Kemppi Oy

Kemppi's Reduced Gap Technology (RGT) challenges conventional joint design principles

White paper

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Reducing the groove angle can add significantly to efficiency and productivity of welding of heavy metal structures. Conventional narrow gap welding can be applied with most welding processes, but it has a disadvantage: it is practically impossible without equipment especially designed for the application. To overcome this constraint, Kemppi has developed a new solution, Reduced Gap Technology (RGT). This technology allows reliable and efficient narrow gap welding with no need for special equipment or accessories for material thicknesses of up to 30 mm. The solution combines intelligent arc control with Kemppi's high-tech power source, wire feeder and mechanization equipment.

RGT changes our understanding of narrow gap welding

In narrow gap welding, the groove angle is typically less than 20 degrees instead of the normal 45 to 60 degrees. This decreases the number of weld passes needed to complete the joint, and it reduces the welding time and the consumption of filler material. It also makes the material less prone to distortion. In other words, reducing the groove volume has a multitude of positive effects on welding quality, efficiency and productivity.

However, reducing the groove angle also brings more challenges to welding. In a narrow groove, the welding arc is difficult to control. This may result in quality issues, unless you invest in welding torch and accessories that are specially designed for the application.

For narrow gap MIG/MAG applications with material thickness below 30 mm, Kemppi's Reduced Gap Technology (RGT) is an ideal new solution. It allows using standard welding equipment and welding application software for narrow gap welding of butt joints and fillet joints. The RGT solution combines the benefits of Wise application software, FastMig or X8 MIG Welder equipment, and A5 MIG Rail System 2500 welding mechanization system.

A control system ensures consistent power and precisely focused arc

At the core of Kemppi's RGT solution is the most advanced arc control system available, which delivers consistent arc power at contact-tip-to-work distances of up to about 30 mm. In addition, the system adaptively adjusts the arc to keep its energy density at the maximum level (see Figure 1). A short, stable, and efficient arc minimizes the risk of incomplete penetration and lack of fusion, because the arc is always focused precisely at the desired point in the groove. The RGT control system enables reliable narrow gap welding of materials with thicknesses up to 30 mm, without the need for special equipment or accessories.

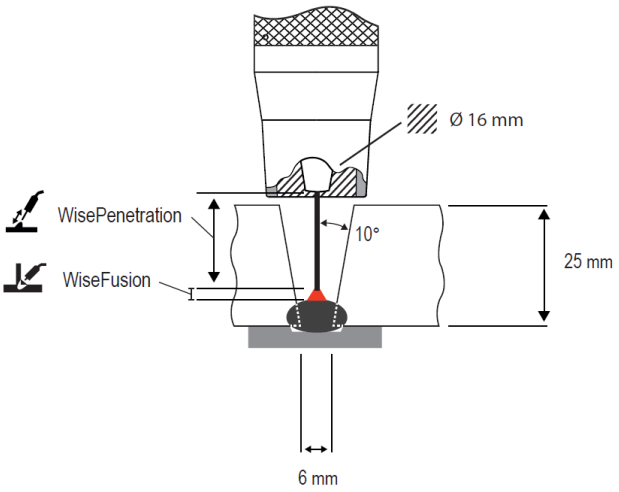


Figure 1. The principle of the RGT control system is that WisePenetration maintains consistent arc power regardless of variation in the contact-tip-to-work distance while WiseFusion provides adaptive regulation that keeps the arc focused and optimally short. In X8 MIG Welder, all of this functionality is combined in WisePenetration+ function.

Kemppi's RGT narrow gap welding solution – for many direct benefits

Narrow gap welding provides many benefits, and in addition to those, Kemppi's RGT solution offers many further advantages, for still greater cost savings and added value:

- Investment costs are low, since no special equipment is needed in welding with material thicknesses under 30 mm.
- WiseFusion keeps the arc stable, improves the control of the weld pool and reduces the magnetic arc blow. This decreases the risk of incomplete penetration and lack of fusion, and it results in lower repair costs.
- WisePenetration keeps the arc power consistent, regardless of variations in the contact-tip-to-work distance. This enables a higher welding speed and deposition rate, and it results in lower labor costs.
- The high energy density of WiseFusion minimizes heat input, which improves impact toughness with high-strength steels and reduces deformation, so there is less need for straightening.
- WiseFusion keeps the arc length stable. The user doesn't need to adjust it, for less hassle and a better arc time ratio.
- The A5 MIG Rail System 2500 rail carriage is optimized for use with FastMig power sources. Power to the rail carriage is supplied through Kemppi's special torch without additional cables, so getting the system ready for operation is fast, and arc time ratios are better than before.
- Remote control of the A5 MIG Rail System 2500 enables quick and easy adjustment of the carriage functions and power source welding parameters. Therefore, the operator can focus on monitoring the welding. The result is fewer welding imperfections and lower repair costs.

