

HONTEK HC05XP1 VS. 3M TAPES

COMPARISON OF HYDROLYSIS RESISTANCE AND OTHERS

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Background

This White Paper provides the comparison of HC05XP1 against 3M 8663 and 8667 tapes under various test conditions.

Hydrolysis-aged Specimens: Combined Sand and Rain Erosion Test Results

Aluminum airfoils with 3M tapes and HC05XP1 coating were placed in the hydrolysis oven at 185°F and 87% relative humidity. 3M tapes were aged for 16 days. HC05XP1 was aged for 23 days. After the hydrolysis aging, the airfoils were dried at 50°C for 5 days. The samples were tested at University of Dayton Research Institute/Wright-Patterson Air Force Base. They were first eroded by sand at 353 mph, using 177-255 micron sands at 90 degree impact angle, at 10 grams/cm² sand mass load. The sand eroded airfoils were further rain eroded at 500 mph, with one inch per hour rainfall.

Hontek HC05XP1 was found to last more than 120 times longer than 3M tapes.

3M 8663 and 8667 Tapes

3M 8663 tape is 0.020” thick and 8667 tape is 0.027” thick. **Both tapes were eroded to the substrate within one minute.** The photos below show the appearance after rain erosion for 5 minutes. As seen in the two photos below, there was nothing left on the leading edge after 5 minutes of rain test.



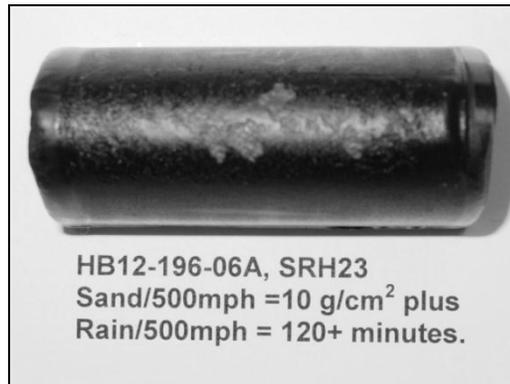
Hydrolysis-aged 3M 8667 after 5 minutes of rain.



Hydrolysis-aged 3M 8663 after 5 minutes of rain.

Hontek HC05XP1

As seen in the photo below, the hydrolysis aged HC05XP1 sample performed well under the combined sand and rain test. **After sand erosion, it survived 120 minutes of additional rain erosion with only minor surface damage. HC05XP1 is more than 120 times better than 3M tapes!**



Hydrolysis-aged Specimens: Toothpick Test Results

3M 8663 Tape

After 15 days of hydrolysis aging, 3M 8663 tape can be easily broken into pieces and smeared around with a weak wooden toothpick. This shows that a true degradation and breakdown of the 3M tape has occurred (see photos below).



Above: Before hydrolysis aging
Clean edges of tape



Above: After 15 days hydrolysis aging
Smeared edges of tape

3M 8667 Tape

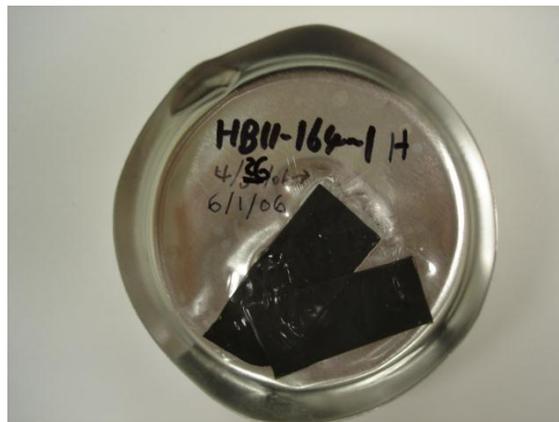
Similar degradation was observed on 3M 8667 tape when observed after 29 days of aging. Because these two tapes are of similar chemistry, it is likely that it was degraded in the same time frame as 3M 8663 tape. Note the tape was smeared with the use of a weak wooden toothpick.



