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RESEARCH PERTAINING TO THE DIGITAL DESIGN OF ELECTRICAL WIRING SYSTEMS WITHIN POWER GENERATION FACILITIES

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Abstract: In view of the problem that the design efficiency cannot meet the design cycle in the traditional power plant design of the electrical major of power generation engineering, a wiring design method based on a digital collaborative design platform is introduced, which acquires, stores and manages the input data of the plant power, carried out load distribution and loop scheme selection, achieved a significant improvement in the quality and efficiency of factory electrical wiring design, and improved the design accuracy of power generation projects.
Keywords: Power generation engineering; Factory electrical wiring; Digitalization; Three-dimensional design

1 ANALYSIS OF CURRENT SITUATION OF POWER DESIGN OF POWER GENERATION ENGINEERING PLANTS

As the power engineering design cycle is shortening day by day and the design accuracy requirements are getting higher and higher, when the two-dimensional engineering drawing software represented by AutoCAD software is used for drawing work of factory electrical wiring design, the design efficiency has been difficult to meet the needs of the design cycle. Common design quality problems are difficult to effectively control. The three-dimensional design of power generation projects has been deepened into establishing an accurate and complete "digital power station". Incorporating the factory electrical wiring design into the three-dimensional design platform is a digital design technology that takes data connectivity as the core and is supported by multi-professional collaborative design[1]. Traditional 2D design software generally does not have multi-professional data transmission functions based on database support. Therefore, the design work is carried out in an independent manner for individual terminals. Factory electrical wiring design is carried out through the 3D design platform, which is upstream of the cable laying design in the traditional mode. The factory electrical wiring design was transferred from a two-dimensional terminal design platform to a digital collaborative design platform, which not only further deepened the design content of the "digital power station" and improved the level of design refinement, but also completely changed the design process. Achieve an overall improvement in the design efficiency of factory electrical wiring and cable laying[2].
At present, domestic and foreign power generation engineering design companies generally use two-dimensional engineering drawing software represented by AutoCAD to carry out drawing work for factory electrical wiring design. There are also some more professional design software developed based on the AutoCAD platform, such as Power Generation Software such as PROMIS.E, IPS and DLFS are widely used in engineering electrical professional design. Although two-dimensional drawing software has been used for many years in the design of electrical wiring in power generation engineering electrical majors, there are still some problems[3].

1.1 The Real-Time Nature of Electricity Load Data in Various Majors is Poor

Power generation engineering design is a step-by-step design process. There is a large amount of data on electrical equipment in various majors, and the data is gradually improved. At the same time, electrical equipment is limited by factors such as equipment manufacturers and mutual submission of data[4]. Electrical load data will be constantly updated and modified, and The time when the electrical load data of various majors are submitted to the electrical major is also synchronized, which results in not only increased labor costs but also an increased probability of errors for electrical designers when sorting out the electrical load data. The reason is that the electrical equipment data has been modified many times, causing work errors in the workflow transfer. During the design process, the design data cannot be updated synchronously, and the design cooperation cannot be based on a unified design platform, so the accuracy of the data cannot be guaranteed[5].

1.2 Factory Electrical Wiring Design and Cable Laying Design Updates are Out of Sync

Restricted by the completeness of the electrical load data of each profession, the design of factory electrical wiring cannot be carried out simultaneously with the design of each process profession. Traditional two-dimensional engineering drawing software divides the factory electrical wiring design and cable laying design into two steps. After completing the factory electrical wiring design, the cable laying design work is carried out. This not only makes the order of plant power design work in the entire engineering design cycle "solidified" in the design process, but also restricts the further improvement of design efficiency. It is impossible to realize the linkage modification of plant power

design and cable laying design. This makes It is difficult to avoid omissions and errors in electrical load and cable data during the coordination process, which will lead to design changes on site.
In addition, because the existing two-dimensional design method does not realize the data connection of all majors, there is no corresponding data management function to support it, and it is impossible to use the data completed in the cable laying design to perform complete factory power distribution system calibration calculations, and it is impossible to realize the power plant's Refined design.

2 DIGITAL FACTORY ELECTRICAL WIRING DESIGN PLATFORM

The digital factory electrical wiring design is based on AVEVA's process collaborative design platform (Tags). According to the factory electrical design process and the data objects involved, the design process is re-smoothed according to the design requirements, and the entire data framework is customized through the design platform. It is used to store data related to digital factory electrical design, and at the same time realizes the dynamic update of factory electrical wiring design data in the platform, and can manage the version and permissions of the data.
According to the functional requirements, logical connections, relevant specifications and other conditions of the factory electrical wiring, a reasonable loop form is selected for each load, and based on the loop wiring design, the data is transferred to the three-dimensional design environment to build cabinet and drawer models, automatically Cables are generated, and finally the cable lengths completed in the 3D design environment are returned to the wiring design for related verification.

