External White Paper, Henkel Adhesives ACM

Fast Cure High Impact Resistance Wearing Compound

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1. Henkel ACM-APAC PD

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Abstract

Wearing compounds are polymer composites that combines superior wear resistant given by abrasive ceramic fillers, with high adhesion provided by epoxy technology. A new wear resistant compound, Loctite PC 9593, was successfully developed and launched recently to protect and extend service life of high wear and impact areas of processing equipment in mining and steel plant applications, such as chutes, screens, hoppers and centrifuges, against severe wear and impact. Loctite PC 9593 is a room temperature curable two-part alumina bead and silicon carbide filled epoxy product. Loctite PC 9593 abrasion resistance was measured by dry abrasion test, 2 body abrasion test and gas jet erosion at different conditions. The abrasion resistant results are compared and discussed with both high impact resistance wearing compound and fast cure wearing compound. This paper will present product development concept, product description and performances.

Introduction

Wearing compounds are polymer composites that combines superior wear resistant abrasive ceramic fillers with high adhesion of two-part epoxy technology. Wearing compound has been widely used as wear resistant protective coatings to extend service life of industrial plant and equipment by protecting them from abrasion and impact. It can be used to either restore worn surfaces or use on new parts.

Henkel is the global market leader and technology supplier for wearing compounds for decades. We have series of high-performance wearing compound products that can meet various wear prevention and rebuilding applications [1]. is The product line include standard wearing compound suitable for use to protect equipment from various abrasion conditions. Beside the standard version, there are high impact resistance wearing compound and fast-curing version wearing compound product, useful for short repair and rebuild time. Recently, it

was requested to combine high impact resistance and fast cure together to develop one fast cure high impact resistance product.

Alumina and silicon carbide have been commonly used as the main abrasive inorganic filler for wearing compound because of the good wear resistant property and easy supply. Hardness of alumina and silicon carbide is shown in Figure 1[2, 3]. Properties of silicon carbide and alumina is shown in Table 1.

Table 1. Properties of silicon carbide and alumina

Property	Silicon carbide	Alumina
True density, g/cm^3	3.21	3.98
Knoop hardness, Hk	2,600	2,000
Melting point, ℃	2600, breaks down	2050
Specific heat, kJ/kg・K	0.63-1.26	0.92-1.26
Thermal cond., W/mK	167.6	30.2
RT	67.0	13.0
400℃	46.9	6.3
1000℃		
CTE, ppm/K		
RT	3.8	6.9
400℃	4.1	7.8
1000℃	4.8	8.3

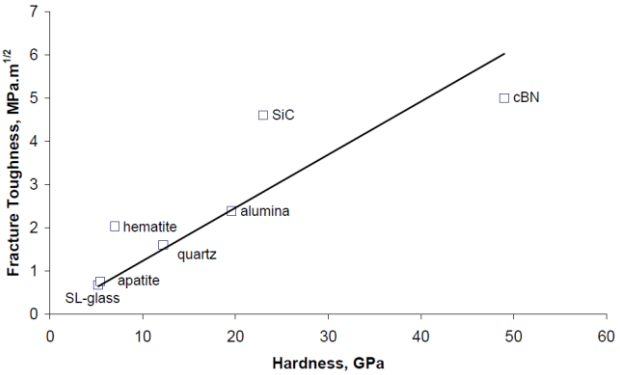

Figure 1. Hardness and fracture toughness for usual abrasive fillers.

Loctite PC 9593 was validated and used for centrifugal machine by a key coal mine customer in China Because the shutdown time for material to cure is only 3 hours, traditional high impact resistance wearing compound doesn't meet curing time requirement. The new fast cure high impact wearing compound Loctite PC 9593 is perfectly suitable for this application.

Materials and Methods

1.1 Material

Loctite PC 9593 A Batch#: MT917S6219
Loctite PC 9593 B Batch#: MT917S6220

1.2 Test Methods and Parameter

Drop impact test
ASTM D 2794
23±2℃, 50±10%RH

Slurry abrasion test was conducted by DUCOM TR-44 slurry abrasion test rig according to ASTM G-75.

