A study of life time management of Power Transformers at E.ON's Öresundsverket, Malmö.

Chaitanya Upadhyay, June 2011.

Electricity plays an important part in our life. Electricity is produced at the power plant and is transmitted to domestic supply at our homes via substations. For effective electricity transmission, losses caused in the electricity transmission should be minimized. This is done by help of the power transformers which reduces the flow of current and increases the flow of voltage in the power supply. For best economical results of power transmission, life time of the transformers should be maximum.

Power Transformer with 6 cooling fans
Source: Siemens Transformers ETGZ

Introduction

This project was carried out at E.ON's Öresundsverket in Mamö. Öresundsverket is considered to be one of most modern combined heat and power plant, runs on natural gas and delivers 3 TWh electricity and 1 TWh district heating in a year. This plant was built to increase the power production and reducing the risk of power outage in Skåne region.

This project lays emphasis on the factors which effects the transformer's service life time. Mainly thermal properties of the transformer are being considered in this report.

Lifetime of the transformer depends upon the hot spot temperature of the transformer. Hot spot temperature is the highest temperature of any region in the transformer. It's therefore important to keep the operating temperature as low as possible. This can be done by cooling the transformer by help of fans and pumps.

Theory

Öresundsverket has two power transformers, one for the gas and one for the steam turbine. These transformers are cooled by help of the fans and pumps. The cooling system consisting of fans and pumps starts when the oil in transformer reaches 60 ^{o}C and switches off at 40 ^{o}C. This process of cooling causes a higher hot spot temperature and thermal stress due to temperature variations caused by switching on-off of the fans. The ideal case would have been that the cooling system is in constant operation throughout with the transformers. By running the transformers according to ideal case, reduces the hot spot temperature and adding life to the transformers.

Degree of polymerization (DP) is a measure of thermal degradation of the insulation present in the transformer. New insulation have DP value of 1200 and at DP value of 300, it’s considered the

end of life of insulation. Thermal degradation of cellulose is dependent on transformer's operating temperature and time.

Gas formation always occurs in the transformer. Interpretation of gases formed, can help in detecting if any fault has occurred in the transformer. The formation of combustible gases can lead to thermal or electrical fault in the transformer. The formation of gases and total gas content also depends on the operating temperature of the transformer.

Method

Hot spot temperatures, loss life time, DP value and gas formation in transformers at Öresundsverket was compared both in an ideal case and in on-off cooling case. These cases were then compared by standards of IEEE (Institute of Electrical and Electronics Engineers) and IEC (International Electrotechnical Commission).

Result

By running the transformers at Öresundsverket according to ideal case, hot spot temperature (according to IEC standard) is reduced by 22 ^{o}C in gas turbine transformer and 26 ^{o}C in steam turbine transformer. The life time gained by ideal case is approx. 4.5 months for both transformers. According to IEEE standards hot spot temperature was reduced by 40 ^{o}C in gas turbine transformer and 53 ^{o}C in the other transformer. The life time gained was approx. 5% of transformers total life time.

Thermal degradation in the insulation was also significantly low in ideal case in both transformers. The total gas content was also reduced in ideal case when compared to on-off cooling method.

Conclusion

For maximum life time of transformers, hot spot temperature should be maintained as low as possible. Constant cooling helps in maintaining low hot spot temperature, thus adding life to the transformer. Constant cooling also slows down the thermal degradation of the insulation. It also decreases the combustible gas and total gas content, thus minimizing any risk for fault.