EFFICIENCY

Note: A and B are fixed losses. C varies by $I^2 \times R$. When the efficiency is computed the computation is done with 100% load.

General

The efficiency of a transformer is very important in terms of energy lost. Efficiency deals with the power losses of a transformer. The less efficient a transformer is, the more heat it dissipates. Efficiency, in mathematical terms, is the ratio of the power out to the power in of a transformer, where the power in is equal to the power out plus the losses. The symbol of efficiency is η . For example:

η = (Power out/ Power in) x 100 and Power in = Power out + losses

Why is it Important to Consider Efficiency?

During operation, a transformer's main purpose is to transfer electrical energy from the primary coil to the secondary coil. The iron core and copper coils of the transformer will convert some of the electrical energy into heat energy. Because of this conversion, the transformer dissipates heat during operation. Heat produced by the transformer represents steel excitation losses and copper losses, and makes the transformer less efficient.

What Causes Inefficiency and Power Loss in the Transformer?

Inefficiency and the power loss in a transformer is caused by three things:

A. Hysteresis loss which is caused by the magnetic field created in the transformer's primary, secondary and harmonic windings.

B. Eddy current loss or skin effect which is caused by the high frequency current traveling on the outer edge of the conductor.

C. Copper loss which is caused by the power dissipated in the windings of a transformer. Copper loss is minimized by using as large conductors as possible in the windings.

Note: A and B are fixed losses. C varies by $I^2 \times R$. When the efficiency is computed the computation is done with 100% load.

Misconceptions of Ferroresonant Transformer Efficiency

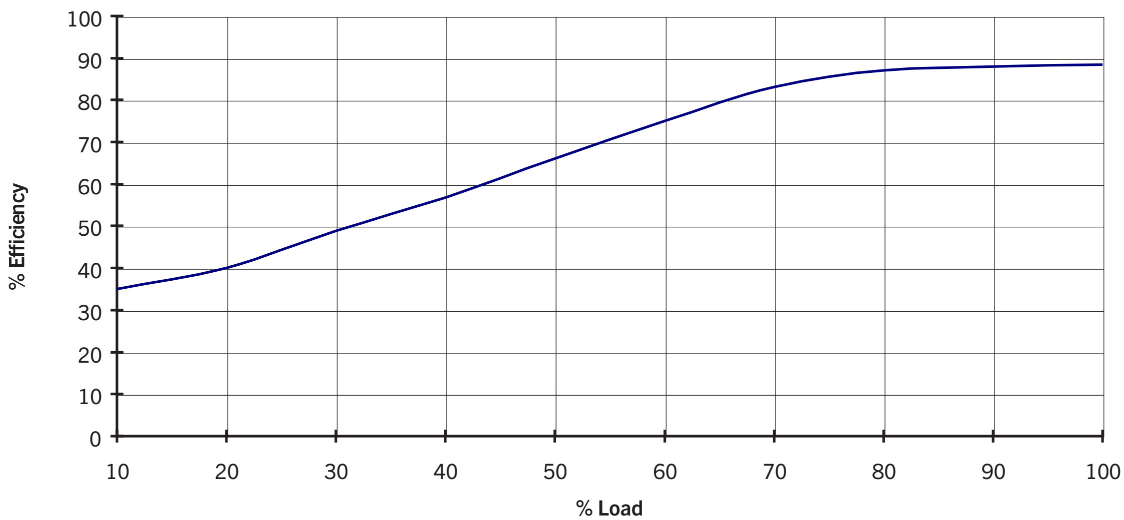
Many engineers and sales representatives have a misconception that all ferroresonant transformers are extremely inefficient at all the levels of the load spectrum. This is akin to saying that all American cars are lemons. It is simply not true. The efficiency of a ferroresonant designed transformer is dependent on the engineering and manufacturing of that transformer, just like anything else.

Efficiency Of Ferroresonant Transformers

Ferroresonant transformers are designed to operate in their saturation region (See Application Note IPPS#10) in order to regulate the output voltage. The operation of the transformer in the saturation region causes a higher magnetic field. The ferroresonant transformer maintains saturation in order to regulate. The resonant circuit provides secondary circu-lating current to assure the satur-ation. Because of the circulating current, losses not associated with standard transformers are encoun-tered. These additional losses are in the order of 3% to 5%. The double magnetic conversion and regulation characteristics more than offset the few points of effi-ciency sacrificed.

To illustrate, consider the efficiency of a typical ferroresonant transformer in the chart below.