Test Parameter:	Speed: 100 rpm
	Revolution:300
	Load: 10.09 kg
	Slurry: 2kg Al2O3 + 500 ml Water
	Specimen Dimention:75X25X6.0 mm

Miller test is conducted by DUCOM TR-45 Miller and Sar number machine according to ASTM G75-01.

Test Parameter:	Load on each arm: 22.4 N
	Test Duration: 2hrs
	Slurry: 150gm Al2O3 + 150 gm water
	Length of Stroke: 203.2 mm

Dry abrasion test

Test Parameter:	Speed: 100 rpm
	Revolution:200
	Load: 5 kg
	Specimen Dimention:76X25.4X12.7 mm

Gas Jet erosion test is conducted by DUCOM TR-471-900 Gas jet erosion tester according to ASTM G-76.

Test Parameter:	Erodent discharge=2gm/min
	Erodent velocity=72m/sec
	Test Condition= Ambient temperature
	Test duration= 15 min on each holder
	Erodent Consumed:30000 mg
	Specimen Dimension: 25X25X5 mm

Results and Discussion

2.1 Product Description

Loctite PC 9593 is a 2-component room temperature curable, 100% solid epoxy system designed to protect, rebuild and repair processing equipment with wearing resistance and high impact resistance requirement, such as centrifugal machine, chutes, screens which are subjected to wearing and impact. This product can also be used for particle abrasion under dry conditions in transport elbows, chutes and other equipment. This product is typically used in applications with an operating range of -30 °C to 120 °C.

2.2 Impact Performance

Drop impact test ASTM D2794 is a standard test method for impact performance. This test involves applying organic coatings to suitable 24 gauges metal panels and dropping a standard weight from a certain distance to induce an indenter deforming the coating as well as the substrate. About 4 mm thickness of wearing compound product is coated on GBMS panel. 1mm and 5mm thickness panel are used for the evaluation. Drop impact test result of Loctite PC 9593 is compared with typical fast cure wearing compound and typical high impact resistance wearing compound in Table 2. PC 9593 passed direct impact test on both 1mm and 5mm thickness GBMS panel. Both typical high impact resistance wearing compound and fast curing wearing compound failed in 1mm thickness direct impact test.

Table 2. Drop impact test result

Product name	Direct drop impact	Indirect drop impact
Loctite PC 9593	1mm thick: pass	1mm thick: fail
	5mm thick: pass	5mm thick: pass
Typical high impact wearing compound	1mm thick: fail	1mm thick: fail
	5mm thick: pass	5mm thick: pass
Typical fast cure wearing compound	1mm thick: fail	1mm thick: fail
	5mm thick: pass	5mm thick: pass

2.3 Abrasion Resistance

Abrasion resistance of Loctite PC 9593 were measured by 4 different abrasion testing methods in order to evaluate and simulate its wearing performance for various industrial applications. The results are compared and discussed with both high impact resistance wearing compound and fast curing wearing compound.

2.4.1 Dry abrasion resistance

Dry abrasion test determines the resistance of wearing materials to scratching abrasion by means of dry sand and a rubber wheel. The results can be used to simulate sliding wear resistant applications such as coal feeders & mills, sinter plant elbow & ducts as well as cement bag house ducts. Dry abrasion test results of Loctite PC 9593 are summarized in Table 3. Its volume loss result is compared with the result of fast cure wearing compound and high impact wearing compound in Figure 2. As seen, Loctite PC 9593 yields higher volume in dry abrasion test. The higher weight loss in Loctite PC 9593 may be attributed to presence of high impact flexible curing agent matrix.

