Efficient And Reliable Method To Upgrade Static Var Compensator (SVC) Control Reusing The Solid-State Valves

Jorge Haros – AMI Automation, Mexico
Antonio Mariscal – AMI Automation, Mexico
Eric Martínez – AMI Automation, Mexico
Jose Luis Pepe – AMI Automation, Mexico
Bernardo Sainz – AMI Automation, Mexico

SVCs' fast-acting reactive power is indispensable for optimal Electrical Steel Making. SVCs, like any other control equipment, are susceptible to component obsolescence. Although advances in Hi-Performance Real-Time Controls allows the possibility to generate optimal control solution with tailored interfaces to existing Power devices. This article presents the design, installation, and benefits of the implementation, presenting advantages, efficiency, and versatility versus a complete valve replacement.

INTRODUCTION

An SVC Static Var Compensator behaves as a variable capacitor whose capacity is regulated according to load variations to achieve unity power factor, balance asymmetrical loads, and minimize voltage disturbances (flicker). It also can reduce the harmonic content caused by the non-linear loads. In addition, it can have functions such as the utilization of surplus power in the Thyristor Controlled Reactor (TCR) to minimize overvoltage events and allow smooth commissioning.

The most common arrangement in industry is shown in Figure 1, where different harmonic filters tuned to the different frequencies of interest can be observed. These filters pursue a double function, firstly they reduce the harmonic content to comply with standards such as IEEE 519, and on the other hand at the fundamental frequency they behave like a large capacitor, capable of providing a reactive power higher than that consumed by the load. The surplus capacitive reactive power is consumed by a TCR because varying the firing angle of the thyristors is achieved by varying the inductance of the TCR a controlled inductance reactor.

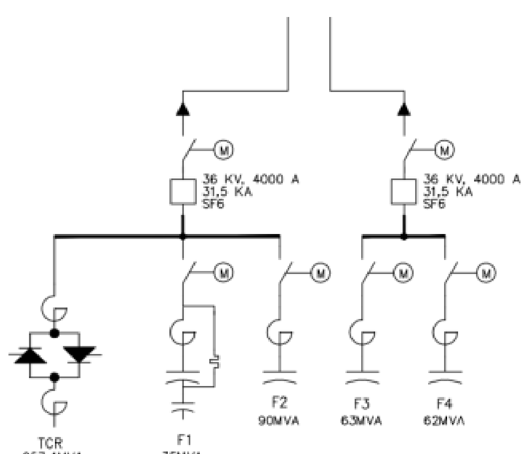

Fig. 1 – 250 MV Ar SVC with TCR

DISCUSSION

SVC Upgrade Challenges

The efficient use of electrical energy is taking relevance in several industries, and the steel industry is not the exception, especially when controlling processes like an Electric Arc Furnace, where each installation demands power in the range of tens to hundreds MVAs.

Additionally, energy regulators, in different regions around the world, have been imposing tighter regulations to load centers, making power utility companies to enforce consumers to meet those by impose different tariff or penalties, even service shutdown.

The focus on power quality KPI's such as power factor, current unbalance, flicker, harmonics, and voltage variations become an essential task for an optimal Steel Making process. This means that a fast-acting, high efficiency and highly reliable SVC system is indispensable to meet all these power quality standards.

Having an updated and efficient SVC system is not an easy task. In several cases the control equipment is reaching a mature or obsolete status in their product lifetime cycle, making it difficult to get spares parts, support, and maintain the equipment operating.

Moreover, an SVC require to communicate and integrate multiple subsystems at different levels, which may include a water cooling system, HMIs, Distributed Control Systems (DCS), Remote IO systems, among others. All these subsystems are subject to change during multiple plant upgrades and if any of those are not longer available to communicate with the SVC, the overall system start to operate inefficiently.

Opportunities

There are different types of SVC, nowadays there are two types which dominate the market: TCR SVC and STATCOM SVC. The first one, is more used in higher power applications, because is a very robust and reliable design, even that TCR and filters continue to have a high cost, it represents a less investment that the STATCOM SVC.

TCR SVCs are widely used in many applications and even though the control equipment it's becoming obsolete rapidly, the power equipment such as filters, thyristors, and mechanical valve and heatsink designs still represent a very reliable equipment because their components are repairable and fully compatible with the actual technology.

Normally the cost of the control system represents a small part of the invested value, around 20%, comparing with the value of the power section. This led us to the big opportunity of upgrading only the control section, increase the reliability, extend diagnostics, simplify troubleshooting, digitize control algorithms and electrical measurements.

Upgrade Strategy

SVC control system upgrade needs to be analyzed carefully. The strategy for a successful upgrade needs to consider the following engineering design stages:

- Full Simulations:
- Thyristor Firing Circuit
- Valve Cooling Unit
- Circuit breakers control
- Power Quality measurements
- Regulation modes
- Trends
- HMIs

Simulations are a key stage during the evaluation of the SVC upgrade because can estimate the results of the control algorithms while keeping the same power equipment and it can simulate the response of the SVC under different conditions or sporadic events. Some of the critical condition may include but not limited to:

- Full-range operating voltage
- Electrical network supplier
- High voltage short-circuit
- Step-down transformers inrush
- Voltage unbalance
- Frequency variations
- External electrical disturbances
- Electric Arc furnace actual operation data
- Blackout

The results from the simulations may conclude that a modification of the filters or other critical devices are required.

A second very important stage, include the Firing Circuit Replacement (FCR) that needs to be meticulously analyzed to define the interface boards required to control the SVC's valve thyristors and subsequently the whole TCR. A simplified one-line diagram is shown in the Figure 2.

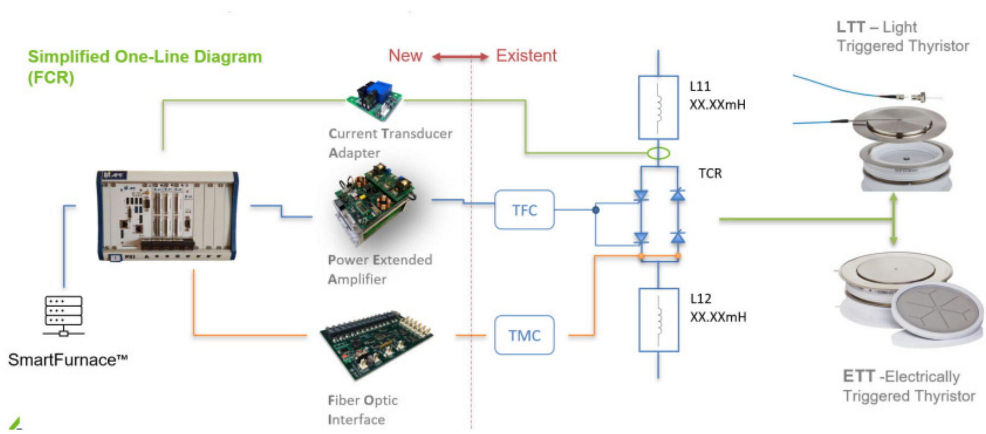

Fig. 2 – FCR Simplified One-line diagram

The additional stages will include site-specific information from existent equipment to complement the design phases and deliver a highly customized product to the customer.

CONCLUSIONS

Upgrading your SVC will give keep your equipment fully integrated with your high-level control systems and will increase the system availability as well as improve the performance that can meet the electrical regulations and efficiency requirements. In order to complete this upgrade, the savings can be even more if you reuse the power components which most of them are compatible and repairable and focus on the control algorithms, digital signal processing and innovative digital regulation modes.