NEW WEAR RESISTANT COMPOUND

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ABSTRACT

Wearing compounds are polymer composite products that combine superior wear resistant abrasive ceramic fillers with high adhesion impacting two-part epoxy technology. A new wear resistant compound, LOCTITE® PC 7332™, has been developed and launched recently for high wear areas of processing equipment in power generation, mining, and steel plant applications such as desulfurization pumps and ducts, slurry pumps and slag granulation pumps to protect against severe wet abrasion. LOCTITE® PC 7332™ is a room temperature curable two-part silicon carbide filled epoxy product. Its abrasion resistance was measured by dry abrasion test, slurry abrasion test, Miller slurry test and gas jet erosion test at different conditions. Test results are discussed and compared with both existing wearing compounds and other protective coating products. Its product properties and key features are also described.

1. INTRODUCTION

Wearing compounds have been widely used as wear resistant protective coating to extend service life of industrial equipment by protecting them from corrosion, abrasion, chemical attack and other wear encountered in harsh industrial environments. It can be used to either restore worn surfaces or used to protect new parts.

Henkel has been the global market leader and technology supplier for wearing compounds for decades. We have a series of high-performance wearing compound products that can meet various wear prevention and rebuilding applications [1]. Recently, it is requested to further improve wear resistance and extend the service life in use due to higher production efficiency requirements.

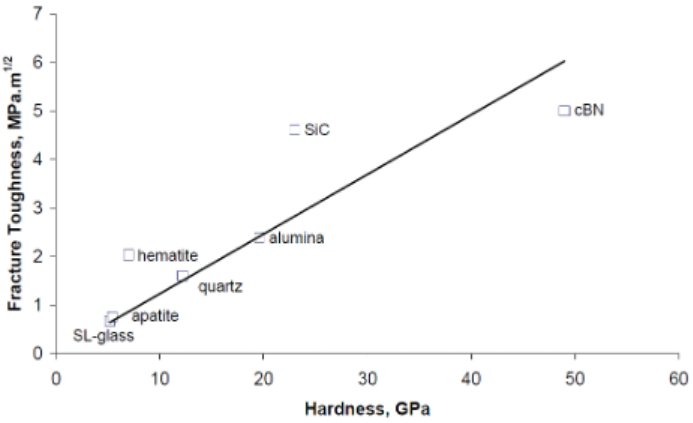
The resin part of wearing compound products is typically composed of epoxy resin, diluent, alumina ceramics, silane coupling agent, and other additives as needed. Its hardener part is mainly composed of aliphatic amine, polyamide, alumina ceramics balls and other additives as needed.

Alumina has been commonly used as the main abrasive ceramic filler for wearing compounds because of good wear resistant property and easy supply. As shown in Figure 2 [2, 3], silicon carbide has both higher hardness and higher toughness than alumina, indicating possible higher wear resistance performance in actual use. Properties of silicon carbide and alumina are compared in Table 2.