3 IMPLEMENTATION OF DIGITAL FACTORY ELECTRICAL WIRING DESIGN

On the digital platform, the input data of the plant's electricity consumption is acquired, stored and managed, and at the same time, the plant's electricity load is distributed and the circuit scheme is selected. Automatically select electrical equipment parameters and cable cross-sections based on load data, and combine the data returned from cable laying to verify the cross-section selection, provide verification result reports, generate factory electrical wiring diagrams, and complete the establishment of two-way data association with digital cable laying design. .

3.1 Preparation Work for Digital Factory Electrical Wiring Design

In the digital factory electrical wiring design, the platform will automatically complete the selection of equipment and cables based on load data, and the selection is based on the pre-configured circuit component selection correspondence table by professional electrical designers based on relevant design specifications, design guidelines and project requirements. And the cable parameter table, import the configuration table into the three-dimensional platform according to the corresponding format. The configuration table includes a matching table of models and specifications of circuit components for motor circuits, feeder circuits and busbar contact circuits under different load power conditions. The three-dimensional platform is based on the load power entered by the process professional designer when entering the electrical load. At the same time, the electrical professional designer determines the type of the circuit as a motor circuit or feeder circuit during load distribution and circuit selection, and selects the required configuration for the circuit. components. The three-dimensional platform can automatically select the model specifications of the circuit components in the pre-entered matching table based on the load power and circuit type. As a result, it is possible to automatically select the types and parameters of motor power incoming lines, feeder power incoming lines, and busbar contact loop components. By matching with the component configuration table, it is also possible to select the cable cross-section for the circuit.

3.2 Load Distribution and Circuit Assembly

Through the operation interface of the platform, the load and bus data stored in the database are read, and the unallocated loads and buses are associated with each other. Before the correlation, the circuit is selected for each load through the function of selecting the electrical load circuit wiring element. element. The platform can automatically select the model specifications of the circuit components in the pre-entered matching table based on the load power and circuit type.
Based on the load of the selected circuit components, the platform will automatically determine the size of the space it occupies, and use this data information as the basis for circuit assembly.

3.2.1 Load distribution

The purpose of load distribution is the process of allocating it to reasonable bus sections based on the power of the load itself and the corresponding technical parameters. The distribution principle is determined according to the relevant design specifications, and the digital platform realizes the establishment of the power supply relationship between the recorded load and the busbar [3].
Before load distribution, typical load circuit configuration needs to be performed on the platform. According to the technical parameters of the load and referring to relevant design specifications and design guidelines, the electrical component configuration of the load loop can be determined on the platform loop configuration interface. Typical circuit configurations are divided into three categories: load type (feeder circuit, motor circuit, motor circuit with differential protection), typical circuit configuration component selection (circuit breaker, fuse, contactor, current

transformer, zero sequence current transformer, Overvoltage protector, thermal relay, grounding switch, zero sequence current transformer), local equipment (iron case switch, frequency converter, local controller, magnetic starter). The load type and circuit scheme are required, and local equipment is optional. All loads in the project need to be distributed to reasonable bus sections before circuit grouping can be carried out.

3.2.2 Circuit panel

Factory electrical wiring needs to express the number of panels under each bus section, the number and type of circuits in the panels, the installation controls and drawer numbers of the drawers corresponding to each circuit, the circuit configuration of the circuits corresponding to each drawer, and the number of each configuration component. Model parameters, as well as the cable code, cable model and cable specification corresponding to the circuit.

When the circuit is assembled, the digital factory power design platform will automatically match the component parameters and models based on the typical circuit electrical component selection scheme set in the background database in advance. The first condition for automatic matching is the load type, and the second condition is the load rated power. Based on the above two conditions and the electrical components selected for the load circuit during load distribution, the model and parameters of the selected components can be determined, the cable model and specifications that meet the current circuit can be determined, and the size information of the drawer corresponding to the current circuit can also be obtained .

The total volume of drawers that each panel cabinet can accommodate is limited. When each circuit is assembled, the required drawer size can be automatically calculated based on the typical circuit matching relationship. Before placing each circuit into the cabinet, the software automatically calculates whether the remaining space in the current cabinet can accommodate the drawers required for the selected circuit.

There are two situations for panel grouping: one is to single-select or multiple-select the load under the current bus to directly group the panel, and the other is to insert the selected circuit into an existing panel cabinet. In both cases, the software will automatically calculate whether the space requirements can be met before completing the disk grouping, and the system will automatically prompt if the requirements cannot be met.

