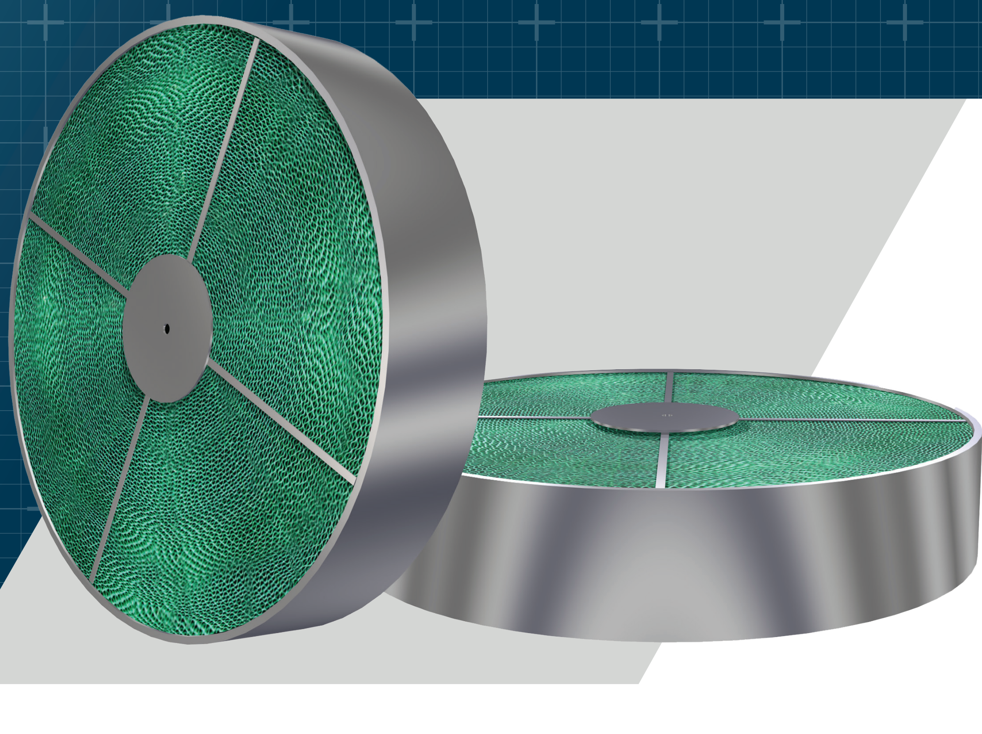
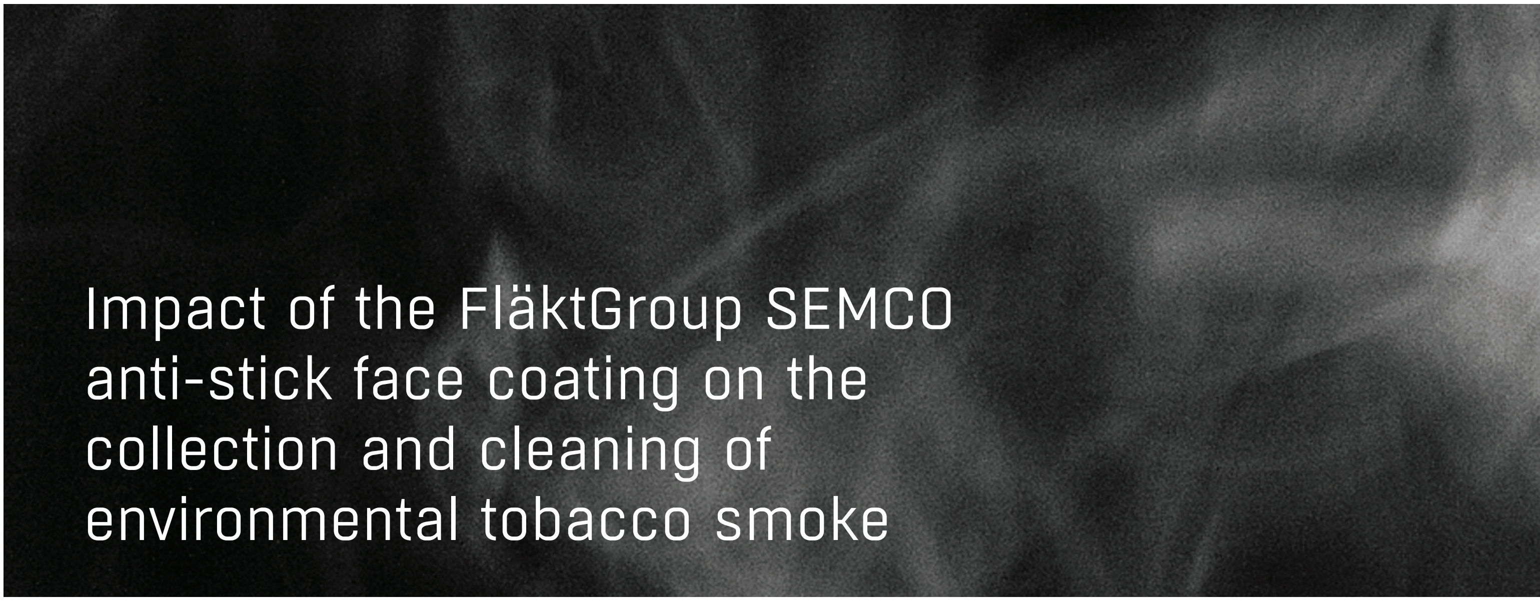
FläktGroup SEMCO