Table 3. Dry abrasion test of Loctite PC 9593

Sample No.	Weight, mg			Weight loss, mg	Volume loss, mm^3
	initial	Final	loss		
1	52367	52032	335		
2	54219	53897	322	346	179
3	51472	51092	380		

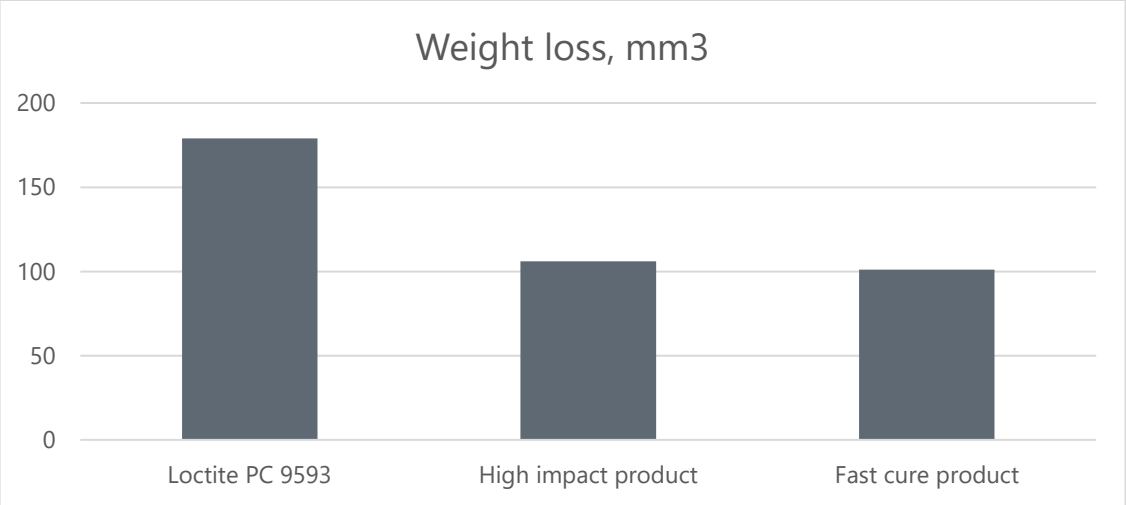

FIGURE 2. Volume loss results from dry abrasion test

2.4.2 Slurry abrasion resistance

Slurry abrasion test determines the resistance of wearing materials as a wet abrasive slurry of alumina passes in between a steel wheel and cured sample. Slurry abrasion result can be used to simulate wear resistant applications for ash handling pumps and clarifier in wastewater treatment. Slurry abrasion test results of Loctite PC 9593 are summarized in Table 4. Its volume loss result is compared with high impact wearing compound and fast cure wearing compound in Figure 3. Weight loss of Loctite PC 9593 is lower than the other two products. This result indicates that Loctite PC 9593 also performs better and can withstand longer time than typical fast cure wearing compound and high impact wearing compound at severe wet slurry wearing conditions in various applications.

Table 4. Slurry abrasion test of Loctite PC 9593

Sample No.	Weight, mg			Weight loss, mg	Volume loss, mm^3
	initial	final	loss		
1	17340	17175	165		
2	20431	20261	170	165	87
3	19040	18881	159		