Savings potential illustrated by a preliminary WPS

Kemppi's RGT narrow gap welding solution has produced good results with a 20° groove angle and material thickness of up to 30 mm. The pWPS shown in Figure 2 is approved via tests in compliance with the standard on welding procedure qualification testing. It provides all the information required for the utilization of Kemppi's narrow gap solution in production welding. It was created for a butt joint with a 20° groove angle and a thickness of 25 mm. Figure 3 shows a calculation of the savings potential that the method yields. The smaller, 20° groove angle will result in a groove volume about 25% lower than with a 45° groove angle.

KEMPPI

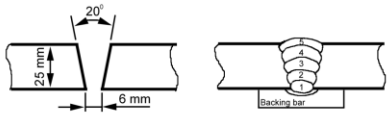
PRELIMINARY WELDING PROCEDURE SPECIFICATION (pWPS)

pWPS no: FI0004MECH
Ref.:
Date: 08.12.15 Rev: 3

Prod. by:	Jyri Uusitalo	Client:	Kemppi oy
Project:	Welding procedure test	Ref. spec.:	
Location:	Lahti	Ref. Proc.:	
Ref. stand:	EN ISO 15609-1		
Exam. body:	Kemppi Oy		

	1	2	3
Welding process	136		
Shielding gas type	Ar+18%CO2		
Weaving (yes/no)	Yes max: 13 mm	max: mm	max: mm

Purging gas type	l/min
Welding positions	PF
Joint type	BW
Joint preparation	Cutting/grinding
Cleaning method	Grinding
Backing	Ceramic
Single/Double	Single side welding
Back gouging	N/A
Flux designation	N/A
Flux handling	N/A
Tungsten electrode	N/A mm
Torch angle	0 °
Stand off distance	mm
Nozzle diameter(s)	N/A mm
Tack welding proc.	N/A Rev: ---



Mechanized welding with the A5 MIG Rail Carriage 2500

Identification of parent metal I: CE max: C max: PCM max: II: CE max: C max: PCM max:

Part	Name/Grade	Standard	Group	Delivery cond.	Thickness range [mm]	Diameter range [mm]
I	S355K2	EN 10204-3.1	1.2		25,00 -	-
II					-	-

Identification of filler metal

Index	Trade name	Classification	Group	Filler handling
1	FILARC PZ6113	EN ISO 17632-A T46 2 P M 1 H10		
2				
3				

Welding Parameters Equipment:

Pass no.	Index	Dia. [mm]	Welding process	Wire feed speed [m/min]	Current [A]	Voltage [V]	Current / Polarity	Transfer Mode	Welding speed [mm/min]	Run Out Length [mm]	Gas [l/min]	Heat input [kJ/mm]
1	1	1,20	136	9,00 - 9,50	220 - 240	24,2 - 26,5	DC+	spray	178, - 182,	25	18	1,4 - 1,7
2	1	1,20	136	9,00 - 9,50	220 - 240	23,0 - 25,5	DC+	spray	178, - 182,	20	18	1,3 - 1,7
3	1	1,20	136	8,20 - 8,70	205 - 220	22,3 - 24,5	DC+	spray	178, - 182,	20	18	1,2 - 1,5
4	1	1,20	136	8,00 - 8,50	200 - 215	22,3 - 24,5	DC+	spray	218, - 222,	20	18	1,0 - 1,2
5	1	1,20	136	8,00 - 8,50	200 - 215	22,0 - 24,0	DC+	spray	148, - 152,	20	18	1,4 - 1,7
				-	-	-			-			-
				-	-	-			-			-
				-	-	-			-			-
				-	-	-			-			-

Heat treatment Method: N/A

Preheat min: °C Interpass temp. max: 115 °C Heat treatment proc.: Temp. control:

PWHT min: °C max: °C Soaking: min/mm min Heating rate: °C/h Cooling rate: °C/h

Remarks:
WisePenetration On/0%; WiseFusion On/35%; weaving parameters:
pass 1 weaving width 4 [mm], delay 0,1 [s] and speed 40 [mm/s]
pass 2 weaving width 6 [mm], delay 0,1 [s] and speed 40 [mm/s]
pass 3 weaving width 7 [mm], delay 0,1 [s] and speed 40 [mm/s]
pass 4 weaving width 7 [mm], delay 0,1 [s] and speed 40 [mm/s]
pass 5 weaving width 13 [mm], delay 0 [s] and speed 50 [mm/s]

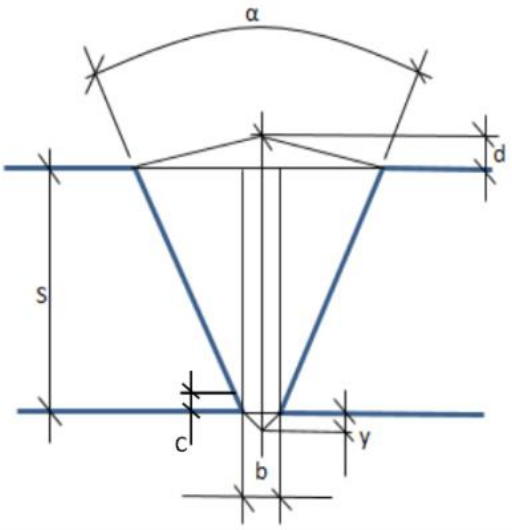
Additional info enclosed (Yes/No):