SPECIALIZED HEALTHY AIR SOLUTIONS

IMPACT OF THE FLÄKTGROUP SEMCO ANTI-STICK FACE COATING ON THE COLLECTION AND CLEANING OF ENVIRONMENTAL TOBACCO SMOKE FROM THE WHEEL SURFACE

RESEARCH FINDINGS





Impact of the FläktGroup SEMCO anti-stick face coating on the collection and cleaning of environmental tobacco smoke

Smoking environments, like casinos require large quantities of outdoor air to maintain an acceptable indoor air quality and to conform to the current building codes. The ASHRAE 90.1 energy code requires that systems serving these types of applications requiring high outdoor air percentages employ total energy recovery wheels (requiring greater than 50% total enthalpy recovery).

One of the major challenges to installing total energy recovery wheels (and other air to air heat exchangers) to serve heavy smoking environments is avoiding the collection of the environmental tobacco smoke (ETS) on the surface of the transfer media, which can result in the increase of pressure loss and the reduction of system airflow.

The FläktGroup SEMCO TE wheel has been specifically designed to minimize the risk of the collection of ETS. It utilizes a unique transfer media "flute" design which has a size (hydraulic diameter) that is significantly larger than that used for other products. This design also recesses the flat section slightly, resulting in a larger initial entryway to the media, reducing the entry effects that cause plating of dust and ETS to occur (see **Figure 1**).

However, despite these enhancements some collection of ETS can occur in heavy smoking environments, especially if filter maintenance is poor and/or if the wheel is allowed to remain stationary for extended periods for any reason. During such conditions it would be highly beneficial if the wheel face could be treated with a specialty coating that would both restrict the collection of the ETS particulate (anti-stick surface) and allow for the removal of a significant portion of any collected particulate with the use of compressed air, if possible.

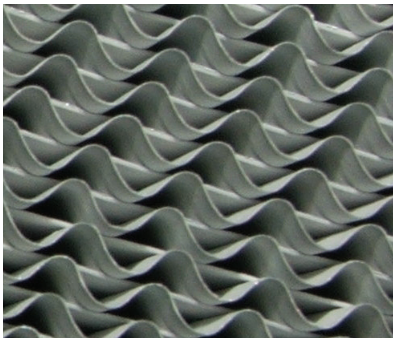


FIGURE 1: Magnified photo of the FläktGroup SEMCO TE wheel face prior to any face coating showing the large flute size and recessed flat section.