3M 8667 tape after 29 days of hydrolysis aging
Broken and smeared edge of tape

Hontek HC05XP1

After 35 days of hydrolysis aging, HC05XP1 softened at this extreme combination, but firmed up within one minute after removal from the oven. It remained strong and could not be broken or spread with a stainless steel spatula (much stronger than wood toothpick!). The photo below shows numerous indentation/push marks inside the coating that resisted the tearing force of the stainless steel spatula, but the coating did not smear like 3M tape. This shows that Hontek HC05XP1 has far superior hydrolysis stability than 3M tapes.



HC05XP1 (HB11-164-1) after 35 days of hydrolysis aging
Did not smear even after pushed/scraped with stainless steel spatula

RAIN EROSION RESISTANCE – Resistance to Delamination

The following rain erosion test results confirm what the helicopter pilots have known for years: 3M tape delaminates unpredictably during flight, causing severe vibration and grounding of the aircraft. The Army does not allow its pilots to fly the helicopters in rain when a small hole develops in the tape. The rain erosion test shows why.

Two aluminum airfoils were covered with 3M 8663 tape and Hontek HC05XP1 coating. Using a razor blade, a 1/8" hole was created on the 3M 8663 airfoil, and a bigger 1/4" hole was created on the HC05XP1 airfoil. *Both were mounted on the same rain erosion test rig at the Wright-Patterson Air Force Base and tested side by side.* Rain test condition was 500 mph, one inch per hour rainfall, 1.8mm raindrop size.

Within 19 minutes, the 3M tape delaminated and was lifted off the aluminum airfoil substrate in large piece. [The photo below shows the 3M taped airfoil after 20 minutes of rain erosion.](#)



3M 8663 tape before rain erosion
Nice and clean

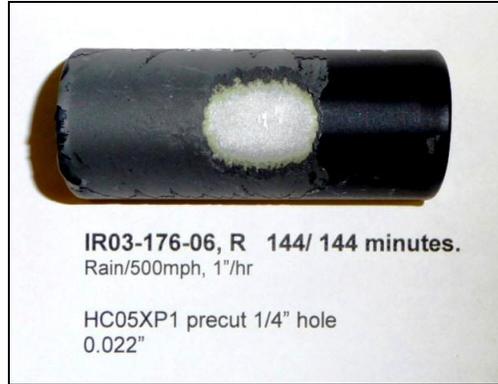


3M 8663 tape after 20 minutes in rain
Catastrophic delamination

With Hontek HC05XP1, even though the hole was twice as big as 3M tape, there was no delamination after 144 minutes. Part of the thin black topcoat layer was removed by the rain, but the basecoat continued to protect the substrate well. [At 144 minutes, the raindrops have already eaten into the aluminum surface, but HC05XP1 coating still showed only limited damage.](#)



**HC06XP1 before rain
Nice and clean**



**HC05XP1 after 144 minutes rain erosion
Very slow damage site propagation**

The above sharp contrast in rain erosion resistance explains why Hontek-coated blades have very large flight safety margin. After 32,000 flight hours in harsh environment, the Army has decided to put the following statement in the Hontek Blade Repair Instructional CD:

“When inspecting damaged blades, keep in mind that NONE of these damages on Hontek-coated blades require the grounding of the aircraft.”

DELAMINATION OF 3M TAPES

The following photos show the typical delamination observed in sand and rain erosion tests. Field experiences in UH-60 show that 3M tape requires repair every 3-20 flight hours. The sudden unexpected peeling of 3M tape caused severe vibration and grounding of the aircraft.

Lab erosion tests in combined sand and rain show that 3M tape typically eroded away in large pieces in 14-20 minutes.





HONTEK COATED BLADES AFTER ONE YEAR IN THEATER

The following photo shows one of the blades returned to Sikorsky after serving 684 hours over one year in Iraq. The blades were in excellent condition. No track and balance issues even after repeated repairs in the field.



The following are blades returned after serving about 620 flight hours over one year in Afghanistan, with repairs done in the field. The blades are in excellent condition.



