



An oil-filled transformer with radiator cooling (ONAF)

ZIEHL-ABEGG 

**AXIAL
FANS**

**FOR RELIABLE
TRANSFORMER
COOLING**



Cooling is of vital importance for increased service life and operational reliability of power transformers.

Axial fans from German fan manufacturer Ziehl-Abegg have been used to efficiently and reliably cool transformers for over 50 years.

As with any technical system, performance losses can occur during the operation of power transformers. These occur primarily because of the heat generated by the transformer windings. If the winding becomes seriously overheated – something that typically occurs in the event of an overload – the transformer must be switched off. In the worst-case scenario, this can lead to a blackout. Even a short power outage can cause significant operational as well as financial issues. In a 2013 study, the Hamburg Institute of International Economics found that just a one-hour power outage during lunchtime in Berlin would have a negative economic impact of approximately €22.74 million [1].

However, it is not just short-term overheating that poses a problem. As the guide on loads of oil-filled power transformers (IEC 60076-7) and studies by the University of Stuttgart show, the anticipated service life of a transformer is halved if the temperature at the hottest section of the winding, commonly called the winding hot-spot, rises by just 6 kelvins. Safe and reliable cooling is therefore a fundamentally necessary measure. This is reinforced by current global trends such as rising ambient temperatures and more dynamic load profiles seen with the larger usage of renewable energies.



Aeroacoustic testing of a radiator in the InVent

Basic principles of transformer cooling

In an oil-filled transformer, the oil serves two purposes as an insulating medium and a cooling medium. At a first glance, the cooling of such transformers looks to be an easy task. The hot insulating oil at "top-oil" temperature flows by natural convection into a radiator where the large radiator surface causes the oil to cool through radiation and air convection. The cooled oil then flows back into the holding tank at a "bottom-oil" temperature. ONAN (Oil Natural Air Natural) is the name given to transformers with this "natural" oil-air cooling circuit.

However, at high power density or high ambient temperatures, the natural cooling of ONAN transformers is no longer sufficient. The simplest way to improve the cooling performance is to increase the natural air cooling with the help of greater air flow using fans. This air-forced cooling is the reason for the name given to these transformers, ONAF (Oil Natural Air Forced).

Reliable transformer cooling using fans

The cooling performance of the ONAF cooling system depends on the local air and oil flow conditions in the radiator and the resultant local temperatures and mass flows. This understanding of the system is essential in order to guarantee efficient, quiet and reliable cooling, and requires collaboration between transformer and fan manufacturers. Axial fans from German fan manufacturer Ziehl-Abegg have been used in ONAF transformers for more than 50 years. With Ziehl-Abegg's free online software program "FANselect", transformer manufacturers can input their specific system requirements and the appropriate fans will be selected.

The data shown in the "FANselect" program is from Ziehl-Abegg's state-of-the-art development center, "InVent." The development center houses the world's largest combined test chamber in which air performance (volume flow and increase in static pressure), electrical power consumption and fan acoustics are accurately measured at the same time:

- * Air performance in accordance with DIN 24166 in accuracy class 1 and AMCA 210
- * Sound power data in accordance with DIN 3745 in accuracy class 1 (type A) and ISO 13347

This testing system is also TÜV and AMCA certified, providing transformer manufacturers with reliable data so they can create the cooling system required.

Axial fans from Ziehl-Abegg have been used to efficiently and reliably cool transformers for over 50 years.



Trials and testing using market standard radiators are conducted in the world's largest combined test chamber for fans – InVent. The knowledge gained from this, such as pressure loss or radiator impact, can be used by manufacturers to optimise their own product.



The "FANselect" program provides realistic fan data which has been measured with the actual fan housing or nozzle used, as well as the required guard grilles. This specific data is of particular relevance when giving details on sound emissions, which is especially important for transformer installations as they are often located near residential areas.

Axial fans from Ziehl-Abegg have been designed to reduce sound emissions. In the FE2owlet fan, engineers used knowledge acquired from the near silent flight of a barn owl to design the shape of the impeller blades. Another fan model, the ZAplus, has corrosion-free fan housing that enables the cooling performance to be improved while keeping sound emissions extremely low. This is achieved through a 3-dimensional, flow-optimized housing geometry, already in common use in turbine technology and which was first used in fans by Ziehl-Abegg.

Today, transformer cooling primarily uses AC fans with an asynchronous motor as a drive unit. With the growing trend of digitalization, electronically commutated motors (EC motors) are increasingly being used as well. Ziehl-Abegg has seen a rise in selections using the ECblue fan, a well-established product in cooling technology for many years. The ECblue design uses an energy-saving and speed-adjustable permanent magnet motor with integrated motor electronics. This enables the cooling fan to be easily integrated into the digitalization of transformers, resulting in very precise oil temperature control through speed adjustment. Current oil temperatures as well as dynamic load changes can be monitored to avoid overheating at the hot spot. The ECblue also offers advanced communication options: internal fan data can be read out, displayed, and documented in the overarching monitoring and surveillance system.



For more than 100 years Ziehl-Abegg has produced fans for outdoor use in various climates and environmental conditions around the globe. This experience is relied upon to develop reliable and durable axial fans to be used for transformer cooling. These fans provide safe, long-term cooling to ensure that transformers remain in continuous operation, while also lowering electricity costs and reducing CO₂ emission and sound emission levels to a minimum. All these factors are key to providing safe and reliable transformer cooling.



About Ziehl-Abegg

Ziehl-Abegg (Kuenzelsau, Baden-Wurttemberg, Germany) is one of the leading global companies in the field of ventilation, control and drive technology. In the 1950s, Ziehl-Abegg established the basis for modern fan drives: external rotor motors which even today are still seen as state-of-the-art worldwide. Another area of business is electric motors which provide the power, for example, for elevators, medical applications (computer tomography equipment) or deep-sea underwater vehicles. The theme of electro-mobility for motor vehicles was established as part of the Ziehl-Abegg Automotive Team in 2012.

The high-tech company has an impressive innovative capability. Ziehl-Abegg employs 2,400 personnel in its production plants in Southern Germany. The company has a global workforce of 4,300 spread between 16 production plants, 29 companies and 113 sales locations. The products, approx. 30,000 in all, are sold in more than 100 countries. Turnover totals 633 million euros, with exports accounting for three quarters of the figure, (all numbers refer to the year 2019).

Emil Ziehl founded the company in Berlin in 1910 as a manufacturer of electric motors. After World War II the company's headquarters were relocated to Southern Germany. Ziehl-Abegg SE is not a listed company but instead is family-owned.

For more information visit www.ziehl-abegg.com.



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