Original Research Article

Design of 35kV Box Substation

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ABSTRACT

In China, the current use of box-type substation is widespread, all walks of life are in use, box-type substation, also known as outdoor complete substation, is the high voltage power, transformer buck, low voltage distribution and other functions organically combined. It is suitable for use in economic development zones where the load is concentrated, and it is suitable for the economic development zone, the factory, the factory building, the factory building, the factory building, Mines, residential quarters and other urban public facilities, the user can be based on different conditions of use, load level selection box-type substation.

KEYWORDS: box type substation; primary system, secondary system, design, selection.

1. Introduction

With the development of China's economy, industrial economy concentrated development zone, factories, mine mechanical and electrical development, requiring high-pressure directly into the load center, the formation of high-voltage power transformer --- transformer substation --- low-voltage distribution power supply pattern, Electricity to the land, energy saving, compact, miniaturization of the direction of development, box-type substation (referred to as box change) is the best products with these characteristics, and thus widely used in the mine power grid.

Box-type substation shell with steel plate or alloy plate has double top cover with good insulation. Shell and skeleton are all through anti-corrosion treatment, with long-term outdoor conditions. Shape and color can be coordinated with the environment. It is easy to install. The occurrence of a fuse with the fuse of the striker, so that three-phase load switches at the same time gate, to avoid the lack of phase operation. Low-voltage side of the load switch plus current limiting fuse protection, automatic air switch under voltage protection or over-current protection will work, low-voltage operation does not occur.

2. The Type, Structure and Technical Characteristics of 2 Box Type Substation

2.1. Box type of substation

Box type substation has American box type substation and European box type substation. American prefabricated substation in our country called 'pre-installed substation' or 'American box change', it will transformer body, high pressure load switch, fuse and high and low connections placed in a common closed tank, constitute a one-piece arrangement The Transformer oil as a live part of the interphase and ground insulation medium. At the same time, install a complete operation to view the instrument, such as pressure gauge, pressure relief valve, oil level gauge, oil temperature table and so on. European prefabricated substation was formerly known as 'modular substation' in our country. It is a high-voltage switchgear, distribution transformer and low-voltage power distribution device arranged in three different compartments, through the cable or bus to achieve electrical connection.

2.2. Technical characteristics of box-type substation

Box-type substation high-pressure room is generally composed of high-voltage load switches, high-voltage fuses and arrester, etc., can be stopped operation and overload and short circuit protection. Low pressure chamber consists of low pressure air switch, current transformer, ammeter, voltmeter and other components. Box type of electrical equipment components, are selected stereotypes products, components of the technical performance are to meet the corresponding standard requirements. The electrical components are interlocked between the electrical components, the electrical components...
components are installed in a sufficient strength and stiffness of the structure, in order to facilitate the connection of the wire. Operation using electric way, without additional power supply, can be led by the TV. In addition, the box also has the power detection, display, measurement function, and can achieve the corresponding protection function, also has a dedicated grounding guide, and a clear grounding mark. In addition to adapt to the outdoor working environment, box-type substation shell roof are generally used compartment structure, containing thermal insulation materials, the bottom of the box and the room has a cooling between the inlet and outlet, the use of natural air-cooled and automatic control of the forced wind Cold and other forms to ensure that the normal cooling of electrical equipment, with rain, dust, to prevent small animals into and other measures. At present, the domestic production of box-type voltage level: high side of 3-35kV, low side of 0.4-10kV.

Box-type substation has the following characteristics:

(1) Advanced technology and safe and reliable

The box is made of the leading domestic technology and technology. The shell is made of galvanized steel. The frame adopts the standard container material and the production process. It has good anti-corrosion performance. The air conditioner and dehumidifier are installed in the box. The equipment is not affected by the natural climate environment and external pollution, can guarantee the -40 °C-+40 °C in the harsh environment of normal operation.

The device is equipped with unit vacuum switchgear, dry-type transformers, dry-type transformers, vacuum circuit breakers (spring operating mechanism) and other leading-edge equipment, products without exposed parts, for the whole insulation structure, fully able to achieve zero electric shock, The whole station can be achieved without oil operation, high security, the second use of computer integrated automation system, can achieve unattended.

(2) Factory prefabricated

Design, as long as the design staff in accordance with the actual requirements of the substation to make a main wiring diagram and the design of the equipment outside the box, you can choose to provide manufacturers by the box specifications and models, all the equipment installed in a factory, commissioned, electrical installation of the factory, shorten the design and manufacturing cycle; on-site installation only box positioning, cable connection between the box, outlet cable connection, protection set value calibration, transmission test and other work to be commissioned, the entire substation from the installation to Put into operation only about 5 to 8 days, greatly reducing the construction period. The

(3) Combination of flexible

Box-type substation because of the relatively compact structure, each box constitute a separate system, which makes the combination of flexible ways.

