Cast Resin Transformer
Introduction

Works
Fuji Electric Co., Ltd. has two cast resin transformer production bases:
Chiba works in Japan, and Fuji Tusco Co., Ltd. in Thailand

Fuji Electric (T&D Business)  TUSCO

1923  Established Fuji Electric Manufacturing Co., Ltd.
1962  Started operation of Chiba factory (transformer)
1968  Started operation of Kobe factory (switchboard)
1971  Started manufacturing rectifier transformer units
1974  Started manufacturing cast resin transformers
1984  Changed company name and logo to Fuji Electric Co., Ltd.
1985  Delivered the first 800kV transformers
1990  Delivered the first 1,100MVA transformer
1996  Delivered the first 8300kV Gas Insulated Switchgear
2002  Introduced new company symbol mark
2009  Delivered the first 1,750V DC, 87.5kA power supply equipment

1981  Founded Tusco Group
1982  Established Theparak Supply Shop
1984  Started Manufacturing of Low Voltage & Medium Voltage Switchboards
1984  Founded Theparak Transformer Co., Ltd.
1990  Founded Thai Union Switchboard Co., Ltd.
1996  Established Tusco Trafo Co., Ltd.
2007  and Thai Corrugate Co., Ltd.
2007  Technical Assignment and Manufacturing Contract for switchboards with
2012  Fuji Electric Co., Ltd.
2007  Production lines of power transformers were increased
2012  Grand opening of new transformer factory

Fuji Tusco has started in Oct 2013

Product Records
Fuji Electric has started manufacturing cast resin transformer since 1974 as first cast resin transformer’s supplier in Japan, and accumulation total number of cast resin transformers produced in Chiba works surpassed 90,000 units including 3,000 units exported to 55 countries until now.

Product Line-Up
- Cast resin Transformers
  up to 4000kVA and 24kV
- Distribution Transformers
  Oil immersed Transformers up to 36kV
  Single Phase up to 1000kVA
  Three Phase up to 30MVA
- Power Transformers
  Oil immersed Transformers up to 245kV
  Single & Three Phase up to 300MVA
- Special Transformers
  Rectifier Transformers up to 30MVA
  Furnace Transformers up to 30MVA
  Testing Transformers up to 300kV
  Unit or Miniature Substation up to 36kV
  Made To Order Transformers
1. Three-limb core
2. HV winding
3. LV winding
4. HV terminals
5. LV terminals
6. Off-circuit tap changer
7. 3-phase connection bars
8. Lifting lugs
9. Foundation holes
10. Wheels (Option)
Features of Product

Vacuum-Casting

Cast resin transformer is manufactured with vacuum casting method using metal pattern. Thus it has following excellent characteristics.

**Void-less**
Vacuum-casting method realizes highly reliable, void-less molded winding with excellent partial discharge characteristics.

**Fire prevention**
Molded insulated parts are fire resistant with self-extinguishing properties.

**Resistance to humidity and dust**
All winding conductors are molded. They have remarkable humdidity resistance which prevents insulation materials from deteriorating due to dust and dirt during operation.

**Robust construction**
Molded winding is highly resistant to secondary short-circuit fault and surface cracking.

**High reliability**
Vacuum-casting process is carried out automatically with advanced customized facilities, to manufacture highly reliable molded winding.

Aluminum Winding

(1) **Weight reduction**
The aluminum winding weights are approximately half of the copper winding, thus realizing weight reduction.

(2) **Low thermal stress and excellent crack resistance**
Aluminum’s thermal expansion coefficient is close to resin, thus reducing thermal stress and improving crack resistance effectively.

<table>
<thead>
<tr>
<th>Material</th>
<th>Thermal expansion coefficient $[\text{mm/mm.h.}^\circ \text{C}]$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td>$2.3 \times 10^4$</td>
</tr>
<tr>
<td>Copper</td>
<td>$1.6 \times 10^5$</td>
</tr>
<tr>
<td>Epoxy resin</td>
<td>$3.3 \times 10^4$</td>
</tr>
</tbody>
</table>

Comparison of the weight in the same resistance

Copper > Aluminum
Sheet Winding

(1) Downsizing
Sheet winding has high lamination factor, thus realizing downsizing of transformers.

(2) High insulation reliability
In use of sheet winding, the voltage between turns is only for one turn, thus having high insulation reliability.

IEC Certification

Fuji Electric’s cast resin transformer have passed all tests of IEC60076-11 including special test and type test in 2006.

- Climatic class : C2 (crack resistance)
- Environmental class : E2 (moisture resistance)
- Fire behavior class : F1 (fire resistance)
- Short-circuit test

Start of fire-test
After test (completely extinguishing)
CESi Certificate
**Electric field analysis**

The insulation of cast resin transformer is composed of resin-air composite insulation. The distributed voltages of individual transformer part depend on their respective dimensions. Thus, appropriate dimensions for insulation are designed with electric field analysis of the individual part of winding including air space.

**Thermal stress analysis**

Molded winding composed of conductor and insulating material is subjected to thermal stress due to the difference in thermal expansion coefficient between conductor and resin, and thermal distribution in the winding block, where winding temperature varies with the load fluctuation of transformer. The stress value obtained in thermal stress analysis is used to design optimum winding structure for high crack-resistance of winding.

