The importance of optimising the quality of electrical power

We aim to develop and improve solutions wich are innovative, sustainable an of the highest quality wich contribute to successful projects in the Marine & Industry.

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Introduction

On board vessels and in industrial environments, the quality of the electrical power is crucial for the safe and efficient operation of machinery and IT systems. However, through the introduction of new and advanced technologies during newbuilds or refits, systems tend to become increasingly complex. This means that unexpected problems such as low energy efficiency or the shorter lifespan of end-use automation systems or computers can easily occur. These disturbances can result in unnecessary costs for the end users through excessive energy consumption, system failures or increased maintenance.

Power quality analysis

As an all-round systems integrator, Alewijnse can detect and analyse electrical inefficiencies and advise on power quality optimisation do as to conform with the latest classification standards. At an early stage of new construction projects we can work with our customers to determine their needs and make proposals regarding the most suitable solutions for their objectives.

During refits and modifications, we can use measuring equipment to map out power, current, voltage and harmonics in the electrical power distribution the systems. After an extensive analysis of the problems encountered and the customer's needs, we design the best customised solutions that will deliver optimal cost efficiency and productivity of your ship systems.

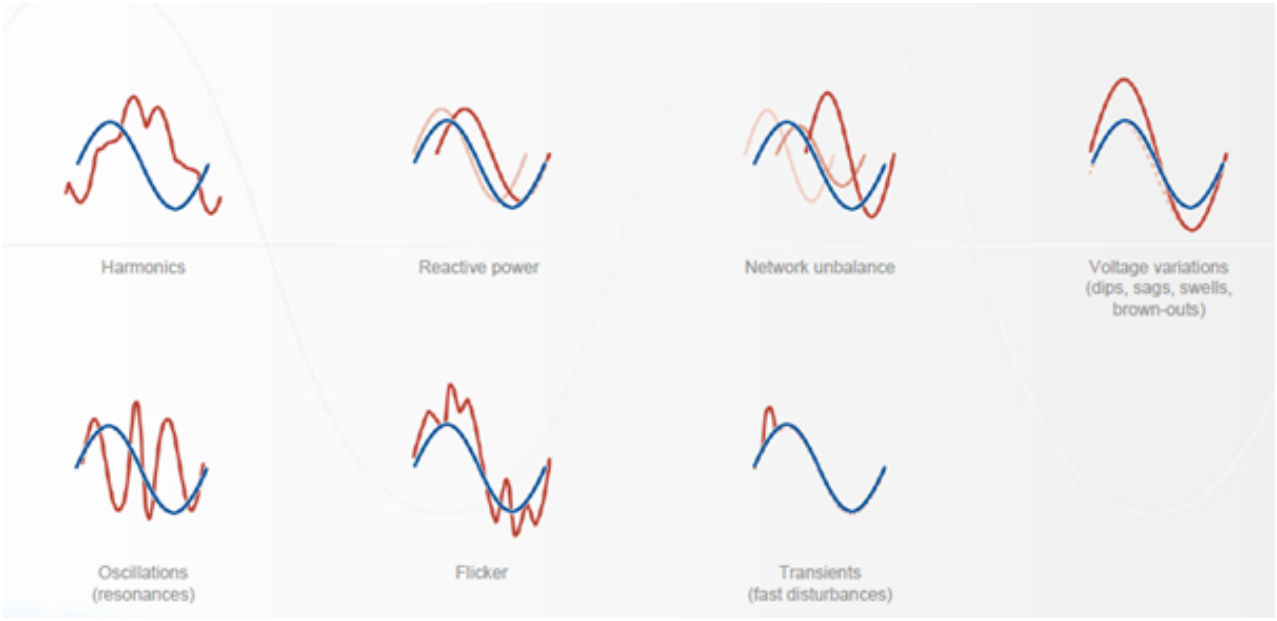

Figure 1: Some examples of power quality anomalies

Problem definitions

Within electrical power plants onboard vessels, the following anomalies are often encountered:

- **Harmonics**

  The presence of harmonics in electrical systems means that both current and voltage are distorted and are deviating from their sinusoidal waveforms.

- **Reactive power**

  Reactive power is the resultant power within an AC circuit when the current waveform is out of phase with the waveform of the voltage. This will usually be by 90 degrees if the load is purely reactive and is the result of either capacitive or inductive loads.

  The actual work is only done when the current is in phase with the voltage, such as in resistive loads (Figure 2).

  An example is powering an incandescent light bulb; in a reactive load energy flows toward the load half the time, whereas in the other half power flows from it, which gives the illusion that the load is neither dissipating nor consuming power.

- **Network voltage unbalance**

  Voltage unbalance is a condition in a three-phase power system where either the phase voltages have asymmetric magnitudes, the phase angle displacement is not equal to 120 ◦ , or a combination of both.

