

Letter to the Editor

1998-06-08

Dear Mr Horne,

I have just read your editorial in the April bulletin. A bit late I know, but I always get around to it eventually!

What prompts me to write is your remark that you don't get much feedback. I can well believe that, considering my own shortcomings in this regard. But I would like to tell you that I always pass the bulletin on to our younger engineering people and almost every time there is some positive comment from one of them. I myself certainly also find it a most useful and interesting publication and would miss it if it no longer appeared.

We also have potential candidates for the "Ticket" who are always interested in the legal knowledge and plant engineering questions. Of course it does the older generation no harm to refresh their memory once in a while!

I would like to say thank you to everyone involved with the Bulletin for a very worthwhile cause.

Best regards
P Haag
Athlone Power Station

The effect of a non-sinusoidal voltage source on the operation of a bank of power factor correcting capacitors

Resumé of a Project by B Tech student I Mohamed under the supervision of G Atkinson-Hope Associate Director Cape Technikon.

ABSTRACT

The paper describes how the operation of an already installed power factor correction bank of capacitors is affected by a non-sinusoidal voltage source. A series of laboratory experiments were undertaken. The capacitor banks' operation was first tested under near-ideal conditions, that is, when the voltage supply source was nearly sinusoidal. Its total harmonic distortion was then allowed to deteriorate and its effect on the power factor correcting operation of the bank was investigated.

INTRODUCTION

The application of capacitors to a power system in the presence of harmonic generating equipment can produce harmonic resonance conditions. At the resonant frequency of any inductive-capacitive (LC) circuit, the inductive reactance will equal the capacitive reactance. In actual electrical systems utilising power factor correction capacitors, both series and parallel resonance or a combination of the two may occur. With series resonance, high current magnitudes could result at the exciting frequency. With parallel resonance, the total impedance at the resonant frequency is very high. Thus, when excited from even a small source at the resonant frequency, a high circulating current will flow between the parallel capacitor and the inductor. The voltage across the parallel combination could be quite high. If the resonant point of these circuits happens to be close to one of the frequencies generated by the harmonic sources in the system, the result may be the flow of excessive amounts of harmonic current and/or the appearance of excessive harmonic overvoltages. These occurrences may cause such problems as capacitor bank failures, excessive capacitor fuse operation, and dielectric breakdown of insulated cables.

The sketch below shows a typical arrangement for power correction of an electric motor, which has an inherently low power factor.

DATA ACQUISITION

An induction motor was run straight from the existing laboratory supply whose total harmonic distortion (THD) was Voltage THD 1,8% and Current THD 2%. The power factor without correction was 0,58 lag at 0,72 kW power.

When 10 microfarad capacitors were switched in the power factor improved to 0,94 lag with negligible change in V-THD of the power source but a change from 2% to 10,7% in the I-THD. The THD of the capacitor bank was V-THD 1.9% & I-THD 18%.

The power source was then changed to provide increased voltage total harmonic distortion of 6,4%. The corresponding I-THD was 5,1% at the motor load before the capacitors were switched in. After switching them in the readings were:

At the supply:	P = 0,89 kW	pF = 0,86 lag
	S = 1,03 kVA	V - THD = 8,8%
	Q = 0,42 kVAR	I - THD = 26,4%

At the motor:	P = 0,64 kW	pF = 0,57 lag
	S = 1,19 kVA	V - THD = 6,6%
	Q = 0,98 kVAR	I - THD = 5,1%

At the capacitors:	P = 0,26 kW	pF = 0,37 lead
	S = 0,70 kVA	V - THD = 8,5%
	Q = 0,54 kVAR	I - THD = 48,8%

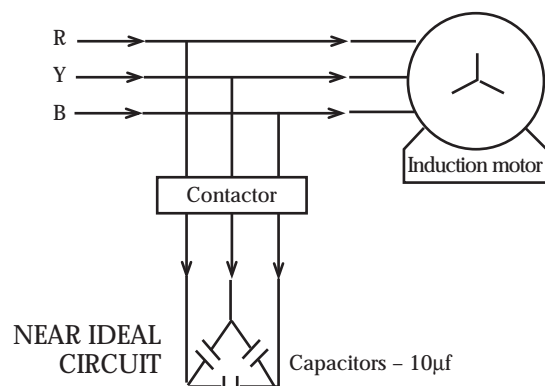
The supply current spectrum showed considerable increases in the currents at harmonic numbers 3, 17 and 19, with increases to a lesser degree at harmonic numbers 5,11,13, 25, 29 and 31.

