AG51 MÖTE 4 NOV

1. Omvärldsbevakning – Pågående forskning & standarder
   - Hydro-axial tension method for whole pipe butt-fusion joint tensile test

2. Arbetsgruppen för Strukturväggsrör
   - AMA26
   - WPS

3. SKZ DVGW GW331

Development of hydro-axial tension method for whole pipe butt-fusion joint tensile test

Varför?

- Provningen vi gör idag undersöker bara sektioner av svetsen vilket gör att kritiska svetsfel kan missas.
- För stora dimensioner krävs väldigt höga krafter vid normal dragprovning av hela rör.

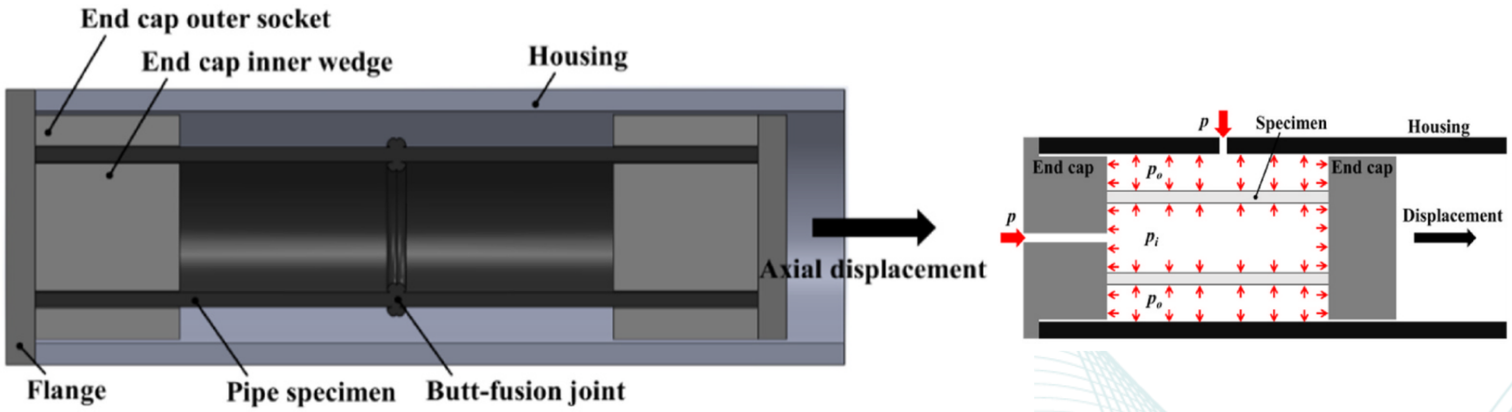


Fig. 19. Illustration of a HAT test jig assembly.

Polymer Testing 109 (2022) 107553

Contents lists available at ScienceDirect

Polymer Testing

journal homepage: www.elsevier.com/locate/polytest

Development of hydro-axial tension method for whole pipe butt-fusion joint tensile test

Pyeong An Lee [a], Sunwoo Kim [a,b], Bob Stakenborghs [c], Yeongsung Suh [d], Sunwoong Choi [a,*]

[a] Department of Polymer Science and Engineering, Hannam University, Daejeon, 34054, South Korea
[b] Korea Research Institute of Chemical Technology, Daejeon, 34114, South Korea
[c] Advanced Microwave Imaging, Baton Rouge, LA, 70815, USA
[d] Department of Mechanical Engineering, Hannam University, Daejeon, 34430, South Korea

A R T I C L E I N F O

Keywords:
Polyethylene pipe
Hydro-axial tension test
Whole pipe axial tensile test
Butt-fusion joint
Cold fusion
Fine particulate contamination

A B S T R A C T

Assessing the integrity of the thermo-fusion joint in plastic pipes is important as they can appear as a weak link in the piping system. In this work, a hydro-axial tension (HAT) test was developed as a whole pipe axial tensile test and applied to evaluate the polyethylene (PE) pipe butt-fusion (BF) joint containing various flaws. HAT test utilizes hydrostatic pressure to cause axial tension in pipes. The experimental and numerical analysis was carried out to confirm the axial tensile stress as the dominant principal stress, causing axial tension in the pipe. The HAT method was further tested against the whole pipe mechanical axial tensile (AT) test, and the HAT was shown to closely duplicate the AT behavior of the whole pipe and the BF joint. In addition, the HAT test correctly identified PE pipe butt-fusions having no flaws and flawed joints containing cold-fusion and fine particulate contamination.

Author statement

Pyeong An Lee: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Data Curation. Sunwoo Kim: Validation, Formal analysis, Data Curation. Bob Stakenborghs: Conceptualization, Investigation, Data Curation, Writing - Review & Editing. Yeongsung Suh: Formal analysis, Writing - Review & Editing. Sunwoong Choi: Conceptualization, Methodology, Formal analysis, Writing - Original Draft, Writing - Review & Editing, Supervision, Project administration, Funding acquisition.

