Dry-type transformers for safety, reliability and environmental impact for F&B

Danang Birowo, Transformers business unit
ABB’s transformer heritage
A long pioneering history

The combined experience of 700 years of transformer manufacturing

- Asea
- Ansaldo/Ital Trafo/IEL/ OEL/OTE
- BBC
- GE, USA
- National Industri
- Strömberg
- Westinghouse
- Kuhlman
- Trasfor (in 2011)
- GE General Electric (2016)
BU Transformers
Present in 34 countries worldwide

Production unit(s):

Americas
• Brazil
• Canada
• Colombia
• Mexico
• USA

Europe
• Finland
• Germany
• Italy
• Poland
• Russia
• Slovakia
• Spain
• Sweden
• Switzerland
• Turkey

India, Middle East and Africa
• Egypt
• India
• Saudi Arabia

Australasia
• Australia
• China
• Korea
• New Zealand
• Singapore
• Thailand
• Vietnam

73 production units in 34 countries, and 36 service centers in 28 countries
Transformers
One-stop shop supplier

- Over $5 billion in orders per year
- Around 17,000 employees
- Global capabilities: 73 sites
- Global presence: revenues in more than 100 countries
- Complete range of power and distribution transformers, components and services
- Service organization in place for global customer support of all installed bases
- Voltage range up to 1000 kV AC and +800 kV DC

www.abb.com/transformers
Transformers
One-stop shop supplier

IEC, ANSI, IEEE standards and other local standards (e.g. JB, CSA, GOST)

The most complete range of transformers, components and services
Product highlights LMPT (Large Medium Power Transformer)
UHVDC 600/660/800 kV DC

A completely new technology level enables bulk power transmission over long distances with low losses in one transmission line

- Power transmission >7000 MW
- Transmission length >2000 km
- Losses 30% less compared to conventional technology
- Less land and material needed for the overhead line
- Gives access to remote hydro power
Product highlights SPT (Small Power Transformer)

Offshore technology – Subsea transformer

The first delivered unit 1.6 MVA, 11/1.04 kV from 1998, in operation since 2000

Makes continuous production of oil and gas possible at depth of several kilometers

Development work started already at 80’s. The first unit has been in operation since 2000

Subsea transformer applications:

- Step down transformers for feeding subsea pumps and compressors
- Transformers for subsea pipeline heating
- Transformers for SEPDIS (Subsea distribution system)
- Transformers for subsea frequency converters
- Transformers for Wave Hubs = connection points of wave power stations to grids
- Transformers for Tidal turbines
- Transformers for offshore windmill parks
Our product

What is a dry transformer?

ABB manufactures a transformer which does not use any kind of liquid for insulation and cooling. Windings are encapsulated under vacuum, in epoxy resin reinforced with fibre glass net.

ABB’s vacuum cast coil transformer is the most technologically advanced design for extreme conditions. ABB has design and manufacturing flexibility to produce for optimum space utilization and special requirements.

These transformers...

– meet strict parameters with respect to electrical system demands.
– are virtually maintenance free.
– are manufactured in accordance with industry and international standards including ISO 9001 and ISO 14001.
Dry Type Transformer

Advantages

1. No Fire Hazard
2. Safety for people and property
3. Outage customer costs
Dry Type Transformer

Advantages
Dry Type Transformer
Advantages

4. Ecological and Environmentally Friendly
5. Maintenance & Pollution Free
6. Suited for damp and/or contaminated
Dry Type Transformer

Advantage

No risk of leakages of inflammable or contaminating substances such as oil or silicon. No oil recycle.
Dry Type Transformer

Advantage

7. Excellent resistance to short circuit effect
8. Excellent capacity to support over load
9. Excellent performance toward seismic phenomenon
Dry Type Transformer

Advantage

10. Saving Costs give lower installation related costs

IDR Rp ???