With the capacitors disconnected the supply voltage THD was 6,4% but with the capacitors connected the supply voltage THD increased to 8,8% which is above the NRS048 Standard of 8%.

CONCLUSIONS

- The current harmonics increased dramatically when the capacitors were closed onto the circuit.
- The actual power factor correction on the other hand was not adversely affected as it improved quite appreciably.
- An increase in supply voltage THD% to approximately the NRS048 limit decreases the corrected power factor from 0,94 lag (1,8% V-THD%) to 0,86 lag (8,8% V-THD%)
- The kVA demand decreased with an increase in supply voltage distortion, which is a saving in tariff. It would however be at the expense of increased supply current distortion.

We thank the Cape Technikon for permission to reproduce the essence of the project.



Take care with forklift trucks

Whilst standing on the running board of a 10 ton forklift truck which was moving at about 8 kph in a large timber yard, the driver's assistant lost his balance when the machine suddenly made a sharp right hand turn and he fell to the ground directly in the path of the left hand rear wheel which passed over the lower section of his body, causing fatal injuries.

The forklift truck is equipped with large running boards on both sides about 1,4 m long by 0,4 m wide composed of checker plating. However, the standing room on the left hand side was restricted by a steel box containing the battery which was centrally placed on the running board. Normally the right hand board was used for the purpose of transporting the assistant from one operating area to the other. In this position he was in full view of the driver and had a positive hand hold on one of the canopy vertical supports. He could even sit on a projection next to the driver under the canopy where he would have been perfectly safe apart from having to avoid the engine air cleaner.

On the occasion of the accident the now deceased chose to stand on the left hand running board behind the battery box and out of sight of the driver, who however was aware of his presence on the vehicle. In this position he did not have as positive a hand hold as would have been the case in a more forward position.

He was anticipating the vehicle making a left hand turn towards a train of railway trucks, but the driver suddenly turned right in answer to a whistle call from the Company's manager.

Despite its size the forklift truck has an extremely narrow turning circle. Turning was effected through the rear wheels which at full lock turned outside the bodywork of the truck. Although the now deceased fell clear of the truck his body lay in the path of the left rear wheel.

It is considered to be a dangerous practice to transport a passenger on a forklift truck unless provided with a seat offering the same protection as the driver's. The Company was aware that it was dangerous but permitted it in view of the large area covered by the timber yard and the time consumed in the driver having to wait for his assistant to walk from the loading to the unloading point and vice versa.

In view of the fact that a large running board was provided on the right hand side equipped with non-skid checker plating prosecution could not be recommended under earlier legislation.

The company was advised to remove the air cleaner on both forklift trucks and equip the area alongside the driver with a neat and safe hand hold.

The deceased was a man of 45 years who had been in the employ of the company as a general worker for 18 years.

The driver was 17 years of age and had been employed for two years. He had been trained as a learner driver and had been a driver for seven and a half months when the incident occurred.

The forklift truck was not carrying a load at the time because it was proceeding to hitch a train of railway trucks to move them into the yard. So the counterweight had its full weight on the rear wheels. The wheel went over his pelvis.

The incident was only reported two and a half months later when the Inquest magistrate asked for the inspector's report.

COMMENT

Under the OH&SA of 1993 a heavy responsibility is placed on the employer to "provide and maintain, as far as is reasonably practicable, a working environment that is safe and without risk to the health of his employees". The general duties of employers to employees is spelt out in Section 8 of this Act and should be closely studied.

