Green & Energy saving concept of ABB MV apparatus
For a better tomorrow
VD4 vacuum circuit-breaker in China
Inheritance and innovation

- Y1992
- Y2003
- Y2006
- Y2010
- Y2014

First to introduce the mid-set switchgear to China
Our understanding of medium voltage switchgear
What kind of MV switchgear is the best to meet market?

- Safety and reliable as the base
- Smart is the core
- Oriented towards green
Energy-saving and green in ABB MV switchgear field

Contents

- **Advanced technology**
  - Innovation for the embedded pole - energy-saving and environment-friendly PT pole
  - Energy saving and reliable low consumption coil
  - Reliable low-consumption mechanism - magnetic drive
  - Remove "SF6 gas" products - reduce the greenhouse effect

- **Science selection of material**
  - The materials with flame retardant - reduce device loss and off-line cost
  - Atoxic wires - reduce the impact on the environment

- **Green manufacturing technology**
  - Trivalent chromium electroplating technique - conforms to RoHs statement.

- **Life cycle cost (LCC) management**
  - Improve the service life - reduce energy consumption
  - The most advanced smart solution - create the whole life cycle cost advantage
  - Environment symbol certification product - power and productivity for a better world
Advanced technology
PT poles and VD4

- The excellent technical parameters:
  - 50,000 CO mechanical life
  - 50 + E2 class short-circuit M&B capacity
  - 5 times the charpy impact resistance of the epoxy resin
  - 30,000 CO electric life
  - 30 years service life
  - -25 ºC environmental withstand temperature
Advanced technology
Green PT poles

- The production efficiency of PT poles is tens of times of traditional epoxy resin embedded poles;
- The world's leading technology not only has brought the production efficiency, but also ensure the ultra high consistency of the quality;
- The energy and power consumption of production are greatly reduced.
20 years later, the quantity of medium voltage circuit-breaker in the whole society will be almost 20 million.

Assumes that the height of each phase epoxy resin pole is 65 cm

\[0.65 \times 3 \times 20,000,000 / 1000 = 40,000 km\] (a circle around the earth!)

Epoxy resin, as a thermosetting resin material, may not be recycled.

With stable performance, insoluble and infusible, good chemical resistance. It will not be degraded after abandoned.

The only recycle use: paving road after crushed?
PT materials can be 100% recycled, and the recycle process is very simple with low cost.

- Crush
- Re-inject into other products

Thousands of application, for example:

- Tape, used for road signs
- Chemical high-pressure pipes, valves
- A variety of industrial components, such as automotive engine
Advanced technology
Green PT poles

- PT pole reduce emissions of CO2 more than 50% by energy-saving.
- The embedded poles PT1 reduce emissions of CO2 by more than 50%.
- Each pole production save 105 kWh power
- This is equivalent to savings of over 3,000 t CO2 each year.
- Equivalent to less fell of 27000 trees per year.
- In other words, each one circuit-breaker = less cut one tree.
Advanced technology
Energy saving and reliable low power coil

- Commonly used coil on the market
- Power is 20W ~ 200W

- Existing safe double coil design
- The power is only 5W
- Each coil will save more than 50 million kWh every year.

- New generation of smart coil
- The power is only 1.5W
- Further to save energy

Incandescent lamp → Energy saving lamp → LED lamp
Advanced technology
VSC contactor with magnetic drive – low consumption

- Energy consumption of VSC with permanent magnetic mechanism: 5W
- Energy consumption of contactors with traditional mechanism: 50~180 W
- ABB’s strategy of sustainable development—reduce operation cost
- Compared with the traditional contactor, VSC vacuum contactor could save 14,000~31,500 kWh in life cycle (20 years). By saving energy, there are less emissions of about 3000~30000 kg CO2.
- In power plant, as 600MW set for example, using 60 VSC vacuum contactor with a full life cycle thant could save 80~1.8 million kWh, and less emissions of 780 ~ 1800 tons CO2.
Advanced technology
Remove “SF₆ gas” products - reduce the greenhouse effect

- Why choose SF₆?
  - A synthetic **noble gas**;
  - **Strong electronegativity.** Easy to combine with electron to form anion, weaken the ability of electron impact ionization;
  - **Quick recombination.** SF₆ will be decomposed under the high temperature arc, but recombine instantly the arc disappear;
  - **Cooling effect.** Heat conduction of SF₆ is 2~5 times of air.

