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Vapor Sealing Properties of Cover Tiles in Toluene

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1.0 INTRODUCTION

Greatario Covers Inc. asked Exova to assess the vapor sealing properties of their Hexa-Cover® floating tiles and ECC, LLC PVDF evaporation balls. In earlier work (Exova Report no. 13-005-28985-3), Exova designed a small scale experiment for quantifying the vapor sealing properties of insulation tiles. The test was performed by using and 85 US gallon drum partially filled with crude oil and heated to 80°C with and without samples. Nitrogen gas was purged into the barrel headspace at a rate of 5 liters/minute. Volatile emissions from the crude oil were condensed in two collection flasks connected in series and chilled in dry ice. Flasks were weighed at regular time intervals to calculate the mass of volatiles collected over time.

This work was repeated by making three modifications to the experiment:

- The crude oil was replaced with toluene. In previous work the more volatile components of the crude oil would deplete over time resulting in a gradual decrease in the amount of volatiles collected. This made it more difficult to quantify the effectiveness of the covers.
- The height of the barrel was lowered from 38 to 24 inches to reduce the amount of toluene required to execute the test;
- Three collection flasks were used rather than two to ensure full capture of volatiles.

The vapor sealing properties of two products was compared under identical conditions by performing four runs - one without tiles, one with Hexa-Cover® floating tiles and two runs using ECC, LLC PVDF Evaporation balls with one and two layers of balls covering the toluene. The Hexa-Cover® tiles were received and logged in as described below:

Client Identification	Our Sample Number
Hexagonal Floating Covers Lot # 2-13-12-8, 15 individual units	13-33250-083877
Hexagonal Floating Covers Lot # 12-8-13-1, 15 individual units	13-33250-083878

The ECC, LLC PVDF evaporation balls were acquired by Exova.

2.0 EXPERIMENTAL

All raw data are referenced in Lab Book No. 13508.

2.1 Test Apparatus

The test apparatus is shown in Figure 1. A 55 US gallon drum (24"H x 26" Dia., 208 L) heated with a 1300W band heater and insulated with 4" of fiberglass sheet was filled with 41 US gallons of toluene (18 '' deep) and maintained at 80 ±1°C by using a rheostat. The temperature of the toluene was monitored by using a calibrated digital thermometer. Nitrogen gas was purged into the barrel headspace at a rate of 5 liters/minute as measured by a rotameter and mass flow meter. The vapor-laden nitrogen flowed through three collection flasks chilled in dry ice.

Equipment

- 2-decimal place balance MII 13998 (calibration due 2014-03-19)
- RMS Clamp meter MII B13644 (Due: 2013-10-26)
- Digital thermometer MII B05318 (Due: 2014-07-23)
- Thermocouple MII B13425 (Due: 2014-05-04)
- Thermocouple MII B13710 (Due: 2014-01-18)
- Thermocouple MII B13427 (Due: 2013-05-04)
- Mass flow meter MIIB05666 (For reference only)
- Multimeter MII B04933 (Due: 2014-05-19)
- Rotameter MII B13580 (Due: 2013-10-29)

Figure 1. Test apparatus used to test vapor sealing properties of tiles.

2.2 Test Procedure

Run without Tiles

1. The drum is filled with 41 US Gallons of toluene and preheated to 80°C the day before testing. The three condensation flasks are then purged with nitrogen and capped with rubber stoppers.
2. The headspace of the drum is purged with nitrogen at a flow of 5 L/minute for at least 1 hour to ensure the system is at a steady state.
3. The flasks are then placed in an insulated container which is then filled with dry ice (volatiles trap) and pre-chilled for at least 10 minutes.
4. The stoppers are then removed and replaced with the drum vent line as shown in Figure 1.
5. Volatiles are collected for 1 hour. Flasks are then re-capped with their stoppers and weighed (2-decimal place balance) to determine the amount of toluene collected.
6. The flasks are then rinsed with methanol and blown out with nitrogen before being put back into the dry ice.
7. After 10 minutes, stoppers are removed, replaced with the drum vent line and the stop watch started.
8. Repeat step 3 to 7 three more times.
9. At the end of the run verify the level of toluene in the drum. If the level dropped by more than 0.5 inches add toluene.

Run with Tiles

1. Open drum and place nylon foam spacer assembly on the surface of the toluene as shown in Figure 2. Figure 3 shows the arrangement of the ECC, LLC PVDF evaporation balls over the surface of toluene for comparison.
2. The drum is left overnight with a low flow of nitrogen (~ 0.3-0.4 L/min.).
3. Repeat steps 1 to 9 from the "Run without Tiles" described above.

Figure 2. Picture showing placement of tiles on the surface of the toluene.

Figure 3. Picture showing ECC, LLC PVDF evaporation balls with one layer (left) and two layers (right) of balls.

3.0 RESULTS AND DISCUSSION

3.1 Vapor Emissions

The effectiveness of the tiles at reducing the rate of volatile emissions was evaluated by performing four collection runs – one without tiles and three with tiles covering the surface of the toluene. Briefly, volatiles were collected by flowing nitrogen gas into the headspace of the drum at a rate of 5 L/minute. At 1 hour intervals the collection flasks were weighed to determine the mass of toluene collected over this period. This procedure was repeated five times and the average mass of volatiles collected was calculated. The mass of volatiles collected over 5 hours for the two products is summarized in Tables I and II.

Table I
Mass of Condensed Toluene Collected Without and With Hexa-Cover® Tiles

Run Time (hours)	Mass (g) of Toluene Collected Without Tiles	Mass (g) of Toluene Collected With Tiles
1	325.4	115.9
2	307.8	112.3
3	324.1	103.2
4	320.5	99.6
5	307.5	116.0
Average Mass (g)	**317.1**	**109.4**
Standard Deviation	**8.8**	**7.6**

Table II
Mass of Condensed Toluene Collected Without and With ECC, LLC PVDF Evaporation Balls

Run Time (hours)	Mass (g) of Toluene Collected Without Tiles	Mass (g) of Toluene Collected with	
		One Layer of Balls	Two Layers of Balls
1	325.4	168.6	171.6
2	307.8	165.7	169.4
3	324.1	165.0	172.2
4	320.5	163.7	163.0
5	307.5	161.1	165.0
Average Mass (g)	**317.1**	**164.8**	**168.2**
Standard Deviation	**8.8**	**2.7**	**4.1**

Covering the exposed toluene surface with Hexa-Cover® tiles resulted in a 66% reduction in volatile emissions when compared to equivalent runs performed without Hexa-Cover® tiles.

Covering the exposed toluene surface with one and two layers of ECC, LLC PVDF evaporation balls resulted in a 48% and 47% reduction, respectively in volatile emissions when compared to equivalent runs performed without balls.

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