no separate room for distribution transformers needed
$20m^2$ at $\ldots \text{Rp/m}^2 = R_p\ldots$

no oil pit

no fire fighting system require

no fire-proof door for transformer room

shorter distance to LV cabinets: reduced cabling costs

$20m$ instead of $70m => 50m$ LV cable savings at $\text{Rp/m} =$ $R_p\ldots$

reduced losses in LV cables

$50m$ less LV cable losses-$150W, 20$ years-$26MWh, \text{Rp/MWh} =$ $R_p\ldots$

reduced insurance fees – dropout, follow-up and reputation costs in case of fires and oil leakage $R_p\ldots$

Less Maintenance: no need periodic maintenance to change the oil (oil purifying) every year $R_p\ldots$

No need schedule electrical shutdown for transformer maintenance $R_p\ldots$
11. Easy Installation
### Comparison: Dry VS Oil

#### Maintenance

<table>
<thead>
<tr>
<th>MAINTENANCE</th>
<th>FREQUENCY</th>
<th>OIL TRAFO</th>
<th>DRY-TRAFO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil-tightness</td>
<td>monthly</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Oil Level</td>
<td>monthly</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Porcelain Insulator Cleaning</td>
<td>annually</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Surface Cleaning</td>
<td>annually</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Connections Tightness</td>
<td>annually</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Painting State</td>
<td>annually</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Oil Analysis (regular oil filtering or replacement, if needed)</td>
<td>annually</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>SILICAGEL (Check and Replace)</td>
<td>annually</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Accessories Checking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buchholz relay</td>
<td>annually</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Over-Pressure Relay</td>
<td>annually</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Oil Level</td>
<td>annually</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Thermometer</td>
<td>annually</td>
<td>YES</td>
<td>YES</td>
</tr>
</tbody>
</table>

- Every maintenance operation requires "DE-ENERGIZING" the transformer.
- More elements to be checked, higher ...failure probability ... expenses in spare parts
Dry Transformer

Applications

Public Works
- Hospitals
- Airports
- Shopping centers
- Food & Beverage
- Office Buildings

Special Industries
- Ships
- Mining industry
- Undergrounds / trains
- Wind Power applications
- Application with rectifiers
ABB dry-type value opposed to dry-type competitors
Flexibility to increase safety, anywhere

<table>
<thead>
<tr>
<th>World class technologies</th>
<th>Widest portfolio</th>
<th>Special applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three advanced winding insulation systems and many other technologies such as internally water cooled and amorphous cores; not available from any other manufacture.</td>
<td>Abilities include a full line of LV magnetics, MV transformers for distribution and rectifier duty, MV iron and air core reactors, as well as the first ever dry-type transformer for sub-transmission.</td>
<td>Everything from 48 pulse, converter duty to completely sealed dry-types for underground networks, we have done it all and can help make your unique application safer.</td>
</tr>
</tbody>
</table>

We can and have done it all; we are your one-stop shop for transformers

- Complementing technologies dedicated to specific market demands
- Nearly 40 years of experience
- Proprietary technology and R&D departments
## Dry Transformer

### Highlights

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual production capacity</td>
<td>Around 30,000 MVA</td>
</tr>
<tr>
<td>Annual sales</td>
<td>Around 650 MUSD</td>
</tr>
<tr>
<td>Employees</td>
<td>Around 1,800</td>
</tr>
<tr>
<td>Five Focus Factories</td>
<td>Global presence</td>
</tr>
<tr>
<td>ABB world market share</td>
<td>23 %</td>
</tr>
</tbody>
</table>
Dry Transformer
The widest product portfolio

Power and voltage range produced
– From 10 kVA to 63 MVA
– From Low Voltage 220 Volt up to 72.5 kV

On-load tap changers (OLTC) available, up to 23 taps ± 18% regulation range
Drives, excitation and rectifier transformers
UL certified transformers
Insulation Class F 155 ºC and Class H 180 ºC
Low loss and high efficiency Eco Dry Transformer with no-load loss at 35 percent of standard dry-type transformers, using amorphous metal as core material
Providing any type of enclosure, including any type of cooling Options, enclosure IP21 up to IP54
Classes: E2, C2, F1
Partial discharges: <10 pC
AN, ANAF (up to +30%), AFWF
Dry Transformer
Electrical insulation system

**Thermal Class**
- It indicates the maximum temperature that a material can admit without changing its characteristics
- The temperature rise admitted in windings will depend on the insulation material thermal class