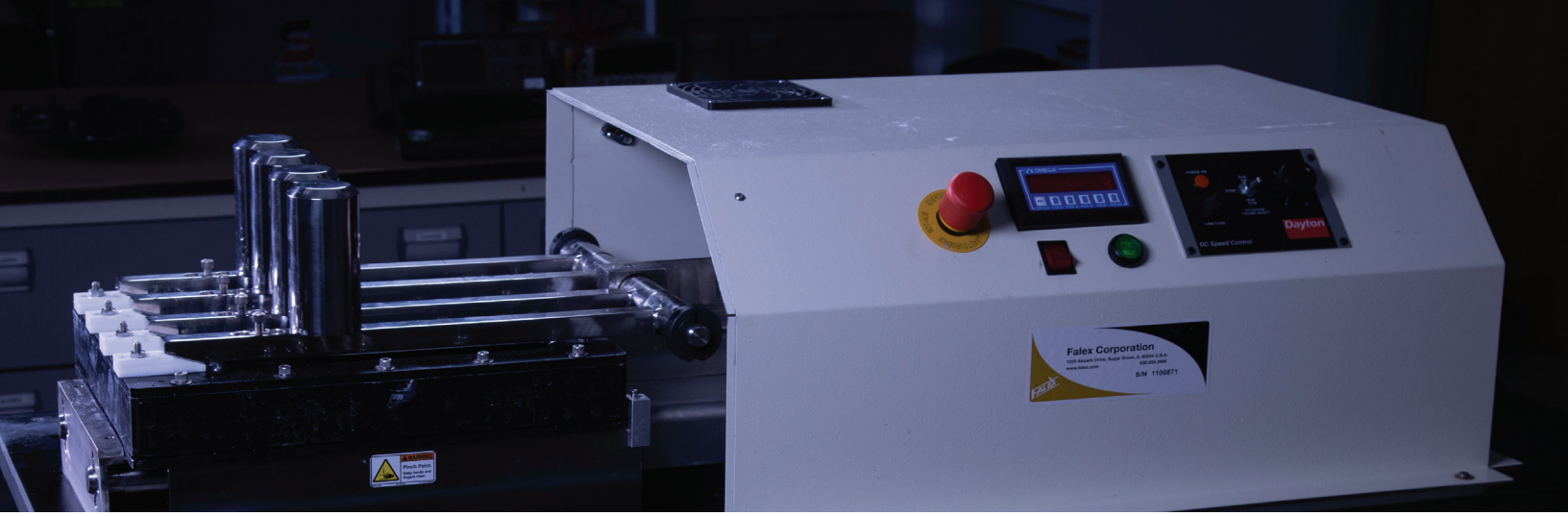
TABLE 2. Properties of silicon carbide and alumina

Property	Silicon carbide	Alumina
True density, g/cm^3	3.21	3.98
Knoop hardness, Hk	2,600	2,000
Melting point, °C	2,600 (breaks down)	2,050
Specific heat, kJ/kg • K	0.63–1.26	0.92–1.26
Thermal cond., W/mK RT 400°C 1,000°C	 167.6 67.0 46.9	 30.2 13.0 6.3
CTE, ppm/K RT 400°C 1,000°C	 3.8 4.1 4.8	 6.9 7.8 8.3

FIGURE 2. Hardness and fracture toughness for usual abrasive fillers.



A new product, LOCTITE® PC 7332™, has been developed successfully and launched recently. LOCTITE® PC 7332™ has been qualified and used for slurry pumps protection under severe wet abrasion conditions, extending service life from 6–8 months to over 18 months, confirming satisfactory and outstanding wear resistant performance in actual use.



2. MATERIALS & METHODS

2.1 Material

LOCTITE® PC 7332™ A Batch#: PM171220A
LOCTITE® PC 7332™ B Batch#: PM171229B

2.2 Test Methods and Parameter

Dry abrasion test is conducted by DUCOM TR-50 dry abrasion tester according to ASTM G-65.

Test Parameter	Speed: 100rpm
	Revolution: 200
	Load: 5kg
	Specimen Dimension: 76×25.4×12.7mm

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

Test Parameter	Speed: 100rpm
	Revolution: 300
	Load: 10.09kg
	Slurry: 2kg Al2O3+500ml water
	Specimen Dimension: 76×25×6mm

DUCOM TR-50

DUCOM TR-44

2.2 Test Methods and Parameter (continued)

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

Test Parameter	Load on each arm: 22.4N
	Test duration: 2hours
	Slurry: 2kg Al2O3+500ml water
	Length of Stroke: 203.2mm

DUCOM TR-45

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/second
	Test condition: Ambient temperature
	Test duration: 15 minutes on each holder
	Erodent consumed: 30000mg
	Specimen dimension: 25×25×5mm

DUCOM TR-471-900

3. RESULTS & DISCUSSION

3.1 Product Description

LOCTITE® PC 7332™ is a room temperature curable two-part silicon carbide filled 100% solid epoxy system designed to protect, rebuild and repair high wear areas of processing equipment, such as desulfurization pumps and ducts, slurry pumps and slag granulation pumps which are subjected to severe wet abrasion. This product can also be used for particle abrasion under dry conditions in transport elbows, chutes and other equipment. It is typically used in applications with an operating temperature range from -30 °C to 120 °C.

3.2 Composition and Property

3.3 Abrasion Resistance

Abrasion resistance of LOCTITE® PC 7332™ were measured by four different abrasion testing methods in order to evaluate and simulate its wearing performances for various industrial applications. The results were compared and discussed with other protective coating products [4].

