GM	WORLDWIDE ENGINEERING STANDARDS	Test Procedure	GMW17086

Temper Etch Inspection for Grinder Burn

1 Introduction

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. This standard establishes requirements and tests for performing temper etch inspection of post ground steel parts which are heat treated above a hardness of 40 Rockwell Hardness, Scale C (HRC) or equivalent.

1.2 Applicability. This test involves the use of corrosive material to etch the surface of finished machined part(s) to determine if heat has been introduced into the component by machining, grinding, or other means, which will adversely affect the required properties of the component. This method allows for detection of localized overheating and is more sensitive to changes than are surface hardness testing methods.

1.3 Remarks. This test method is to be used as a basis for the tempered etch inspection process. Individuals may need to slightly alter or modify the process to accurately obtain results. The most common practices are presented here as well as some visual standards. Visual standards specifically developed for individual products may be required by those testing the parts.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

ANSI/AGMA-C00 ASTM F22 MIL-STD-867 SAE AMS 2649C

2.2 GM Standards/Specifications.

None

2.3 Additional References.

Automatic System for Thermal Damage Detection in Manufacturing Process with Internet Monitoring. Journal of the Brazilian Society of Mechanical Science & Engineering. April - June, 2006, Volume XXVIII, Page 156.

3 Resources

3.1 Facilities. The test process should take place in a well-ventilated hood. This hood should meet local standards for environmental, health, safety and corrosive material, and be large enough to allow for the test of the part(s) at that facility.

3.1.1 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label.

3.1.2 Alternatives. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

3.2 Equipment.

3.2.1 Cleaning Materials. Cleaning materials shall be such that they are capable of removing dirt, grease, grit, oil(s), etc. These cleaning methods can be vapor degreasing, hot ultrasonic cleaning, water based hot alkaline cleaning, etc. See Table 1.

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Table 1: Recommended Cleaning Methods

Type of Contaminant	Method of Cleaning
Dyes, Inks, Paints, etc.	Solvents, acetone, alcohol, etc.
Dirt, Grit, Soil, etc.	Soap and Hot Tap Water or Ultrasonic Cleaning
Grease, Oil, Waxes, etc.	Vapor Degreaser or Ultrasonic Cleaning

Note: More than one of the processes may be required to produce a **Water Break** Clean Surface.

3.2.2 Processing Materials (Chemicals). SAE AMS 2649C (Etch Inspection of High Strength Steel Parts), ANSI/AGMA-C00 (Gears – Surface Temper Etch Inspection After Grinding) and MIL-STD-867 (Temper Etch Inspection).

3.2.2.1 Ethyl Alcohol.

3.2.2.2 Hydrochloric Acid. (HCl).

3.2.2.3 Nitric Acid (HNO_3).

3.2.2.4 Sodium Hydroxide (NaOH). Optional.

3.2.2.5 Ammonium Peroxydisulfate (Ammonium Persulfate) ($(NH_4)_2S_2O_8$). Commercial grade, optional.

3.2.2.6 Rust Preventive (RP) Oil which does not mask the etching results.

3.2.3 Personal Protective Equipment (PPE).

3.2.3.1 Eye protection.

3.2.3.2 Chemical resistant gloves.

3.2.3.3 Tongs or like device to handle part(s).

3.2.3.4 Eyewash station.

3.3 Test Vehicle/Test Piece. Test piece(s) shall be obtained from a predetermined location: audit chute, reject chute, end of the line, etc. The test pieces shall have completed all grinding and machining operations that would affect the area being examined.

3.4 Test Time. See Table 2.

3.5 Test Required Information. The results of the testing will be logged and distributed per the local requirements.

3.6 Personnel/Skills. Personnel shall be properly trained in the use of the chemicals and equipment used in the testing.

4 Procedure

Note 1: It is advisable to test one (1) part at a time instead of a batch of parts. Batching parts can cause unreadable surfaces and/or false rejects.

Note 2: Flow Chart is attached in Appendix A, Figure A1.

4.1 Preparation.

4.1.1 Turn on the hood exhaust fan and lights.

4.1.2 Put on PPE.

4.1.3 Check all the containers of chemicals to ensure they are at the proper levels. Make or refill as needed.

4.1.4 Turn on rinse waters.

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Table 2: Procedure and Time of Testing

Step	Process Note 1	Solution Note 2	Recommended Time Note 3	Remarks
1	Cleaning	See Table 1	As needed	Solution depends on condition
2	Rinse	Water	5 s to 20 s	**Water Break** free surface
3	Alcohol Rinse	Alcohol	Dip and Dry	To remove the water and prevent flash rusting
4	Activate	6% to 10% Hydrochloric Acid (HCl)	1 minute to 3 minutes	Time should be established per part requirements to allow for proper etching
5	Rinse	Water	5 s to 20 s	Allow enough time to remove the acid
6	Alcohol Rinse	Alcohol	Dip and Dry	To remove the water and prevent flash rusting
7	Etch	3% to 5% Nitric Acid (HNO_3)	10 s to 40 s	Individual facilities must establish times that produce a uniform black surface film to the part; it should be reproducible
		Water or Alcohol	20 s to 60 s	
8	Rinse	Water	5 s to 20 s	Allow enough time to remove the acid
9	Alcohol Rinse	Alcohol	Dip and Dry	To remove the water and prevent flash rusting
10	Desmut	6% to 10% Hydrochloric Acid (HCl)	1 minute to 3 minutes	Time should be established per part requirements to allow for a uniform color around an undamaged part
11	Rinse	Water	5 s to 20 s	Allow enough time to remove the acid
12	Neutralize	Alkaline solution with a pH of 10 minimum	10 s to 60 s	Agitate parts when immersed
13	Rinse	Water	5 s to 20 s	Allow enough time to remove the acid
14	Alcohol Rinse	Alcohol	Dip and Dry	To remove the water and prevent flash rusting
15	RP	Rust Preventive Oil	Dip	Should not mask indications on the part
16	Inspection	None	None	Check for non-uniform areas of color on the part, and check with the boundary samples for identification

Note 1: All parts will be agitated during the process.
Note 2: All solutions will be at ambient temperature.
Note 3: All times are recommended. Deviations are allowed based on part needs and the ability to show uniform, repeatable results.

4.2 Conditions.

4.2.1 Environmental Conditions. Not applicable.

4.2.2 Test Conditions. Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

4.3 Instructions. Reference SAE AMS 2649C, ANSI/AGMA-C00 and MIL-STD-867.

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