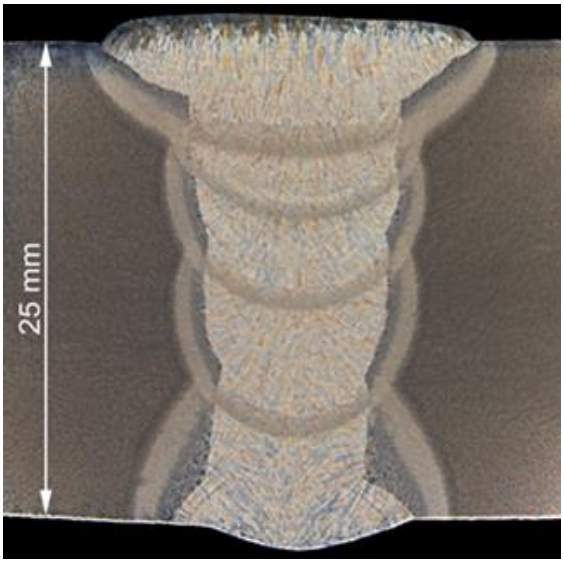
Date/Signature: 08.12.15 JU
Jyri Uusitalo

Approved:

Index no. 11200088 Page 1 of 1 Produced by Kemppi ARC System

Figure 2. Preliminary Welding Procedure Specification (pWPS) for narrow gap welding of a butt joint.





Five weld passes

Groove dimensions	Current 45° groove	New 20° groove
Material thickness	s = 25.0 mm	s = 25.0 mm
Bevel angle	α/2 = 22.5°	α/2 = 10°
Root gap	b = 4.0 mm	b = 6.0 mm
Root face	c = 1.5 mm	c = 0 mm
Root reinforcement	y = 2.0 mm	y = 2.0 mm
Reinforcement	d = 2.0 mm	d = 2.0 mm
Groove volume	A = 372 mm²	A = 281 mm²
Weight of weld metal	G = 2.9 kg/m	G = 2.2 kg/m

Figure 3. Benefits of Kemppi's RGT narrow gap solution in terms of groove volume and filler material consumption. The 45° angle includes 1.5 mm root faces (c). The difference in the root gap is also considered (b). The 20° groove has sharp root edges.

Device and software requirements with the RGT solution

The narrow gap welding solution is available for Kemppi's FastMig KMS, FastMig M, FastMig Pulse, FastMig X and X8 MIG Welder equipment. Use of this solution requires that the machine is equipped with the WisePenetration and WiseFusion application software. With X8 MIG Welder, only WisePenetration+ is needed, as it includes all necessary functions. The required Wise application software products are easy to purchase and install after machine purchase. To optimize usability and welding efficiency, it is recommendable to use this technology with the A5 MIG Rail System 2500 (see Figure 4).

Figure 4. The A5 MIG Rail System 2500: rail carriage, rails, a FastMig welding machine, and an integrated remote controller for managing the entire system.

Arctech Helsinki Shipyard uses Kemppi's technology

Among the users of Kemppi's RGT narrow gap welding solution is Arctech Helsinki Shipyard (see Figure 5), which has managed to reduce the groove angles from 45 to 30 degrees with the new technology. The shipyard uses WPS documents based on welding procedure qualification records (WPQRs) for mechanized welding in the construction of icebreakers. “Adoption of the new technology has brought us cost savings and improved the welding quality,” says Arctech’s Hull Production Manager Niko Rautiainen. “Welding work has gained speed, because the groove volume and the number of beads to be welded have decreased. Also less filler material is needed. Mechanization has also improved the arc time ratio and made the welds more consistent in quality,” he adds.

Figure 5. Welding of block sections of an icebreaker, using Kemppi's narrow gap welding solution, with Kemppi's A5 MIG Rail System 2500 and FastMig M 520 power source. Photos: Arctech Helsinki Shipyard.

Summary

The RGT narrow gap welding solution developed by Kemppi is based on an intelligent control system that keeps the arc power consistent regardless of the variations in the contact-tip-to-work distance. In addition, the system controls the arc adaptively, to keep its energy density at the maximum level. A short, stable, and efficient arc minimizes the risk of incomplete penetration and lack of fusion, because the arc is always focused precisely at the desired point in the groove. The control system enables reliable narrow gap welding of materials with thicknesses of up to 30 mm, with a 20° groove angle, from one side, and without the need for special equipment or accessories. Smaller groove volume yields significant cost savings through reductions in welding time and filler-material consumption. The method is excellently suited to both butt and fillet joints, no matter the welding position. To optimize usability and welding efficiency, using the solution with the A5 MIG Rail System 2500 is recommended.