

# Low Alloy Steels

## DATA SHEET

## A-20

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## P92 CONSUMABLES

### Alloy type

9%Cr steel alloyed with W, Mo, V, Nb, and N for high temperature creep resistance.

### Materials to be welded

#### ASTM

- A 213 T92 (seamless tubes)
- A 335 P92 (seamless pipes)
- A 387 Gr 92 (plates)
- A 182 F92 (forgings)
- A 369 FP92 (forged & bored pipe)

#### EN

X10CrWMoVNb 9-2

### Applications

These consumables are designed to weld equivalent 'type 92' 9%Cr steels modified with tungsten, vanadium, niobium, nitrogen and a small addition boron to give improved long term creep properties.

They are specifically intended for high integrity structural service at elevated temperature so the minor alloy additions responsible for its creep strength are kept above the minimum considered necessary to ensure satisfactory performance. In practice, weldments will be weakest in the softened (intercritical) HAZ region of parent material, as indicated by so-called 'type IV' failure in transverse weld creep tests.

The rupture strength of P92 is up to 30% greater than P91, and interest in its use is growing as a candidate for components such as **headers, main steam piping and turbine casings**, in fossil fuelled **power generating plants**.

### Microstructure

In the PWHT condition the microstructure consists of tempered martensite.

### PWHT

Minimum preheat temperature 200°C with maximum interpass temperature of 350°C; in practice a preheat-interpass range of 200 – 300°C is normal. To ensure full martensite transformation welds should be cooled to ~100°C prior to PWHT; up to 50mm wall thickness can be cooled to room temperature whilst thick wall forgings or castings should not be cooled below ~80°C prior to PWHT.

ASME base material codes allow PWHT down to 730°C but for weld metals PWHT is normally carried out in the range 750-770°C. Optimum properties are obtained with PWHT at 760°C for 4 hours.

When compared with directly matching weld metal, the addition of some nickel and reduction of niobium provides a useful improvement in toughness after PWHT.

### Additional information






D Richardot, J C Vaillant, A Arbab, W Bendick: "The T92/P92 Book" Vallourec & Mannesmann Tubes, 2000.

### Products available

Process	Product	Specification
MMA	<b>Chromet 92</b>	--
TIG	<b>9CrWV</b>	--
SAW	<b>9CrWV (wire)</b>	--
	<b>LA491 (flux)</b>	BS EN SA FB 255AC
	<b>LA492 (flux)</b>	BS EN SA CS 155DC
FCW	<b>Supercore F92</b>	--

# CHROMET 92

MMA all-positional electrode for joining P92 creep resisting steel

<b>Product description</b>	Basic coated MMA electrode made on matching core wire. Moisture resistant coatings giving very low weld metal hydrogen levels. Recovery is approx 120% with respect to core wire, 65% with respect to whole electrode.																		
<b>Specifications</b>	None applicable.																		
<b>ASME IX Qualification</b>	<b>QW422</b> P-No 5B group 2, <b>QW432</b> F-No --, <b>QW442</b> A-No --																		
<b>Composition (weld metal wt %)</b>		C	Mn	Si	S	P	Cr	Ni	Mo	W	Nb	V	N	B	Al	Cu			
min		0.08	0.40	--	--	--	8.0	--	0.30	1.5	0.04	0.15	0.03	0.001	--	--			
max		0.13	1.00	0.40	0.015	0.020	9.5	0.80	0.60	2.0	0.07	0.25	0.07	0.005	0.03	0.15			
typ		0.11	0.6	0.25	0.01	0.01	9	0.6	0.45	1.7	0.05	0.2	0.05	0.003	<0.01	<0.05			
<b>All-weld mechanical properties</b>	PWHT 760°C / 2-4h						min	typical	----- High Temperature -----										
													+550°C	+600°C	+650°C				
Tensile strength						MPa	620	740					511	422	340				
0.2% Proof stress						MPa	440	630					419	320	229				
Elongation on 4d						%	17	22					15	19.5	19.5				
Elongation on 5d						%	16	19					14	18	18				
Reduction of area						%	--	50					64	73	80				
Impact energy					+ 20°C	J	--	60					--	--	--				
Hardness						HV	--	230-260					--	--	--				
<b>Packaging data</b>	ø mm			2.5			3.2			4.0			5.0						
	length mm			300			350			350			450						
	kg/carton			12			14.1			13.5			16.5						
	pieces/carton			762			393			267			150						
<b>Operating parameters</b>	DC +ve.		AC (OCV 70V min)																
	ø mm			2.5			3.2			4.0			5.0						
	min A			70			80			100			140						
	max A			110			140			180			240						
<b>Storage</b>	<b>3 hermetically sealed ring-pull metal tins</b> per carton, with unlimited shelf life. Direct use from tin will give <b>hydrogen</b> <5ml/100g weld metal during 8h working shift. For electrodes that have been exposed: <b>Redry</b> 250 – 300°C/1-2h to ensure H <sub>2</sub> < 10ml/100g, 300 – 350°C/1-2h to ensure H <sub>2</sub> < 5ml/100g. Maximum 420°C, 3 cycles, 10h total. <b>Storage</b> of redried electrodes at 100 – 200°C in holding oven, or 50 – 150°C in heated quivers: no limit, but maximum 6 weeks recommended.																		
<b>Fume data</b>	Fume composition (wt %)																		
		Fe	Mn	Ni	Cr	Cu	Pb	F	OES (mg/m <sup>3</sup> )										
		15	5	< 0.1	< 3	< 0.1	< 0.1	18	1.7										

