

DEVELOPMENT OF VOLTAGE SAGS MONITORING AND MITIGATION
ANALYSIS FOR CEMENT MANUFACTURING INDUSTRIES

MOHD AZHAR BIN MOHD NOOR

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ABSTRACT

Supply voltage sags are one of the power quality problems, which have become a big concern in the recent years. In all types of networks; industrial, commercial and residential, various load devices are utilised, which are very sensitive to voltage sags like examples electronic controls, computers, adjustable speed drives. Many customer experience severe consequences of voltage sags, which can prevent appliances from proper operating and make industrial processes, shut down. An interruption of industrial process due to voltage sag can result in big economical losses and costs. This project investigates the impact of voltage sags on the plant operation in a heavy industry electrical network. Understanding the existing system immunity to voltage sags is essential, and to accomplish that, MATLAB Simulink was used. Actual plant load flow is modelled and simulation result analysed. Area of vulnerability has been determined and system level of sensitivity has been developed. Result shows that equipments weakness not due to voltage sags at 11kV, but mainly due to failure of lower voltage; i.e. control voltage to hold operation during voltage sags. Further investigation is recommended on the low voltage level. From the investigation, proposed mitigation has been suggested and verified by simulation technique.

ABSTRAK

Bekalan voltan lendut adalah salah satu daripada masalah kualiti kuasa, dimana masalah ini telah menjadi semakin membimbangkan dalam tahun-tahun kebelakangan ini. Didalam pelbagai system jaringan elektrik; industri, komersil dan domestik, pelbagai jenis beban peralatan digunakan, dimana peralatan-peralatan itu sangat sensitif kepada voltan lendut contohnya seperti kawalan elektronik, komputer, kawalan kelajuan berubah-ubah. Terdapat ramai pengguna mengalami kesan negatif akibat daripada voltan lendut, yang menyebabkan peralatan-peralatan tidak dapat beroperasi dan proses-proses industri terhenti. Sebarang gangguan kepada proses industri yang disebabkan oleh voltan lendut boleh menyebabkan kerugian yang besar dan peningkatan kos. Projek ini mengkaji kesan voltan lendut kepada jaringan elektrik bagi operasi sebuah industri berat. Bagi tujuan itu, kita perlu memahami keadaan sebenar imuniti system kepada voltan lendut, dan untuk menjayakannya, program MATLAB Simulink telah digunakan. Keadaan sebenar aliran beban dimodelkan dan keputusan simulasi dianalisa. Kawasan yang mudah menerima kesan voltan lendut dan aras kesensitifan system akan diketahui. Hasil kajian memunjukkan bahawa kelemahan peralatan bukan kerana voltan lendut pada 11kV, tetapi kegagalan pada voltan lebih rendah; contohnya voltan kawalan untuk mengekalkan operasi semasa voltan lendut. Kajian diperingkat voltan yang lebih rendah dicadangkan untuk diteruskan. Berdasarkan kajian yang dilakukan, cadangan untuk mengatasi masalah ini telah di tunjukkan dengan teknik simulasi.

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CHAPTER 1

INTRODUCTION

1.1 Project background

Cement manufacturing is a heavy industries which involved various types of electrical equipments from high voltage power supplies to control system i.e. DCS, PLC, Computers, to control a complex process. Cement plant is an integrated system where if any of the machine in the loop stop, will cause total process interruption. Hence, short duration of power quality is enough to cause interruption to the whole operation, losses is significant, and detection and mitigation will save million of Ringgit in company revenue.

A cement manufacturing facilities in Rawang, Selangor is the main source of the study. Almost all the power quality events experience by the plants is voltage sags. Since year 2000, the plant experience 42 numbers of voltage sag conditions which those causing electrical equipments to trip and consequently stop the plant.

Table 1.1 is the summary of Voltage Sag counts in Cement Manufacturing Plant in Rawang plant since 2000[1]:

Table 1.1 Voltage sags counts in a cement manufacturing plant causing plant interruption.

Year	Voltage Sag Count	Est. Losses (RM)
2000	10	518,480
2001	8	1,050,257
2002	2	174,539
2003	5	166,500
2004	5	213,044
2005	8	422,000
2006	4	367,430
2007 (Till Mar07)	1	66,755
TOTAL	43	2,979,005
AVERAGE	6/year	69,279/incident

The above losses only count the opportunity losses and fuel cost taken to restart heating process before production will resume. But, there is many other losses not counted above i.e. material wastages, extra electricity cost incurred, extra overhead incurred, equipments damages, environmental impact (tripping causing release emission to environment).

The sources of voltage sags can be internal or external in view of the industrial plant, voltage sags can occur on utility system (Tenaga National Berhad in Malaysia) both at distribution voltages and transmission voltages. Voltage sags that occur at higher voltages will normally spread through a utility system and will be transmitted to lower voltage systems via transformers. Voltage sag can be created within an industrial complex without any influence from the utility system. These sag typically caused by starting large motors or by electrical faults inside the facility.

Frequently industrial customers blame their local electrical utility for unplanned production stoppages and claim that other jurisdictions have much better power quality. Unfortunately in many cases there is little or nothing the utility can do and very few utilities, anywhere in the world, escape voltage sags.

Since the utility faults cannot be eliminated completely, solution to sag problems must always be tackled at the customer facility; accurate estimates of sag characteristics can help the facility personnel to take decision on purchasing power quality mitigation equipment [2].

1.2 Objectives of project

The objectives of the project are as follows:

- 1.2.1 To develop a systematic method in monitoring, detection and data interpretation related to voltage sag problems in general and cement manufacturing industries in particular.
- 1.2.2 To model the actual cement manufacturing plant for voltage sag analysis and proposed mitigation methods.
- 1.2.3 To verify the result with the incoming supply Power Quality monitoring devices to determine sensitive equipments.

1.3 Scope of project

The project focuses on voltage sags detection and mitigation specific to the actual cement manufacturing industries electrical network. The electrical network or distribution system is modelled to understand the impact of voltage sag to plant electrical network and the equipment or area of vulnerability to voltage sag will be determined. Detection of voltage sags by simulation of fault, mainly single to ground or three phase fault, and result is analysed for sensitivity of the plant network. Proposed mitigation technique is based on cost efficiency and functionality and selection of mitigation method based on existing technology available, and do not include detail design.

1.4 Outline of the thesis

The thesis consists of 5 chapters. In chapter 2, a brief review of voltage sags related to the project is discussed, where definition, sources of voltage sags, characteristics, reference standard, detection methods and mitigation available explained.

In chapter 3, research methodology is proposed, MATLAB Simulink is the software used to study the load flow and analysis of voltage sags. Source of voltage sags is 3-phase fault with assumption of no loading changes during the analysis, and a typical load condition is used through out the analysis. Explanation on how the equipments are modelled also detailed in this chapter.

In chapter 4, result of the analysis is discussed, and all relevant information is compared to understand the equipments behaviours during voltage sags. From the analysis we managed to understand the bigger pictures if voltage sags impact on the plant operations, and stages of mitigation could be proposed.

Conclusion of the project is explained in chapter 5, where the project considered successful of achieving the objectives and actual proposal being implemented in the plant as a result of the study.

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