

Paper No.
16536



Should socket welds be used in sour service process environments and what are the quality control requirements?

Jan Baas
McDermott
Prinses Beatrixlaan 35
2595 AK The Hague
The Netherlands

ABSTRACT

Socket weld connections are frequently used in the petroleum and petrochemical industry for small bore carbon steel piping. These connections are allowed by piping codes such as ASME¹ B31.3 (1) for process piping and are considered cost effective as they can be produced relatively quickly and they are to some extent tolerant regarding field fit up issues. The requirements for a socket weld are specified in the figures 328.5.2.A, B and C of ASME B31.3. These figures define the minimum size of the fillet weld in relation to the pipe and flange thickness and also specify a gap of approximately 1.5 mm after inserting the pipe in the socket before welding to allow for thermal expansion during welding. These socket welds are fillet welds and are normally made using the gas tungsten arc welding (GTAW) process. The objective of this paper is to explain that it is important to exercise caution in the use of socket welds in sour service process environments. This paper will explain the difficulty during socket welding in ensuring compliance to the ANSI²/NACE³ MR0103/ ISO⁴ 17945 (2) and NACE SP0472 (3) specification requirements. McDermott sets quality control requirements for socket welds to guarantee that socket welds are obtained with acceptable hardness figures that are resistant against Sulfide Stress Cracking (SSC).

Key words: Sulfide Stress Cracking, SSC, Socket Welds, Hardness, Sour Service

INTRODUCTION

Socket welds, which are fillet welds, are made in accordance with a suitable welding procedure specification (WPS) which is qualified by a welding procedure qualification record (PQR). As per ASME

¹ American Society of Mechanical Engineers (ASME), Two Park Avenue, New York, NY 10016-5990, USA

² American National Standards Society (ANSI), 1899L Street, NW, 11th floor, Washington DC 20036, USA

³ National Association of Corrosion Engineers (NACE), St John's Innovation Centre Cowley Road, Cambridge CB4 0WS, UK

⁴ International Organization for Standardization (ISO), Chemin de Blandonnet 8, CP401-1214 Vernier, Geneva, Switzerland

BPVC.IX (4) welding code these fillet welds can be qualified by a fillet weld qualification but also by a butt welding procedure qualification as per QW-202.2.C and QW-451.4 (4). For fillet welds, i.e. socket welds used in sour service, such a butt welding qualification with butt weld hardness records should not be used to qualify a fillet weld operating in sour service.

To prevent SSC, ANSI/ NACE MR0103/ISO 17945 and NACE SP0472 specify compliance with additional requirements when socket welds are used in sour service. These requirements can be summarized as:

- 1) NACE SP0472 section 2.3.5.3.8 specifies that the hardness of the weld deposit and the heat affected zone (HAZ) shall be measured during welding procedure qualification as per applicable weld configuration detail. For the fillet weld this is covered by the fillet weld hardness test details in ANSI/ NACE MR0103/ISO 17945 figure C.6
- 2) The maximum weld deposit hardness during welding procedure qualification shall be below 248 HV10 and the average weld deposit hardness shall be below 210 HV10 as per NACE SP0472 section 2.3.5.3.6
- 3) The heat affected zone (HAZ) hardness of the base materials shall be below 248 HV 10 as per NACE SP0472 per table 1 and section 2.3.5.3.5
- 4) The weld deposit hardness of the production welds shall be below 200 HBW as per table 1 of NACE SP0472.

SOCKET WELD FAILURES IN SOUR SERVICE

McDermott⁵ has recently experienced socket weld failures after a plant start up. An example of these failed socket welds is shown in figure 1. Initially a total of 8 socket welds failed almost immediately after the first plant start up and this resulted in the spilling of sour liquid. Construction personnel did not realize that the failed socket welds were all in sour service. Visual and PT inspection revealed weld cracking for these 8 socket welds, but also indicated that the size of the failed socket welds, and many other socket welds which did not fail, was insufficient and not in accordance with ASME B31.3 figure 3.2.8.5.2A, B, C.



Figure 1: Socket weld failure and crack

⁵ McDermott, Prinses Beatrixlaan 35, 2595AK, The Hague, The Netherlands