## 9CrWV

Solid wire for TIG and SAW

<b>Product description</b>	Solid wire, non-copper coated, for TIG and SAW welding.																
<b>Specifications</b>	None applicable.																
<b>ASME IX Qualification</b>	QW422 P-No 5B group 2, QW432 F-No --, QW442 A-No --																
<b>Composition (wire wt %)</b>		C	Mn	Si	S	P	Cr	Ni	Mo	W	Nb	V	N	B	Al	Cu	
	min	0.08	0.40	--	--	--	8.0	--	0.30	1.5	0.04	0.15	0.03	0.001	--	--	
	max	0.13	1.00	0.40	0.015	0.015	9.5	0.80	0.60	2.0	0.07	0.25	0.07	0.005	0.03	0.15	
	Typ	0.11	0.7	0.30	0.01	0.01	9	0.5	0.45	1.7	0.06	0.2	0.05	0.003	<0.01	<0.05	
<b>All-weld mechanical properties</b>	PWHT 760°C / 2 – 4h							min	TIG	----- High Temperature TIG -----							
									typical	+550°C	+600°C	+650°C					
	Tensile strength							MPa	620	800	455	387	312				
	0.2% Proof stress							MPa	440	700	374	282	200				
	Elongation on 4d							%	16	22	24.5	20.5	28				
	Elongation on 5d							%	--	19	22.5	19	25.5				
	Reduction of area							%	--	70	82	85	89				
Impact energy							+ 20°C J	--	220	--	--	--					
Hardness							HV (mid)	--	265	--	--	--					
<b>Parameters</b>								TIG	SAW	MIG							
	Shielding							Argon	LA491/LA492 flux	9CrWV is not recommended for MIG welding.							
	Diameter, mm							2.4	2.4	Supercore F92 should be used.							
	Current							DC-	DC+								
	Typical parameters							100A, 12V	450A, 30V, 450mm/min								
<b>Packaging data</b>	ø mm							TIG	SAW								
	2.4							5kg tube	25kg coil								
	3.2							5kg tube	20kg coil								
<b>Fume data</b>	Fume composition (wt %); TIG and SAW fume is negligible:																
		Fe	Mn	Ni	Cr	Mo	Cu	OES (mg/m <sup>3</sup> )									
	50	4	< 0.4	6	0.5	< 0.5	5										

## LA491 & LA492

Sub-arc fluxes for use with 9CrWV solid wire

<b>Product description</b>	Agglomerated basic submerged arc welding fluxes															
<b>Specifications</b>	<b>LA491</b>				BS EN 760				SA FB 255 AC							
	<b>LA492</b>				BS EN 760				SA CS 155 DC H5							
<b>Composition (weld metal wt %)</b>	<b>LA491:</b>								<b>LA492:</b>							
	15% SiO <sub>2</sub> + Ti O <sub>2</sub> 40% CaO + Mg O 20% AlO <sub>3</sub> + MnO 25% CaF <sub>2</sub> Basicity index ~2.7 (Boniszewski)								20% SiO <sub>2</sub> 40% MgO + CaO 20% Al <sub>2</sub> O <sub>3</sub> + K <sub>2</sub> O 20% CaF <sub>2</sub> Basicity index ~2.25 (Boniszewski)							
<b>Analysis deposit (typical)</b>		C	Mn	Si	S	P	Cr	Ni	Mo	W	Nb	V	N	B		
	9CrWV Wire	0.11	0.7	0.3	0.01	0.01	9.0	0.5	0.4	1.7	0.06	0.19	0.05	0.003		
	LA491 dep.	0.09	0.7	0.3	0.01	0.01	8.5	0.5	0.4	1.7	0.04	0.16	0.04	0.001		
	LA492 dep.	0.08	0.7	0.3	0.01	0.01	8.4	0.4	0.4	1.6	0.04	0.14	0.04	0.001		