**HONTEK-COATED BLADES: LOCALIZED DAMAGED SITES.
LOW CONSUMPTION OF REPAIR KITS**

Hontek-coated blades do not delaminate like tapes. The following photo shows the average damages experienced after 100-120 flight hours in the theater, with combination of rain, sand and gravel impact damages. The damaged sites are isolated and small.



BLADE COATING REMOVAL

Hontek-coated blades can be re-used through many years of deployment cycles. The coated blades have potential to achieve “unlimited blade life” if properly maintained with Hontek repair kits. As such, the cost of operating with Hontek-coated blade is higher in the first year due to the cost of spraying the blades, but dropped substantially in the second year and after. The cost of operating the coated blades will be just the cost of using the repair kits.

If for some reason the coating on the blades must be removed, it can be done efficiently with plastic media blasting and a combination of power sanding and hand sanding. Acrylic beads can strip the coatings on the metal substrate within second upon blasting. On the composite substrate, power sander is used to remove the sand erosion resistant topcoat layer and about 0.010” thick basecoat layer. Afterward, hand sanding is used to remove the remaining hand-sandable basecoat layer.

The following photo shows a stripped UH-60 blade with this process.



BENEFITS OF HONTEK HC05XP1 VS. 3M TAPE

The following comparisons were made by Virginia Army National Guard at the end of their one-year deployment in Iraq in 2007:

ADVANTAGE OF HONTEK HC05XP1:

1. Easy field repair with topcoat touch up. Spray topcoat at about 40 flight hour intervals. Aircraft can be in the mix 3 hours later. Aircraft can fly immediately after touch up repair if needed. No flight safety issue.
2. For primer /basecoat/ topcoat repair, apply at about 120 flight hour intervals. Took 12 hours including cure time and ready to go. (Note: Actual repair time about 3- hours)
3. No need to touch up tail rotor blades.
4. No need to touch up tip caps.
5. No need to track and balance.
6. Enable blade de-ice
7. Reduce halo on blades.

PROBLEMS WITH 3M TAPES

1. Tape flying off during test flight or ground runs post PMI and flight. Tape issues every 15 hours typical having some sort of PMI work.
2. Need to cut out section then copy on opposite blade
3. Cannot fly until Maintenance can rebalance the blade
4. Need to wait for cure. Downtime 24-36 hours.
5. No tape on tip caps- impartial coverage.
6. No blade de-ice capability. Need to remove tape to do blade de-ice.
7. Still has halo effect since tip caps are not covered.

PROBLEMS WITHOUT PROTECTION

1. Swap a blade and balance. Need 1.5 days minimum to be up and running.
2. Realistically takes 2-5 days to get parts on hand.
3. Tail rotor another 24-36 hours
4. Tip caps another 24 hours.

WHEN ZERO IS A PERFECT SCORE

CELEBRATING TWO HISTORICAL ACHIEVEMENTS IN ROTOR BLADE DURABILITY AND FIELD REPAIRS



In 2006-2007, the Virginia Army National Guard flew two Black Hawks in Iraq for a total of 1,447 hours with Hontek-coated blades, **achieving ZERO main blade replacement**. Eighteen other Black Hawks in the same mission without Hontek coatings experienced a 30% main blade replacement rate.*

In 2008-2009, 159th CAB/101st Airborne Division flew 50 Black Hawks with Hontek-coated blades, including 30 new UH-60Ms, for a total of 31,000 hours in Afghanistan, *also achieving ZERO main blade replacements*. In comparison, a previous mission in a similar environment without Hontek-coated blades required a 26% main blade replacement rate*.

Hontek-coated blades are de-ice compatible, permit fast repairs with no blade removal and reduce downtime. This new technology reduces the need for blade replacements, increases aircraft availability and provides the Army with dramatic cost savings in fleet operation.

(* Data may contain some blade replacements not caused by erosion damage.)



*As a result of the achievements by the 159th CAB, Hontek is the proud winner of 2009 AAAA Army Aviation Materiel Readiness Award for a Contribution by a Small Business Organization.



PROVEN EROSION PROTECTION

www.Rain-Sand-Erosion.com

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