Oil-Immersed Transformer Characteristics

PRODUCT FEATURES | TECHNICAL SPECIFICATIONS | APPLICATION GUIDANCE

01 Product Overview

An oil-immersed transformer operates with its magnetic core and windings immersed in insulating oil. The oil provides both electrical insulation and heat dissipation. This is among the most widely used and technologically mature transformer types in power systems. Products range from distribution transformers (30-2,500 kVA) to power transformers (100 MVA and above, subject to project requirements). Applications include transmission and distribution, industrial facilities and mines, municipal and commercial buildings, and renewable-energy power plants.

02 Operating Principle

Oil-immersed transformers operate on electromagnetic induction. When an AC supply energizes the primary winding, an alternating magnetic flux is established in the core and induces an electromotive force in the secondary winding. Voltage is approximately proportional to winding turns ($U_1/U_2 \approx N_1/N_2$); adjusting the turns ratio provides voltage step-up or step-down. The insulating oil electrically separates the windings and core while transferring heat by convection to the tank and radiators, maintaining the operating temperature rise within allowable limits.

03 Main Structure and Components

Core. Laminated cold-rolled grain-oriented (CRGO) electrical steel, such as 30Q120 or 27QG095, with fully mitered 45° joints to reduce no-load losses and noise.

Windings. High- and low-voltage windings made of oxygen-free copper conductors (aluminum optional), with layer-type or disc-type construction and reliable turn-to-turn insulation.

Insulating oil. Primarily mineral insulating oil; environmentally preferable alternatives include vegetable-based oil/natural esters offering biodegradability and a high fire point.

Tank and cooling system. Corrugated tanks, cooling tubes, or panel-type radiators; cooling fans may be provided for higher-capacity units.

Oil conservator. Compensates for oil expansion caused by temperature variations; a breather/desiccant breather helps maintain oil quality.

Protective devices. Gas-operated (Buchholz) relay, pressure-relief valve, oil-level indicator, and oil-temperature/winding-temperature gauges.

Tap changer. Off-circuit tap changer (±2 × 2.5% or ±5%) or on-load tap changer (e.g., ±8 × 1.25%).

Bushings and grounding. High- and low-voltage bushings, neutral bushing, and grounding arrangements.

04 Product Classification

Cooling method. ONAN (Oil Natural Air Natural), ONAF (Oil Natural Air Forced), OFAF (Oil Forced Air Forced), and OFWF (Oil Forced Water Forced).

Voltage regulation. Off-circuit tap changing (±5%) or on-load tap changing.

Application. Step-up, step-down, distribution, interconnecting/tie, and station-service transformers.

Number of phases. Single-phase or three-phase.

Winding configuration. Two-winding, three-winding, or split-winding.

05 Key Technical Specifications (Typical Values)

ITEM	TYPICAL SPECIFICATION
Rated capacity	Distribution: 30-2,500 kVA; power: up to 100 MVA or above (project-dependent).
Rated voltage	LV: 0.4 kV; HV: 10/20/33/35/66/110/220 kV, etc.
Rated frequency	50 Hz / 60 Hz
Vector group	Dyn11, Yyn0, YNd11, Yd11, etc.
Cooling	ONAN, ONAF, OFAF, OFWF
Insulation class	Class A (105 °C thermal rating).
Temperature-rise limits	Average winding: ≤65 K; top oil: ≤60 K (natural oil circulation) or ≤65 K (forced oil circulation).
Short-circuit impedance	10 kV distribution: 4%-6%; 35 kV: approx. 6.5%-8%; 110 kV: approx. 10.5%.
Insulation levels	10 kV class: LI 75 kV, AC 35 kV; 35 kV class: LI 200 kV, AC 85 kV.
Loss performance	Per GB 20052 energy-efficiency Grade 1/2/3 or customer-specified standard.
Partial discharge	Conforms to GB 1094.3 / IEC 60076-3: ≤100 pC for 110 kV class; ≤300 pC for 66 kV class and below.
Noise level	Typically 50-60 dB(A), depending on rating and design.
Design service life	Approximately 20-30 years, based on the thermal-aging model of IEC 60076-7.

06 Product Features and Advantages

Effective heat dissipation. Circulating insulating oil provides heat removal, ample temperature-rise margin, and strong overload capability.

Reliable operation. Mature technology and extensive operating experience, with a low failure rate and straightforward maintenance.

Cost-effectiveness. Generally lower initial cost than a dry-type transformer at the same rated capacity.