The young driver responded automatically to his manager's whistle and without realising that his assistant would be caught off guard he swung the wheel. An experienced driver would also have been aware of the danger that a narrow base forklift truck could capsize if direction was suddenly changed. The current

Act requires adequate training of employees to do their tasks safely for their own welfare and that of other workers.

The non-reporting of an incident is a serious contravention of the Act. Section 24 requires an incident of this nature to be reported within 14 days.

In terms of Section 38(1) the maximum penalty for an offence under the Act is R50 000 or one year's imprisonment or both.

Occupational Health & Safety Act No 85 of 1993

Issue No 14

Regulations Concerning the Certificate of Competency (CCC)
In force 16 March 1990)

Regulation 3:

Suspension or cancellation of certificates

Reg CCC 3(1):

Chief Inspector may suspend or cancel certificate in event of proven gross negligence or misconduct.

Regulation 5:

Commission of Examiners

Reg CCC 5(4):

Made up of:

2 DoL Inspectors (not specified that they must be CEs)

2 Officers under the Mining Rights Act

2 Mechanical CEs with DoL or Mines certificates

2 Electrical CEs with DoL or Mines certificates

A secretary from DoL

Reg CCC 5(9): Chief Inspector & GME draw up rules and curricula for the examination.

Regulation 6:

Qualifying examination

Department of Education & Culture conducts the examination.

Subjects: Plant Engineering, The Act and Regulations.

Apply through Dept of E & C.

Must first be accepted as a candidate by Comm of Examiners.

Regulation 7:

Acceptance as Candidate

(a) At least 23 years of age

(b) Acceptable practical experience.

How do they do that?

If you like to know, listen to this.

How do you perform an hydraulic test on a 3 m³ vertical pressure vessel if you cannot expel the air from above the water level, trapping about 0,3 m³ of air?

The contractor looked at me in disbelief when I asked him, "Fill the vessel with water and pressurise with the hand pump", he explained.

But as air is compressible a lot of pumping would be required to reach a pressure of 1,3 bar.

The logbook recorded 5 tests all signed by the plant engineer, but performed by various contractors.

But how did they do that? Two answers are possible. Answer one is: they did not do that! What? Pressurise the vessel. Only pressurised the test pump hose and pressure gauge. Old trick!

Answer two is that they pumped till they were blue in the face and cursed the pump. (Remember P1V1 = P2V2)

The vent hole I asked to be made worked a predictable wonder. It took less than 5 minutes the following day to perform the test after expelling the air.

If you want to know next time how they do it, in fact, anything, come over yourself and look very closely.

A. Wynthje

Occupational Health & Safety Act No 85 of 1993

Question No 1

- (a) Define "Health and Safety standard" (4 marks) *Definitions S 1(1)(xv)*
- (b) The minister may by notice in the gazette incorporate in the regulations any health and safety standard and such standard apart from two conditional exclusions shall be deemed to be regulations.

State (i) THREE items mentioned in the Act that the notice must contain to identify the standard. *S 44(1): Number, title & year of issue of standard.*

(ii) The name of the council that must be consulted before a health and safety standard is incorporated in the regulations. *S 44(2): Advisory Council for Occupational Health & Safety.*

(iii) The TWO conditions when such a standard shall not be deemed regulations in terms of the Act. *S 44(3): A standard repugnant to these regulations and within two months of incorporation.*

(iv) FOUR duties placed on the Chief Inspector when health and safety standards are incorporated. *S 44(5): Keep a register of every publication and of amendments, where such publication is obtainable and make such register available to the public.* (10 marks)

- (c) The Act provides for special powers by inspectors whereby he may in writing serve a "prohibition", a "direction" or a "notice" on an employer or user who contravenes the Act or permits an act which in the opinion of an inspector threatens the health and safety of persons.