1. Introduction

Plastic pipes are now well accepted as an integral part of fluid conveyance systems and are widely used in oil, gas, water, and industrial fluid transport. More demanding applications are emerging where higher pressure and larger diameter requirements are on the agenda [1–4]. Among them, nuclear industries have developed an ASME B&PV code section to include the use of high-density polyethylene (PE-HD) piping for safety Class 3 applications [5]. These emerging applications are often the result of the unparalleled mechanical and physical properties that the newly developed plastic materials for pipings are capable of delivering. They offer higher safety and cost-effectiveness in terms of ease of installation, use in rigorous conditions (e.g., toxic soil and seismic loading), and are almost free of long-term maintenance (e.g., galvanic corrosion and tuberculation) [6–10]. This, along with the excellent long years of safety record offered, plastic pipes are becoming the choice for replacing conventional material pressure pipes. One of the challenges faced when using plastic pipes in such demanding applications is the assurance of the joint integrity of the piping system. Joints are considered the weakest link in any piping system, and delivering leak-free performance is of utmost importance. Extensive destructive and non-destructive testing is being carried out to demonstrate their structural integrity. Two of the most popular plastic pipe jointing methods are butt-fusion (BF) [11,12] and electrofusion (EF) jointing [11,13,14], and their choice is mostly based on installation accessibility and pipe size. Both are thermal-fusion jointing, activated by the auto-adhesion mechanisms [15–17]. Thus any hindrances to auto-adhesion, such as cold fusion (CF), fine particulate contamination (FPC), planar flaws, are all known to reduce fusion joint integrity. Several test methods are available for determining the integrity of fusion joints [8,11,18–26]. However, most of them are based on coupon tests, where the specimens are locally removed and tested as a single entity with a limited portion of the actual fusion joint included [8,11,23–25]. Thus, if the flawed portion of the fusion joint is missed in the cut out from the pipe circumference, an erroneous assessment of the fusion joint can occur. The advantage of doing a whole pipe BF tensile test is evident

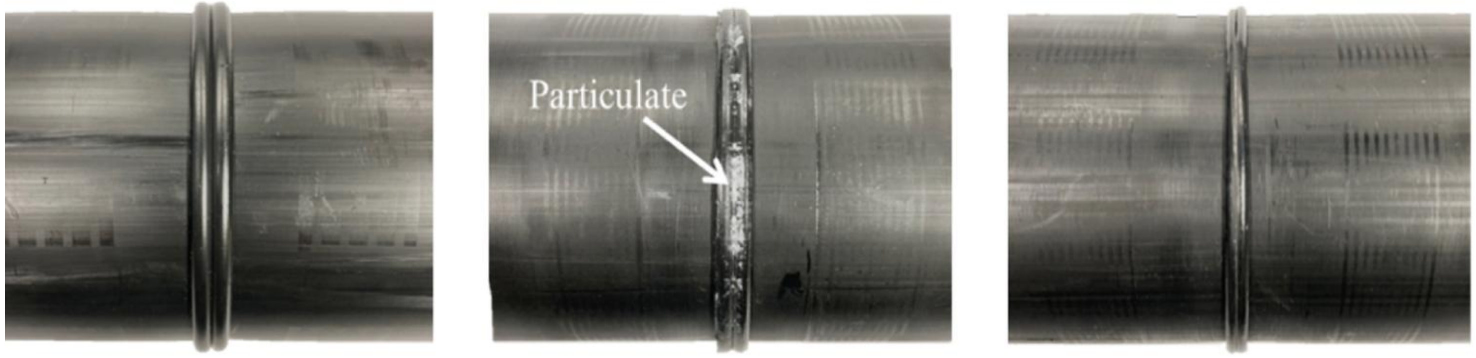
* Corresponding author.
E-mail address: swchoi@hnu.kr (S. Choi).

https://doi.org/10.1016/j.polymertesting.2022.107553
Received 13 December 2021; Received in revised form 5 March 2022; Accepted 20 March 2022
Available online 22 March 2022

Bra svets

Partiklar

För lång omställningstid



(a) (b) (c)

Fig. 17. Relative shape and size of BF bead. (a) NI, (b) FPC, and (c) CF joint.

3.2.2. Butt fused specimen

Three types of BF joints, a normal joint with no flaw (NI), a cold fusion (CF) joint, and a joint with fine particulate contamination (FPC), were made. All joints were made using two 250 mm long pipes in a Georg Fischer TD-315 BF machine according to the SLP procedure of ISO 21307. The heating plate temperature was 230 °C, and the jointing pressure of 1.5 bar was applied for all butt-fusions. CF joints were produced by increasing the change over time (COT) of the pressure-time BF curve (ISO 21307). A normal 5 s COT was used to create NI and FPC joints, while a COT of 70 s was employed to produce the CF joint. A 70-s COT was found to be adequate to have the heated interface of 110 SDR 11 pipe to cool down to nearly the crystallization temperature of the pipe resin, resulting in cold fusion in the BF joint [38]. All jointing was done at an ambient temperature of 23 °C, 50% relative humidity. The BF joint with FPC was made using fine quicklime particulates. After planar machining to square each pipe ends, quicklime particles were applied to each end using a soft cloth glove until a predetermined amount of fine particulates covered the total pipe end surfaces (Fig. 16). The SLP BF procedure was then applied with 5 s COT. Fig. 17 illustrates the relative bead shape and size of NI, CF, and FPC BF joints. For FPC, the squeeze melt flow during BF jointing causes much of the fine particulates to flow out and accumulate on the surface of the fusion bead, as shown in Fig. 17b. On the other hand, CF causes the bead shape and size to be different from the normal NI joint (Fig. 17a). For some BF joints, two 10 mm diameter holes were drilled completely through the BF at 180° apart along the circumference, as shown in Fig. 18. BF pipes were left at ambient conditions for 24 h before final dimensioning using a lathe to a total length of 460 mm for both the AT and HAT tests. All specimens were then conditioned at 23 °C, 50% RH for at least 24 h before the test.

