

Lasting connections: filler materials for welding pipelines

Robert Bischof of voestalpine Böhler Welding, discusses the specially developed welding consumables selections that have been customised for pipeline use.

Oil and natural gas are currently still among the most important sources of energy. Countless transport pipelines already exist worldwide or are at the project planning stage. The development of new high-strength pipe steels places ever-greater demands on welding technology. In the following article we present the specially developed welding materials from Böhler Welding, voestalpine Böhler Welding's brand for joint-welding



Above: Böhler Welding's combination method using cellulose-coated electrodes offers maximum security against cracks. The root is welded with BÖHLER FOX CEL and the other layers are welded with filler materials matched to the strength classes of the pipe material.

Left: Countless oil and gas transport pipelines already exist worldwide or are at the project planning stage.

consumable that are optimally adapted to individual pipe materials and therefore comply fully with the increasingly stringent quality requirements and the safety regulations.

Circumferential pipe seams are often welded using cellulose-coated rod electrodes using a vertical-down welding position. This method enables welding with larger electrode diameters, higher currents and achieves higher welding speeds. This results in significant economic advantages in comparison to its most common alternative; vertical-up seam welding using rutile- or basic-coated stick electrodes.

Welding with cellulose-coated electrodes

Careful seam preparation is of great importance for achieving high-quality weld joints. Electrodes such as Böhler FOX CEL are particularly suitable for root pass welding, even with high-strength pipe steels.

Welding technologists from voestalpine Böhler Welding have developed

the technique referred to as the combination method for maximum security against cracks, in which the root is welded with BÖHLER FOX CEL – regardless of the pipe material – and the other layers are welded with filler materials matched to the strength classes of the pipe material. The Ø2.5 or Ø3.2 mm BÖHLER FOX CEL electrode is recommended for root pass welding of pipes with smaller diameters – up to 200 mm.

The FOX CEL portfolio of cellulose electrodes product is summarised in Table 1.

Preheating and inter-pass temperature

Preheating and maintaining an appropriate inter-pass temperature promotes or accelerates the effusion of hydrogen and counteracts the possible formation of hydrogen-induced cracks. The ends of the pipes are preheated according to Figure 1.

The inter-pass temperature also influences the metallurgical processes that take place during solidification and cooling and therefore has an influence on the mechanical properties of the weld metal.

Welding with basic coated electrodes

For several reasons the use of basic-coated electrodes is preferred to cellulose-coated electrodes in pipeline construction in some countries. The use of basic electrodes is generally recommended for welding thick – over 25 mm – pipe steels that are sensitive to hardening.

The reason for this is the very low hydrogen content of this type of electrode. The high heat dissipation with greater metal thicknesses and the simultaneously higher hydrogen content increases the risk of cracking when using cellulose-coated rod electrodes.

Böhler Welding started the development of basic vertical-down (BVD) electrodes as early as the mid-1970s. The reason for this was the desire to use high-strength thermomechanically treated TM pipe steels with relatively high toughness – X80, for example. Using cellulose electrodes, the requirements for cold-crack resistance and toughness properties of the weld metal could only be met to a limited extent, and in some cases, cellulose electrodes could not be used at all.

Economic efficiency is largely determined by the achievable deposition rate

Designation	AWS A 5.1 A5.5	Use for pipeline steels to API specification 5L
FOX CEL	E6010	A, B, X42, X46, X52, X56, (X60, X 65, X70, X80*)
FOX CEL+	E6010	A, B, X42, X46, X52, X56, (X60, X 65, X70, X80*)
FOX CEL 70-P	E7010-P1	X52, X56, X60
FOX CEL 75	E7010-P1	X52, X56, X60
FOX CEL Mo	E7010-A1	X52, X56, X60
FOX CEL 80-P	E6010-P1	X56, X60, X65, X70
FOX CEL 85	E8010-P1	X56, X60, X65, X70
FOX CEL 90	E9010-P1	X65, X70, X80

Table 1: The cellulose portfolio of electrodes from Böhler Welding. *Only for root-pass welding.

BÖHLER Designation	AWS classification	Use for pipeline steels to API specification 5 LX
FOX BVD 85	E8045-P2	A, B, X42 – X65
FOX BVD 90	E9045-P2 (mod.)	X 70, X80
FOX BVD 100	E10045-P2(_mod.)	X80
FOX BVD 110	E11018-G	X100
FOX BVD 120	E12018-G	X110

Table 2: Böhler Welding's basic vertical-down electrode portfolio.

