

where v_{Dr} is the wire speed (m/min), v_s the welding speed (m/min), F the super-elevation (e.g., 20% = 1.2), s the thickness of the workpiece (mm), a the gap width (mm), and d_{Dr} the wire diameter (mm).

A simple approximation results if the diameter of the wire is 0.8 mm and $F = 1$. Setting $\pi d_{Dr}^2 \approx 2$:

$$v_{Dr} = v_s \sqrt{2 s a}$$

As a result, welding of 3 mm material with gaps in the range of 0.2 to 0.5 mm leads to a wire speed – welding speed ratio of 1.2 to 3 and wire speeds of 3.0 to 9.0 m/min accordingly.

Required Power

The power for melting the wire must be taken from the laser beam. The beam will melt the same quantity of material at the same power and speed. If use of filler material yields a wider weld, more material is fused and laser power must increase.

The use of steel wires for gap bridging reduces the welding speed to about 60% compared to autogeneous welding with the same weld width and perfect joint fitup.

Because of its low heat capacity, aluminum wires need less power. Especially if no gap bridging is desired, the wire speed is very low and the power needed is accordingly low.

Figure 50 (next page) shows the power needed for welding with steel and aluminum wire as a function of wire velocity.

Wire Materials; Filler Wire for Steel Welding

When welding high-alloy stainless steel, an even higher-alloyed filler wire is required to prevent the loss of low-vaporization-temperature melting alloys within the melting zone. Additional alloying with nickel improves the ductility.

Table 9 presents chemical compositions of wire suitable for mild and stainless steel welding.

Table 9. Filler Wire for Mild and Stainless Steel Welding

Wire material		Chemical analysis mass fraction %					
Short sign	Internat. reg. no.	C	Si	Mn	P	S	Cu
SG 1		0.06 to 0.12	0.5 to 0.7	1.0 to 1.3	R 0.025	R 0.025	R 0.30
SG 2, G421CG3Si1	ER70S-6	0.06 to 0.13	> 0.7 to 1.0	> 1.3 to 1.6	R 0.025	R 0.025	R 0.30
SG 3, G462CG4Si1	ER70S-6	0.06 to 0.12	0.8 to 1.2	> 1.6 to 1.9	R 0.025	R 0.025	R 0.30

Table 10. Filler Wire for Aluminum Welding (Al Mg Si Types)

Wire material		Chemical analysis (maximum values) mass fraction %								
Short name	Internat. reg. no.	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti ^a	Rest
S-AlSi5	4043	4.5 to 5.5	0.40	0.05	0.1	0.1	—	0.20	0.25	0.15
S-AlMg4,5Mn	5087	0.5 to 0.9	0.40	0.05	0.6 to 1.0	4.3 to 5.2	0.05 to 0.25	0.25	0.1 to 0.25	0.15
S-AlSi12	4047	11.0 to 13.5	0.6	0.05	0 to 0.5	0.05	—	0.20	0.10	0.15

^aTitanium can be substituted with any refining alloy.