3.3.1 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 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 7332™ were summarized in Table 4. Its volume loss result is compared with a typical wearing compound in Figure 3. As can be seen, volume loss of LOCTITE® PC 7332™ is much lower, indicating a longer coating life. When compared to other protective coating products, it is found that LOCTITE® PC 7332™ performs at the highest level dry abrasion resistance among all the products tested till today. Its volume loss is even lower than those of heat cure wearing compounds.

3.3.2 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 7332™ are summarized in Table 5. Its volume loss result is compared with a typical wearing compound in Figure 4. Weight loss of LOCTITE® PC 7332™ is much lower, roughly 1/4 that of the standard product. This result indicates that LOCTITE® PC 7332™ also performs much better and can last much longer under severe wet slurry wearing conditions in various actual applications.

TABLE 4. Dry abrasion test of LOCTITE® PC 7332™

Sample No.	Weight, mg (initial, final, loss)	Weight loss, mg	Volume loss, mm^3
1	52319, 52249, 70	80	35
2	46714, 46626, 88		
3	46829, 46748, 81		

TABLE 5. Slurry abrasion test of LOCTITE® PC 7332™

Sample No.	Weight, mg (initial, final, loss)	Weight loss, mg	Volume loss, mm^3
1	26979, 26896, 83	79	35
2	27511, 27436, 75		
3	25985, 25899, 86		

FIGURE 3. Volume loss results from dry abrasion test.

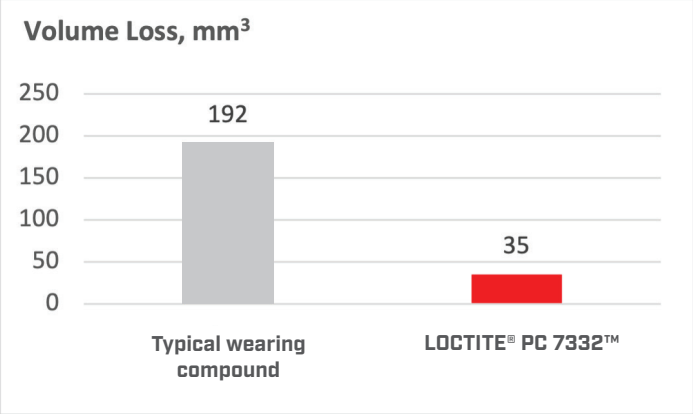
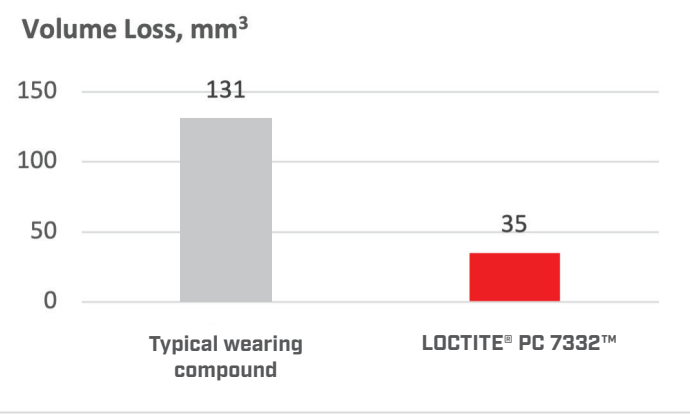


FIGURE 4. Volume loss results from slurry abrasion test.



