DIN EN 1011-6:2019-04 (E)

Welding - Recommendation for welding of metallic materials - Part 6: Laser beam welding

Contents

Page

European foreword 5

Introduction 6

1 Scope 7

2 Normative references 7

3 Terms and definitions 9

4 Health and safety and protection of the environment 9

5 Quality requirements 9

6 Equipment 10
6.1 General 10
6.2 Provisions for acceptance testing 10
6.3 Provisions for maintenance and calibration 10

7 Qualification of welding personnel 10

8 Welding procedure specification 10

9 Welding procedure test 10

10 Consumables 11
10.1 Filler metals 11
10.2 Gases 11

11 Design 11
11.1 Overall design of structure or product 11
11.2 Joint design 11
11.3 Joint preparation 12

12 Laser beam welding 13
12.1 Characteristics 13
12.1.1 Modes 13
12.1.2 Energy transfer 13
12.1.3 Pulsed beam welding 14
12.1.4 Beam oscillation 14
12.1.5 Ramping 14
12.1.6 Beam focussing 14
12.1.7 Gas shielding 14
12.1.8 Use of consumables 14
12.1.9 Hybrid processes 14
12.2 Advantages and limitations 15
12.3 Assembling and fixtures 15
12.4 Process control 15
12.5 Inspection and testing 16
12.6 Imperfections 16

Annex A (informative) Equipment 17

A.1 Description of laser process 17
A.1.1 Principles 17
A.1.2 Components 17
A.2 Laser beam sources 18
A.2.1 CO2 lasers 18
A.2.2 Nd:YAG lasers, lamp pumped 19
A.2.3 Nd:YAG lasers, diode pumped 19
A.2.4 Yb:YAG lasers, diode pumped (disc lasers) 20
A.2.5 High power diode array lasers 20
A.2.6 Fibre lasers 21
A.2.7 Other types of lasers 21
A.3 Guiding, shaping and focusing the beam 21
A.3.1 Guiding the beam 21
A.3.2 Beam shaping devices (focusing optics) 22
A.4 Devices used to create a relative movement between the laser beam and the work piece 25
A.5 Fixtures used to hold the work piece 26
A.6 Cooling systems 27
A.7 Control systems 27

Annex B (informative) Laser beam properties 28

Annex C (informative) Information about weldability of metallic materials 30

C.1 General 30
C.2 Steels and iron alloys 30
C.2.1 General 30
C.2.2 C-Mn and structural steels 31
C.2.3 Alloy steels 31
C.2.4 Stainless steels 31
C.2.5 Cast irons 31
C.2.6 Soft iron 31
C.3 Nickel alloys 32
C.4 Aluminium and magnesium alloys 32
C.5 Copper and its alloys 32
C.6 Refractory and reactive metals 32
C.7 Titanium and its alloys 33
C.8 Dissimilar metals 33
C.9 Non-metals 33

Annex D (informative) Information about causes of weld imperfections and prevention 34

Annex E (informative) Beam control and monitoring 37

E.1 General 37
E.2 Focus point 37
E.3 Beam alignment and pilot beam coincidence 37
E.4 Beam power 38
E.5 Beam power distribution 38
E.6 Nozzle alignment 38
E.7 Pulsed beam power data 39
E.8 Manipulators, guides, etc 39

Annex F (informative) Laser beam processing 40

F.1 Laser beam cutting 40
F.1.1 Characteristics 40
F.2 Laser beam drilling 41
F.2.1 Characteristics 41
F.2.2 Advantages and limitations 42

F.2.3 Surface preparation 42
F.3 Laser beam surface treatment 42
F.3.1 Characteristics 42
F.3.2 Advantages and limitations 42
F.3.3 Surface preparation 43
F.4 Laser beam cladding characteristics 43
F.4.1 Modes 43
F.4.2 Advantages and limitations 43
F.4.3 Surface preparation 43
F.5 Laser beam marking and engraving 43
F.5.1 Characteristics 43
F.5.2 Advantages and limitations 44
F.5.3 Surface preparation 44

Bibliography 45