

Test results indicate significant differences in particle capture and retention characteristics of wipers

By Peter K. Kang, Ph.D., Senior Development Engineer for Milliken Anticon Products

How well does a wiper wipe? When it comes to cleaning or removing micron or submicron size contaminants from surfaces, that's a tougher question to answer than one would imagine. To the author's knowledge, there are no widely accepted test methods to directly measure the performance of wipers during usage. There are some tests to determine the amount of grease/oil pick-up during wiping and some attempts to measure particle pick-up during wiping, but these all have limitations. Instead, wiper buyers typically specify certain levels of cleanliness and sorbency profiles. The sorbency profile includes the rate of wicking as well as the liquid holding capacity of the wiper. The cleanliness specification includes the number of particles released from the wipers during testing, which involves placing the wipers in containers with water and shaking the containers for a specified amount of time. It is implied from these results that the wiper releasing the fewest number of particles in the testing will give the best performance or release the fewest contaminants into the clean environment.

Because the cleanliness profile of the wiper is used as an indication of its performance in use, manufacturers have gone to great efforts to reduce the amount of releasable particulate contaminants. For example, Paley et al. (U.S. Patent Number 4,888,229) patented a fused-border wiper to try to reduce particulate contaminants released from the edges. Diaber et al. developed a knitted tube wiper where only two of the edges are cut and sealed, thus attempting to reduce the sources of contamination (U.S. Patent Number 5,229,181). Reynolds (U.S. Patent Number 5,069,735) patented a hot-air jet to seal the edges of cut wipers. Morin et al. (U.S. Patent Number 6,189,189) described a process for minimizing the amount of releasable particulates in presaturated wipers when the wipers are saturated with solvents. None of these inventions, however, addresses the removal of the contaminants on the surface.

This article reports the results of particle capture and release testing conducted by Milliken & Company's "Anticon" Products Business on a new wiper technology designed to accomplish both minimal releasable contaminants, as well as the capture and retention of contaminants from the surfaces being cleaned. The wipers tested and compared incorporate the company's Particle Attraction Technology (P.A.T.), which involves chemical modification of the fibers to improve their particle attraction and retention features.

Test methodology

In general, the testing process was very similar to IEST-RP-CC-004.2 section 5.2 in that it used the same specified shaker, same duration of shaking time, and laser particle counter. The capture and release data was then calculated from these results. Third-party testing was not an option in this case as there are no existing standard test methods to test for particle capture and release.

The ideal wiper...should not only start out clean but be able to capture and hold contaminants until they can be taken out of the clean environment.

Two different types of standardized test dusts were used. A.C. Fine Test Dust was purchased from Duke Scientific Corporation (Palo Alto, CA) and carbon black particles, Monarch 1300, were supplied by Cabot Corporation (Billerica, MA). Suspensions of both particles were made with deionized (DI) water. An ultrasonic bath was used to ensure that the particle aggregates were broken up as much as possible.

Procedure for particle attraction (capture) and retention testing

1. A suspension containing 0.100 g A.C. Fine Test Dusts (or carbon black) in 3,000 g of DI water was vigorously shaken and then allowed to settle for 30 minutes. Approximately 2000 g was decanted off the top and used as the stock solution.

wiper testing

2. From the stock solution, 2.1 g of the A.C. Fine Test Dusts solution (or 1.0 g carbon black) was then added to filtered DI water to make 400 g of particle suspension.
3. The suspension was placed in an ultrasonic bath for 10 minutes and then shaken on a Gilson biaxial shaker for 5 minutes.
4. Particle concentration was measured using 25 g of the suspension.
5. A dry wiper was weighed and then added to the remaining 375 g in a 1.0 L wide-mouth HDPE jar. The jar was then shaken for 5 minutes with the biaxial shaker.
6. The wiper was removed and added to a jar containing 375 g of clean DI water in which the particle count had already been measured. The weight of the wet wiper was recorded and the jar, with the wiper in it, was shaken on the biaxial shaker for 5 minutes. The wiper was then removed and discarded.
7. Particle concentrations in both jars were measured.
8. Steps 2 through 5 were repeated with a jar containing only particle suspension (no wiper) to determine the amount of particle break-up or redistribution.
9. Steps 5 and 6 were repeated with jars containing only clean DI water and wiper to determine the amount of particles released from the wiper.