3.3 Cable Data Transmission and Verification

3.3.1 Cable data transfer

The core of the factory power design platform is data transmission, which is reflected in the platform automatically selecting electrical equipment parameters and also selecting the cable cross-section for the loop. In the 3D model design environment, cable information in the wiring design can be automatically obtained: cable codes, starting and terminal equipment codes, cable model sections, etc., as the initial cable inventory for cable laying design.

First, check whether the starting and terminal equipment of the cable exist in the 3D model design environment through the unique code of the equipment (KKS code). Secondly, check whether the cable model specifications have matching items in the model database. When the above two conditions are met, the cable data model is automatically generated in the three-dimensional design environment. If the wiring diagram is modified in the middle and later stages, the software can also automatically compare whether the cable information in the 3D design environment is consistent with the wiring design. The user can decide whether to modify the cable information in the 3D design.

For cables that have been laid and designed in the 3D model environment, the length can be returned to the wiring design environment for relevant verification calculations.

3.3.2 Related check calculations

After the plant power design platform obtains the cable length from the model design environment, it combines the pre-entered calculation parameters of the feed network, transformer, and motor with the "cable characteristic matching table" in the database. Through the above parameters, as well as the load and busbar, busbar and The connection relationship between busbars is based on DL/T5153 - 2014 "Technical Regulations for Power Design of Thermal Power Plants". The digital platform can automatically calculate the effective value of single-phase short-circuit current at the end of the cable, the effective value of three-phase short-circuit current and the terminal voltage loss. .

After the verification calculation is completed, the electrical designer will judge whether the design requirements are met based on the results. If the verification calculation results do not meet the design requirements, the design platform will return the information to the load distribution and panel assembly, reselect the cables, and then complete the cable laying through data transmission. The cable length is returned to the factory electrical wiring design, and the verification calculation is performed again until the verification results meet the design requirements.

4 THE FINISHED PRODUCT OF ELECTRICAL WIRING DESIGN FOR DIGITAL FACTORY

4.1 Factory Electrical Wiring Diagram

After the busbar wiring design is completed, it is verified through relevant calibration calculations to meet the design requirements. Based on the results of load distribution and circuit grouping, the platform's own report tool can be used to generate a busbar-based wiring diagram. The report format is customized based on the finished product model designed by the electrical wiring diagram of the electrical professional factory. The wiring diagram includes: switch cabinet KKS code, primary configuration diagram in the cabinet, circuit breaker information, fuse information, contactor information, current transformer information, voltage transformer information, overvoltage protector information, grounding switch information, zero sequence current Transformer information, cable information (KKS

code, model, number of roots, core number, cross-section), terminal load/power supply information (name, KKS code, rated capacity, rated current, overvoltage protector, current transformer), secondary Picture number, etc.

4.2 Cable Inventory

After the cable laying is completed in the 3D model design environment, the cable length, cable detailed path, buried pipe specifications and length information can be obtained in the factory power design platform. By customizing reports, cable inventories can be generated with one click. The cable inventory includes: cable number, buried pipe specifications, buried pipe length, cable specifications, cable starting end code, cable starting end description, cable terminal code, cable terminal description, cable length, cable laying path and other information.

4.3 Board Layout Diagram

According to the circuit group information of a certain panel cabinet in the Tags wiring diagram, that is, the number of drawers in the cabinet and the space occupied by each drawer, in the three-dimensional modeling module Equipment, the drawers of the cabinet can be completed with one-click operation. Model creation means that the cabinet is divided into a specified number of drawer models and automatically named. Then through the drawing module, the panel layout can be completed.

5 CONCLUSION

The problem of inconsistency between wiring design and cable design caused by modification of process data; by pre-setting the typical loop component selection table, quickly select loop components and improve design efficiency; automatically calculate short-circuit current and voltage drop to reduce the probability of errors; can Draw uniform wiring diagrams and cable inventories based on customized templates.

Factory electrical wiring is one of the important contents of the electrical professional design of power generation projects. The design of factory electrical wiring is incorporated into the three-dimensional collaborative design platform to realize the data connection between the electrical equipment of various process professions and the electrical professional power distribution equipment and cables. It can break through the constraints of traditional two-dimensional design on the overall design progress of the electrical major, and is expected to advance the overall design progress of the relatively lagging electrical major and improve design efficiency. The digital factory electrical wiring design platform not only manages load data, but also includes design products such as factory electrical wiring diagrams after verification and calculation, as well as seamless connection with cable laying work on the three-dimensional platform, promoting complete and accurate design. The process of refined design of the three-dimensional "digital power station".

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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