(4) Small footprint.

(5) Investment in the province, quick

Box-type substation with the same size from the substation to reduce investment 40% to 50%.

2.3. Box-type substation box requirements

(1) The cabinet lighting, ventilation, sand, heat should meet the normal operation and maintenance requirements, and should be installed temperature, humidity meter, condensate, smoke alarm device, and the temperature, humidity, Alarm probe signal access integrated automation system, to consider the location of the installation of communications equipment.

(2) The roof should consider the natural drainage function.

(3) To anti-ultraviolet radiation, anti-exposure performance is good, easy to heat can avoid the external temperature is too high caused by the box temperature rise.

(4) Moisture resistance is good, not because of hot and cold mutations and condensation.

(5) Anti-corrosion, anti-cracking, fire-retardant, antifreeze performance.

(6) To high mechanical strength, pressure resistance, impact resistance.

(7) The environment has a good coordination, to beautify the environment, can adapt to a variety of climatic conditions, beautiful appearance, compact structure, the box covers an area of small, saving land.

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3. **Overall Structure Design of 3 35kV Box Type Substation**

3.1. **Basic Requirements for Main Wiring of Box Substation**

In general, the basic requirements for main wiring include safety, reliability, flexibility, and economic aspects of the four.

Safety includes equipment safety and personal safety. To meet this point, must be in accordance with the provisions of national standards and norms, the correct choice of electrical equipment and under normal circumstances under the surveillance system and the failure of the protection system, consider a variety of personal safety technical measures.

Reliable is the main wiring should meet the different load without interruption of power supply, and the protection device in the normal operation does not malfunction, the accident does not move, as much as possible to reduce the power outage range. In order to meet the reliability requirements, the main wiring should be simple and clear.

Flexibility is to use the least switch, can adapt to different modes of operation, to meet the scheduling requirements, and can be flexible, simple and rapid switching operation mode, so that the failure of the shortest time, the smallest impact.

Economy is to meet the requirements of the above conditions, to ensure that the required design investment at least. In the main wiring design, the main contradiction often occurs between the reliability and economy.

3.2. **Selection of main wiring**

The main wiring using a single bus segment wiring, single bus segment wiring is the use of circuit breakers (or disconnector) will bus section, usually divided into two sections. After the bus segment can be segmented overhaul, for important users, can lead from two different sections of the circuit, when a bus failure, because the sub-circuit breaker in the relay protection under the action of the fault segment will be quickly removed to ensure that The normal bus uninterrupted power supply and does not cause important users to power outage.

3.3. **High-voltage wiring**

High-voltage side, the use of load switch + current limiting fuse as the main protection of the transformer, the general ring network, dual power supply and terminal three power supply, current-limiting fuse must be linked when a three-phase load switch, The occurrence of missing phase.

3.4. **Box type substation box to determine**

The base and the frame of the box are generally made of welded steel and angle steel. The roof and the four walls are made of metal plate lined with flame retardant material, which can play the role of heat insulation. According to the local situation, the main structure of the order can be made when the corresponding requirements. Cabinet sealing and dust is an important aspect, especially the protection device on the dust and other indicators require a higher, should pay attention. The bottom of the box under the general, as a cable room, in considering the box based on the design, should take into account the cable installation and maintenance convenience, should consider personnel access, ventilation and lighting and other requirements.

3.5. **Transformer heat treatment**

Transformer settings are available in two ways: one that exposes the transformer and the other installs the compressor in a closed compartment. 35kV box-type substation transformer using the second wiring, the transformer installed in the closed transformer compartment. For ventilation, the transformer compartment is set on the box. The structure of the blinds allows the air to go in and the dust is separated. To prevent the impact of dust on the insulation, in the transformer connection with insulation shield.

3.6. **box-type substation overall layout**

35kV box substation high pressure chamber rated voltage 35kV, low pressure chamber rated voltage 10kV. In the structural design with anti-pressure, rain and anti-small animals and other measures and small footprint, easy to operate, safe and reliable, you can move and so on. Box-type substation mainly includes four parts, namely the frame, high-pressure room, low-pressure room, transformer room.

(1) Frame: the basic structure is welded by the channel, angle and steel plate, door and roof with steel production.
(2) High pressure chamber: equipped with vacuum circuit breaker.

(3) Low-pressure room: equipped with fixed low-voltage distribution screen, including the main switchgear, measuring counters and so on.

