

# A860 Grade WPHY70

ASTM/ASME A/SA 860 WPHY70 · High-strength butt weld fittings for pipelines ·  $R_p \geq 482$  MPa (70 ksi)

- Material group:** High-strength microalloyed pipeline fitting material (HSLA)
- ASTM / ASME standard:** ASTM A860 / ASME SA-860
- Grade:** WPHY70 (Wrought Pipe High Yield – 70 ksi)
- EN equivalent:**  $\approx$  L485 / X70 (1.8972) for pipeline steels
- Matching pipe grades:** API 5L Grade X70 (PSL1 / PSL2) · ISO 3183
- Matching flange grade:** ASTM A694 F70 · MSS SP-44
- Service temperature:**  $-46$  °C to  $+345$  °C (standard per ASME B31.4 / B31.8)
- Standards (fittings):** ASTM A860 / ASME SA-860 · MSS SP-75 · ASME B16.9
- Forms (Nirotec):** Elbows · tees · reducers · caps · custom parts

## 1 Material Equivalents & Comparable Grades

### National equivalents

Standard / region	Designation	Material no. / Grade	Remark
ASTM/ASME	A860 / SA-860 WPHY70	–	Current designation
API	5L Grade X70 (pipes)	L485	Matching pipeline pipes
ASTM	A694 F70	–	Matching pipeline flanges
MSS	SP-75 WPHY70	–	Identical specification (pipeline industry)
EN	L485 ( $\approx$ )	1.8972	Approximate European equivalent
ISO	3183 L485M/N	–	International pipeline standard

### Alternative materials

Material	Material no.	Reference / use	Note
A860 WPHY60	–	Lower strength ( $\geq 414$ MPa)	X60 equivalent
A860 WPHY65	–	Medium strength ( $\geq 448$ MPa)	X65 equivalent
A860 WPHY80	–	Higher strength ( $\geq 552$ MPa)	X80 equivalent
A234 WPB	–	Standard C-steel, lower strength	Not pipeline-rated

## 2 Chemical Composition

Composition in mass percent (%). Standard: ASTM A860 / SA-860. WPHY70 is the pipeline fitting grade with minimum yield strength 482 MPa (70 ksi). Strength is achieved via TMCP (Thermo-Mechanical Controlled Processing) and microalloying with Nb/V/Ti. Very low S content protects against HIC (Hydrogen Induced Cracking) in sour service.

Element	Symbol	Min. (heat)	Max. (heat)	Max. (product)	Function / remark
Carbon	C	–	0.12	0.12	Strength, weldability
Manganese	Mn	–	1.85	1.85	Strength, toughness
Phosphorus	P	–	0.025	0.025	Impurity – limit
Sulfur	S	–	0.010	0.010	Impurity – very low for HIC
Silicon	Si	–	0.50	0.50	Deoxidation
Aluminium	Al	0.015	0.060	0.060	Grain refining
Niobium	Nb	–	0.10	0.10	Microalloying, strength
Vanadium	V	–	0.10	0.10	Microalloying, strength
Titanium	Ti	–	0.06	0.06	Grain refining
Nb+V+Ti (sum)	Σ	–	0.15	0.15	Total microalloying limit
Chromium	Cr	–	0.50	0.50	Residual
Copper	Cu	–	0.50	0.50	Residual
Molybdenum	Mo	–	0.50	0.50	Residual
Nickel	Ni	–	0.50	0.50	Residual
CE (carbon equiv.)	CE <sub>IIW</sub>	–	0.45	0.45	Calculation per IIW formula

## 3 Mechanical Properties

### Quenched + tempered – minimum requirements (ASTM A860)

*Delivery condition: quenched + tempered – essential for strength and toughness.*

Property	Symbol	Unit	Minimum value	Remark
Yield strength	Rp0.2	MPa	≥ 482	70 ksi
Tensile strength	Rm	MPa	≥ 565	82 ksi
Y/T ratio	Y/T	–	≤ 0.93	Pipeline-typical value
Elongation	A	%	≥ 20	Longitudinal, e ≥ 50.8 mm
Impact energy (0 °C)	KV	J	≥ 41	Mean value

Property	Symbol	Unit	Minimum value	Remark
Impact energy (-46 °C)	KV	J	≥ 27	Under supplemental requirement
Hardness	HV	–	≤ 248	NACE MR0175 sour service

#### Hot yield strength Rp0.2 in MPa (typical values per standard)

Temperature	100 °F	200 °F	400 °F	600 °F
Allow. Stress (ksi)	20.0	20.0	20.0	19.6

## 4 Physical Properties

Property	Symbol	20 °C	200 °C	400 °C	Unit
Density	$\rho$	7.85	7.78	7.68	g/cm <sup>3</sup>
Modulus of elasticity	E	207	194	178	GPa
Thermal conductivity	$\lambda$	48	45	41	W/(m·K)
Coeff. thermal expansion	$\alpha$	11.5	12.3	13.0	10 <sup>-6</sup> /K
Specific heat capacity	cp	475	510	545	J/(kg·K)

