POWER QUALITY IMPROVEMENT IN SYSTEM DISTRIBUTION USING COMPENSATOR

P.VENKATESH¹, V.NAGA RAJU²

Abstract- This paper presents the enhancement of voltage sags, harmonic distortion and low power factor using Distribution Static Compensator with LCL Passive Filter in distribution system. The model is based on the Voltage Source Converter (VSC) principle. The D-STATCOM injects a current into the system to mitigate the voltage sags. LCL Passive Filter was then added to D-STATCOM to improve harmonic distortion and low power factor. The simulations were performed using MATLAB SIMULINK version R2007b.

Keywords- Compensator, Voltage Sags, Voltage Source Converter (VSC), LCL Passive Filter, Total harmonics.

I. INTRODUCTION

An increasing demand for high quality, reliable electrical power and increasing number of distorting loads may leads to an increased awareness of power quality both by customers and utilities. The most common power quality problems today are voltage sags, harmonic distortion and low power factor. Voltage sags is a short time (10 ms to 1 minute) event during which a reduction in r.m.s voltage magnitude occurs [4]. It is often set only by two parameters, depth/magnitude and duration. The voltage sags magnitude is ranged from 10% to 90% of nominal voltage and with duration from half a cycle to 1 min.

Voltage sags is caused by a fault in the utility system, a fault within the customer’s facility or a large increase of the load current, like starting a motor or transformer energizing [2, 3]. Voltage sags are one of the most occurring power quality problems. For an industry voltage sags occur more often and cause severe problems and economical losses. Utilities often focus on disturbances from end-user equipment as the main power quality problems [5].

Harmonic currents in distribution system can cause harmonic distortion, low power factor and additional losses as well as heating in the electrical equipment. It also can cause vibration and noise in machines and malfunction of the sensitive equipment.

In this paper, the configuration and design of the Compensator with LCL Passive Filter are analyzed. It is connected in shunt or parallel to the 11 kV test distribution system. It also is design to enhance the power quality such as voltage sags, harmonic distortion and low power factor in distribution system.

II. LITERATURE SURVEY

A Compensator consists of a two-level VSC, a dc energy storage device, controller and a coupling transformer connected in shunt to the distribution network. Figure 2.1 shows the schematic diagram of Compensator.

![Figure 2.1: Compensator](image)

2.1 Voltage Converter
A common use of the voltage converter is for a device that allows appliances made for the mains voltage of one geographical region to operate in an area with different voltage. Such a device may be called a voltage converter, power converter, travel adapter, etc. Most single phase alternating-current electrical outlets in the world supply power at 210–240 V or at 100–120 V. A transformer or autotransformer can be used; (auto)transformers are inherently reversible, so the same transformer can be used to step the voltage up, or step it down by the same ratio. Lighter and smaller devices can be made using electronic circuitry; reducing the voltage electronically is simpler and cheaper than increasing it. Small, inexpensive, travel adapters suitable for low-power devices such as electric shavers, but not, say, hairdryers, are available; travel adapters usually include plug-end adapters for the different standards used in different countries. A transformer would be used for higher power.

Transformers do not change the frequency of electricity; in many regions with 100–120 V, electricity is supplied at 60 Hz, and 210–240 V regions tend to use 50 Hz. This may affect operation of devices which depend on mains frequency (some audio turntables and mains-only electric clocks, etc., although modern equipment is less likely to depend upon mains frequency). Equipment with high-
powered motors or internal transformers designed to operate at 60 Hz may overheat at 50 Hz even if the voltage supplied is correct. Most mains-powered electrical equipment can be used either on any voltage from 100 to 120V, or on any voltage from 210 to 240 V; so that voltage converters need only be specified to convert any voltage in one range to a voltage in the other, rather than separate converters being required for all pairs of nominal voltages (110–220, 117–220, 110–230, ...).

2.2 Controller system
An automatic sequential control system may trigger a series of mechanical actuators in the correct sequence to perform a task. For example, various electric and pneumatic transducers may fold and glue a cardboard box, fill it with product and then seal it in an automatic packaging machine.

Programmable logic controllers are used in many cases such as this, but several alternative technologies exist. In the case of linear feedback systems, a control loop, including sensors, control algorithms and actuators, is arranged in such a fashion as to try to regulate a variable at a setpoint or reference value. An example of this may increase the fuel supply to a furnace when a measured temperature drops. PID controllers are common and effective in cases such as this. Control systems that include some sensing of the results they are trying to achieve are making use of feedback and so can, to some extent, adapt to varying circumstances. Open-loop control systems do not make use of feedback, and run only in pre-arranged ways.

![Feedback Model](image_url)

III. METHODOLOGY

![Methodology Diagram](image_url)
The test system shown in figure 3.1 comprises a 230kV, 50Hz transmission system, represented by a Thevenin equivalent, feeding into the primary side of a 3-winding transformer connected in Y/Y/Y, 230/11/11 kV. A varying load is connected to the 11 kV, secondary side of the transformer. A two-level compensator is connected to the 11 kV tertiary winding to provide instantaneous voltage support at the load point. A 750 µF capacitor on the dc side provides the compensator energy storage capabilities. Breaker 1 is used to control the period of operation of the D-STATCOM and breaker 2 is used to control the connection of load 1 to the system.

B. Simulink Model for the test system

The test system was design using MATLAB simulink is shown in figure 3.2 below.

### IV. RESULTS AND DISCUSSION

#### TABLE 4.1. RESULTS OF VOLTAGE SAGS FOR DIFFERENT TYPES OF FAULT.

<table>
<thead>
<tr>
<th>Fault Resistance (Ω)</th>
<th>Voltage sags for TPG fault (p.u.)</th>
<th>Voltage sags for DLG fault (p.u.)</th>
<th>Voltage sags for LL fault (p.u.)</th>
<th>Voltage sags for SLG fault (p.u.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.45</td>
<td>0.6600</td>
<td>0.7070</td>
<td>0.7567</td>
<td>0.8259</td>
</tr>
<tr>
<td>0.86</td>
<td>0.7107</td>
<td>0.7648</td>
<td>0.7844</td>
<td>0.8146</td>
</tr>
<tr>
<td>0.96</td>
<td>0.8545</td>
<td>0.9843</td>
<td>0.92510</td>
<td>0.98779</td>
</tr>
</tbody>
</table>

Figure 3.1: Line Diagram

Figure 3.2: Diagram of the test system

Figure 4.1 Voltages at Different Levels
CONCLUSION

The simulation results show that the voltage sags can be mitigate by inserting compensator to the distribution system. By adding low Passive filter to compensator, the third reduced within the basic Standard The power factors also increase close to unity. Thus, it can be concluded that by adding compensator with Low filter the power quality is improved.

REFERENCES


BIBLIOGRAPHY

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