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Introduction to the New Electrical Power Theory

PREFACE

How do you dismiss existing power theory while having long-lasting years and worldwide acceptance?

What happened was a combination of accidental conditions and facing an unsolved problem.
We worked in an EPC company that followed the petrochemical electrolyzer technology. The electrolyzer is fed by a very high DC current rectifier, which generates harmful harmonic currents.

We engaged in an invention concerning the harmonic currents reduction in high-power rectifiers.

It was necessary to calculate harmonic currents in different nonlinear loads. But all references concerning the harmonic currents pay attention only to a conditional case, smoothed current waveform. So, there was *an unsolved problem* on the table. We solved it finally by using the Fourier Series Theory.

The First Step. Now, the calculating of harmonic current (IHD%) in all nonlinear loads is possible by defining the sign (±) and array (Sin / Cos).
A method has been used for trigonometric calculating of harmonic currents for eliminating specified orders of harmonic currents.
The soft *elimination of all orders of harmonic currents* is available just now, without using the filter harmonics

The Second Step. Was using the Fourier series for power analysis in the nonlinear loads, which results in a new power equation: $V(t) \cdot I(t) = P(t) + Q(t)$

The third Step. Was following the power calculation in the linear loads, which resulted in the same power equation: $V(t) \cdot I(t) = P(t) + Q(t)$
Also, finding a sequential incorrect assumption in the power definition.

CHALLENGES ON EXISTING POWER THEORY.

In the nonsinusoidal system, two approaches were introduced for power definitions by Budeanu in 1927 and Fryze in 1932. Also, other scientists represent questions and theories, e.g., L.S. Czarnecki and P. S. Filipski.

The IEEE standard 1459, as a reference for existing power theory in the nonsinusoidal system, represents frequent equations and interpretations but without an executable and practical procedure.

All presented interpretations by scientists, couldn`t represent a comprehensive, universal, and applicable procedure in the nonsinusoidal system because they believe, insist, and use the sinusoidal system issues.

The power theory in the nonsinusoidal system is subject to significant challenges with unanswered questions, especially in the reactive power sector.

THE LIST OF CLAIMS

The electrical knowledge must rely on the physics and mathematics principles.
Any deviation from these two principles causes misinterpretations and incorrect assumptions.

We must open our minds to finding a reasonable interpretation by backing physics and math principles.

There is a sequential incorrect assumption in the existing electrical power definition:

1) The active and reactive power are not perpendicular. ~~$P \perp Q$~~
2) The reactive power statement is *an incorrect* assumption. ~~$[Q = V.I \sin \varphi]$~~
3) The reactive power has the measurement unit of *Watts*.
4) There is no *Power Triangle* phasor diagram. ~~$[S^2 = P^2 + Q^2]$~~

The valid statements in the existing power definition*:*

1) The amount of active power is $[P = Vrms.\ Irms \cos\varphi]$ in the sinusoidal system.
2) The amount of active power is $[P = Vrms.\ If\ rms]$ in the nonsinusoidal system.
3) The amount of apparent power is $[S = Vrms\ .\ Irms]$.

THE NEW APPROACH TO ELECTRICAL POWER THEORY.

The new power theory relied on the acceptance of the following points:

a) The instantaneous power definition wherein the instantaneous power is the product of the instantaneous voltage and current $\{V(t) \cdot I(t)\}$.
b) The Fourier series theory states any function can be written in a series of trigonometric functions.
c) Any definition of powers must fulfill the conservation of energy`s law at every instant.
d) The electrical knowledge must rely on the physics and mathematics principles, without any deviation.

The power calculation in a sinusoidal system and power analysis in the nonsinusoidal system show that:

The **product** of Instantaneous Voltage and Instantaneous Current

is equal to

The **sum** of Instantaneous Active Power and Instantaneous Reactive Power

$$V(t) \cdot I(t) = P(t) + Q(t)$$

This power equation is valid for the sinusoidal and nonsinusoidal systems