(4) Transformer room: equipped with 2500kVA oil-immersed transformers.

4. Design and Equipment Selection of 35KV Box Type Substation

4.1. System design

35kV bus using single bus wiring, 10kV side bus using a single bus segment wiring. The box is double-sealed, double-layer iron plate filled with high-strength polyurethane, with temperature, moisture and other characteristics. The outer layer of stainless steel body, chassis steel frame with metal spray zinc technology, a good anti-corrosion properties. The inner layer is equipped with aluminum alloy gusset box installed in the air conditioning and dehumidification device, which is running the equipment from the natural environment and external pollution.

4.2. Box-type substation equipment selection should pay attention to aspects

(1) A device within the box should be oil-free, maintenance-free or less maintenance equipment is appropriate. Circuit breaker can be used vacuum circuit breaker CT operation, current transformers, voltage transformers and station use should be selected dry equipment.

(2) Due to the box within the space is small, the actual operation of the hanging, grounding is very convenient, so many boxes in the switchgear unit installed grounding switch, but by space constraints, some box manufacturers will be ground switch and isolation Switch with a linked form, open the isolation switch, the ground switch is closed; close the isolation switch, the ground switch opened.

(3) The switchgear inside the box should be left with an appropriate viewing window to observe the condition of the operating equipment.

4.3. Vasic principles of equipment selection

The right choice of electrical appliances is the use of electrical main wiring and power distribution devices to achieve safe and economical operation of the important conditions. In the selection of electrical appliances should be based on the actual situation of the project, in accordance with the relevant design specifications, to ensure safe and reliable under the premise of active and safe use of new technologies, and pay attention to save investment, choose the right electrical.

Electrical equipment selection considers the environmental conditions of electrical installations and electrical requirements. Environmental conditions refers to the location of electrical appliances in the device characteristics; electrical requirements refers to the electrical device on the device voltage, current, frequency and other requirements; for some electrical appliances such as switches, fuses, etc., should also consider the drying capacity.

(1) Consider the working environment of the selected equipment.

(2) The rated voltage of the selected equipment shall not be lower than the installation site grid voltage.

4.4. High-voltage primary equipment selection

High-voltage primary equipment selection, must meet the normal conditions of a circuit and short-circuit fault conditions, the work requirements, while the equipment should be safe and reliable operation, easy operation and maintenance, investment and economic rational.

4.5. Low-voltage primary equipment selection

The choice of low-voltage primary equipment, like the choice of high-voltage primary equipment, must consider the installation site and meet the normal conditions and short-circuit fault conditions to work requirements; the same equipment safe and reliable, easy operation and maintenance, investment and economic rational.

4.6. Selection of high voltage fuses

Fuse rated current selection and environmental conditions are determined according to the use of indoor or outdoor, but also include the rated current of the melt pipe and melt rated current selection.
4.7. Switchgear selection

The factory produces a variety of different circuit switchgear, distribution screen or standard components, many varieties. Design can be in accordance with the main wiring to select the appropriate circuit cabinet, screen or components to form a set of power distribution device. High-voltage switchgear and low-voltage power distribution screen selection, should meet the requirements of a circuit diagram of the demolition of a circuit and after several technical and economic comparison, the preferred cabinet, screen type and its line program number, and determine the All the equipment specifications and specifications of the equipment. To the switch electrical plant ordered high-voltage switchgear should be provided to the manufacturers of primary and secondary circuit drawings and related technical information.

5. Design of Secondary System of 5 35kV Box Substation

5.1. Definition and classification of secondary systems

Box-type substation equipment can usually be divided into two major categories of equipment and secondary equipment. The main wiring is connected to a device, and the secondary device is the measurement meter, control and signal equipment, relay protection equipment, automatic devices and sports devices. According to the measurement, control, protection and signal display requirements, said secondary devices connected to each other circuit, known as the secondary wiring or secondary circuit.

According to the secondary wiring power quality, there are AC and DC circuit, according to the use of secondary wiring points, there are operating power circuit, measuring meter circuit, circuit breaker control and signal loop, the central signal loop, relay protection and automatic circuit Wait.

5.2. Electrical measuring instruments and measuring circuits

In order to ensure the safe operation of the power supply system and the safe use of the user's electricity, so that a safe, reliable and economical operation of the equipment must be installed in the variable (with) power plant electrical measuring instruments to monitor its operation.

