than the public health safety level for chronic exposure set by OEHHA (800 micrograms/m3). The carbon disulfide is likely emitted from the colorants used to make the polypropylene-based coating black. Other colors will not likely emit carbon disulfide. Note that carbon disulfide should be detected with the VOC sensor head used here for measurement of total VOCs.

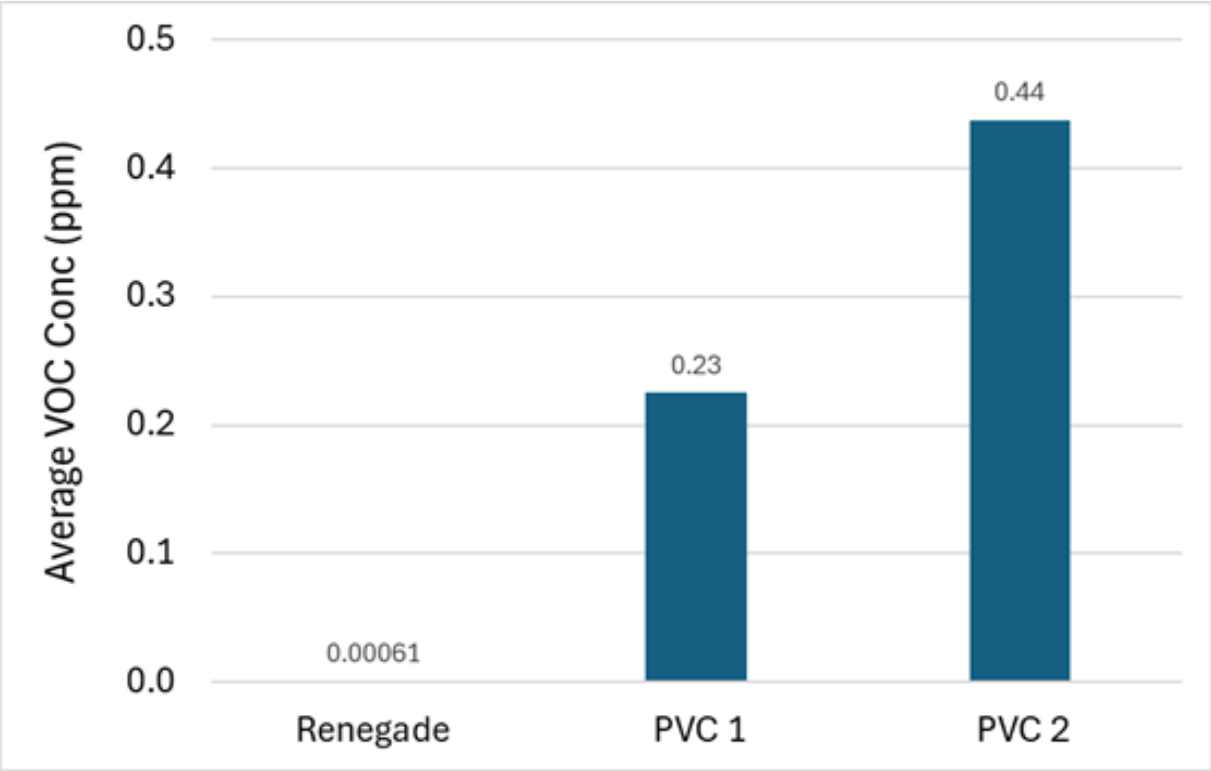

Figure 3. Average Total VOC concentration during each welding test.

Compound	Concentration (micrograms/m^3)	NIOSH REL (micrograms/m^3)	OEHHA (micrograms/m^3)
Trimethylbenzenes	5.6	125000	4 (chronic) 8 (8-hour)
Dodecane	2.5	1400	None
Isopropyl benzene	0.29	245000	None
Decane	13	None	None
Nonane	3.4	1050000	None
Propylbenzene	0.45	None	None
Undecane	11	None	None

Table 1. VOC compounds that increased during PVC 1 hot air welding

CONCLUSIONS

Thermal welding is a common method of fabrication for plastic-coated textiles. Both the Renegade polypropylene-based coated textiles and PVC-coated textiles can be thermally welded using hot air machines. We measured the total VOCs and some individual VOC compounds during fabrication of Renegade-coated textiles and PVC-coated textiles. PVC-coated textile fabrication led to an increase in VOCs of 2-4 ppm whereas the total VOCs measured during welding with Renegade-coated textiles were not statistically different than the average background concentration. Therefore, if fabricators are looking for an ultra-low VOC alternative to PVC-coated textiles, Renegade's polypropylene-based coated plastic textiles are the ideal alternative.