FläktGroup SEMCO has developed an effective anti-stick coating that has been shown to meet these objectives. This document summarizes the results of a research project initiated to investigate the effectiveness of this enhanced wheel face coating with regard to the collection and cleaning of ETS.

A test chamber built and operated by researchers at the Georgia Tech Research Institute provided the data necessary to confirm the benefits offered by the anti-stick face coating. The new coating was found to both reduce the amount of ETS collected and to promote effective removal with compressed air alone.

Test apparatus

A simple flow test loop was constructed as shown by **Figure 2**. The test loop employed a smoking machine that steadily puffed a popular brand of cigarette that had the filters removed to maximize smoke injection. By re-circulating the majority of the challenged airflow, a very high smoke density was created and maintained over time.

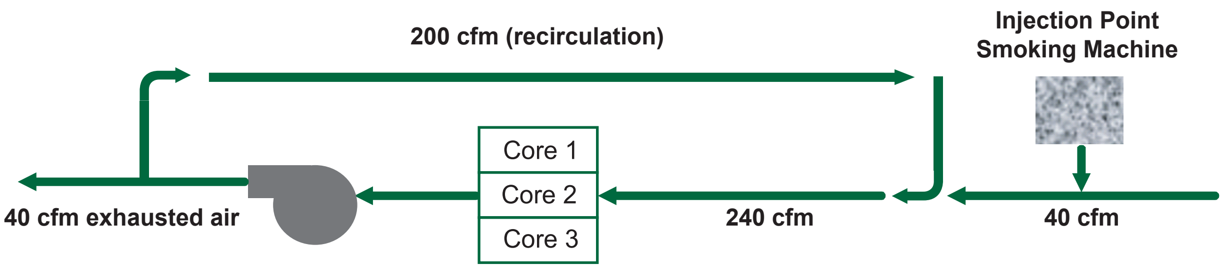


FIGURE 2: Schematic of test loop used by GTRI for this research investigation.

Three wheel media core samples, each measuring 12” by 4” across and 6” deep were stacked and placed within a test box to form a one square foot section of wheel media comprised of three different materials, but all challenged with the same ETS smoke density.

The first core section was standard FläktGroup SEMCO FV wheel media without any face coating. The second core section was the standard FläktGroup SEMCO FV media (as per core 1) but treated with custom face coating modified to include a proprietary anti-stick agent. The third core section was identical to core 2 but treated with twice the anti-stick agent concentration.

The purpose of the testing was to investigate the effectiveness of the customized face coating with regard to avoiding the collection of ETS particulate and the ease by which any collected particulate could be removed using compressed air alone.

Test procedures

The test procedure involved challenging the wheel media with a concentration of ETS particulates over a duration that would simulate approximately 4 years of heavy smoking. The number of cigarettes required to achieve the desired loading was based upon the following assumptions:

Assumptions:

1) Based upon a casino with 15 cfm/person of outdoor air
   33% of all occupants smokers, 3 cigarettes per hour smoked
   20 hours of peak smoking per week, 50 weeks per year or 1,000 hours

2) Therefore, for each square foot of transfer media processing 240 cfm as per the test loop, the equivalent of 16 filtered cigarettes per hour is required ((240 cfm)/(15 cfm/person * .33 smokers * 3 cigarettes per hour))

3) Four years or 4,000 hours requires the equivalent of 64,000 filtered cigarettes

4) Cigarette filters, human consumption, plating out on building surfaces and return air filters combine to remove 80% of the particles generated before they reach the wheel therefore 12,800 unfiltered cigarettes required

5) Recirculation arrangement in rig returns 90% of challenge ETS, significantly increasing the ETS concentration (approximate factor of 10) so to reach the targeted four-year loading, 1,280 cigarettes were used.