HAT – Hydro Axial Tension

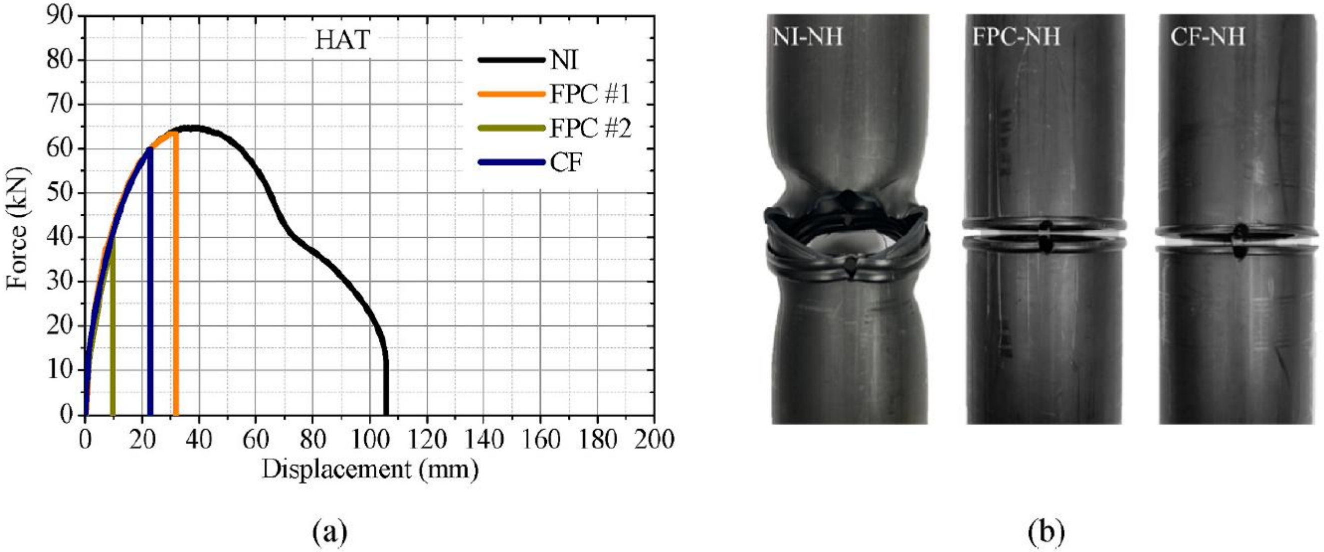


Fig. 29. (a) Force-displacement curves of HAT tests with holes, and (b) specimens after HAT test.

AT – Axial Tension

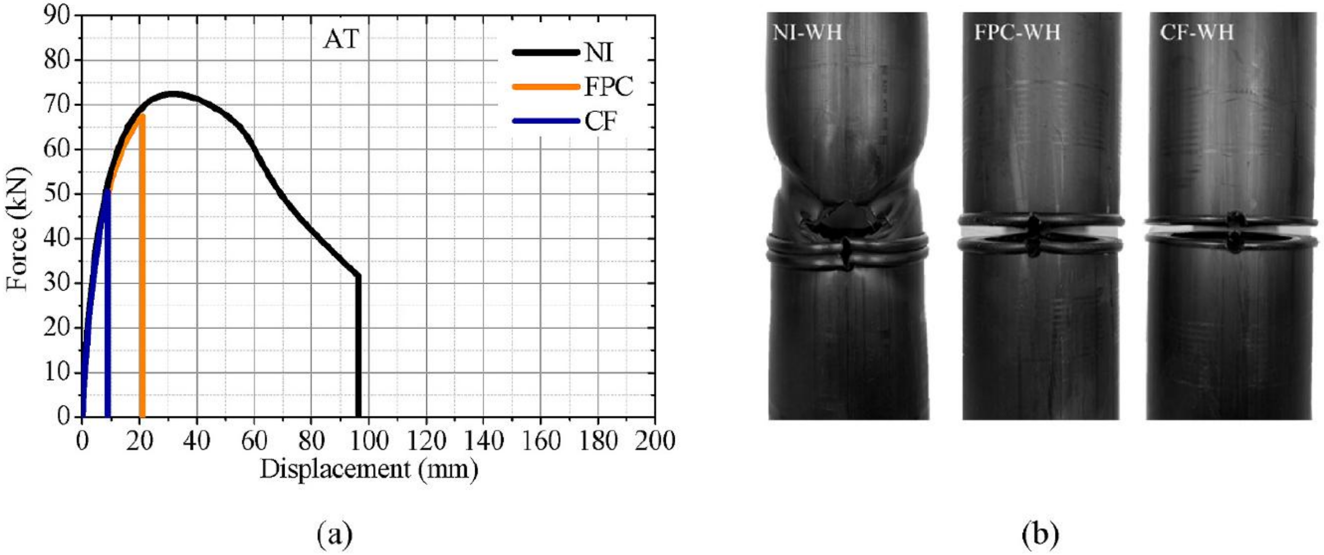


Fig. 30. (a) Force-displacement curves of AT tests with holes, and (b) specimens after AT test.