Definition of particle capture and release

With the experiment outlined above, the total number of particles that were generated includes the initial number of particles in the suspension, the number of particles released from the wipe during the biaxial shaking, and the number of particles created from the break-up of larger aggregates. If the number of particles captured is negative, meaning that more particles were released into the water than removed, then the number of particles captured is defined as zero. Therefore, the number of particles captured by the wiper is defined as:

$$\text{number of particles captured} = \text{initial particles in solution} + \text{particles released from wiper} + \text{particles created from particle break-up} - \text{particles after biaxial shake}$$

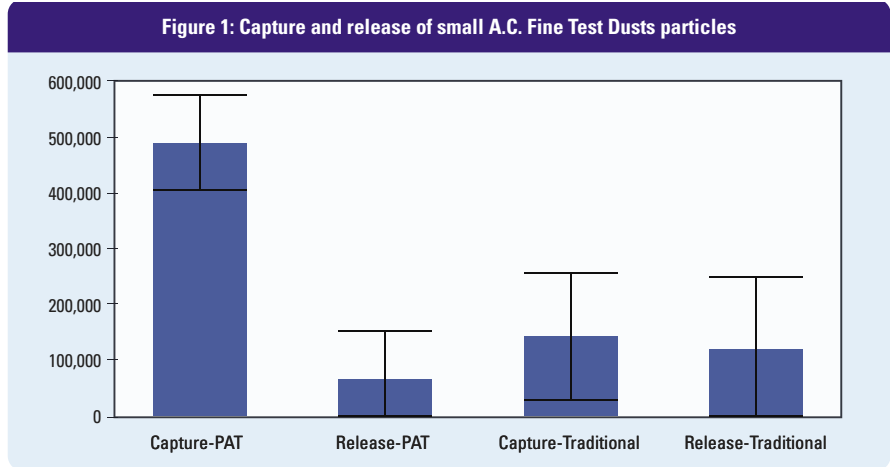


Figure 1. Capture and release of small A.C. Fine Test Dusts particles from solution for P.A.T. wipers and traditional wipers.

Particle retention by the wiper is just as important as particle pick-up. If the wiper does not retain the contaminants, they will recontaminate the surface or environment one is trying to clean. Therefore, it is of great interest to see how many of the particles that were captured were retained by the wiper. If the number of particles released is negative, then it is defined as zero since no particles were released:

$$\text{number of particles released} = \text{particles after biaxial shake (step 6)} - \text{particles in wet wiper} - \text{particles released from clean wiper}$$

Test results

Results were analyzed for traditional wipers

and P.A.T. wipers for both A.C. Fine Test Dusts and carbon black Monarch 1300. The reported results for P.A.T. wipers are averages of five replicates. Since the results of traditional wipers are averages of wipers from several competing companies, they are averages of 15 replicates. Error bars shown on graphs are plus/minus one standard deviation. Tests involving small particles have higher variability than large particle testing.

Figures 1 & 2 show results for A.C. Fine Test Dusts for small particles and large particles, respectively. Small particles are defined as the sum of 0.5 μm or larger particles and large particles are defined as the sum of 5.0 μm and larger particles. Initial concentrations