State: (i) In terms of the Act TWO actions required to be taken by the user of machinery to have a non-self revoking prohibition notice revoked. *S 30(1)(d): Make arrangements which will satisfy the inspector to dispose of the threat. What is the other action?*

(ii) The remedial action that should be taken by the user when a notice is issued to him for failing to comply with regulation requirements. The specified time period in the notice is 60 days. *S 30(4): He must take the remedial action within the period specified and bring the contents of the notice to the attention of H & S representatives and employees.*

(6 Marks)

Plant Engineering

June 1992 Question No 2

A process plant which has an electrical demand of 5 MW at a lagging power factor of 0,8 is supplied in parallel with a 4,8 MW separately excited motor which has a demand of 5,333 MVA at a leading power factor of 0,9. The system voltage is 11 kV. The motor drives a compressor which delivers 50 000 m³/h of air.

- (a) Four types of motor protection, other than thermal overload, and the purpose of each one, have to be stated. (6)
- (b) The power factor of the complete reticulation system has to be determined (14)
- (20 Marks)

Answer to Question No 2 of June 1992

- a) Additional electrical protection can be provided in the form of
- phase failure relay (also phase reversal relay) to prevent the motor attempting to run with one phase dead or two phases reversed,
 - low voltage sensing coils connected to a contactor so as to prevent the motor running at too low a supply voltage,
 - over voltage protection,
 - lightning surge protection,
 - over current protection, as distinct from thermal overload protection, which will isolate the supply very rapidly at any preset current value,
 - frequency monitoring, should there be any need to isolate the supply in the event of a frequency deviation, etc.
- b) For some reason which may not be known to the Commission of Examiners, too much information was given in this question, namely the power and power factor of the compressors. Either one would have been adequate!

$$\text{Compressors: } VA = \sqrt{3} \cdot E_1 \cdot I_1 \text{ so } I_{1c} = \frac{5333 \cdot 10^3}{\sqrt{3} \cdot 11000} = 279,9 \text{ amps}$$

$$\phi_{\text{lead}} = \cos^{-1} 0,9 = 25,842^\circ \text{ leading}$$

$$\text{Active current, } I_{ca} = 279,9 \cdot \cos 25,842^\circ = 251,91 \text{ amps}$$

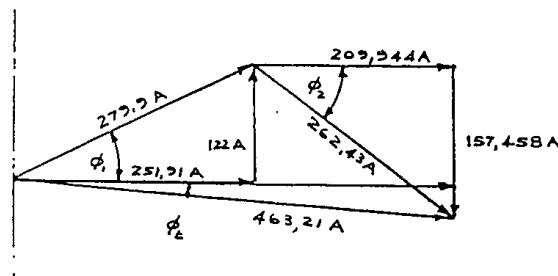
$$\text{Reactive current, } I_{ca} = 279,9 \cdot \sin 25,842^\circ = 122 \text{ amps}$$

$$\text{Plant: } I_{1p} = \frac{5000 \cdot 10^3}{\sqrt{3} \cdot 11000} = 262,43 \text{ amps}$$

$$\phi_{\text{lagging}} = \cos^{-1} 0,8 = 36,87^\circ \text{ lagging}$$

$$\text{Active current, } I_{ap} = 262,43 \cdot \cos 36,87^\circ = 209,944 \text{ amps}$$

$$\text{Reactive current, } I_{rp} = 262,43 \cdot \sin 36,87^\circ = (-) 157,458 \text{ amps}$$



Combined installation:

$$\text{Total active current, } I_{at} = (251,91 + 209,944) = 461,854 \text{ amps}$$

$$\text{Total reactive current } I_{rt} = (122 - 157,458) = (-) 35,458 \text{ amps}$$

$$I_{lt} = \sqrt{(461,854)^2 + (35,458)^2} = 463,21 \text{ amps}$$

$$\phi_{\text{total}} = \tan^{-1} \frac{\text{reactive}}{\text{active}} = \tan^{-1} \frac{(-)35,458}{461,854} = 4,39^\circ$$

$$\text{p.f.}_{\text{total}} = \cos 4,39^\circ = 0,997$$