For electrical measuring instruments, to ensure that its measurement range and accuracy to meet the power distribution equipment monitoring and measurement requirements, and strive to beautiful appearance, easy to observe, economic and durable. Specific requirements are as follows;

(1) High accuracy, small error. Its value should meet the requirements of the level of accuracy;

(2) The error should not change with time, temperature, humidity and external magnetic field and other external conditions;

(3) The power consumption of the instrument itself should be as small as possible;

(4) The instrument should have sufficient insulation strength, pressure and short-term overload capacity to ensure safe operation;

5.3. Secondary system design

The system is a hierarchical, distributed multi-CPU integrated automation system, including the substation required for a variety of relay protection, such as transformer protection, 35kV / 10kV line, the use of substation computer automation protection device, the system as a layered, distributed multi-CPU integrated automation system, Protection, capacitor protection, with substation measurement, real-time data acquisition, operating conditions monitoring, control operations, automatic control and regulation and all remote function. The system adopts distributed control system, configuration, expansion, configuration flexibility, centralized control and management, decentralized data, real-time data processing, safe and reliable transmission, flexible and convenient operation.

The main protection system for the substation is mainly used in the following devices, they have the following characteristics:

(1) The device has the ability to resist system harmonics;

(2) The device has a self-test function, self-test error alarm and latch-up protection;

(3) The device exit and action circuit can be set to cast cutting plate;

(4) Device protection action export and monitoring action export independent;
(5) Device set measurement, measurement, protection, control functions in one.

5.4. circuit breaker control and signal loop

Circuit breaker control according to the control site can be divided into centralized control and local control. The so-called centralized control is concentrated in the control room to control; local control is installed in the circuit breaker to control. Control of the circuit breaker in the power distribution unit in the control room is called distance control. This control is mainly composed of control switches, control cables and operating mechanisms.

The basic requirements of the circuit breaker control circuit are:

(1) can be manually tripped, closing, but also to complete the automatic trip, circuit breaker trip (closing) process is completed, can automatically cut off the trip (closing) coil loop current to prevent the coil for a long time power and burn;

(2) a position signal which prevents the circuit breaker from being repeatedly tripped or closed;

(3) a circuit that reflects the breakout or closing of the circuit breaker;

(4) a position signal with a circuit breaker automatically tripped or closed;

(5) has a control loop integrity monitoring signal;

(6) to meet the requirements of the premise, and strive to simple and reliable.

The central control signal device is divided into light signal and audio signal. The light signal indicates the nature of the abnormal working condition, and the acoustic signal is causing the operator's attention. Light signal through the installation of a control screen on the signal lights and light plate, indicating that the situation of various electrical equipment and sound signals through the buzzer and the bell to achieve the sound, set in the control room. By the whole of the shared audio signal, it is known as the central audio signal device.

The central signaling device is divided into use: the accident signal, the warning signal and the position signal.

5.5. Control circuit design

(1) Computer monitoring and control system has a closing and opening relay output contacts, and connected to the switchgear of the sub-gate switch or button can be carried out on the remote closing operation.

(2) Computer monitoring and control system of the sub-gate relay contacts and switchgear on the switch between the switch or button should be designed between the manual and remote automatic switch.

(3) 10KV and above for the power supply and distribution system requires computer monitoring and control system for remote closing operation, the control switch should be canceled not corresponding to the wiring, you can use self-reset switch, you can also use the control button.

(4) All manual switching of the remote operation switch into the computer monitoring and control system The switch or button should have a pair of independent normally open contacts leading to the computer monitoring and control system for monitoring and controlling the computer during manual opening System a switch input signal to prevent manual opening when there is false alarm signal.

6. Conclusion

The design of the main 35kV box-type substation is the basic introduction of the box-type substation structure, characteristics and applications. The main work includes three aspects: the first box-type substation overall structure design, followed by box-type substation a system design and equipment selection, and finally box-type substation two system designs. Through this design system so that I have their own professional knowledge to further consolidate and improve, especially for the selection of electrical equipment, the main circuit wiring has a more profound understanding.

References

1. Huang Shaoping. Complete sets of electrical technology [M]. Hunan Institute of Engineering lectures (internal information), 2002
2. Fei Guangbiao. 35kV box-type substation model design [M]. China Electric Power Press, 2003
3. Zhu Baohua. A new type of box-type substation - integrated substation [J]. Journal of Electrical Engineering, 2002 (2)
4. Mai Yenhong. Application and analysis of new box-type substation [J]. Guangxi Water Resources 'u0026 Hydropower Engineering, 2001 (1)
5. Xiong Zuosheng. Technical improvement of 35kv box type substation [J]. Electric Age, 2001 (3)
6. LU Ya-jie. Structure and applicable analysis of box change [J]. Journal of Datong Vocational and Technical College, 2001 (1)