TÄNKVÄRT RESULTAT FRÅN FORSKNINGEN

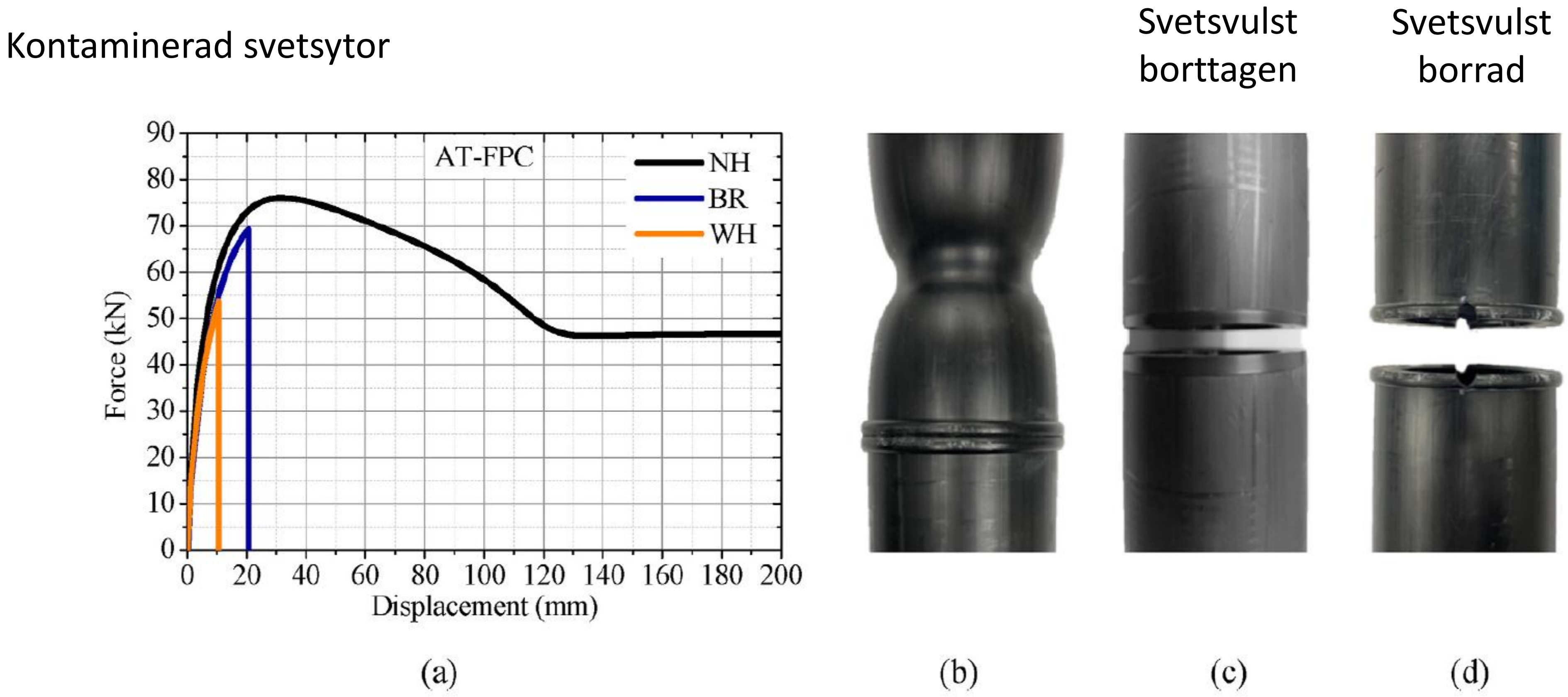


Fig. 28. AT tests on FPC specimens with different bead types. (a) Force-displacement curves, (b) bead intact, (c) bead removed, and (d) bead with holes (WH).

ISO TC 138/ SC 5/WG 17

WG 17 – Alternative test methods (Mr. Choi)
Works on

ISO/DTS 22499-2	Thermoplastic pipes for the conveyance of fluids — Inspection of polyethylene butt fusion joints using phased array ultrasonic testing
ISO/PWI 19251-1	Thermoplastic pipes for the conveyance of fluid - Hydro axial tension (HAT) test – Resistance of pipe or pipe/joint assemblies to tensile loading
ISO/PWI 19251-2	Thermoplastic pipes for the conveyance of fluid - Hydro axial tension (HAT) test – stress rupture
ISO/DIS 24399	Thermoplastic pipes for the conveyance of fluids — Inspection of polyethylene butt fusion joints using time of flight diffraction testing

ISO/NP 19251-1:2024(E)
ISO TC 138/SC 5/WG 17
Date: 2024-07-xx

Thermoplastic pipes for the conveyance of fluid - Hydroaxial tension (HAT) method – Part 1. Determination of the longitudinal tensile strength of pipe or pipe/pipe or pipe/fitting assemblies

NP Stage

Warning for WDs and CDs

This document is not an ISO International Standard. It is distributed for review and comment. It is subject to change without notice and may not be referred to as an International Standard.

Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

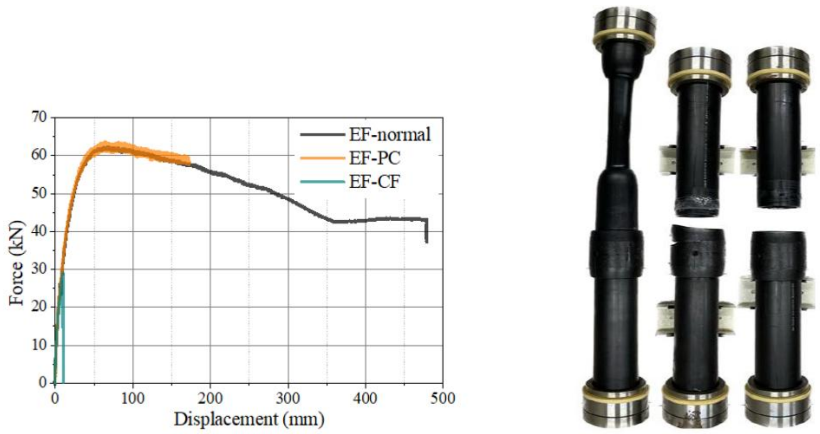


Figure A.6. Force-displacement results and corresponding photos of electro-fusion joints (normal, particulate contaminants, cold fusion) from the HAT test.

KUL MED STANDARDER

ISO/TC 138 SC 2

SS-EN ISO 15874- **Plastics piping systems for hot and cold water installations - Polypropylene (PP)**

EN ISO 15874 “PP” – Butt fusion: Revision to integrate butt fusion
The issue is on PWI stage. Under ISO/TC 138 SC 2 lead, a test method was worked out to ensure weldability of PP-R and PP-RCT material. A round robin will be conducted in 2024 with 9 labs involved to check the test method

CEN/TC 249/WG 16

CEN/TC 249/WG 16 **N 578**

CEN/TC 249/WG 16 "Welding of thermoplastics"
WG Secretariat: **UNI**
Convenor: **Murgia Michele Mr**

N578 Draft PWI Qualification of WPS with modifications on 2024-06-12

1 Scope

This document specifies a procedure to qualify a preliminary welding procedure specification (pWPS) by welding procedure tests to produce a qualified welding procedure specification (WPS).

NOTE 1: The application of this document ensures that the qualification of the pWPS is carried out according to a uniform test procedure.

NOTE 2: The primary purpose of welding procedure qualification is to demonstrate that the joining process proposed for construction is capable of producing joints having the required mechanical properties for the intended application.

This document applies to the following thermoplastic welding processes:

- hot gas welding: round nozzle, speed, wedge;
- extrusion welding;
- heated tool welding: butt, socket, wedge;

Contents Page

STRUKTURVÄGGRÖR AG51

Förslag på text

AMA23

PBB.5214 Ledning av PE-rör, fabrikatspecifika markavloppsrör, i ledningsgrav

Rör och rördelar ska uppfylla kraven för kvalitetsmärkningen Nordic Poly Mark eller vara tredjepartsverifierade till motsvarande nivå.

Rör och rördelar ska vara av konstruktionsrör typ B med slät insida, profilerad utsida och med utvändig dimensionsserie och uppfylla krav enligt SS-EN 13476-1 och SS-EN 13476-3.

Rörens slaghållfasthet vid −10 °C ska verifieras enligt SS-EN 13476-3.

Rör ska vara av styvhetsklass minst SN8. Rördelar ska tillsammans med rakrör konstruktionsmässigt vara av styvhetsklass SN8.

Fogning

Gummiringsfog

Fogning ska utföras med gummiring som uppfyller krav enligt SS-EN 681-1 och som är godkänd av rörtillverkaren och anpassad för den levererade rörtypen.

Fogning ska utföras enligt tillverkarens anvisningar.

Svetsarbete

Extrudersvets

Extrudersvetsning ska utföras enligt DVS 2207-4 eller tillverkarens anvisningar.

Svetsare ska för aktuell metod och aktuellt dimensionsområde ha genomgått certifierad utbildning och ha ett giltigt svetscertifikat enligt EWF 581 och SS-EN 13067.

Dokumentation av svetsparametrar ska minst innehålla de som anges i svetsprotokoll enligt DVS 2207-4.

Fog med koppling

Spännband ska efterdras.

AMA26

PBB.5214 Ledning av PE-rör, fabrikatspecifika markavloppsrör, i ledningsgrav

Rör och rördelar ska uppfylla kraven för kvalitetsmärkningen Nordic Poly Mark eller vara tredjepartsverifierade till motsvarande nivå.

Rör och rördelar ska vara av konstruktionsrör typ B med slät insida, profilerad utsida och med utvändig dimensionsserie och uppfylla krav enligt SS-EN 13476-1 och SS-EN 13476-3.

Rörens slaghållfasthet vid −10 °C ska verifieras enligt SS-EN 13476-3.

Rör ska vara av styvhetsklass minst SN8. Rördelar ska tillsammans med rakrör konstruktionsmässigt vara av styvhetsklass SN8.