## LA491 & LA492 Flux (continued)

Sub-arc fluxes for use with 9CrWV solid wire

<b>All-weld mechanical properties</b>	PWHT 760°C / 2 – 4h		min	SAW & LA491 typical	SAW & LA492 typical
	Tensile strength	MPa	620	740	700
	0.2% Proof stress	MPa	440	630	580
	Elongation on 4d	%	16	20	25
	Reduction of area	%	--	60	65
	Impact energy	+ 20°C J	--	35	45
	Hardness	HV (mid)	--	250	225
<b>Parameters</b>	AC or DC+ 800A maximum				
<b>Packaging data</b>	<b>LA491:</b> 25kg sealed drums <b>LA492:</b> 22.5kg sealed drums Preferred storage <60%RH, > 18°C. If flux becomes damp, rebake at 300 – 350°C / 1 – 2hours to restore to as-packed condition. For critical work, it is recommended to redry to ensure <5ml H <sub>2</sub> /100g.				

## SUPERCORE F92

All-positional flux cored wire

<b>Product description</b>	All-positional flux cored wire designed to weld equivalent P92 steels. Rutile flux system with an alloyed strip producing weld metal recovery of about 90%.															
<b>Specifications</b>	<b>AWS A5.29</b> No current national standards.															
<b>ASME IX Qualification</b>	<b>QW432</b> F-No -, <b>QW442</b> A-No -															
<b>Composition (wire wt %)</b>		C	Mn	Si	S	P	Cr	Ni	Mo	W	Nb	V	N	B	Al	Cu
	min	0.08	0.40	--	--	--	8.5	0.30	0.30	1.5	0.03	0.15	0.03	0.001	--	--
	max	0.13	1.20	0.40	0.015	0.020	9.5	0.80	0.60	2.0	0.07	0.25	0.07	0.005	0.03	0.15
	Typ	0.11	0.8	0.30	0.01	0.017	9	0.5	0.45	1.7	0.04	0.2	0.04	0.003	<0.01	<0.05
<b>All-weld mechanical properties</b>	PWHT 760°C / 4-6h		typical		----- High Temperature -----											
					+550°C	+600°C	+650°C	+700°C								
	Tensile strength			775	471	400	308	215								
	0.2% Proof stress			650	385	294	194	125								
	Elongation on 4d			21	18.5	25	26.5	25.5								
	Elongation on 5d			18	17	22.5	24.5	23.5								
	Reduction of area			50	68	77	81	86								
Impact energy	+ 20°C		25	--	--	--	--									
Hardness			260	--	--	--	--									
<b>Operating parameters</b>	<b>Shielding gas:</b> 80%Ar-20%CO <sub>2</sub> (or 15 – 25%CO <sub>2</sub> ) or 100% CO <sub>2</sub> at 20-25l/min.															
	<b>Current:</b> DC+ve ranges as below:															
	∅	welding position	amp-volt range *				typical				stickout					
	1.2mm (0.045in)	Positional	140-170A, 24-26V				160A, 25V				15-25mm					
* Using 100%CO <sub>2</sub> the voltage should be increased by 1-2V																
<b>Packaging data</b>	Spools vacuum-sealed in barrier foil with cardboard carton: 15kg (33 lbs) The as-packed shelf life is virtually indefinite. Resistance to moisture absorption is high, but to maintain the high integrity of the wire surface and prevent any possibility of porosity, it is advised that part-used spools are returned to polythene wrappers. Where possible, preferred storage conditions are 60% RH max, 18°C min.															
<b>Fume data</b>	Fume composition (wt %), shielding gas 80%Ar-20%CO <sub>2</sub> :															
		Fe	Mn	Ni	Cr <sup>3</sup>	Cr <sup>6</sup>	Cu	F	OES (mg/m <sup>3</sup> )							
		18	8	< 0.5	3	3	< 1	8	1.7							