Example 9-3 (From Electric Machinery by P.F. Ryff)

A 75-kVA, 6600/230V, single-phase transformer requires 310V across the primary terminals to circulate full-load current in the short-circuit test. The power absorbed in this test is 1.6 kW. Determine the voltage regulation at the unity power factor.

Determine R_{eHV}, X_{eHV} with short-circuit test, then use value to determine VR.

Equivalent circuit referred to primary side →

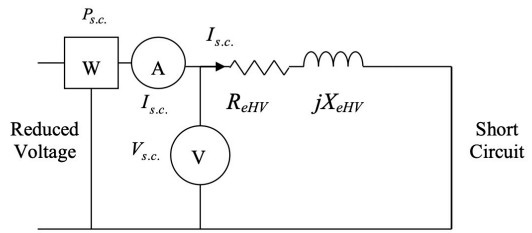

Fig. E9-3-1

$P_{s.c} = 1.6\ kW$, $I_{s.c} = I_{FL} = \frac{75\ kVA}{6600\ V} = 11.36\ A$, $V_{s.c} = 310\ V$

$$R_{eHV} = \frac{P_{s.c}}{I_{s.c}^2} = \frac{1600}{(11.36)^2} = 12.4\ \Omega$$

$$|Z_{eHV}| = \frac{V_{s.c}}{I_{s.c}} = \frac{310}{11.36} = 27.3\ \Omega$$

$$X_{eHV} = \sqrt{Z_{eHV}^2 - R_{eHV}^2} = \sqrt{(27.3)^2 - (12.4)^2} = 24.32\ \Omega$$

Equivalent circuit at full load and PF = 1 →

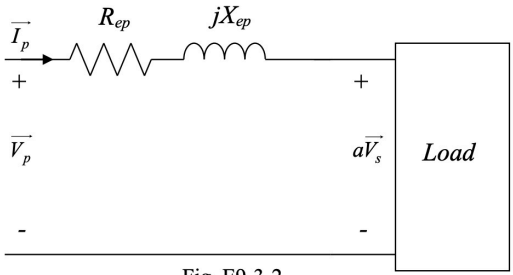

Fig. E9-3-2

In the equivalent circuit:

$$a\vec{V}_s = 6600\ \angle 0^\circ\ V$$

$$\vec{I}_{p,\,rated} = 11.36\ \angle 0^\circ\ V$$

$$\therefore \vec{V}_p = (R_{ep} + X_{ep})\,\vec{I}_{p,\,rated} + a\vec{V}_s$$

$$= (12.4 + j24.32)(11.36\ \angle 0^\circ) + 6600\ \angle 0^\circ$$

$$= 6747.99\ \angle 2.65^\circ\ V$$

$$\therefore VR = \frac{V_p - aV_s}{aV_s} \times 100\% = \frac{6747.99 - 6600}{6600} \times 100\% = \boxed{2.24\ \%}$$