According to these characteristics, in the 40.5kV voltage and for capacitive load, SF₆ circuit-breaker is still the best choice.
Advanced technology
The upgrade 40.5kV vacuum circuit-breaker

- Benefit from:
  - The new contact material is developed by Germany ABB;
  - Further optimization of the circuit-breaker mechanical parameters.

- The upgrade 40.5kV VD4 can meet:
  - Rated breaking current of back-to-back capacitor bank ≥800A*;
  - The first vacuum circuit-breaker at 40.5kV to switch 800A back-to-back capacitor bank.

Note: The actual current through the type test up to 820A.
Science selection of material
Improve the safety of equipment - reduce the loss of failure

- Composite materials with good flame retardants;
- Limit the scope of accident and to prevent accident expand;
- Reduce the cost of customer equipment loss and off-line!
Science selection of material
Improve the safety of equipment - reduce the loss of failure

- The application for non flame retardant materials will expand the scope of failure.
Science selection of material
Improve the safety of equipment - reduce the loss of failure

- The secondary parts all use the high cost with low atoxic wire, which does not contain halogen (F, Cl, Br, I, At), and plumbum, cadmium, chromium, mercury which damage the environmental. Its combustion does not emit atoxic fumes, and has good flame retardant.
Green manufacturing technology
The commitment for environment

- The production process of MV products fully keep to ABB strict standards and specification, as far as possible to reduce the pollution of the environment. For example:
  - Cr6+ Zinc plating process has been completely eliminated by Cr3+ Zinc plating, which is more difficult and high cost, but with low atoxic and no pollution.
  - Cr6+ is easy to be absorbed and accumulated in the body, its atoxic is more 100 times than Cr3+.
  - As the ROHS policy, the content of Cr6+ shall be under 0.1%.

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Life cycle cost (LCC) management
Full life cycle for switchgear

Establish the full life cycle cost management for equipment, improve the service life, reduce energy consumption.

- Repair
- Diagnosis
- Original spare parts
- Engineering consulting
- On-site inspection
- Maintenance
- Training
- Upgrade

Reliability Operation efficiency

Failure maintenance solution

Risk maintenance and condition-based maintenance solution

Run-in period Stable period Focus period Fluctuant period Life-extension period

| Period         | 0  | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 … 30 |
|----------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|--------|
| Service life   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |        |
| Life cycle     | -  | Stable period | Focus period | Fluctuant period | Life-extension period |
| Maintenance    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    | Once a year |
| Diagnosis      |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
Focus period and fluctuant period
Familiar failure for switchgear

- Statistics show that the typical failure and rate for China power system in the 1990s as below:
  - Mechanical fault (fail to open or close, reject, malfunction):
    - 33.3%
  - Dielectric fault:
    - 37.3%
  - Temperature rise fault and others (current-carrying):
    - 29.4%
Life cycle cost (LCC) management
Smart solution based on whole switchgear

**TR online monitoring**
- For tulip of CB
- For busbar lap surface
- For lap joints of outgoing cable end
- For LV compartment
- Reliable wireless RF technology
- Embedded design, without impact on dielectric and PD
- Self supply and magnetic saturation technology
- High quality components

**CB parameter monitoring**
- Charging time and average current of charging motor
- Tripping current of open and close coil
- Open and closing time and speed of circuit-breaker
- Non intrusive technology for voltage and current measurement
- Completely isolated from the control/protection system

**Full motorized drive**
- Motorized truck system
- Motorized earthing switch system
- Intelligent control and protection
- The turbine worm drive chain
- Unique intelligent motor control and protection system
- Tens of thousands on-site service experience
Life cycle cost (LCC) management
Help to identify the early potential failure

- Online monitoring is helpful to identify the early potential failures of the circuit breakers, e.g. to a charging motor:
  - Failure mode: Gear wheel broken.
  - Initial stage: One or two teeth broken, but motor could still be able to finish the charging
  - After several operations the entire gear pairs damaged completely
  - The online monitoring system could detect the abnormal current vibration, alarm is given in early stage.
  - Replacement plan can be made before it is completely out of work. No emergency cases happened.
Life cycle cost (LCC) management
The most green energy is the energy saved

- To consume the resources and energy in the whole life cycle;
- The cost of energy consumption, environment, disposal, recycling and out of commission should be considered.

- Environmental symbol is not only the legal proof of environmental friendly for product, but also the guarantee of sustainable development for company. Product must pass the evaluation certified by the State Certification Committee of Environmental Labeling (SCCEL) of the State Environmental Protection Agency (SEPA). It can be declared as green products only after qualified.