Chemistry Behind the Life of a Transformer

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Introduction

Transformer life management [1] is an essential part of a modern power operation system. Oil filled transformer technology has been used for more than 100 years. The principle of operation has not changed over many decades. Many transformers that were built and installed in post World War still remain in service. A properly maintained power transformer can function for 50 to 75 years. However, the maintenance of the insulation system largely determines the extent of a transformer’s life. Future transformers will no doubt have increased capacity and size and their design may require the use of new materials. Transformers may operate at higher temperatures and in turn demand transformer oils of greater stability.

Types and Ranges of Transformers

Power transformers and distribution transformers are used in numerous public and private sector set-ups involved in electricity consumption, distribution and generation. An ideal transformer should have a negligible winding resistance, perfect coupling between windings and an ideal core (Figure 1).

The transformers used in India range from 10 KVA capacity to 150 MVA. Reliable electrical supply has become one of the basic needs for development of society with the ever-increasing gap.
between demand and supply of electrical power. It is essential to utilize the existing power network to its optimal design capability. Economic factors usually favor continued operation of a power system as long as possible. The power transformer is an important and one of the costliest equipments in electrical power transmission system (Figure 2).

**Insulation System of the Transformer**

When electrical energy is transformed from one voltage to another, heat is developed. This temperature must be within limits so that it will not adversely affect the dimensional stability of the materials used in the construction of the transformer. In power transformers, the high electrical stresses and amount of heat developed require both solid and liquid insulation, with the fluid conducting the generated heat away to cooling surfaces, where it gets dissipated. The combination of oil and cellulose products has remained unchanged for reasons of electric strength and cost. The amount of insulating oil and cellulose vary with different types of transformers based on function and voltage class.

The life of the transformer is actually the life of the internal insulation system. The most widely used systems are liquid insulation (transformer oil) and solid insulation (kraft paper,