Load vs. Efficiency of Conventional Ferroresonant Transformers



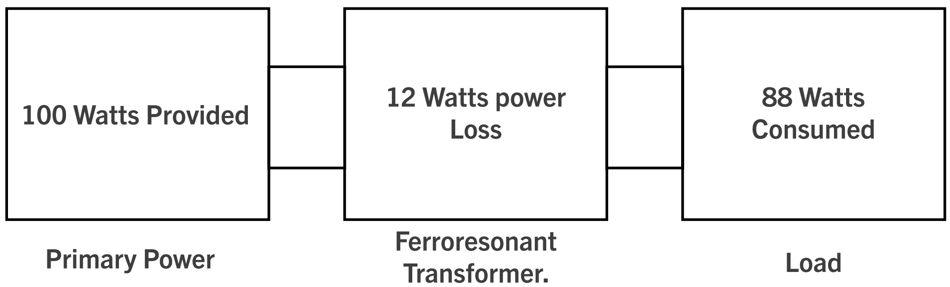
The chart above represents the percentage of efficiency of a typical ferro-resonant transformer at different load levels. As illustrated, conventional ferroresonant transformers provide approximately 89% efficiency at a full load, and approximately 65% efficiency at a half load. These transformers use outdated engineering and manufacturing processes and as a result are very inefficient. The misconception that all ferroresonant transformers are inefficient is due to typical ferroresonant transformers manufactured with less copper, less core, no double magnetic conversion technology, ordinary design and low cost manufacturing process.

Efficiency of The Power Purifier

The old school of thought, rumors, and improper testing techniques have given the ferroresonant transformer a bad reputation. When a ferroresonant transformer, such as the Trystar Power Purifier is designed, efficiency is a primary consideration. Up-sizing the wire and using high grade transformer steel keeps the losses to a minium. One can expect typically 92% efficiency from the Power Purifier.

Consider the following block diagram of a typical ferroresonant transformer.

Transformer efficiency. Power loss occurs because the transformer converts some electrical energy into heat energy.



To determine the efficiency of a transformer that requires 112 Watts of primary power to provide 100 Watts of secondary power, the following calculation is done:

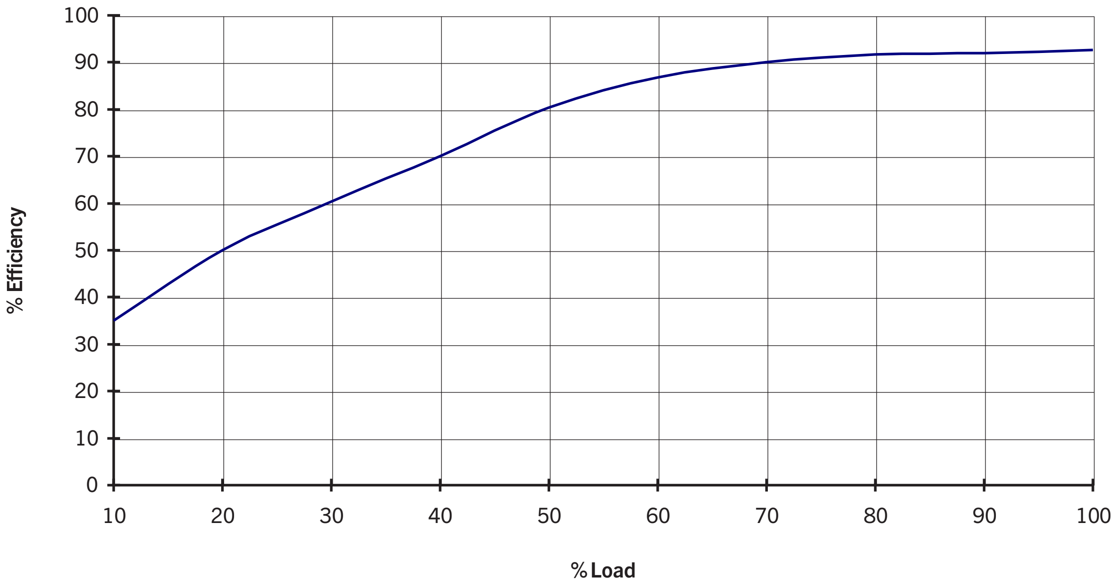
% Efficiency = { Power out/ (Power out + Losses) } x 100

% Efficiency = { 88 Watts/ (88 + 12) Watts} x 100 = 88

In the above calculation, 12 watts was lost in the transformer which is considerable compared to the 88 watts consumed by the load. In this case, the typical ferroresonant transformer is 88% efficient.

To illustrate that the Power Purifier manufactured by Trystar is more efficient than it's common competitors, consider the following efficiency chart.

Load vs. Efficiency of The Power Purifier



Notice in the above chart, the efficiency of the Power Purifier is 92% at a full load, 80% at a half load, and still very efficient at low loads. The reason behind achieving the optimum efficiency at different loads is that Trystar uses more copper and high grade transformer steel in its engineering design and incorporates a honed manufacturing process.

Summary

The key elements in determining the efficiency of a transformer is the amount of copper in the primary, secondary, and harmonic coils, as well as, the amount of core in the ferroresonant transformer. Energy losses in typical ferroresonant transformers can be attributed to cheaper materials and manufacturing processes.