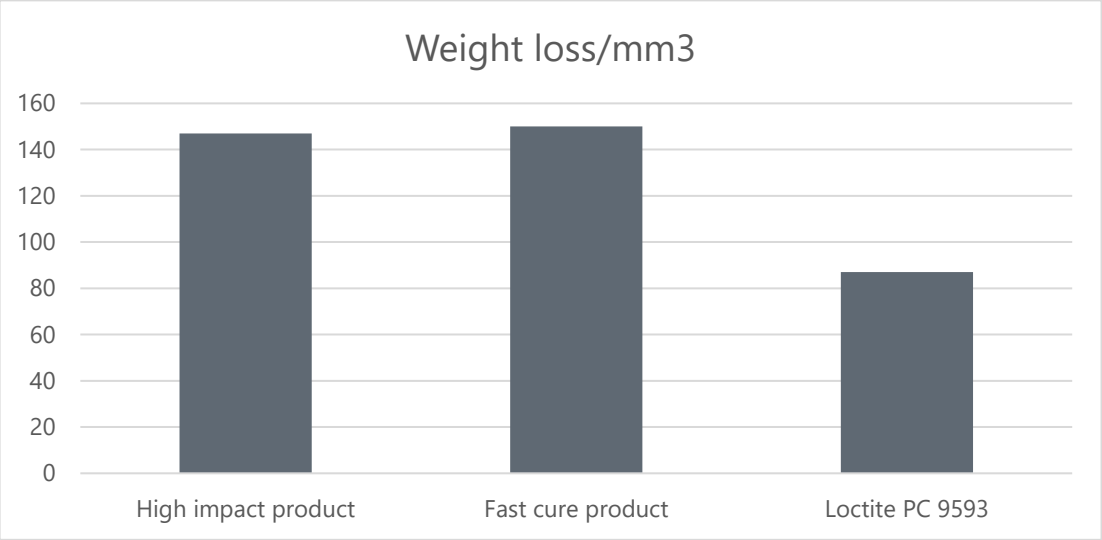

FIGURE 3. Volume loss results from slurry abrasion test

2.4.3 Miller Slurry Abrasion

Miller slurry test determines either the relative abrasivity of any slurry or the response of different materials to the abrasivity of different slurries. Miller slurry result can be used to simulate wear protective applications for slurry handling pump in power plant, ash handling pies & elbow in material handling systems, and dredging pumps. Miller test results of Loctite PC 9593 are summarized in Table 5. Its volume loss result is compared with that of high impact resistance and fast cure wearing compound in Figure 4. As can be seen, volume loss of Loctite PC 9593 is higher than that of the other two products in miller test. Because impact resistance curing agent in PC 9593 hardener part make it a little bit soft, this leads to the relative higher weight loss in dry abrasion.

Table 5. Miller test of Loctite PC 9593

	Weight loss, mg		
	2hrs	4hrs	6hrs
Loctite PC 9593	76	106	119

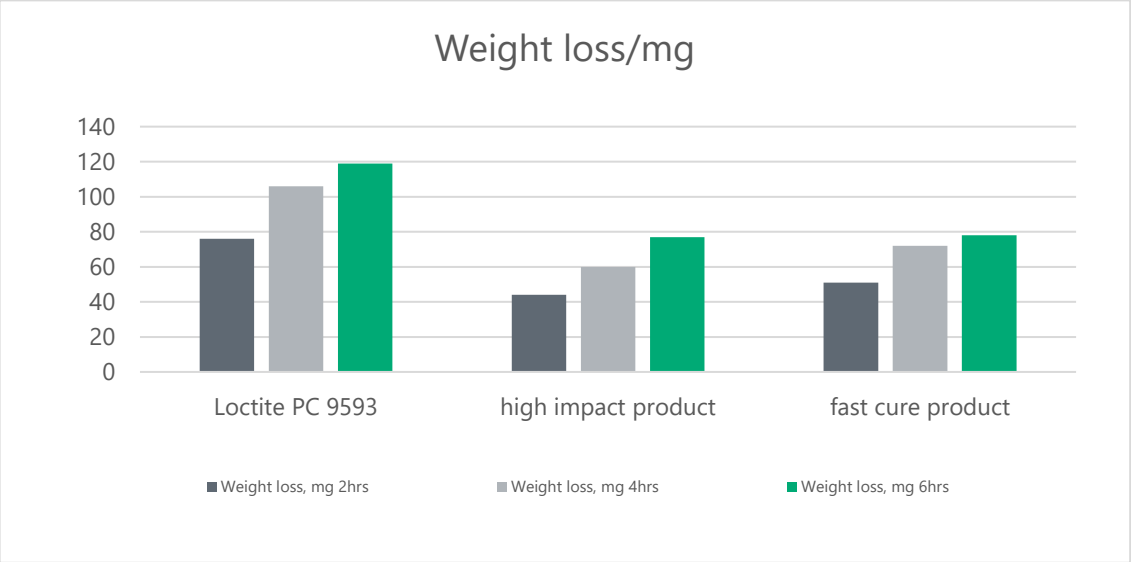

FIGURE 4. Volume loss results from Miller test.

