

# The Research on GIS Substation and Teaching Reform of High Voltage Technology

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**Abstract**—The relationship between scientific research and teaching is one of the topics worthy of discussion in the reform of college curriculum teaching. Scientific research can be carried out around teaching to serve teaching better. In the teaching and learning of high voltage technology, the promotion achieved by scientific research is particularly important. The insulation characteristics of GIS substation serves as an important part of high voltage technology teaching, and the research of it plays an significant role in promoting and deepening the teaching of high voltage technology course. This reflects the idea of combining teaching and research, stimulating scientific research through teaching and advancing teaching through scientific research. Taking the GIS substation research as an example, this paper illustrates the role of scientific research in the teaching of high voltage technology.

**Keywords**—GIS substation; High voltage technology course; Scientific research

## I. INTRODUCTION

Scientific research and teaching are the most basic work of university teachers, and teaching is worthy first. However, the recent situation of many college classes is worrying in china.

Students are blind in learning, and their learning content is useless except for exams, knowing little about its application. What is more, there are also rumors that the utilization ratio of the contents in class is less than 10% after graduation, which misleads students to learn neglectfully, so that many students suffer a lot. Finally, the students' desire for learning is only examination surrounded, the understanding of knowledge only stays in the level of recitation. Under the restriction of examination system, the propositions by teachers are simplified and repeated. Persist in so doing, not only the learning mode of students follows the same pattern, but also the teaching mode of teachers are old-fashioned, and can not reflect the characteristics of teaching in the present era.

Under the background of this information age, all walks of life have been pushed into the tide of reform and innovation, all kinds of products, whether technology or service, not only pursue specialization, but also need to meet the needs of individuation. However, in education at present, there is still following an old teaching mode, from primary school, junior high school to high school, teachers are always the core of teaching, teaching is examination-centered, and the learning of students depends on teachers. Classroom teaching does not arouse students' desire to seek knowledge, teaching is loyal to books, and the content of the extension of the teaching materials is far away for students.

As for the relationship between teaching and scientific research at present, it is not optimistic yet. Some colleges focus on teaching, and some universities emphasize research, rarely can achieve the perfect combination. The narration in classes only revolves around the books, and the content extend less towards researching. As most teachers hold the opinion that the students are not proficient enough to master even the basic knowledge points, how can they talk about the profound words which need for a certain amount of knowledge accumulated in scientific research? However, everything has a side simple and easy to understand, that means finding a more popular point to entry. It is a matter that worth thinking about.

It can be seen that the information technology permeates all aspects of life deeply. It is promoted in this paper, it is urgent to put some new teaching modes into practice, awaken the students to learn passionately. So, the teaching reform which relying on the internet technology is both an opportunity and a challenge for teachers works in the university [1-2]. Perhaps teachers can introduce parts of scientific research topics in the classes through appropriate metaphors and citations, so that seemingly profound knowledge becomes easy to understand for their lovable listeners -students. After all, explain profound theories in simple language, it is one of the common skills in the teaching of science and engineering.

Winding and curved roads lead to secluded place. When teachers introduce their scientific research ideas into the classroom to lead students to see the scenery outside the traditional classroom, and the vision of students to the forefront of the subject development. It is a sharp contrast with the traditional teaching that inject new vigor into the teaching content, and ignite the enthusiasm of students for pioneering and innovating.

## II. TEACHING CHARACTERISTICS OF HIGH VOLTAGE TECHNOLOGY

### A. From practice to practice

With the rapid development of power industry, large power and long distance transmission promote the development of high voltage technology. As we all know high voltage technology is a course that comes from the practice of the electric power production which is used to achieve long-distance power transmission and reduce energy loss in the meantime. When the sturdy and reliable theory is established after a long term research following up the actual electric power production, then it is used into the power transformation project. That is from practice, to practice. This is a course

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which needs closely combination of the theory and the practice. It is a very high request that the teaching must be supported by convincing theory and stand up to the test of practice [3].

On the other hand, students may face many practical problems of high-voltage technology in their job. For example, the installation and maintenance test and management of electrical equipment, such as electrical equipment insulation testing, diagnosis, maintenance and maintenance, such as simple design and calculation of high voltage technology, and so on[4]. Therefore, from the perspective of their later work demands, the course of high voltage technology must also focus on the practice of engineering.

#### *B. Inadequate experiments due to the lack of equipment*

The core of high voltage technology course is about how the equipment is breakdown under the action of high voltage and large field strength, and how to prevent it, then what measures can be taken to improve the electrical resistance of the insulation. The theory can predict whether the insulation will be breakdown or not roughly, but it is often necessary to simulate the running state of the equipment in the laboratory and to carry out preventive tests and tests of electrical ultimate strength. Therefore, experiments play an important role in the teaching of high voltage technology.