<table>
<thead>
<tr>
<th>thermal class</th>
<th>max. temp. admitted by the insulation material (°C)</th>
<th>average max. temperature rise in windings (°K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A)</td>
<td>105</td>
<td>65  Oil</td>
</tr>
<tr>
<td>(B)</td>
<td>130</td>
<td>80  Dry</td>
</tr>
<tr>
<td>(F)</td>
<td>155</td>
<td>100 Dry</td>
</tr>
<tr>
<td>(H)</td>
<td>180</td>
<td>125 Dry</td>
</tr>
<tr>
<td>(C)</td>
<td>220</td>
<td>150 Dry</td>
</tr>
</tbody>
</table>
Dry Transformer

Classes

Environmental Class:

E0 Normal indoor installation, no condensation, no considerable pollution
E1 Limited pollution, occasional condensation e.g. off circuit periods
E2 Heavy pollution, frequent condensation

Climate Class:

C1 Highest ambient temperatures:
  • operation – 5°C
  • storage and transport - 25°C

C2 Highest ambient temperatures:
  • operation –25 °C
  • storage and transport at –25°C

Fire Class:

F0 No special requirements except typical characteristics for dry-type transformers
F1 Increased demands
  • All materials practically free of halogens
  • Limited formation of fumes
  • Limited contribution with calorific energy to the source of fire
  • Self extinguishing transformer fire
ABB Dry Type Factories
Germany, Spain, Switzerland, Italy, Korea, USA, Poland, China, India, Brazil, Saudi Arabia, Egypt

ABB Trasfor Switzerland | ABB Brilon Germany | ABB Korea | ABB Zaragoza Spain
ABB Vacuum Cast : Common Technology

Common Design System (CDS)
Common Technical Standards
- Materials
- Productions
- Processes
- Procedures & Instructions
Common Key Machineries
- HV Winding
- Vacuum Casting
- Core Cutting
Quality Assurance : Testing
(IEC & ANSI/IEEE & ABNT NBR)

Routine
- Winding resistance
- Voltage ratio
- Vector relationship
- Impedance and load loss
- No-load loss and current
- Separate-source voltage
- Induced over-voltage
- Partial Discharge

Type
- Lightning Impulse
- Temperature Rise

Special
- Sound Level
- Short Circuit (3rd party)
Accessory (Optional)

- Surge arrester
- Digital thermometer
- Plug-in Bushing
- Extension bus-bar
- Cooling fan
- Enclosure
Certification
Certification

ISO 9001:2000
KS A 9001:2001

ISO 14001:2004
KS A 14001:2004

Certifications from Lloyd’s Register

KEMA Type Test Certificate
Certification

KEMA Type Test -2006

Short-Circuit withstand test (3 s)
Certification

Type Test

Vibration Test Certificate for windmill-2006

Fig. 1: Position of the transformer in the nacelle
Fig. 1: Transformer location in the nacelle

VIBRATION Qualification Certificate

Delivered on: 21-12-2006
Ref:
- IEC61400-4:2005

Equipment tested:
- ABB Type Transformers: T-Type 37.5 MVA, 50 Hz, 6kV/400V, 3ph, 3/1, for AKELA BROWN SOVEREY S.A., said number 11-09300.
- Equipment drawing: IL285047-UK, issue 1 of 07/04/06.

The overall dimensions and the weight of the equipment are as follows:
- 2014 mm high x 1650 mm wide x 820 mm deep and 4040 kg.

We hereby certify that the equipment listed above has been tested in our laboratory of ABB between the 6th and the 9th of October 2006, according to General Technical documentation number (S053241), issue 02.

The Transformer was successfully passed the tests if has undergone, no structural deformations being detected.

In the report number 201284 of VIRLAB, S.A., it included all the information obtained, with tables, photographs and so on.

VIRLAB representative
Mr. JUAN ANTONIO PÉREZ
Laboratory Manager

Certificate number 201284
Certification
Type Test

Short Circuit Test

TEST OBJECT: Dry type three-phase transformer
DESIGNATION: DTE 330/64 AF
REQUESTED BY: ABB, Power Technologies, S.A.
MANUFACTURER: ABB, Power Technologies, S.A.
STANDARD: IEC 60721-11:2004
RECEPTION DATE: September 14th 2006
TESTS DATE: September 18th to 31st 2006

The test object has been subjected to the tests required by the applicant, applying the procedures specified in the standard indicated below.

