

Analyzing a Power Plant's Performance for Operational Improvement

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Abstract: Power plants need performance analysis on a regular basis to reach their operational maximum efficiency levels. Researchers studied the performance of a 400/220 kV 630 MVA power plant as the main subject for analysis. The research shows that the transformer station (installed station) features immense capacity in comparison to the load it distributed during its underutilized and underloaded operations. The station became less efficient in operation at the same time when the incoming voltage reached higher levels than its designed voltage limits. The dependence of power supply became at risk when one of the 400 kV inbound lines experienced trips under off-peak loading conditions. Through this examination researchers present several recommendations along with insights to improve both performance and loading pattern optimization at the power plant facility.

Keywords: Station capacity, performance analysis, energy audit, energy efficiency, and bus reactor

I. Introduction

The development of productive countries into prosperous nations needs electrical power as its fundamental requirement. Its demand has expanded substantially because of these reasons. The power generation capacity has struggled to match demand because of several factors such as energy theft alongside low growth in power generation and T&D losses and limited availability of conventional energy resources and non-conventional energy sources and rising living standards and an increasing population and poor energy conservation awareness and power waste. The power deficit has worsened because of this while electricity quality has declined and requires swift correction.

Efforts to expand power capacities by using an increasing amount of fossil fuels have backfired and caused environmental issues. However, further research and studies on the utilization of unconventional energy sources with more advanced and effective technologies would aid in both pollution management and the expansion of power producing capacity. Good initial plant design, efficient equipment correction, supplier and customer cooperation, and regular monitoring and maintenance all contribute to a high-quality power supply. The last strategy is the most cost-effective, eco-friendly, and straightforward of the ones that have been proposed.

II. Performance Analysis

For the purpose of analysis, the substation operational data that was manually recorded at hourly and four-hourly intervals and recorded in an automatic data logger was gathered and examined throughout a 24-month period.

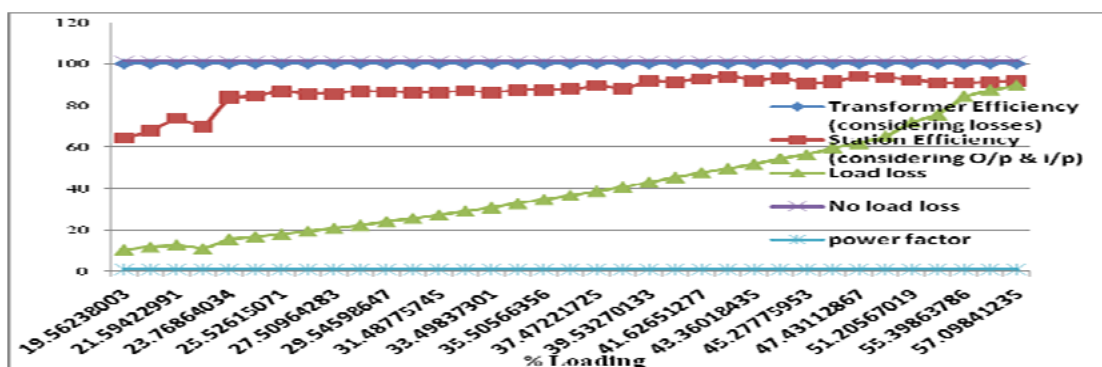


Fig 1: Substation performance parameters

Figure 1 shows the data from the station performance study graphically. It demonstrates that the actual transformer efficiency and station efficiency figures, which should have been almost equal under ideal circumstances, diverge significantly. Station intake and output (in MVA) were taken into account for assessing station efficiency. However, no load and full load losses have been taken into account when determining the transformer efficiency based on the actual transformer loading (in MW).