The Marlboro brand of cigarettes was used with the filters removed. The negative pressure at the inlet to the test chamber ensured that all of the smoke generated could pass through the three cores of wheel media. No filters were used within the test loop and the 1,280 cigarettes were injected continuously over the course of several days. Once the challenge was completed, the sample cores were removed, labeled in plastic bags, photographed and then analyzed.

In an attempt to represent the “worst case” scenario, the FläktGroup SEMCO wheel media used for this research was cut from an FV series product where the flute height (hydraulic diameter) is smaller than the TE series wheel. The FV flute height is approximately 25% less than that used for the deeper, TE wheel. The flute height used by the FV product is more inline with that used in the marketplace by FläktGroup SEMCO competitors, including those bidding against the FläktGroup SEMCO TE product offering.

We know from years of experience that the laminar flow exhibited by the recovery wheel media will limit the collection of any particulates within the inner surfaces of the transfer core. As a result, any particulate that does not impinge on the face of the wheel is re-circulated for another pass, which quickly builds the challenge stream to a very high concentration. We also know that any impingement that occurs will collect on the entering or exiting edge, up to approximately 1/16" into the wheel media due to the turbulent entering and exiting effects.

FIGURE 3: Ten times magnification of core 1, the untreated sample after the simulated 4 years of heavy ETS loading. The buildup of ETS is clearly visible, with perhaps 20% of the flow area blocked.

As a result, the analysis of both collected particulate and ease of cleaning is limited to the surface of the wheel media. Therefore, relative differences between the three media samples were easily made visually, through the use of a simple 10 times magnification. A more quantitative approach was used to judge the effectiveness of removal with compressed air. To accomplish this, actual samples of the wheel media entering edge was removed, dissolved in a solvent and then analyzed to see the percentage reduction in nicotine, the most logical marker for ETS. This is discussed in more detail by the following sections.

Findings and results: particulate collection

Significant differences were observed between the collection of ET particulate on the wheels treated with the anti-stick face coating (core 2 and 3) and the baseline core that was not (core 1.) A substantial amount of buildup occurred on the untreated wheel (shown as **Figure 3**) while little buildup was observed for the two treated wheels (shown as **Figure 4**)

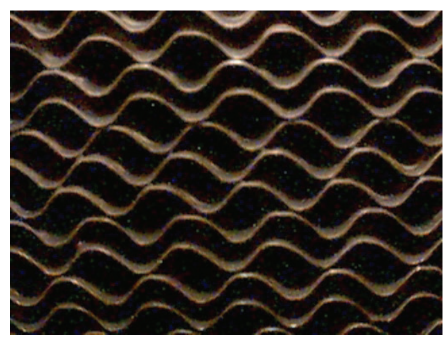


FIGURE 4: Ten times magnification of core 2, the anti-stick treated sample after the simulated 4 years of heavy ETS loading. Little buildup of ETS is visible and no significant media blocking exists.

No visual difference was noted between the two anti-stick face coated wheel samples (cores 2 and 3) with regard to buildup of ETS. For this reason, only cores 1 and 2 are compared in this report.

As clearly demonstrated by **Figures 3 and 4**, the face coating with the incorporated anti-stick agent provides an important advantage over a non-face coated product since it resists the collection of particulate in heavy smoking environments (and likely other applications where the buildup of particulate is of concern.)

The degree of buildup shown by **Figure 3** would have added substantial pressure loss to the HVAC system, thereby reducing airflow and stressed the wheel cassette. Eliminating surface buildup is also critical to minimize the change of transferring ETS odors into the supply air stream.

Findings and results: particulate removal with compressed air

The sample cores shown in **Figures 3 and 4** were flushed with low-pressure (canned) compressed air in an attempt to remove the collected ETS particulate without the use of any other cleaning methods. Photographs of these core samples after cleaning are shown in **Figures 5 and 6**.