## 5 Corrosion Resistance

Medium / environment	Remark	Resistance
Crude oil (dewatered)	Standard application	++
Natural gas (dry, treated)	Pipeline standard medium	++
Dry hydrocarbons	Resistant	+
Hydrogen (dry)	Resistant – consider API 941 / Nelson curve	+
Atmosphere / humid air	Corrosion protection required (coating, CP)	o
Sour gas (H <sub>2</sub> S)	Only with NACE MR0175 qualification, ≤ 248 HV	o
Condensate / free water	Internal corrosion possible	o
CO <sub>2</sub> -bearing media (wet)	Sweet/sour water – review material selection	o
Acids	Not resistant	-
Chloride-bearing media	Corrosion risk	-

++ excellent resistance
+ good resistance
o limited resistance
- not resistant

A860 WPHY70 is a high-strength unalloyed steel – corrosion protection comes from external coating (3LPE, FBE) and cathodic protection, not from the material itself. Key advantage: high strength allows thinner walls / higher pressures.

## 6 Typical Applications

Industry / plant	Typical application	Operating condition
Onshore oil pipelines	Trunk lines, station piping	ASME B31.4
Onshore gas pipelines	Cross-country transmission	ASME B31.8
Offshore pipelines	Subsea installation	DNV-OS-F101
LNG terminals	Landfall piping	Low-temperature possible
Storage facilities	Gas-storage connections	High-pressure applications
Hydrogen pipelines	H <sub>2</sub> transport (with design review)	Emerging application – verify specs

## 7 Forms Available at Nirotec

Component	Standard (EN)	Standard (ASME/ASTM)	Remark
Elbows	–	ASME B16.9 · MSS SP-75 · A860 WPHY70	LR/SR, 1.5D / 3D / 5D, custom angles
Tees	–	ASME B16.9 · MSS SP-75 · A860 WPHY70	Equal and reducing branch
Reducers	–	ASME B16.9 · A860 WPHY70	Concentric and eccentric
Caps	–	ASME B16.9 · A860 WPHY70	Hemispherical caps
Hot tap fittings	–	Per specification	On request
Custom parts	Per drawing	Per drawing	Custom geometries on request

## 8 Standards, Approvals & Codes

Standard / code	Title / application
ASTM A860 / ASME SA-860	Wrought High-Strength Ferritic Steel Buttwelding Fittings
MSS SP-75	High-Strength Wrought Butt-Welding Fittings (pipeline industry)
API 5L	Specification for Line Pipe (Grade X70 = matching pipes)
ASTM A694 F70	Matching pipeline flanges
ASME B16.9	Factory-Made Wrought Buttwelding Fittings
ASME B16.49	Factory-Made Wrought Steel Bends for Pipeline Service
ASME B31.4	Pipeline Transportation Systems for Liquids
ASME B31.8	Gas Transmission and Distribution Piping Systems

Standard / code	Title / application
NACE MR0175 / ISO 15156	Materials for H <sub>2</sub> S-containing environments
DNV-OS-F101	Submarine Pipeline Systems (offshore)

## 9 Processing Notes

### Weldability

Parameter	Specification / recommendation	Remark
Preheat	50–150 °C for t > 20 mm	CE-dependent, prevents cold cracking
Post-weld heat treatment	Stress relief 590–620 °C	Mandatory for pressure-bearing parts
Filler metal	AWS A5.5 E9018-G / E10018-G	Higher strength, low hydrogen
Welding processes	GTAW, GMAW, SMAW, SAW	Low-hydrogen processes mandatory
Interpass temperature	≤ 250 °C	Pipeline standard practice
Hydrogen diffusion	≤ 5 ml H <sub>2</sub> /100 g weld metal	Pipeline requirement

- Delivery condition: quenched + tempered – heat treatment must be confirmed on certificate
- Charpy at 0 °C mandatory, –46 °C common as supplemental requirement
- Identification per ASTM A860: manufacturer, A860, WPHY70, heat, Q+T status
- For sour service: NACE MR0175 mandatory, hardness ≤ 248 HV required
- HIC test (NACE TM0284) recommended for sour gas applications
- Matching pipes: API 5L X70 or L485M (DSAW)

## 10 Inquiry & Contact

For a project-specific inquiry we ideally require:

- Standard and type (e.g. ASME B16.9 LR 1.5D 90° in A860 WPHY70)
- Wall thickness and schedule (pipeline class, class location)
- Sour service / NACE MR0175 required?
- Lowest operating temperature (for Charpy specification)
- Required documentation (EN 10204 type 3.1 / 3.2, NDT, HIC test)
- Applicable code (ASME B31.4 or B31.8, DNV)

### Nirotec GmbH & Co. KG

Otto-Hahn-Str. 4 · 59423 Unna · Germany

Tel.: +49 (0) 2303 / 985-0 · info@nirotec.de · www.nirotec.de