GM WORLDWIDE ENGINEERING STANDARDS	Test Procedure	GMW16086

Evaluation for Susceptibility to Secondary Cold Work Embrittlement and Low Temperature Impact Fractures of Ultra Low Carbon and Phosphorus Bearing Sheet Steels

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 was designed to evaluate the susceptibility to secondary work embrittlement (SWE) and to intergranular fracture at low temperature from impact loading of ultra-low carbon, interstitial free, and rephosphorized steels. The test may also be used to determine the ductile-to-brittle transition temperature (DBTT) of any sheet steel that has sufficiently high ductility to be deep-drawn.

1.2 Applicability. This test was initially designed for the evaluation of any ultra-low carbon steel that is subject to high drawing strains in part manufacture.

1.2.1 Ultra low carbon and rephosphorized grades of ultra-low carbon steels can, under specific conditions, be susceptible to intergranular cracking from impacts at low temperatures and from cold forming of sheet steel that has previously been subjected to large drawing strains during a previous forming process. This test is designed to evaluate a steels susceptibility to these types of failures through the determination of the ductile-to-brittle transition temperature (DBTT).

1.2.2 There are many factors and conditions that can affect the DBTT. The DBTT test described in this standard does not necessarily correlate to field temperatures at which brittle fracture may occur. This test only provides a method to evaluate the relative performance of steels compared to those with established field performance.

1.3 Remarks. The test consists of a series of cups which are deep-drawn from a sheet of the test material. These cups are cooled to various low temperatures and then subjected to a drop test from a fixed height and with a constant weight. The highest temperature at which the cups fracture in a brittle manner is observed and recorded.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

None

3 Resources

3.1 Facilities.

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. The following equipment is required for this test:

3.2.1 Blanking die.

3.2.2 Hydraulic press (Tinius Olsen Ductomatic or equivalent).

© Copyright 2019 General Motors Company All Rights Reserved

Documents
Document Sharing Hub

Copyright General Motors
Provided by IHS Markit under license with General Motors

Full document details: GM GMW16086 2019

3.2.3 Lathe.

3.2.4 Drop Impact Tester (see Appendix A, Figures A1 and A2).

3.2.5 Coolant bath.

3.2.6 Polypropylene sheet.

3.3 Test Vehicle/Test Piece. Not applicable.

3.4 Test Time.

Calendar time:	1 h
Test time:	1 h
Coordination time:	1 h

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills. Test technician familiar with test facilities and equipment.

4 Procedure

4.1 Preparation.

4.1.1 Blank Preparation and Cup Formation. The standard test specimen is a cup that is 33 mm in diameter and 22 mm in height that is deep drawn from a 66 mm diameter disc. This cup therefore represents a draw ratio of 2.0 (66 mm/33 mm). Typically, the strain state near the rim of the cup exhibits a major strain of about 55% and a minor strain of about -35%. Approximately 50 cups are required to determine the DBTT of a given material.

4.1.1.1 Disks that are 66 mm in diameter are blanked from the steel sheet according to the following procedure:

4.1.1.1.1 A strip of 75 mm to 100 mm wide is cut across the coil width.

4.1.1.1.2 Sixty-six millimeter (66 mm) diameter discs are then blanked from the strip having a thickness between 0.8 mm and 1.2 mm. Alternate thicknesses shall be agreed upon between GM and the supplier.

4.1.1.1.3 Draw blanks to form a cup utilizing a draw ratio of 2.0. The punch shoulder radius shall be 6.0 mm ± 0.5 mm. For coated materials, the die is to be cleaned after each forming operation. The hold down pressure used to form the cups is to be recorded.

Note: Lubrication can be used to eliminate wrinkling and reduce die wear. The lubricant will be a polypropylene sheet 0.040 mm ± 0.005 mm.

4.1.2 The flat bottom cups are drawn from each circular blank using a Tinius Olsen machine with a punch diameter selected to be ~33 mm.

4.1.3 Die selection will depend upon the required die clearance, which is generally in the range of 40% to 100% using the following formulas:

$$40 < \left[\left(\frac{D_{die} - D_{punch}}{2} - t\right) \times \frac{100}{t}\right] < 100$$

Where:

D_{die} = Diameter of the die.

D_{punch} = Diameter of the punch.

t = Material thickness.

or

$$40 < \left[\left(\frac{D_{die} - 33}{2} - t\right) \times \frac{100}{t}\right] < 100$$

© Copyright 2019

Documents
Document Sharing Hub
Copyright General Motors
Provided by IHS Markit under license with General Motors
Full document details: GM GMW16086 2019