Recommendations for tube end welding

Publication 143

Edition 2

ISBN 978 0 85931 217 2
Imprint reference 02-2017
First published 02-2017

Registered and Trading Address:
EEMUA, Second Floor, 16 Black Friars Lane, London EC4V 6EB
Telephone: +44 (0)20 7488 0801
Email: sales@eemua.org
Website: www.eemua.org

Contents

Preface ..... **VII**

1. Scope **1**

1.1 Acronyms and definitions 1
1.2 Convention 1

2. Welding process and joint detail **3**

2.1 Manual processes 3
2.2 Automatic and semi-automatic processes 3
2.3 Acceptable welding processes 3
2.4 Joint types 3
2.4.1 Expansion only (no welding) 3
2.4.2 Expansion and seal-welding 4
2.4.3 External fillet weld 4
2.4.4 External butt and fillet weld 5
2.4.5 Internal fillet weld 5
2.4.6 Castellated 6
2.4.7 Full penetration internal butt weld 6

3. Qualification of welding procedure **7**

3.1 Introduction 7
3.2 Test samples 7
3.3 Non-destructive testing 7
3.3.1 Visual examination 7
3.3.2 Radiographic examination 7
3.4 Destructive testing 7
3.4.1 Weld strength tests 7
3.4.2 Macroexamination and hardness tests 8
3.4.3 Ferrite test 9
3.4.4 Corrosion test 9

4. Qualification of welders and welding operators **11**

4.1 Test samples 11
4.2 Test purpose 11
4.3 Previous qualification 11
4.4 Operators deemed competent 11

5. Preparation of tubes and tube-plates 13

5.1 Cleaning 13
5.2 Tube holes 13
5.3 Assembly 13

6. Tube location 15

6.1 Tube fit accuracy 15
6.2 Preparation for welding 15

7. Preheat and interpass temperature 17

7.1 General 17
7.2 Practical limits 18
7.3 Weld interruption 18
7.4 Preferred means of preheating 18

8. Welding 19

8.1 General 19
8.2 Welding individually 19
8.3 Distortion minimisation 19
8.4 Autogenous welding 19
8.5 Additional controls 19

9. Post-weld heat treatment 21

9.1 General 21
9.2 Heating rates 21
9.3 Additional welding 21

10. Quality control and health and safety 23

10.1 General 23
10.2 Samples 23
10.3 Examination of materials 23
10.3.1 Tubes 23
10.3.2 Tube-plates 23
10.4 Health and Safety 23

11. Cleaning and inspection 25

11.1 General 25
11.2 Dye penetrant testing 25
11.3 Other 25

12. Leak detection 27

12.1 General 27
12.2 Air testing 27
12.3 Gas leak testing 27
12.4 Other leak testing 27
12.5 Leak investigation 27

13. Repairs 29

13.1 Leaks 29
13.2 Qualified procedure 29
13.3 Cause of defect 29

14. Tube expansion 31

14.1 General 31
14.2 Location 31
14.3 Equipment 31
14.4 Tube wall thinning 31
14.5 Bores 31

15. Pressure testing 33

15.1 Cleaning 33
15.2 Final acceptance pressure test 33
15.3 Leaks 33
15.4 Repair 33

16. Draining and dewatering 35

16.1 General 35
16.2 Heating 35

17. Supervision and inspection 37

17.1 General 37
17.2 Inspection and Test Plan (ITP) 37

18. Records **39**

References **41**

Figures

Figure 1 Expansion only 3
Figure 2 Expansion and seal-welding 4
Figure 3 External fillet weld 4
Figure 4 External butt and fillet weld 5
Figure 5 Internal fillet weld 5
Figure 6 Castellated 6
Figure 7 Full penetration internal butt weld 6
Figure 8 Weld strength tests 8

Tables

Table 1 Preheat and interpass temperature 17

Preface

Publication 143 was first published under the EEMUA banner in 1985 following the merger of the Engineering Equipment Users Association (EEUA) and the Oil Companies Materials Association (OCMA). The Publication was originally *OCMA Specification No. TEW-1: Recommendations for tube end welding: tubular heat transfer equipment, Part 1 – Ferrous materials.* It was written by OCMA's Welding Panel with assistance from the Heat Transfer Society.

A joint meeting was convened in October 1966 of members of OCMA welding panel and representatives of the Heat Transfer Society to exchange information on experience gained in making welded joints between heat exchanger tubes and tube-plates. It was the opinion of that meeting that an urgent need existed for standardised procedures to be established for the design, fabrication, inspection and testing of these and similar components. At that time, there was no national or international standard in existence that adequately covered this important subject. Members pooled their knowledge and experience, and co-operated in preparing a recommended practice for tube end welding and testing. Such a recommendation could then be used as a basis for specifying requirements for the oil, chemical and other industries.

In the interim, codes such as ASME BPVC VIII, ASME IX and particularly EN ISO 15614-8:2002 have covered much of the same ground. This new Second Edition of EEMUA 143 takes ISO 15614-8:2016 *Specification and qualification of welding procedures for metallic materials - Welding procedure test – Part 8: Welding of tubes to tube-plate joints* as the primary source material with some additions where it was felt that the standard required further clarification, or does not address the topic sufficiently.