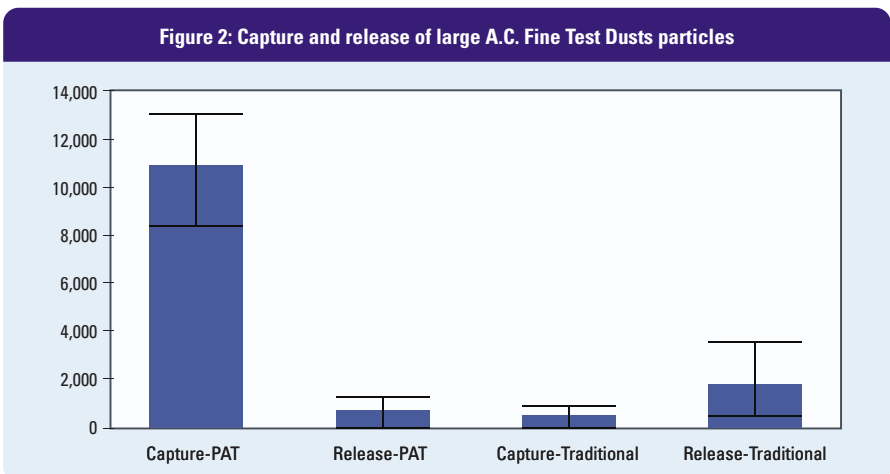


Figure 2. Capture and release of large A.C. Fine Test Dusts particles for P.A.T. wipers and traditional wipers.

Figure 3: Capture and release of small carbon black particles

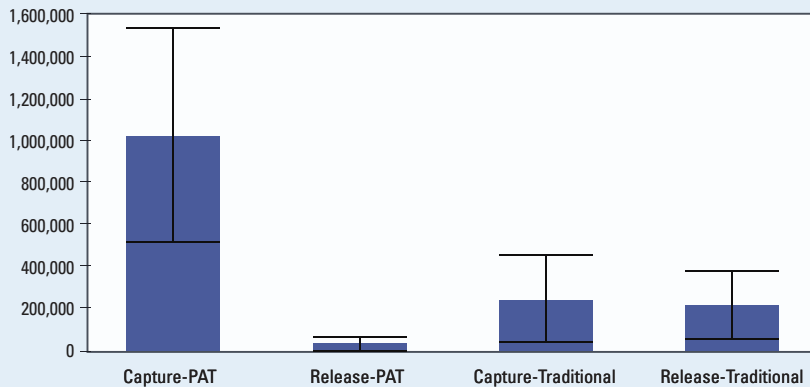


Figure 3. Capture and release of small carbon black particles for P.A.T. wipers and traditional wipers.

Figure 4: Capture and release of large carbon black particles

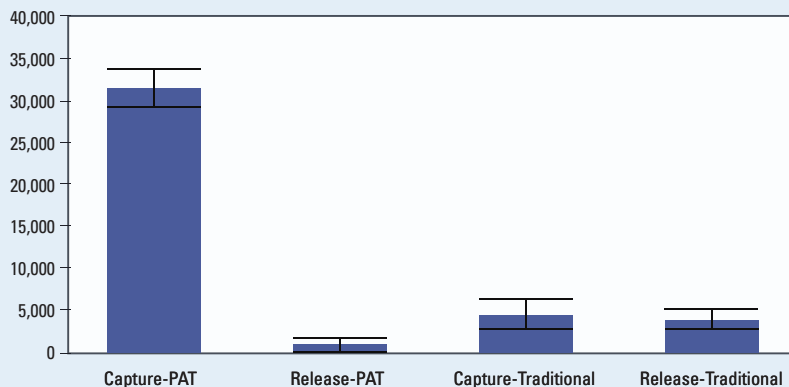


Figure 4: Capture and release of large carbon black particles for P.A.T. wipers and traditional wipers.

for small particles and large particles are approximately 3,000,000 and 10,000 particles, respectively. As shown in Figure 1, the test results showed wipers with P.A.T. captured over 3 times more small particles than traditional wipers, releasing only 14 percent of the particle they captured. Traditional wipers were seen to release 85 percent of the particles on the wipers. Potentially, these released particles could cause recontamination or cross-contamination issues.

The test results for large particles showed that the P.A.T. wipers captured over 35 times more particles than the other wipers tested. Only a very small percentage of those captured particles were released. The traditional wipers released essentially all of the large particles they captured.