Svetsarbete

Extrudersvets

Extrudersvetsning ska utföras enligt DVS 2207-4 eller tillverkarens anvisningar.

Svetsare ska för aktuell metod och material (PE) aktuellt dimensionsområde ha genomgått certifierad utbildning och ha ett giltigt svetscertifikat enligt EWF 581 och SS-EN 13067.

Dokumentation av svetsparametrar ska minst innehålla de som anges i svetsprotokoll enligt DVS 2207-4.

Svetsare ska utföra visuell kontroll enligt DVS 2202 till quality level 1.

Vid svetsning ska hela spaltens godstjocklek fyllas med smält material, runt hela röret.

Vid fuktig eller blåsig väderlek ska svetsning utföras under skydd.

Svets får inte utsättas för drag- eller böj påkänning under svetsning eller under avsvalningsförloppet.

Extrudersvetsfog ska uppfylla krav enligt SS-EN ISO 13262.

För godkänd extruder svetsfog får ingen provkropp uppvisa brott i svetsfogen enligt SS-EN 13476.

Före svetsning ska en svetsprocedurspecifikation (WPS) för aktuell extrudersvetsfog och dimension redovisas.

Ange krav på extrudersvetsning utöver i AMA angivna krav.

Ange kontroll av fogning genom extrudersvetsning under YHB.1312.

Förslag på text AMA26

PP
2.1 Trådsvetsning
2.2 Extrudersvetsning

PE
3.1 Trådsvetsning
3.2 Extrudersvetsning

PBB.5214 Ledning av PE-rör, fabrikatspecifika markavloppsrör, i ledningsgrav

Rör och rördelar ska uppfylla kraven för kvalitetsmärkningen Nordic Poly Mark eller vara tredjepartsverifierade till motsvarande nivå.

Rör och rördelar ska vara av konstruktionsrör typ B med slät insida, profilerad utsida och med utvändig dimensionsserie och uppfylla krav enligt SS-EN 13476-1 och SS-EN 13476-3.

Rörens slaghållfasthet vid −10 °C ska verifieras enligt SS-EN 13476-3.

Rör ska vara av styvhetsklass minst SN8. Rördelar ska tillsammans med rakrör konstruktionsmässigt vara av styvhetsklass SN8.

Svetsarbete

Extrudersvets

Extrudersvetsning ska utföras enligt DVS 2207-4 eller tillverkarens anvisningar.

Svetsare ska för aktuell metod och material (PE) aktuellt dimensionsområde ha genomgått certifierad utbildning och ha ett giltigt svetscertifikat enligt EWF 581 och SS-EN 13067.

Dokumentation av svetsparametrar ska minst innehålla de som anges i svetsprotokoll enligt DVS 2207-4.

Svetsare ska utföra visuell kontroll enligt DVS 2202 till quality level 1.

Vid svetsning ska hela spaltens godstjocklek fyllas med smält material, runt hela röret.

Vid fuktig eller blåsig väderlek ska svetsning utföras under skydd.

Svets får inte utsättas för drag- eller böj påkänning under svetsning eller under avsvalningsförloppet.

Extrudersvetsfog ska uppfylla krav enligt SS-EN ISO 13262.

För godkänd extruder svetsfog får ingen provkropp uppvisa brott i svetsfogen enligt SS-EN 13476.

Före svetsning ska en svetsprocedurspecifikation (WPS) för aktuell extrudersvetsfog och dimension redovisas.

Ange krav på extrudersvetsning utöver i AMA angivna krav.

Ange kontroll av fogning genom extrudersvetsning under YHB.1312.

DVS 2207-4
Grundläggande kring
- temperatur

SS-EN ISO 13262:2017

Plaströrssystem av termoplast för avlopp i mark - Spiralformade lättviktsrör av thermoplast - Bestämning av draghållfasthet hos en söm (ISO 13262:2010)

Tabellen med vilken kraft en svets ska klara kommer tas bort i den nya uppdateringen av standarden

Unika produkter allt täcks inte av DVS

DVS 2207-4

Appendix 1. Quick guide to welding.

1. Putting together the welding equipment (Section 9)

- Valid qualification certificate (for example Guidline DVS 2212-1)
- The hot-gas extrusion welding equipment appropriate to the welding task with operating instructions
- Possibly a hot-gas welding device for tacking the joining parts
- Welding shoes in line with the weld shape
- Flow meter for welding gas
- Thermometer with sensors to measure the hot-gas and extrudate and the temperature of the semi-finished product
- Suitable measuring equipment for checking misalignment/diameter/thickness
- Tool rest
- Scraper, drawing blade
- Personal protective equipment
- Dust protection for welding wire
- Suitable cleaning agent
- Supplement 1: Materials and welding parameters
- Appendix 2: Welding protocol
- Special welding procedure specification

2. Check working conditions and arrange measures (Section 9)

- Accessibility
- Clean working environment
- Adequate lighting
- Protective tent
- Heating
- Adequate ventilation / fume extraction
- Special protective equipment

3. Checking weldability (Section 7)

- Check the manufacturer's information regarding the semi-finished products and filler materials to ensure a match
- Check the condition and cleanness of the items to be joined and clean if necessary
- Where necessary, check the weldability of the items to be joined by surface welding in accordance with Guideline DVS 2201-2 or by trial welds.