BÖHLER Designation	AWS classification A5.36	Use for pipeline steels to API specification 5 L
BÖHLER Ti 52 T-FD	E71T1-M21A4-CS1-DH8	X 42 - X 65
BÖHLER Ti 60 T-FD	E81T1-M21A8-Ni1-H4	X 42 - X 70
BÖHLER Ti 70 Pipe T-FD	E91T1-M21A6-K2-H4	X 52 - X 80
BÖHLER Ti 75 T-FD	E101T1-M21A4-K2-H4	X 70, X 80
BÖHLER Ti 80 T-FD	E111T1-M21A8-GH4	X 80, X100

Table 3: Gas-shielded rutile cored wires for semi or fully automatic pipeline welding in the vertical-up position.

BÖHLER Designation	AWS classification A5.36	Use for pipeline steels to API specification 5 L
BÖHLER Pipeshield 71T8-FD	E71T8-A4-K6	X 42 - X 60 (X 65, X 70)
BÖHLER Pipeshield 71.1T8-FD	E71T8-A4-Ni1	X 42 - X 70
BÖHLER Pipeshield 81T8-FD	E81T8-A4-Ni2	X 65 - X 70
BÖHLER Pipeshield 91T8-FD	E91T8-A4-G	X 80

Table 4: Self-shielded cored wires for welding in the vertical-down position.

and the possible welding speeds. The welding speeds achievable with basic vertical-down electrodes are generally higher than with cellulose electrodes. In comparison to basic vertical-up seam electrodes, significant time advantages of 40 to 50% can be achieved by using basic vertical-down electrodes for the filling and cap passes.

Welding with cored

For economic reasons, the use of cored wires for fill and cap passes is becoming increasingly important in the welding of pipelines. Basically, these cored wires are divided into two groups, gas-shielded and self-shielded cored wires.

A significant advantage of these types is that it is possible to weld in all positions using a single set of welding parameters. For fully automated welding

only a simple feed unit with a weaving device is required. The supporting effect of the rapidly solidifying slag makes it possible to use relatively high currents to achieve high deposition rates.

As is evident from the name, self-shielded cored wire consumables are designed to be used without an external shielding gas, with the core constituents protecting the weld pool against external atmospheric influences. The wire diameter is 2.0 mm. These cored wires are welded using dc-polarity.

All of voestalpine Böhler Welding Group's customised pipeline consumables, along with advice and support from local and global welding specialists, is available through Böhler Uddeholm Africa, the brand's African distribution partner.

www.voestalpine.com/welding

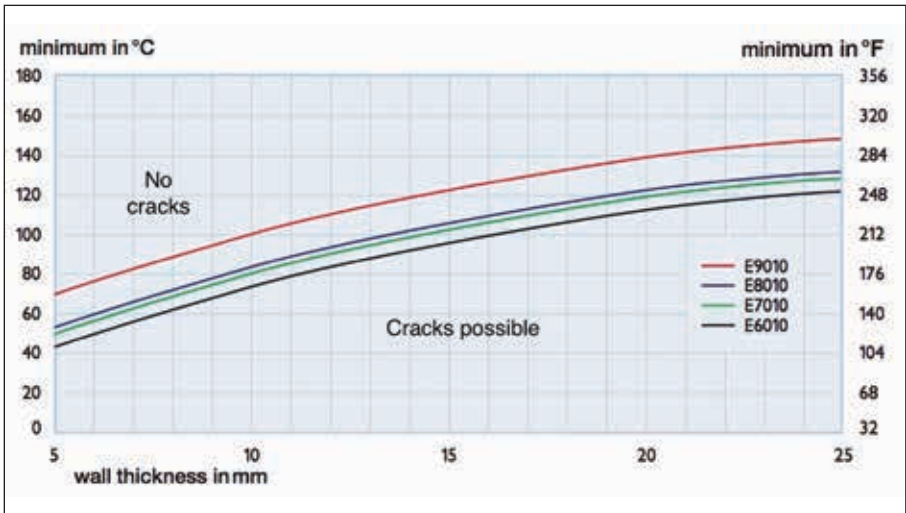


Figure 1: Inter-pass temperature as a function of pipe wall thickness when using cellulose electrodes.