**Electric field analysis**

**Routine test:**
- Measurement of insulation resistance
- Measurement of voltage ratio and check of phase displacement
- Measurement of no-load loss and exciting current
- Measurement of short circuit impedance and load loss
- Separated-source voltage withstand test
- Induced over voltage withstand test
- Measurement of insulation resistance
- Measurement of partial discharge

**Type test**
- Lightning impulse voltage withstand test
- Temperature-rise test
- Measurement of sound level

**Note:**
Type test will be carried out on one transformer of same specification. The costs of all tests and test reports shall be extra charge.
Fuji Tusco cast resin transformers are made in the excellent workshop equipped with new facilities.
Applications

Cast resin transformer is suitable for the following places.

- Sites where compact size and light weight are required.
- Sites where easy maintenance is required.
- Sites where there are airborne contaminants and extremely severe environments.
- Sites where fire prevention is the highest priority.

For example

- Multi Storey Buildings
- Hospitals
- Hotels
- Laboratories
- Shopping centers
- Building complexes
- Schools
- Art galleries
- Theaters
- Stadiums
- Underground shopping centers
- Petrochemical plants
- Industrial complexes
- Underground railways
- Railway substations
- Tunnels
- Cranes
- Water and sewerage plants
- Power supply for construction sites
- Refuse disposal plants
- Wind power sites
High-rise Building Applications
- The largest capacity in Japan
- Provision for restriction of weight and dimension

Ship Applications
- Provision for rolling

Railway Applications
- Withstand cyclic load
- Provision for harmonics of rectifier

Wind Turbine Applications
- Compact and light by optimum design
- Possible to install inside the nacelle
Accessories

- **Lifting lugs**
  Four lifting lugs are provided as standard fixtures on the transformer body.

- **Nameplate**
  A warning label is attached to warn against contacting surface of the HV windings.

- **Off-circuit tap changer terminals**
  The tap voltage can be changed by switching the shorting bar connector.

- **Earthing terminals with clamping bolts**
  Two earthing terminals are provided at the lower frame ends: one on the primary side and one on the secondary side. (One of these earthing terminals is in use.)

- **Enclosure (Option)**

- **Bi-directional wheels (Option)**

- **Rubber vibration isolator (Option)**

- **Dial thermometer (Option)**
Technical Specification

<table>
<thead>
<tr>
<th>Item</th>
<th>Standard specification</th>
<th>Optional specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Unit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated Capacity (kVA)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary Voltage (kV)</td>
<td>11kV, 24kV</td>
<td>22kV</td>
</tr>
<tr>
<td>Secondary Voltage (kV)</td>
<td>400V</td>
<td>Other:</td>
</tr>
<tr>
<td>Tapping range</td>
<td>±2x2.5%</td>
<td>Other:</td>
</tr>
<tr>
<td>Number of Phase</td>
<td>3ф</td>
<td>Other:</td>
</tr>
<tr>
<td>Vector Group</td>
<td>Dyn11</td>
<td>Other:</td>
</tr>
<tr>
<td>Impedance Voltage (%)</td>
<td>Manufacturer Standard</td>
<td>Other:</td>
</tr>
<tr>
<td>Cooling Method (*)</td>
<td>AN</td>
<td>AF, AN/AF</td>
</tr>
<tr>
<td>Insulation class (Thermal)</td>
<td>F</td>
<td>Other:</td>
</tr>
<tr>
<td>Frequency (Hz)</td>
<td>50, 60</td>
<td>Other:</td>
</tr>
<tr>
<td>Standards</td>
<td>IEC60076-11</td>
<td>Other:</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>Standard -5~40°C</td>
<td>Other:</td>
</tr>
<tr>
<td>Altitude</td>
<td>Standard 0~1000m</td>
<td>Other:</td>
</tr>
<tr>
<td>Overload</td>
<td>Continuous 100%</td>
<td>Other:</td>
</tr>
<tr>
<td>K-Rating (if any)</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

<Insulation levels>

- Separate source AC Primary(kV): 28kV, 50kV, Other:
- Withstand voltage Secondary(kV): 3kV, Other:
- Lightning Impulse Test Primary(kV): 75kV, 95kV, 125kV, Other:
- Secondary(kV): -

<OPTION Optional Accessories>

- Dial Thermometer: Unnecessary, Necessary
- Wheels: Unnecessary, Necessary
- Resistance thermometer bulb(Pt 100Ω): Unnecessary, Necessary
- Rubber vibration isolator: Unnecessary, Necessary
- Protection Endorse: Unnecessary, Necessary
- If Yes, Degree of Protection will be selected: -
- If Yes, cable entry will be selected: - Bottom, Top, Other:

<OPTION Special test & Witness test>

- Temperature rise test: Unnecessary, Necessary
- Lightning impulse test: Unnecessary, Necessary
- Measurement of sound level: Unnecessary, Necessary
- Witness Routine test: Unnecessary, Necessary

<OPTION Other request item>

- Other request item: -

(*) Remarks
- AN: Naturally-air-cooled type
- AF: Forced-air-cooled type with cooling fan
- AN/AF: Naturally-air-cooled/Forced-air-cooled type with cooling fan