However, the high voltage tests of the electrical equipment are usually loaded with several thousand volts, hundreds or even thousands of volts. However, general laboratory does not have such conditions at all. It is hard for students, teachers and even some researchers to see the high-voltage tests of electrical equipment. This brings many difficulties to the course teaching.

#### *C. Imperfect theory and the great space for exploration*

Physics, materials science and electricity theory are basic disciplines involved in the high voltage technology. In electricity, it is mainly concerned with the basic theory of electric engineering, electric circuit, electromagnetic field and electromagnetic wave. For high voltage technology is engineering based, and the engineering practice is often unfathomable and complicated. Theoretical construction lags behind the actual engineering in most cases, which is not perfect and is still in the process of establishment. Such as the solid and liquid dielectric breakdown process, the work is complicated enough that the universal law applicable to all liquid dielectric is unclear, nor failed to find the breakdown laws for the solid dielectric yet. Therefore, there are many problems to be explored in the subject of high voltage technology, which also brings a lot of fun to the teaching of high pressure technology [5-6]. Only with thinking and exploring, one can make long-term progress in the study of high voltage technology.

### III. ACCUMULATION OF TEACHING MATERIALS BY RESEARCH

In the course of human society, experience is accumulated, knowledge is updated and equipment is constantly improved, science and technology continue to make progress. Teachers can keep track of practical engineering problems and accumulate teaching materials through scientific research to update teaching contents. The same is true to high voltage

technology researching and teaching. For example, by GIS research, it leads the accumulation and renewal of knowledge, and shows the development of substation as well.

#### *A. Teaching materials of conventional substations*

As we all know, substation is one of the important members in the electric power system. The first truly modern power system came into being in Germany in 1882, shortly before the advent of substations. Substations are the intermediate link between power sources and power users, that mainly to receive electricity and transform the voltage and current to achieve power distribution. Generally, booster substations are connected to power survives, while the step-down substation are connected to users. With the commonly development of electric power system for over 100 years, great changes have taken place in the area of construction site, voltage grade, electrical equipment running condition.

In terms of the construction site of substations, the earliest substations were all open outdoor substations, and later, indoor substations and underground substations appeared gradually. At the same time, the area of the substation is gradually reduced.

With the development of power technology, the voltage level of substation operation is rising gradually. Previously, it was a small power grid transmission mode with 35kV terminal substation, and hub substation is of 110 kV and 220 kV voltage level. Nowadays, it has been gradually developed into a large power transmission mode with UHV level of 1000kV substation, 500kV substation is used as the hub substation, while 220kV and 110kV substation is the terminal substation.

In the case of electrical equipment of substations, such as transformers, circuit breakers, isolators, current transformers, voltage transformers, busbars, lightning arresters, lightning conductor, capacitors, reactors and other primary equipment, they change from the original open outdoor equipment to fully enclosed gas combination appliances or semi-enclosed appliances. At the same time, relay protection device and automatic device, measurement and control device, metering device, automation system as well as the other secondary equipment are change from transistor and the integrated circuit protection early to the microcomputer protection.

#### *B. Teaching materials of new substations with GIS*

When it comes to the substation with GIS, it is well know that electrical appliances are in combination and placed in gas chambers, which is fully enclosed and insulated by the dielectric gas named SF<sub>6</sub>. Its small volume and excellent technical performance have win a long way in recent years.

All charged parts of GIS are surrounded by metal shells made of aluminum, stainless steel or non-magnetic metal to form a closed space. The enclosed gas chamber is formed by insulator, expansion joint and so on. The insulating gas composed of SF<sub>6</sub> and N<sub>2</sub> is filled around the different electrical equipment in the inner. GIS enclosure is grounded by copper conductor generally.

The electric field structure of GIS equipment is coaxial cylinder gas gap, which is a slightly uneven electric field with similar electrical performance to uniform electric field, while

the conventional substations are mostly rod - plate air gap, which is an uneven electric field typically. Therefore, GIS has good technical performances, and less size which can save land resources.

#### IV. PROBLEM-ORIENTED LEARNING GUIDANCE

The basic knowledge above is often popular in the lecture of teacher in class, because it is easy to understand and well-recognized. But, when it comes to abstract theory, it maybe not so attractive most of time. At the moment, it is advisable to guide students to start a problem-oriented study. It is easy to implement by projects and graduation thesis.

