Problem 5-28

In the single-phase rectifier:

$V_{d,max} = 138.6\ V$

$V_{d,min} = 107.3\ V$

$\Delta V_{d\ p-p} = 31.3\ V$

$V_{d(avg)} = 122.2\ V$

$\%\Delta V_{d\ p-p} = \frac{31.3}{122.2} \times 100 = 25.6\ \%$

$\phi_1 = -24.31^\circ$, $THD_i = 45.34\ \%$

$\therefore$ DPF = 0.911 (lagging) PF = 0.83 [using Eq 3-45]

Energy Storage (based on $V_{d(avg)}$) $= \frac{1}{2} C V_{d\,avg}^2 = 8.21\ W\text{-}s$

Three-Phase Rectifier

By trial-and-error, it is determined that $C_d = 275\,\mu F$ results in approximately the same energy stored as in the 1-phase case. However, the simulation becomes unstable with a constant power load. Therefore, it is represented by $R_{Load} = 14.8\,\Omega$.

$V_{d,max} = 285.9\,V$

$V_{d,min} = 257.8\,V$

$\Delta V_{d\,p\text{-}p} = 28.1\,V$

$V_{d,avg} = 271.4\,V$

$\%\,\Delta V_{d\,p\text{-}p} = 10.35\,\%$

$\phi_1 = -15.64^\circ (Lag)$, $THD_i = 43.5\,\%$

$DPF = 0.963$ (lagging)

$PF = 0.883$

Comparing the two results, the 3-phase rectifier results in substantially less dc-voltage ripple and also operates at a better power factor.