Calculate WFS for GMAW, DC, 0.045 in wire DCEP, ESO 0.5 in, 250 A, $T_d = 25°C$.

$$v_c = \frac{V_{all} I + (R_{ct} + R_{so}) I^2}{m'_c \left[\Delta i_{ref} + c(T_d - T_{ref}) \right]}$$

$V_{all} = 4.8\ V$ (anode)

$R_{ct} = 2\ m\Omega$

$R_{so} = \frac{\rho_{eff} L_{so}}{A_e} = 8.912 \times 10^{-3}\ \Omega \approx 9\ m\Omega$

$A_e = \frac{\pi d^2}{4} = 1.026 \times 10^{-6}\ m^2$

$d = 0.045\ in \cdot 0.0254\ m = 1.143\ mm$

$\rho_{eff} = 7.2 \times 10^{-7}\ \Omega m$

$L_{so} = 0.5\ in \cdot 0.0254\ m = 12.7\ mm.$

$m'_c = A_c \rho_c = 8.065 \times 10^{-3}\ kg/m$

$A_c = A_e = 1.026 \times 10^{-6}\ m^2$

$\rho_c = 7860\ \frac{kg}{m^3}$

$\Delta i_{ref} = 2.11 \times 10^6\ \frac{J}{kg}$

1200 W 682 W → 1882 W

$$v_c = \frac{4.8\ V \cdot 250\ A + \left(2 \times 10^{-3}\ \Omega + 8.912 \times 10^{-3}\right)(250\ A)^2}{8.065 \times 10^{-3}\ \frac{kg}{m} \cdot 2.11 \times 10^6\ \frac{J}{kg}}$$

$= 0.1106\ \frac{m}{s} = 0.1106\ \frac{m}{s} \cdot \frac{in}{0.0254\ m} \cdot 60\ \frac{s}{min} = 261.2\ \frac{in}{min}$

(2)

Burnoff $= \dot{m}'_c U_c = 0.1106 \frac{lbm}{s} \; 8.065 \times 10^{-3} \frac{kg}{lbm} = 8.920 \times 10^{-4} \frac{kg}{s}$

$= 8.920 \frac{kg}{s} \; 2.204 \frac{lb}{kg} \; 3600 \frac{s}{h} = 7.077 \frac{lb}{h}$

$\times 10^{-4}$

$= 2.831 \frac{lb}{h \cdot 100 A}$

$V_{SO} \qquad R_{SO} I = 8.912 \times 10^{-3} \times 250 A = 2.228 V$

For Aluminum. DCEP, DCEP, 0.0453 in wire
E50 0.5 in, 250 A, $T_d = 2000^\circ C$.

$$v_c = \frac{V_{fill} I + (R_{ct} + R_{50}) I^2}{m'_c [\Delta i_{nf} + c(T_d - T_{ref})]}$$

$V_{fill} = 9.2\ V$

$R_{ct} = 2\ m\Omega$

$R_{50} = 6.312 \times 10^{-4}\ \Omega$.

$\rho_{eff} = 5.10 \times 10^{-8}\ \Omega m$ (9043)

$m'_c = 2770 \times 10^{-3}\ kg/in.$

$\rho_c = 2700\ \frac{kg}{m^3}$

$\Delta i_{nf} = 1.57 \times 10^6\ \frac{J}{kg}$

$c = 1.19 \times 10^3\ \frac{J}{kg\,K}$

$T_{drop} = 2000\ ^\circ C.$

$T_{ref} = 1000$

$v_c = 0.1612\ \frac{in}{s} = 382.1\ ipm.$

Increase $\rho_{eff} = 7 \times 10^{-8}$ (5356).

$v_c = 386.7\ ipm.$ ($\Delta = 4.6\ ipm$)

Decrease T_{drop} by $150^\circ C$

$v_c = 407.8\ ipm$ ($\Delta = 21.1\ ipm$)