THE PRESENT REPORT CONSISTS OF:
No. of pages: 17 (and annex of 10)
Photographs: Annex
Oscillograms: Annex

Agustín Ramón
Test Chief
Head of Electrical Equipment Laboratory

Luis Martínez
Assistant to the Test Chief

Benevento, December 3rd 2007
ABB dry transformers reference list

...power the biggest and tallest buildings of the world

Burj Khalifa, Dubai: 828m
- 72 transformers
- 750 – 2'000 kVA, 11/0.4 kV

Shanghai World Financial Center: 492 m
- 3 transformers
- 12'500 kVA, 35/10.5 kV
Food and Beverage
Marine

...power the largest ships on the oceans

Oasis of the seas:
World’s largest cruise ship,
4000 passengers
Length: 360m; Width: 47m

Transformers: 6 x 11700 / 2 x 5850kVA
24 pulse, AFWF

AIDA Diva:
2500 passengers & 646 crew members
Gross tonnage 68.500 GT,
Length 252 m, width 32 m
Main Diesel 36 MW, propulsion 24.5 MW

Transformers: 2x2 units 8.8 MVA/11kV,
24-pulse, AFWF
Airport References

King Abdullah International Airport project (Jeddah)

- ABB contributes with the restructuring project of KAIA Airport in Jeddah (third largest air facility in Saudi Arabia).
  - 70/80 million passengers a year, using the three existing runways
- ABB offered 252 vacuum cast coil dry-type distribution up to 2,000 kVA, provided with metallic enclosure IP21 and copper / copper windings and energy efficiency rates: A0Ak

Why ABB
- Critical installation: safety for people and property and proven reliability track required
- High efficiency transformers for saving energy costs in an energy intensive installation due to climatic conditions
- ABB production capacity to execute the project in record time (three months)
Soccer world cup 2010: stadiums in South Africa

Soccer City, Johannesburg: 95’000 seats, 14 x 500-1’000 kVA
Green Point stadium, Capetown: 12 x 1’200 kVA
### Oil and Gas

**Bayu Undan East Timor Sea**

<table>
<thead>
<tr>
<th>Units</th>
<th>KVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>2500</td>
</tr>
<tr>
<td>8</td>
<td>1600</td>
</tr>
<tr>
<td>1</td>
<td>800</td>
</tr>
<tr>
<td>5</td>
<td>500</td>
</tr>
<tr>
<td>2</td>
<td>400</td>
</tr>
<tr>
<td>8</td>
<td>315</td>
</tr>
<tr>
<td>11</td>
<td>250</td>
</tr>
<tr>
<td>7</td>
<td>200</td>
</tr>
</tbody>
</table>

**Natuna sea**

- Troll Field, Bayu Undan
- Natuna sea

![Shell](image1.jpg)

![PremierOil](image2.jpg)
Metal, Mining & Mineral
Utility Power Generation

Excitation Transformer

Kendal Industrial Park
A Cost-Competitive Location for Global Market
Industry

12 MVA & 10 MVA and
More than 50 units Distribution Transformer
Skytrain (inter-terminal train)
Soekarno Hatta International Airport

LRT Palembang
18 units Rectifier Transformers 3520 kVA, 3 winding 20kV/585/585 V, High Duty Class VI 300% in 1 minute
ABB VCC Transformers
Advantages

• No. 1 Transformer supplier in the world
• One Global Factory – Wherever you need us, we are close to you
• Technology Leading Company
• Common Technology for the same products
• H-Class Solid Epoxy Insulation System (180°C)
• Type test certificate available for Climatic, Environmental and Fire Behavior classes qualified (C2-E2-F1), short circuit, Temp. Rise, Lightning impulse
• Strong Characteristics to Withstand Short-Circuit, Overload and Lightning/Switching Surges
• Partial Discharge Free
So let’s talk