Test results for small and large carbon black particles are shown in Figures 3 and 4, respectively. The tests showed that P.A.T. wipers captured 4 times more small particles and 7.5 times more large particles than the other wipers tested. The P.A.T. wipers released 2 percent of

the captured small particles compared to the other wipers tested, which released 88 percent of the captured small particles. In the large particles tests, results showed P.A.T. wipers released 3 percent of the captured particles compared to the other wipers tested, which released 88 percent. Again, these particles that are not bound to the wiper surface will be a source of contamination.

Figure 5 shows the number of particles captured by the wipers after they were subjected to a 0.1 percent Monarch 1300 carbon black solution and then dried. The image on the left shows that the P.A.T. wiper has significantly more particles attached to the surface of the fibers than the traditional wiper on the right.

Conclusion

Although there are no commonly accepted test methods to directly evaluate the performance of wipers, indirect methods have been developed by the industry to set specifications for wipers. Using these measurement tools, improvements have been made in the reduction of particles released from wipers through unique wiper constructions, edge sealing, and laundering processes. The ideal wiper, however, should not only start out clean but be able to capture and hold contaminants until they can be taken out of the clean environment and discarded. [E](#)

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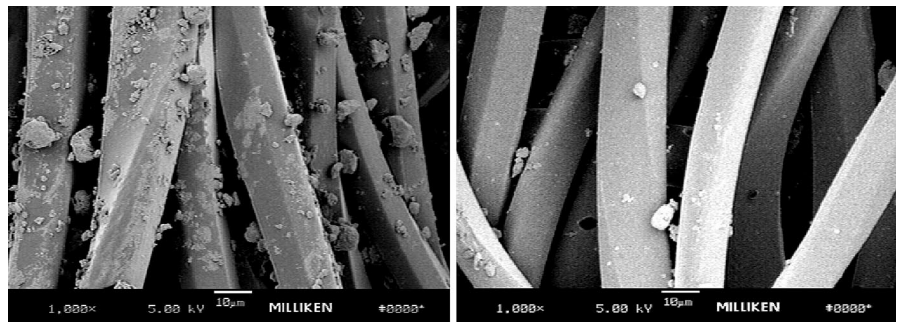


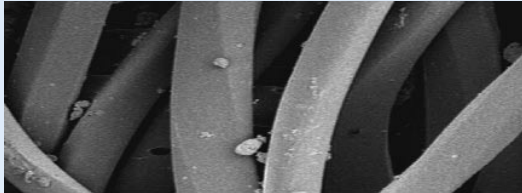
Figure 5: Scanning electron micrograph of particles captured by P.A.T. wiper (left) and traditional wiper (right).



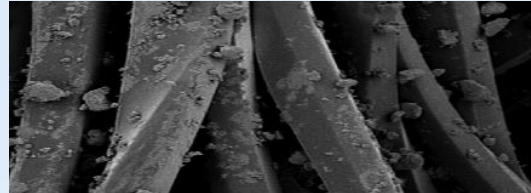
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Try Anticon® with P.A.T., and see what you've been missing.



Wiper without P.A.T. after use
attracts and retains far fewer particles.



Wiper with P.A.T. after use
attracts 35 times more particles.

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- 3. Retains 95% of the particles captured**, so there's less chance of re-contamination

Advantages of Anticon:

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- Laundered and packaged in an ISO Class I cleanroom environment
- Arrives with minimal particles, fibers, ions and extractables
- Available in various bases and weights in economical bulk packaging
- Works well with solvents

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Product	Milliken Number	Size	Wipers/Pk	Pks/Cs
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White Magic with P.A.T.	493200-529	9"x9"	150	14
StandardWeight with P.A.T.	493300-549	9"x9"	150	14
HeavyWeight with P.A.T.	493400-569	9"x9"	150	8

If you're not using Anticon wipers with P.A.T., you're leaving too much on the table. For more information on putting Anticon with Particle Attraction Technology to work for you:

Call 1-800-762-3472 or e-mail us at anticon@milliken.com.

