

بسم الله الرحمن الرحيم

(الله لا اله إلا هو الحي القيوم لا تأخذه سنة ولا نوم له ما في السماوات و
ما في الأرض من ذا الذي يشفع عنده إلا بإذنه يعلم ما بين أيديهم وما خلفهم
و لا يحيطون بشئ من علمه إلا بما شاء وسع كرسيه السماوات والأرض ولا
يؤده حفظهما وهو العلي العظيم)

صدق اله العظيم

سورة البقرة

الآية (255)

Dedication

To my family

Mother, father, sisters, brothers and relatives,

To my teachers,

To those who work in silence for others,

To my friends and colleagues,

Acknowledgements

I would like to thank my teachers who helped me a lot especially my supervisor, Dr. Eisa Bashier, for his advice, wise guidance, and for his effective contribution in the successful fulfilment of this research.

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Ultimately, I pray to Allah to bless my humble efforts with his grace and acceptance.

Abstract

The Harmonics in Distribution Systems come from transformers or saturable reactors, arc furnace, welding machines, florescent lamps, rotating machines and power electronics devices. In general, the non linear loads in which the relationship between the voltage and current is not constant.

It is considered that there is no risk of harmful perturbation from 5 to 10%. Above 10%, problems will certainly occur.

Equipments can be affected by the harmonics like transformers with increase of losses, risk of overheating, noise and even insulation stress problems. Cables that can heat too much due to as Kelvin effect above 400 Hz. Induction relays and meters that are pertubated by harmonic torques giving incorrect trippings and readings.

The solutions that can be used to improve the p.f. and to protect the capacitors are either de-rate the capacitors or using detuning reactors, and also by using harmonic filters.

This thesis presents the definitions of harmonics, generation, causes, analysis and solutions due to IEEE 519 standard of harmonics. The basic aim of the study is how to minimize the Harmonics in Distribution Systems and applied the study in Sudanese Malaysian steel factory.

It was found that the factory has been suffered from the damage of sensitive electronic control devices, poor power factor and tripping of circuit breaker. By the measuring the power ,current ,voltage ,power factor and the total harmonic distortion with aid of standard formulas and calculation the suitable solution was found that using capacitors with reactors in series for both minimization of harmonics and improving the power factor in the factor.

مستخلص

إن وجود التوافقيات في شبكات توزيع القدرة الكهربائية ينتج من التشبع في محولات القدرة، واستخدام أفران القوس الكهربائي، وماكينات اللحام و لمبات الفلوريسنت، والماكينات الدوارة وأدوات الكترونيات القدرة. وبمعنى أشمل؛ الأحمال غير الخطية والتي تكون العلاقة بين الجهد و التيار فيها غير ثابتة.

كما انه إذا تعدى معامل التشوه التوافقي عن نسبة معينة (10%) فانه ينتج ضرر كبير و مشاكل عدة، والتي تتمثل في: زيادة الفقد في المحولات وتكمن الخطورة في ارتفاع الحرارة و اجهادات الموصلات والعوازل، كما أن الكوابل ترفع درجة حرارتها، والمرحلات و أجهزة القياس تفصل وتتغير قراءتها نتيجة للعزوم الإضافية الناتجة من التوافقيات. و تكمن الحلول بالنسبة لمشاكل التوافقيات في: تحسين معامل القدرة بواسطة المكثفات، وحماية هذه المكثفات باستعمال الملفات مع المكثفات. بالإضافة إلى استعمال المرشحات للحد من خطورة هذه التوافقيات.

تتناول هذه الرسالة تعريف التوافقيات و مولداتها و أسبابها و تحليلها و معالجتها حسب المواصفات القياسية العالمية (IEEE 519 Standard for harmonics)، و كما أن الهدف الأساسي من هذه الرسالة هو تقليل التوافقيات في منظومة التوزيع لا قدرة الكهربائية. كما أنه تم اخذ دراسة حالة المصنع السوداني الماليزي للصناعات الحديدية، والذي وجد فيه أخطاء في التشغيل تتمثل في الأعطال المتكررة في كروت التحكم الالكترونية، وضعف معامل القدرة، والفصل المتكرر لقواطع التيار ومرحلات الحماية الكهربائية. وبعد إجراء قراءات للجهود والتيارات والقدرة ومعامل القدرة والتشوه الكلي الناتج من التوافقيات تم حل المشكلة في استخدام الملفات علي التوالي مع المكثفات لتقليل التوافقيات. وتحسين معامل القدرة.

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Glossary

ECL₁: Eddy Current Loss at rated fundamental current

FC: Frequency Resonance

H.D: Individual Harmonic Distortion

H.F: Harmonic Factor

H: Harmonic Order

I₁: Rated Current (fundamental)

I_h: Harmonic Current

LCDH: Losses in Capacitors Due to Harmonics

N: Harmonic Resonance

PNL: Proliferating Nonlinear Loads

Q: Capacitors Output

R.M.S: Root Mean Square

T.H.D: Total Harmonic Distortion

T_{CC}: Short Circuit Voltage of the transformer

T_{ECL}: Total Eddy-Current Losses

A LEAD: Amps lead Volts

A LAG: Amps lag Volts

CF: Crest Factor (Ratio of a wave form's peak value to its r.m.s value)

PDF: Displacement Power Factor $\cos \varphi$ (fundamental)

Hz: Frequency of selected harmonic in hertz

PF: Power Factor

KF: K Factor

%THD-F: Total Harmonic Distortion as (% of fundamental)

%THD_R: Total Harmonic Distortion as (% of r.m.s total)

V_{RMS}: Volts r.m.s (includes dc component)

$\cos \varphi$: cosine of the angle between the voltage at any single frequency

V_{pk}: Peak volts

V_{DC}: Volts DC

V_{HM}: Harmonic Volts r.m.s

KVA: Kilo Volt Ampere

KVAR: Kilo Volt Ampere Reactive

Kw: Kilo watt

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