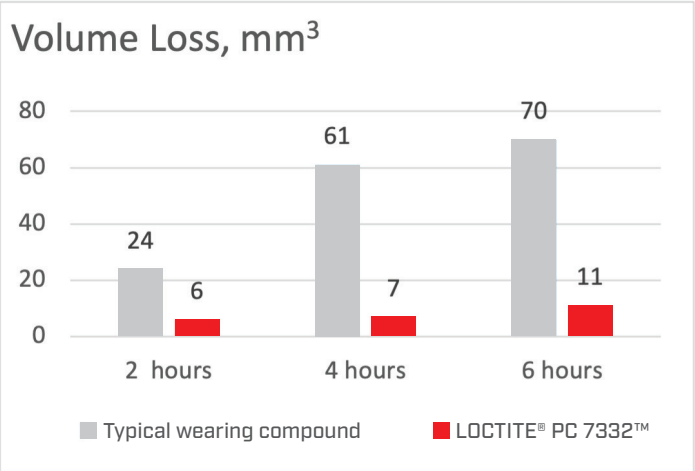
3.3.3 Miller Slurry Abrasion

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 pipes & elbow in material handling systems, and dredging pumps. Miller test results of LOCTITE® PC 7332™ are summarized in Table 6. Its volume loss result is compared with that of a typical wearing compound in Figure 5. As can be seen, volume loss of LOCTITE® PC 7332™ is much lower. Compared to other existing protective coating products, it is found that LOCTITE® PC 7332™ performs at the highest level in slurry abrasion resistance among all the products tested until today. Its volume loss is even lower than those of heat cure wearing compounds.

TABLE 6. Miller test of LOCTITE® PC 7332™

Sample No.	Weight, mg (initial, 2hrs, 4hrs, 6hrs)	Weight loss, mg (2hrs, 4hrs, 6hrs)
1	4036, 4020, 4017, 4012	16, 19, 24
2	3886, 3873, 3868, 3855	13, 18, 31
3	3917, 3906, 3904, 3900	11, 13, 17
Average weight loss, mg		13, 17, 24
Volume loss, mm^3		6, 7, 11

FIGURE 5. Volume loss results from Miller test.



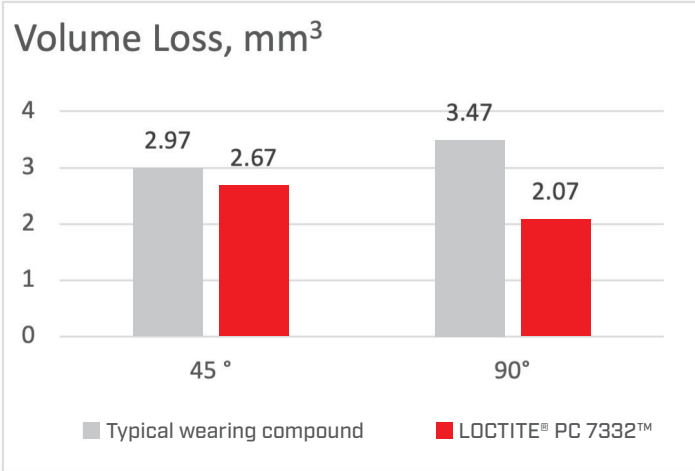
3.3.4 Gas Jet Erosion

Gas jet erosion test determines material loss by gas entrained solid particles 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 result of LOCTITE® PC 7332™ is summarized in Table 7. Its volume loss result is compared with that of a standard wearing compound in Figure 6. As shown, volume loss of LOCTITE® PC 7332™ is lower than typical wearing compound at both 45° and 90° testing. When compared to other protective coating products tested, LOCTITE® PC 7332™ is the best performer.

TABLE 7. Dry abrasion test of LOCTITE® PC 7332™

Impinge Angle	Sample No.	Weight, mg (initial, final, loss)	Mass loss, mg	Volume loss, mm^3
45°	1	7204, 7199, 5	6	2.67
	2	6669, 6662, 7		
	3	6341, 6335, 6		
90°	1	6895, 6889, 6	5	2.07
	2	7160, 7156, 6		
	3	6265, 6261, 4		

FIGURE 6. Volume loss results from gas jet erosion test.



4. CONCLUSION

LOCTITE® PC 7332™ was developed as a high wear resistant compound by optimizing both epoxy resin and abrasive filler compositions. Outstanding wear resistant performance and long service time has been confirmed in slurry pump protection application under severe wet abrasion environment in a steel plant. Various tribology testing results show that LOCTITE® PC 7332™ possesses the highest level of abrasion performance by various testing methods. This suggests LOCTITE® PC 7332™ is suitable for use to protect, rebuild and repair high wear areas of processing equipment in power generation, mining and steel plant applications such as desulfurization pumps and ducts, slurry pumps and slag granulation pumps which are subjected to severe wet abrasion. LOCTITE® PC 7332™ can also be used for particle abrasion under dry conditions in transport elbows, chutes and other equipment.

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