TECH NOTES

The Effect of Heat on PVC Membrane Filters

Introduction

PVC membrane is a preferred filter medium for gravimetric analysis of respirable crystalline silica, airborne dust, hexavalent chromium, and other analytes. This filter material is hydrophobic and considered to be gravimetrically stable with a gravimetric variance of less than 0.5% in temperatures up to 49 C (120 F), that is, the filter should have less than a 0.5% change in weight compared to its original weight when allowed to equilibrate under controlled laboratory conditions and then reweighed. Increasing temperatures and tighter standard requirements necessitate an understanding of how this material would behave if exposed to temperatures exceeding the 49 C (120 F) benchmark in correlation to gravimetric results. PVC filters can be exposed to higher temperatures in the shipping process, in warehouses, or even in the field in extreme conditions.

Results and Discussion

To assess the gravimetric stability of PVC membrane filters, 15 loose filters and 5 filters assembled into cassettes were exposed to various temperatures. Filters and cassettes were allowed to equilibrate to room temperature for 2 hours before being weighed. All filters were weighed on the same analytical balance at temperatures ranging from 20 to 23 C (68 to 73.4 F) and in a relative humidity range of 40 to 50%. This testing was conducted across multiple lots of PVC filters.

An initial baseline study was conducted by exposing the filters and cassettes to room temperatures (20 to 23 C [68 to 73.4 F]); a second set was exposed to 50 C in an incubator. The room temperature loose filter samples reported an average loss of 0.0473% over 8 weeks with a standard deviation of 0.0926. The room temperature cassette sealed samples had an average gain of 0.0177% with a standard deviation of 0.0618 over the same 8-week period. The 50 C (122 F) incubator samples were run in conjunction with the room temperature samples. Over that period, the loose filters showed an average loss of 0.0083% with a standard deviation of 0.0922, and the sealed cassettes reported an average loss of 0.0773% with a standard deviation of 0.1037. Both sample sets performed similarly and showed the ability of the filters to maintain a gravimetric variance of less than 0.5% when stored in these conditions; no samples exceeded this threshold.

After baseline performance was determined, three new samples sets were exposed to 72 C (161 F), 60 C (140 F), and 54 C (130 F). The filters and cassettes exposed to 72 C (161 F) were weighed after 24 hours of storage in the incubator and showed an immediate significant weight loss. The average weight loss was 0.63% for the 15 loose filters with a standard deviation of 0.0209 and 0.51% for the 5 cassettes with a standard deviation of 0.1259. Both values are outside the expected 0.5% variance. These samples were left in the incubator for 7 days to see if any more loss would occur. The samples were weighed on days 4 and 7 with results similar to those on day 1, indicating an immediate weight loss and subsequent return to a steady and stable weight at temperature.

The samples exposed to 60 C (140 F) were weighed after 24 hours in testing parameters. These samples also experienced significant weight loss. After 24 hours the loose filters showed an average loss of 0.74% with a standard

deviation of 0.0734 and the cassettes a loss of 0.62% with a standard deviation of 0.1229, both of which exceeded the expected 0.5% variance. When these samples were weighed again after 4 days in the incubator, some individual samples showed weight loss up to 1%. To determine if that weight loss was permanent, after day 4 testing, these samples were left out in room atmosphere (20 to 23 C [68 to 73.4 F] and relative humidity 40 to 50%) for 3 days and weighed again on day 7. The day 7 data did not show any recovery in weight, indicating permanent weight loss.

The test samples exposed to 54 C (130 F) were weighed after 24 hours of exposure to the elevated temperature. The 15 loose filters showed an average weight loss of 0.49% with a standard deviation of 0.0890; the 5 cassettes showed a weight loss of 0.29% with a standard deviation of 0.0374. The samples were weighed on days 4, 7, and 14 with each day showing an increased loss in weight. On day 14, the filters in the cassette had an average net loss of 0.58% with a standard deviation of 0.12291 and the loose filters lost an average of 0.71% with a standard deviation of 0.0924. With both sample sets exceeding the 0.5% variance, the testing was concluded.

During this study it was noted that the filters experienced a physical property change: when exposed to the elevated temperatures, their edges began to curl. *See Figure 1.* This change was observed primarily in the loose filters at 70 C (158 F) as they were not compressed in a cassette.

With an average filter weight of 11.23 mg, a loss of 0.5% weight reflects a negative weight of approximately 56 µg. Filters kept at or below 50 C (122 F) had a variance of less than 0.1%, which would reflect a change of 11 µg.

Recommendation

As a result of this study SKC recommends that PVC material not be exposed to temperatures greater than 49 C (120 F) as it may result in significant gravimetric loss to the medium.

Figure 1. PVC filter exposed to 70 C (158 F)

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