2.4.4 Gas Jet Erosion

Gas jet erosion test determines material loss by gas entrained solid particle impingement erosion. The test result can be used to simulate wear resistant applications for raw mills, bag house & kiln coolers in the cement industry, inner cones & ash handling systems in the power generation industry as well as blast furnace equipment in the steel and coal industry. Gas jet erosion test results of Loctite PC 9593 are summarized in Table 6. Its volume loss result is compared with that of fast cure and high impact wearing compound in Figure 5. As seen, volume loss of Loctite PC 9593 is at same level of the other two product at 45° testing. At 90° testing, volume loss of PC 9593 is lower than data of other two product.

Table 6. Gas jet test of Loctite PC 9593

Impinge Angel	Sample No.	Weight, mg			Mass loss, mg	Volume loss, mm^3
		initial	final	loss		
45°	1	6340	6339	1	1.33	0.69
	2	6996	6995	1		
	3	6263	6261	2		
90°	1	6265	6263	2	0.33	0.69
	2	6889	6888	1		
	3	7077	7076	1		

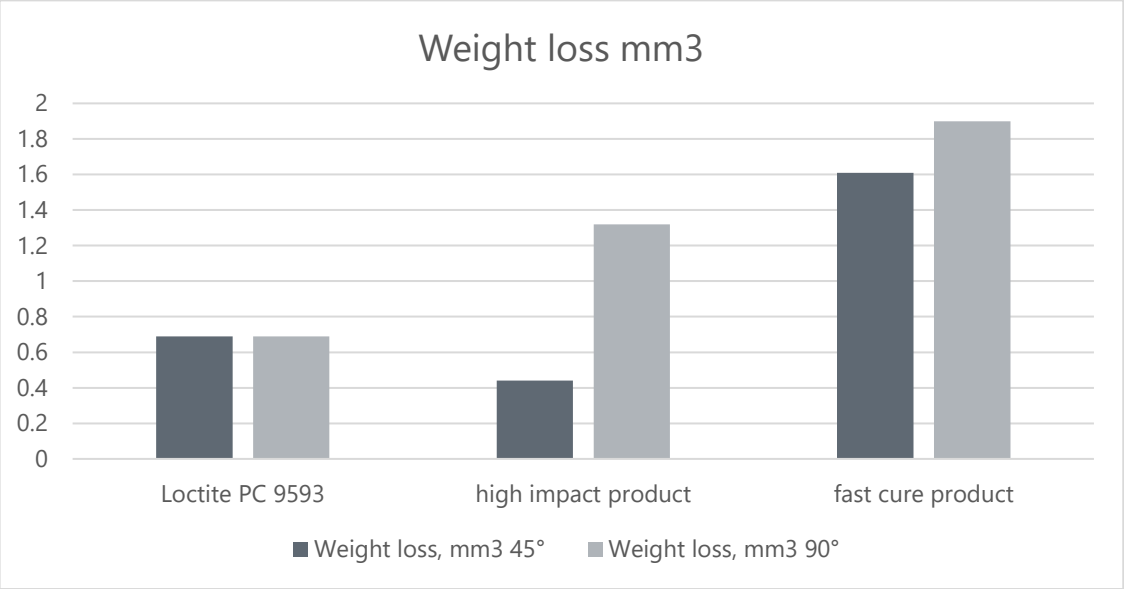

FIGURE 5. Volume loss results from gas jet erosion test.

Conclusions

Newly designed Loctite PC 9593 offers unique combination of higher impact and wear resistance along with faster cure rate which results in direct customer benefits of down time reduction and longer asset life. High impact and wearing resistance performance were confirmed in cyclone underflow discharge pan in coal mine and other similar application in power plant, steel plant etc. Various tribology testing results show that Loctite PC 9593 possesses higher level impact resistance than other existing product. Fast curing property of PC 9593 meet customer needs for fast repair during shutdown and breakdown.

Acknowledgement

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