The compressed air cleaning removed a significant portion of the buildup that had collected on the face of the untreated wheel, but a substantial amount still remained. A close visual estimate of the remaining buildup was 30%.

The remaining buildup was far more than desired, would still have a significant impact on the pressure loss across the wheel media and could contribute to the carry-over of ETS odors (See **Figure 5.**)

In contrast, the wheel media treated with the anti-stick face coating, following the cleaning with compressed air, appeared very much the way it did prior to the ETS challenge. No visual particle collection remained and, as a result, no significant impact on air pressure loss or odor carry-over would be expected of this core sample (See **Figure 6**). Being able to clean the wheel to this extent using only compressed air is a highly beneficial (and desired) advantage for smoking applications and other installations where particulate loading is a concern.

It is appropriate to point out that the photos of the anti-stick face coated samples shown above (**Figures 4 and 6**) are somewhat misleading because the face coating applied is black in color, making it difficult to distinguish between it and accumulated ETS. **Figure 7** is provided to show what the face coated media looked like prior to the ETS challenge. A careful look at both **Figures 6 and 7** will show the black coating on the entering edges of the transfer media, in a depth of approximately 1/16”. Beyond this face coating covering the entering edges of the media, the white desiccant coating can be seen.

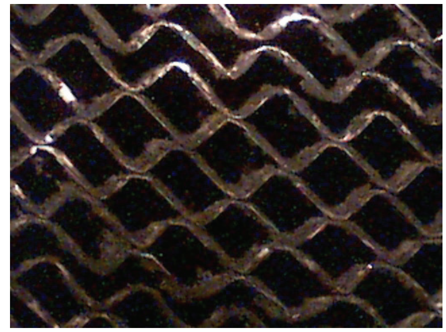


FIGURE 5: Ten times magnification of core 1, the untreated sample after the simulated 4 years of heavy ETS loading and compressed air cleaning. As compared to Figure 3, much of the buildup has been removed but approximately 30% still remains.

FIGURE 6: Ten times magnification of core 2, the anti-stick treated sample after the simulated 4 years of heavy ETS loading and compressed air cleaning. Essentially all the buildup observed in Figure 4 is removed.

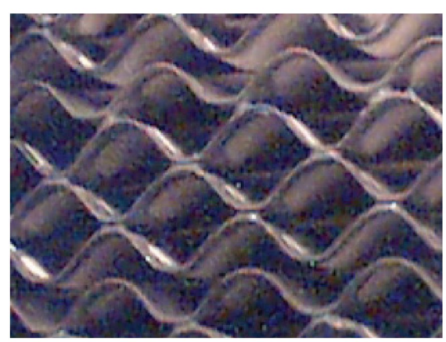


FIGURE 7: Media shown with anti-stick face coating prior to challenge with heavy ETS in test chamber.

Findings and results: particulate removal efficiency based on quantitative nicotine analysis

The microscopic photos shown as Figures 3 through 6 provides clear visual evidence to document the difference is both the relative ETS loading as well as the degree to which this loading was removed though the use of compressed air.

One of the main objectives of the research was to quantify the relative improvement in compressed air particle removal, if any, associated with anti-stick face coating. In an attempt to obtain this data, samples of the wheel media's entering edge (first 1/16th inch) were cut from each of the three core samples and analyzed using a gas chromatography/mass spectrometer apparatus. Samples were collected and analyzed by the Georgia Tech Research Institute.

The procedure used involved rinsing these wheel face samples with methanol. Samples were taken from and analyzed for each of the three wheel cores prior to and after one cleaning cycle with low-pressure compressed air. A sample of each of the rinses was then injected into the gas chromatography/mass spectrometer system for analysis.