4. Preparing the weld seams and joint surfaces (Section 6, 10)

- Check, define and establish the weld geometry and weld shape
- Remove oxide layer on the joint surfaces

5. Tacking the joining parts (section 10)

- Partial or continuous root pass with hot-gas welding device

6. Commission and prepare the weld extruder (Section 8)

- Check supply lines (current, air) for anything that could obstruct the welding operation
- Connect and start the extruder in line with operating instructions
- Select, adjust and mount the welding shoe and hot-gas nozzle according to seam geometry and seam shape
- Extrude re-heated welding filler from the cylinder
- Set and check parameters (Appendix 1)
- Pre-heat the welding shoe

7. Welding (Section 10)

- Check for sufficient plasticisation of the base material (for example by piercing with a blunt tool)
- Check speed of travel and monitor evenness
- Check the weld extruder continuously and make the necessary corrections
- If necessary cover the surface of the weld to prevent it from cooling down too quickly
- Bevel seam ends before new starts
- Protect filler material from contamination

8. Post-processing of the weld seam (Section 10)

- Allow welded parts to cool sufficiently before unclamping them and subjecting them to loads
- Mechanical dressing of escaped weld seam material and weld reinforcements

9. Drawing up a welding protocol (Section 10)

- Complete welding protocol (Appendix 2) and carry out visual inspection in line with Guideline DVS 2202 Supplement 5

Table 1. Welding parameter reference values.

Materials	Abbreviation	Compound temperature [1] [°C]	Hot-gas temperature [2] [°C]	Hot-gas volume [3] [°C]
High-density polyethylene	PE [4]	210…230	250…300	150…400
Polypropylene Type 1, 2, 3	PP-H, PP-B, PP-R	210…240	250…300	150…400
Polyvinyl chloride unplasticised	PVC-U	190…200	330…360	150…400
Polyvinyl chloride high impact resistance	PVC-HI	170…180	280…340	150…400
Polyvinyl chloride chlorinated	PVC-C	195…210	300…360	150…400
Polyvinylidene fluoride	PVDF	240…260	280…350	150…400

[1] measured with a thermometer inserted at the extruder outlet of the welding machine
[2] Measured at the centre of the nozzle orifice, 5 mm into the nozzle
[3] Cold air intake volume at ambient pressure, depending on the output volume
[4] PE 63, PE 80, PE 100

SV-RÖREN

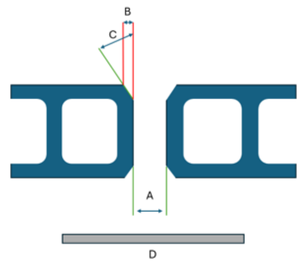
Krav från AMA gruppen är att det ska finnas en WPS tillgänglig, ett utkast finns som följer SS-EN ISO 15609

WPS kommentarer:
- WPS ska vi börja kalla det för svetsdatablad?
- När man pratar denna typ av rör så mäter man ID, inte YD. Ändra till ID och profilhöjd.
- Vilken typ av fasningsverktyg/maskin och skrapnings verktyg/maskin får användas för att inte förstöra materialets egenskaper och för att inte värma upp materialet vid detta moment?

WRS kommentarer:
- Tillverkningsnummer på svetsutrustningen saknas
- ID och profilhöjd
- Fasning saknas
- Skrapning saknas
- Finns det något krav på besiktning/kalibrering av handextruders eller är det något vi skall fråga marknaden om det finns ett behov

Svetsprocedurspecifikation (WPS)

WPS nr.		Tillsatsmaterial, typ och tillverkare	
Tillverkare och material rör		Svetsmaskin fabrikat och modell	
Utvändig diameter(mm) samt godsjocklek rör (mm)		Svetsmaskin output kg/h	
Metod för fogberedning och rengöring samt förutsättningar för genomförande (väder, väderskydd samt omgivande temperatur)			

Fogutformning	Svetsordning
	

Fogutformning

Spalt mm (A)	Avfasnings mått mm [B]	Avfasningsvinkel (C)	Z-fog eller rak skarv	Svetssko Typ profil skiss	Plåtband (D)	Distanser antal och typ
					Bredd: Tjocklek: Fixering: Tid efter svetsning:	

Svetsordning (rita in i bild ovan)

Sträng (passage)	Svetsläge (UT-utsidan, IN-insidan)	Manuell eller robot	Temperatur på luft °C	Temperatur på massan °C

Kontroll

OFP		Rapport nummer:
Mekanisk provning		Rapport nummer:

Utarbetad av (Tillverkare)		Granskare (om annan än tillverkare)	
Namn		Namn	
Signatur		Signatur	
Datum		Datum	

Rev. 1.1

10.1 SKZ


Kunststoff-fügen
JOINING CENTER · WÜRZBURG/LENGFELD
JOINING CENTER · WÜRZBURG/ZELLERAU
COMPOSITE AND ADHESIVE BONDING · HALLE
JOINING CENTER · PEINE
JOINING CENTER · HORB
✓ Recognized DVGW training center
✓ Training partner of brbv
✓ Trainings according to DVS guidelines
✓ Testing laboratory
✓ In-house trainings
✓ Welding and adhesive bonding
✓ Composites
DISPERSION TECHNOLOGIES · SELB
ADHESIVE BONDING LABORATORY · WÜRZBURG