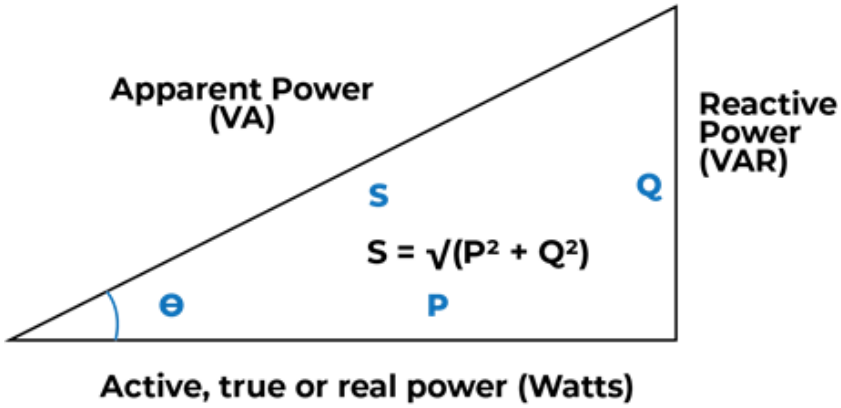

Figure 2

- **Electrical oscillations in an electrical power network**
  Electronic oscillation is a repeating cyclical variation in voltage or current in an electrical circuit, resulting in a periodic waveform. The frequency of the oscillation (measured in hertz) is the number of times the cycle repeats per second.

- **Voltage variations**
  The variation of the supply voltage is defined as an increase or a decrease in the amplitude of the voltage, with respect to its nominal value, which can be caused by variations in input power, variations in loads (e.g. starting of motors, manoeuvers in the system) or by system failures.

- **Flicker**
  Flicker is the name given to changing light intensity caused by fluctuations in the voltage. It is the second most common power quality problem causing both irritation and possible medical consequences to users exposed to its effects.

- **Transients**
  Transients are power quality disturbances that involve destructively high magnitudes of current (kA) and voltage (kV) or even both. They can reach thousands of volts and amps even in low voltage systems. However, such phenomena only exist for very short durations, from less than 50 nanoseconds to as long as 50 milliseconds.

- **RFI (EMI) / EMC Disturbance**

  Electromagnetic compatibility (EMC) is the ability of electrical equipment and systems to function acceptably in their electromagnetic environment, by limiting the unintentional generation, propagation and reception of electromagnetic energy which may cause unwanted effects such as electromagnetic interference (EMI) or even cause physical damage to operational equipment. The goal of EMC is the correct operation of different equipment in a common electromagnetic environment. It is also the name given to the associated branch of electrical engineering.

  These disturbances are all addressed in the field of the power quality. The power quality requirements are described in the different IEC and IEEE standards, which are applicable to the maritime industry. The same standards are used as references in the class requirements (Lloyd's, Bureau Veritas, DNV, etc) for defining the required minimum power quality.

Frequent problems for users

Poor power quality can result in a number of different problems including:

- Overheating tranformers, generators and motors
- Tripping power breakers
- Non-compliance (class requirements Lloyd's, Bureau Veritas, DNV, ..ETC)
- Shorter lifetime of the equipment
- Production failure/downtime
- Exceeding of norm limits
- Failures in the electrical systems (low reliability)

Additional consequences of poor power quality includes:

- Higher fuel consumption and energy costs
- Greater emissions of CO_2, and NOx pollutants
- Reputatuonal damage to the owner/ operator

Optimal solutions

At Alewijnse, the typical approach for the comprehensive review and improvement of the quality of the electrical power on both new or/and refit vessels involves the following activities:

- Establishing the customer's need (problem definition)
  a. Electrical power plant analysis and consultancy (only for new builds)
  b. THD calculation (only for new builds or on the implementation of high power VFDs)
- Power quality measurements (S, P, Q, I, V, cosphi, power factor, THD, transients)
- Power quality analyses and monitoring
- Presenting the technical proposal for the mitigations and improvement of the power quality
- Implementation of the compensation system and permanent measurement system
- Verification and validation of the compensation system
- Implementing permanent monitoring and evaluation of the electrical power plant system
- Project evaluation

The success of these activities is highly dependent on the accuracy of the problem definition. At the start of a project, all the activities required to address the actual power quality problem on board the vessel must be identified and specified in detail in the general plan.

Successful experiences

Over the years, Alewijnse has successfully optimised the power quality on many ships and industrial installations. These have included cable layers, research vessels, superyachts, dredgers, LNG tankers and cruise ships.

We Connect People and Technology

At Alewijnse we believe that by connectig people we are able to deliver the best solutin for our customers and as partners make the diffrence in maritie and industry.

If you would like to discuss your specifineeds, or require help in defiing andestablishing you dream, please contact:

Designer engineer

Zoran Malbasic

Z.malbasic@alewijnse.com

+31 6 23 67 94 45

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