The concentration of the ETS marker compound, nicotine was measured by the gas chromatography/mass spectrometer

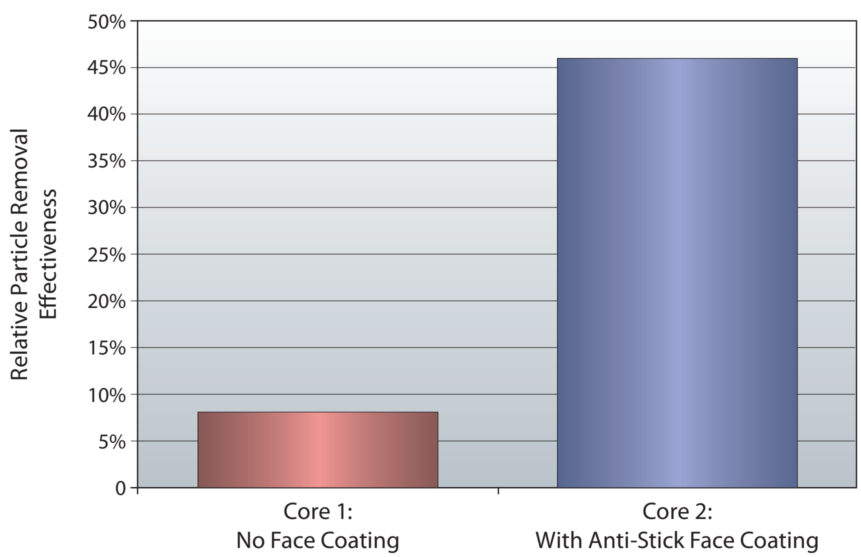


FIGURE 8: Summary of relative nicotine removal from untreated core (core 1) and treated cores (average of cores 2 and 3) after compressed air cleaning. Data compares the nicotine content of the wheel media sample before and after one low-pressure compressed air cleaning cycle.

for each of the six rinse samples using the equipment's internal standard of toluene. Knowing the nicotine concentration of each wheel core sample both before and after cleaning with compressed air provided the data used to prepare the summary graphic shown as **Figure 8**.

The results of this quantitative testing suggested that the compressed air cleaning removed approximately 5.5 times more nicotine from the wheel media samples treated with the anti-stick face coating than was observed for the non-treated core. The nicotine reduction for samples #2 and #3 averaged 46% while the nicotine initially contained on the sample #1 wheel surface was only reduced by 8%.

The results of this quantitative investigation support the conclusion made based upon the visual inspections reported as **Figures 3 through 6**. The anti-stick face coating significantly improved the ability to remove a significant portion of any airborne particulate (ETS) that collects on the treated wheel surfaces when cleaned with compressed air.

Since the anti-stick treated samples were found to collect less surface particulate over time, and since a much greater percentage of any buildup is removed through a simple compressed air cleaning cycle, the benefits associated with the anti-stick coating are additive. As a result, this product enhancement is highly recommended for all applications, especially those involving high levels of airborne particulate. This is especially true for applications involving environmental tobacco smoke.

Research conclusions:

Testing was configured to simulate heavy loading of cigarette smoke (ETS) introduced to three wheel core samples for a challenge period designed to simulate the equivalent of approximately four years. Under these conditions, the wheels treated with the anti-stick face coating were shown to collect far fewer particles than the wheel without the anti-stick face coating.

In addition, the ETS particles collected (as documented by nicotine analysis) were removed using compressed air alone far more effectively when the anti-stick face coating was applied. By contrast, the non-face coated wheel sample still exhibited significant particulate loading after compressed air cleaning and would have required detergent/wet cleaning.

The combined advantages of lower initial ETS collection and improved compressed air cleaning offered by the anti-stick face coating are highly beneficial to applications where particulate collection is a concern (i.e. smoking environments.) This coating should result in lower fan energy over time (lower pressure loss,) less risk of odor carry-over associated with heavy surface ETS particle collection and allow for routine cleaning (as necessary) using only compressed air, which eliminates the high cost, inconvenience and mess associated with the detergent/wet cleaning process.

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