Low noise. Relatively low overall noise levels.

Wide capacity range. Suitable for applications from small distribution units to large power transformers.

Environmentally preferable options. Biodegradable natural-ester/vegetable-oil insulation is available, with a high fire point (>300 °C).

Considerations. Oil quality and oil level require periodic inspection. Oil leakage is possible. Indoor installation must satisfy applicable fire-protection requirements, including oil-containment provisions and other fire-prevention measures. Equipment size and weight are comparatively high.

07 Applications and Industries

Transmission and distribution. Step-up and step-down substations and distribution networks.

Industry and mining. Factory power distribution, mine power supplies, metallurgy, and chemical industries.

Renewable energy. Step-up applications for photovoltaic plants and wind farms, including box-type and American-style packaged configurations.

Municipal and commercial facilities. Residential-community distribution, offices, hospitals, etc., in outdoor installations or separate transformer rooms.

Export projects. Projects specifying IEC, IEEE/ANSI, GOST, or other relevant standards.

08 Selection Guidelines

Capacity. Calculate load using coincidence and load factors, allowing a 10%-20% capacity margin.

Voltage and vector group. Select in accordance with the system voltage and grounding method.

Energy efficiency. Choose to meet local energy-efficiency regulations, such as China GB 20052 or EU Ecodesign Tier 1/2.

Impedance and short-circuit duty. Match the transformer to the power system short-circuit capacity.

Site conditions. Consider altitude, ambient temperature, pollution severity, and seismic intensity. Above 1,000 m altitude, apply derating or corrections required by applicable standards.

Frequency. Select 50 Hz or 60 Hz for the target market.

Protection and accessories. Specify anti-pollution bushings, on-load tap changing, forced-air cooling, online monitoring, etc., as needed.

09 Frequently Asked Questions and Standard Responses

Q1. What capacity range of oil-immersed transformers do you manufacture?

Answer. Our distribution transformers cover 30 kVA to 2500 kVA; power transformers can be designed above 100 MVA per project. Custom designs are available.

Q2. What is the difference between oil-immersed and dry-type transformers?

Answer. Oil-immersed units offer better heat dissipation, lower cost and stronger overload capability—suitable for outdoor and substation use. Dry-type units are fire-proof, environmentally friendly and maintenance-free—ideal for indoor and high fire-safety locations.

Q3. Which standards do you manufacture to?

Answer. We manufacture to IEC 60076, IEEE/ANSI C57.12, GB 1094 and other international/national standards. Third-party type tests (e.g., KEMA, CESI) can be arranged upon confirmation.

Q4. Do you support 60 Hz?

Answer. Yes. Both 50 Hz and 60 Hz are available. 60 Hz units are designed to IEEE/ANSI standards for North American, South American and Middle East markets.

Q5. Can oil-immersed transformers be installed indoors?

Answer. Yes, provided fire-protection requirements are met (e.g., oil containment pit, fire walls). For sensitive indoor locations, a dry-type transformer is recommended.

Q6. What energy-efficiency levels are available?

Answer. Levels 1, 2 and 3 per GB 20052-2020 (Level 1 is best), roughly S11≈Level 3, S13≈Level 2, S15+≈Level 1. Designs to IEC 60076-20 or EU Eco-design Tier 1/2 are also available.

Q7. What about warranty and service life?

Answer. Warranty is 12 months from shipment under agreed terms. Design life is 20–30 years based on the IEC 60076-7 normal loading ageing model.

Q8. How are transformers packed and shipped?

Answer. Distribution transformers are packed in wooden/steel cases and shipped complete. Large power transformers are shipped with nitrogen/dry-air filling or protective sea-fastening as required. Export packaging can be customized.

Q9. Can it operate at high altitude?

Answer. Yes. Above 1000 m, temperature rise and insulation are corrected per standards (derating). Please provide the altitude and site conditions.

Q10. Do you offer vegetable-oil transformers?

Answer. Yes. Natural/synthetic ester insulating oils are available—biodegradable, high fire point (>300 °C) and better fire safety for environmentally sensitive projects.

10 Related Standards and Certifications

IEC 60076 series (power transformers); GB 1094 series; GB/T 6451 (technical parameters and requirements for oil-immersed power transformers); GB 20052-2020 (energy efficiency); IEEE C57.12.00 / C57.12.10 / C57.12.90; GOST (Russian standards), and others. Factory/routine test reports can be provided on request; type testing and third-party inspection or supervision may also be arranged, subject to confirmation.