RIPPLE FACTOR

It is parameter used to indicate how much component AC is left in D.C. (output).

Ripple $\rightarrow$ fluctuations $\rightarrow$ A.C. compoenent (rms only)

It is defined as ratio of r.m.s. value of A.C. component to D.C. component (also called average value) Ripple factor $(r) = \frac{V'_{rms}}{V_{dc}} = \frac{I'_{rms}}{I_{dc}}$

V'_{rms} is rms value of A.C. component of in output of rectifier.Total current, I = D.C. component + A.C. component (pulsating dc)

$i = I_{dc} + i'$ i' is A.C. component ; I'_{rms} is rms value of i' as per definition of ripple factor

$i' - i - I_{dc}$

$$I'_{rms} = \sqrt{\frac{1}{2\pi}\int_0^{2\pi} (i')^2 \, d\alpha}$$

Where $i' - i - I_{dc}$

$$I'_{rms} = \sqrt{\frac{1}{2\pi}\int_0^{2\pi} (i - I_{dc})^2 \, d\alpha}$$

$$= \sqrt{\frac{1}{2\pi}\int_0^{2\pi} \left(i^2 - 2iI_{dc} + I^2{}_{dc}\right)^2 d\alpha}$$

Since I_{dc} is constant

$$I'_{rms} = \sqrt{\frac{1}{2\pi}\left[\int_0^{2\pi} i^2 d\alpha - 2iI_{dc}\int_0^{2\pi} i d\alpha\right] + I^2{}_{dc}\int_0^{2\pi} 1 d\alpha}$$

$$= \sqrt{(I_{rms})^2 - 2I_{dc}(I_{dc}) + I^2 dc}$$

$$= \sqrt{I_{rms}{}^2 - 2I_{dc}{}^2 + I^2 dc}$$

$$= \sqrt{I_{rms}{}^2 - I_{dc}{}^2}$$

Ripple factor r $= \frac{I'_{rms}}{I_{dc}} = \sqrt{\frac{I_{rms}{}^2 - I_{dc}{}^2}{I_{dc}}}$

$$= \sqrt{\frac{I_{rms}{}^{2}}{I_{dc}{}^{2}} - 1}$$

General expression for ripple factor of any rectifier

$$r = \sqrt{\left(\frac{I_{rms}{}^{2}}{I_{dc}{}^{2}}\right) - 1}$$

In terms of voltages

$$r = \frac{V'_{rms}}{V_{dc}} = \sqrt{\left(\frac{V_{rms}}{V_{dc}}\right)^{2} - 1}$$

Ripple factor for half wave rectifier is

$$I_{rms} = \frac{I_m}{2}$$

$$I_{dc} = \frac{I_m}{\pi}$$

$$r = \sqrt{\frac{\left(\frac{I_m}{2}\right)^{2}}{\left(\frac{I_m}{\pi}\right)^{2}} - 1}$$

$$= \sqrt{\frac{\pi^{2}}{4} - 1}$$

$$= 1.21$$

Ripple factor for half-wave rectifier $= 1.21$

Here the result is more than 1. Whenever any result is more than 1 the numerator is greater than denominator. Here Nr is a.c. component and denominator is d.c. component. But from result ac component is more which is undesirable. So it is not a efficient.

Rectification efficiency : It is defined as ratio of d.c. output power to a.c. input power

$$\%\eta = \frac{P_{dc}}{P_{ac}} \times 100$$

$$= \frac{dc\ output\ \ power}{ac\ input\ \ power} \times 100$$

$$P_{dc} = I_{dc}^{\ 2} \cdot R_L$$

$$P_{ac} = I_{rms}^{\ 2}\left(R_f + R_S + R_L\right)$$

$$\%\eta = \frac{I^2{}_{dc} R_L}{I^2{}_{rms}\left(R_f + R_S + R_L\right)} \times 100 \quad \rightarrow$$

General expression fro

efficiency of a rectifier

If given is a half-wave rectifier

$$\%\eta = \frac{\left(\frac{I_m}{\pi}\right)^2 R_L}{\left(\frac{I_m}{\pi}\right)^2 \left(R_f + R_S + R_L\right)} \times 100$$

$$= \frac{4}{\pi^2} \frac{1}{\frac{R_f + R_S}{R_L} + 1} \times 100$$

$$R_f + R_S << R_L$$

So we can neglect $\frac{R_f + R_S}{R_L}$

$$\therefore \%\eta = 40.5\%$$

Only 40.6% of ac input power is converted into DC output power.

Peak Inverse voltage (PIV) :

It is defined as max. reverse voltage that diode can withstand without destroying the junction.The PIV of half wave rectifier v_m (peak of –ve half cycle)

PIV deals with half-cycle when diode is non-conducting.

Form Factor : Form factor $= \frac{Rms}{avg} = \frac{Vm/2}{Vm/\pi} = \frac{\pi}{2} 1.57$

Peak factor : $= \frac{v_m}{Rms} = 2$

Transformer utilization factor (TUF) : In the design of any power supply the rating of transformer is important.

$$TUF = \frac{dc\ power\ delivered\ to\ load}{ac\ power\ rating\ of\ transformer\ secondary}$$
$$= \frac{P_{dc}}{P_{ac}(rated)}$$

The ac powr rating is different from (greater than) actual ac power delivered to the circuit. Power rating of transformer secondary, $P_{ac}(rated)$

$$P_{ac}(rated) = V_{ac}(rms) \cdot I_{ac}(rms)$$

$$\boxed{TUF = \frac{P_{dc}}{P_{ac}(rated)} = \frac{I^2{}_{dc} \cdot R_L}{V_{ac}(rms) \cdot I_{ac}(rms)}}$$

Since secondary voltage is purely sinusoidal and hence its rms value, is equal to $\frac{1}{\sqrt{2}}$ times of its max. value for half wave rectifier.

$$\therefore V_{ac}(rms) = \frac{V_m}{\sqrt{2}}$$

$$I(rms) = \frac{I_m}{2}$$

$$TUT = \frac{\left(\frac{I_m}{\pi}\right)^2 R_L}{\frac{V_m}{\sqrt{2}} \cdot \frac{I_m}{2}}$$

$$= \frac{\frac{I_m{}^2}{\pi^2} R_L}{\frac{V_m \cdot I_m}{2\sqrt{2}}}$$

But $I_m = \dfrac{V_m}{R_f + R_s + R_L}$

$$V_m = I_m\left(R_f + R_s + R_L\right)$$

$$TUF = \quad = \frac{\frac{I_m{}^2}{\pi^2} R_L}{\frac{I_m}{2\sqrt{2}}\left(R_f + R_S + R_L\right) I_m} = \frac{2\sqrt{2} R_L}{\pi^2\left(R_f + R_S + R_L\right)}$$

$$\frac{2\sqrt{2}}{\pi^2} \frac{1}{\frac{Rf + R_S}{R_L} + 1}$$

$$\frac{Rf + R_S}{R_L} << 1$$

$$TUF = \frac{2\sqrt{2}}{\pi^2}$$
$$= 0.287$$

The DC power delivered to load $= 0.287 \times$ ac power rating of transformer secondary

ac power rating of transformer secondary $= \dfrac{dc\ \ power\ \ delivered\ \ to\ \ load}{0.287}$