Mitigation of Voltage Flicker Caused by Resistance Welder

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1. Introduction

Unlike some loads that operate continuously, resistance welders operate many times each minute and draw a large amount of reactive power (VAR) for short periods during which little real power is needed. This type of load causes voltage flicker, which is experienced not only by the owner of the welder, but also by any other utility customers receiving power from the same distribution feeder. A shunt capacitor, series capacitor, synchronous condenser and static VAR compensator are some of the sources of reactive power that can directly connected to the system to solve the flickering problem. In our study a distribution line with a resistance welder is simulated using MATLAB Simulink software. Then the voltage flicker in the line is observed. The historical flicker curve is used to quantify flicker[1]. Then the mitigation techniques are simulated and their effectiveness at reducing flicker is studied. Finally, the best solution for this problem is proposed.

2. Experiment, Result, Discussion and Significance

(a) Voltage Flicker

Historically measured voltage changes have been used in conjunction with the “flicker curve” shown in Fig. 1[1]. The relative change in voltage magnitude (ΔV/V) and the number of changes per minute are used to determine if flicker is significant enough to be noticed by humans. This curve is used as the standard in this study.

(b) Resistance Welder

The resistance welder in the system studied is rated 480 V, 300 kVA, and has a power factor of 0.2 lagging. The source reactance is 2.4 Ω. The welder is modeled by a circuit breaker switching a reactive load of 300 kVA, power factor 0.2 lagging load. Figures 2 and 3 show the system voltage with and without the welder operating.

(c) Shunt Capacitors

The first solution simulated is a 300 kVAr bank of three-phase static capacitors directly connected in parallel with the welder. They inject leading reactive power into the system. The simulation shows in fig. 4 that the shunt capacitor can provide the VArs required by the welder. But due to the dynamic nature of the welder, when it cycles off, the voltage rises due to the shunt capacitance, and the problem of flickering remains the same.
(d) **Series Capacitors**

Next, 2.25 \( \mu F \) capacitors are connected in series with the line. They improve voltage regulation by decreasing the line impedance. Fig. 5 shows that the series capacitors solve the flickering problem caused by welders. Reduced line impedance, however, increases current during faults on the system. Series capacitors therefore need special protective devices to protect the capacitors and reduce short circuit currents.

(e) **Static VAR Compensator**

A static VAR compensator (SVC) is a reactive power generator whose output varies to control the flow of reactive power to meet specific operating conditions. Unlike shunt capacitors, an SVC has very fast response to changes in system reactive power needs. The SVC modeled here responds in one-quarter cycle with the required VAR. Fig. 6 shows the results when 320 kVAR is switched in response to welder operation. The remaining voltage changes are too fast to be detected by the human eye, and the SVC thus solves the flicker problem.

(f) **Synchronous Condensers**

A synchronous machine operating under no load can absorb and provide VARs to the system by varying its excitation. It feeds positive VARs to the system when overexcited, and negative VARs when under excited. A machine thus running is called a synchronous condenser. The synchronous machine used in the simulation is rated 0.75MVA. Fig. 7 shows that this synchronous condenser is able to solve the flickering problem caused by the resistance welder.

3. **Conclusion**

The Series capacitor, Static VAR Compensator, and Synchronous Condenser are able to mitigate flicker caused by a resistance welder. The final selection among these for a particular case should be based on technical as well as financial analyses.

4. **References**