III. Analysis and Results

Multiple insights stem from the present station operations and the collected field data and assessment results of performance. Between 440 kV and 290 kV, the station's input voltage fluctuates greatly. The voltage range stands between 420–280 kV when the 70 MVAR bus shunt reactor enables its operation. The combination of Ferranti effect with light line loading establishes the main mechanisms that increase voltage spikes thus putting transformer life and station equipment operability at risk. The station produces electrical energy that varies between 220 kV and 440 kV at its output terminal. The frequency fluctuates between 60 and 65.5 Hz.

Second-line reactor operation with 80 MVAR capacity is installed at the sending station due to existing 70 MVAR shunt bus reactor at this substation. Using the supplementary 80 MVAR reactor the voltage stays elevated to 420 kV although it surpasses the maximum rated 300 kV at the incoming station. During weak load conditions one of the 400 kV incoming lines requires daily virtual outage as the final means to control incoming voltage elevation. The transformers operate together in parallel and technicians maintain them in their operating state twenty-four hours daily. Both transformers operate with equal distribution of the overall load. The loading rate for each transformer normally varies between 19 and 70 percent. The transformer's maximum loading rate remains below 60% throughout brief situations of peak demand. The transformer operation remains below its maximum capacity for almost all hours of daylight.

IV. Recommendations and Conclusions

The study has produced relevant recommendations for energy conservation together with operational efficiency enhancements of the station based on the performance analysis observations. Operations of all transformers should reach optimal efficiency through maintaining 60.82 percent of their loading potential. The transformers operate within a range of 29 to 80 percent loading at present. The transformer loading stays close to the maximum of 60% for brief periods but spends most of its daily operation time at a much lower level. Transformers feature design characteristics to reach better efficiency during conditions of higher percent loading. The station/transformer operations require the following approach for adjustments.

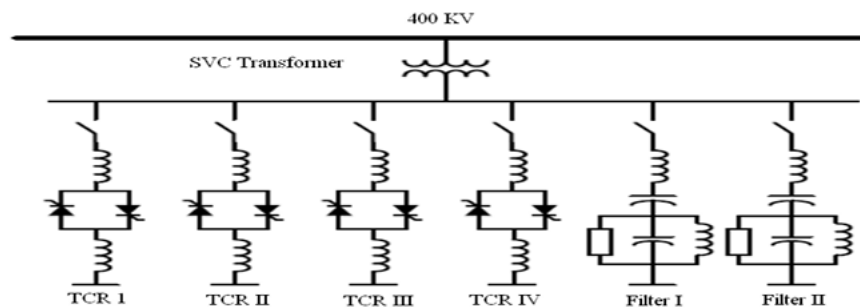


Fig 2: TCRs, SVC and Filters connections

References

- [1] P.W. O'Callaghan, S.D. Probert, "Energy Management", *Applied Energy*, vol 3, Issue 2, pp. 127-138, April 1977.
- [2] Dr. Clive Beggs, "Energy audits and surveys", *Energy Management and Conservation*, pp 73-91, 2002.
- [3] Bureau of Energy Efficiency, "General Aspects of Energy Management and Energy Audit", Book I, IInd edition, 2005.
- [4] F. Roberts, "Aggregation of the UK's Energy Conservation Options", *Applied Energy*, vol 6, Issue 1, pp 21-48, January-February 1980.
- [5] Bureau of Energy Efficiency, "Energy Performance Assessment for Equipment Utility System", Book IV, IInd edition, 2005.
- [6] Sanjoy Parida, Ashwani Kumar, S.C. Srivastava and S.N. Singh, "Enhancement of Power System Loadability with Optimal Allocation of TCPAR in Competitive Electricity Market using MILP", *Proceedings. of International Conference on Power System (ICPS 2004)*,

- [7] Kathmandu, Nepal,, pp. 705-710, 3-5 Nov 2004. M.K. Verma and S.C. Srivastava, “Optimal Placement of SVC for Static and Dynamic Voltage Security Enhancement”, in International Conference on Power System (ICPS 2004), Nov 2004, pp. 131-136.