COMPETENCE
OVER 60 YEARS
>700 TRAININGS
PER YEAR
ANNUAL 13.000
HAPPY PARTICIPANTS
SECTOR FOCUS
PLASTICS INDUSTRY
ASSURED QUALITY
ISO 9001:2015

SKZ-DVGW -331

Varje företag har svetsansvarig – supervisor

Supervisor kan förlänga den svetsande personalens certifikat

Reflektioner:

- Kunskapskraven på svetsaren är högre i Sverige än Tyskland
- Hänvisning till tillverkarnas rekommendationer i större utsträckning
- DVGW materialet var framtaget av IKV – alla har samma utbildningsmaterial
- Antal svetsmaskiner per deltagare var högt
- Examinationen

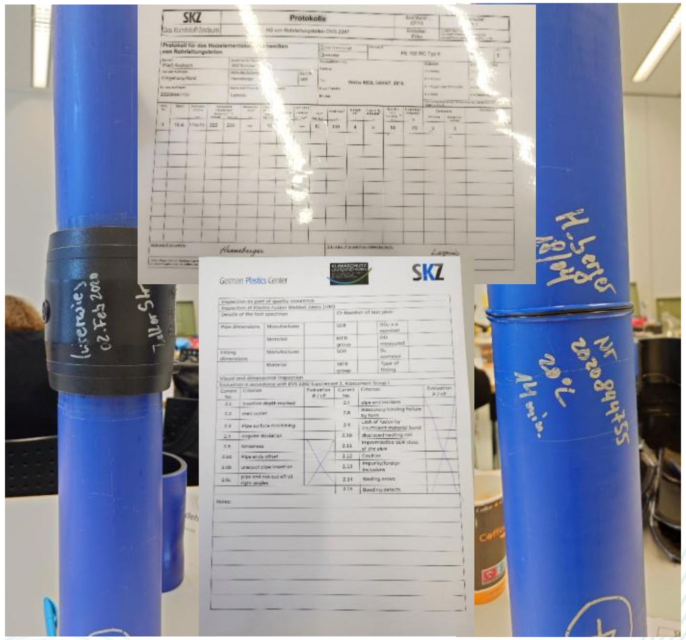
INSTITUT FÜR KUNSTSTOFF VERARBEITUNG in Industrie und Handwerk an der RWTH Aachen

Institute for Plastics Processing: Research for Practical Use

EXAMINATIONEN

Praktisk

Kontroll av svetsar

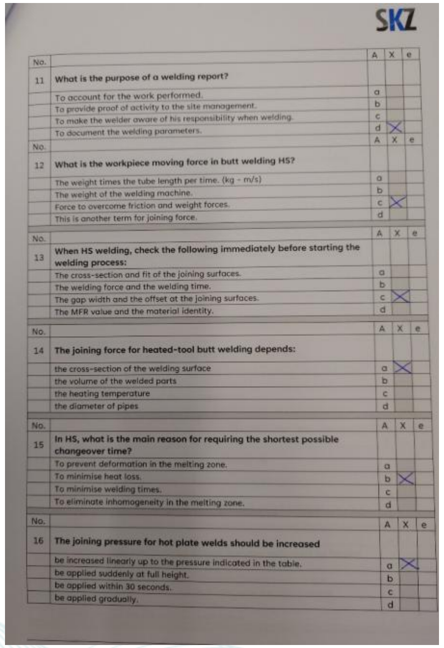


Praktisk/Teoretisk

Onsite-instruktion

Teoretisk

Teoriprov



SKZ

No.		A	X	e
11	**What is the purpose of a welding report?**			
	To account for the work performed.	a		
	To provide proof of activity to the site management.	b		
	To make the welder aware of his responsibility when welding.	c		
	To document the welding parameters.	d	X	
No.		A	X	e
12	**What is the workpiece moving force in butt welding HS?**			
	The weight times the tube length per time. (kg - m/s)	a		
	The weight of the welding machine.	b		
	Force to overcome friction and weight forces.	c	X	
	This is another term for joining force.	d		
No.		A	X	e
13	**When HS welding, check the following immediately before starting the welding process:**			
	The cross-section and fit of the joining surfaces.	a		
	The welding force and the welding time.	b		
	The gap width and the offset at the joining surfaces.	c	X	
	The MFR value and the material identity.	d		
No.		A	X	e
14	**The joining force for heated-tool butt welding depends:**			
	the cross-section of the welding surface	a	X	
	the volume of the welded parts	b		
	the heating temperature	c		
	the diameter of pipes	d		
No.		A	X	e
15	**In HS, what is the main reason for requiring the shortest possible changeover time?**			
	To prevent deformation in the melting zone.	a		
	To minimise heat loss.	b	X	
	To minimise welding times.	c		
	To eliminate inhomogeneity in the melting zone.	d		
No.		A	X	e
16	**The joining pressure for hot plate welds should be increased**			
	be increased linearly up to the pressure indicated in the table.	a	X	
	be applied suddenly at full height.	b		
	be applied within 30 seconds.	c		
	be applied gradually.	d		