##### A. *Problem-oriented learning guidance by projects*

Some projects suitable for teaching and learning can be designed according to scientific research problems. The problem oriented approach enables students to participate in the projects as creative and active learners not the passive content receivers. For example, one project for students is to complete the geometry structure design of GIS generally. In the design of GIS busbars, there are a series of problems that are closely related to the actual project stay to be solved by the students. Such as, how are conductors arranged in the enclosure? Is it triangular or horizontal arranged? Share an enclosure or make separated shell for each one for the three phase busbars? Such as how to determine the diameter of conductors, what about the enclosure. Under this problem oriented, students access to numerous data, find that the arrangement and encapsulation form of GIS busbars are determined according to the voltage grade. When the voltage grade is 110 kV and below, it is triangular arrangement, when it higher than 220 kV and above, the arrangement becomes horizontal. Triangularly arranged conductors share a single shell and horizontally one in separate enclosures. As far as size is concerned, students find that the diameter of enclosure is usually 2.7 times of the conductor through a lot of data. In engineering design, the ratio of shell diameter to conductor diameter is natural logarithm  $e$ , that is, 2.718, so as to increase the uniformity of electric field and make the breakdown voltage reach highest value.

In corner design of GIS tank, it happens to coincide that students are all designed as arcs. When stating the reason, some say that it is to imitate the electric field of coaxial cylinder to make the field as uniform as possible, while the others insist that it is for faster fluid flow and better heat dissipation. In fact, all the angles of GIS are arc structure as supposed. Students discovered the truth, and the enthusiasm for learning naturally rise.

##### B. *Problem-oriented learning guidance by thesis*

In the research of GIS substation, several subtopics within students' ability are taken as the subject of graduation thesis or graduation design. In this teaching reform, two sub-topics are selected in the study of GIS substation, namely, the electric design of 110 kV GIS substation and the analysis of electromagnetic field of GIS busbars. Through the first training, the key points in the former course named electric power engineering are reviewed many times, not only the main wiring design of the GIS substation is carried out but also the selection and verification of the main electrical equipment are done as

well as the layout diagram substation by students through consulting the power design code and other related documents. By the second training item, students have mastered the basic usage methods of ANSYS, a popular large-scale general software, and interpreted the subtle relationship between electric field and magnetic field which is long standing in a live device or equipment with electric.

In the process, students keep exploring, focusing on the heart of the matter, showing up a surprising motivation, which is completely different from the previous performance until the problem is solved.

#### V. WONDERFUL CLASSES FOR PASSIONATE AND INNOVATION

##### A. *A wonderful and passionate class*

A wonderful class is similar to a passionate lecture, which should be the pursuit of teachers and the yearning of students. As the saying goes, teaching without research is shallow, and research without teaching is empty. The popular classroom requires not only the accumulation of knowledge, the sense of humor in the words, but also the scientific research closely related to the teaching content.

The demands for teachers can be summed up as "speak clear, more naturally" in a perfect class. To speak correctly and thoroughly, actual parts are linked to the related theories, theoretical explanations are made for the practical and operational content, the latest developments related to the content are introduced, clear and naturally .

Relying on the scientific research of subject content, the understanding of relevant knowledge can be deepened for teachers, and a scrupulously knowledge system may be established too. When teachers pay attention to the key points, characteristics and difficulties in scientific research of subject content. The information is used as example in class, the teachers can control the classroom in the whole, and the lifeblood of subject grasped. Then it happens naturally that teachers work as a high level guider to lead student to the point of interest inquiry-based learning in the class. From this point of view, without more solid scientific research experience, teachers can not be full of confidence in the classroom, can not speak clearly and freely.

For example, after explaining the insulation characteristics of SF<sub>6</sub> gas by GIS, in spite of its excellent insulating property, it can be pointed out that the SF<sub>6</sub> gas has its obvious disadvantages yet. Such as its liquefaction temperature is low, the requirement for uniformity of electric field is high, it has some harmful effects on environment in addition. So, scientists are exploring the alternative gas of SF<sub>6</sub> in order to achieve the goal of environmental friendliness while ensuring the insulation strength at present. In this way, student can fully aware that everything has two sides, the current engineering practice still has a lot to be explored in scientific research, many difficulties stand to be attacked continually, and the development of the society still needs young people to struggle further. It can breed a sense of responsibility for the power industry to students as well. In this process, students' identity with teacher arises spontaneously, then the teacher can get a good evaluation of teaching that equals to the efforts, and

teacher gains the happiness of being recognized. So as to better organizing and teaching are carried out involuntarily. It is a virtuous circle in which both teachers and students benefit.

#### *B. Inspire students to innovate and explore*

Research is often about exploration. While traditional education only focuses on the imparting and memory of knowledge, students learn more and more passive, and their innovative thinking is increasingly thin. If students can participate in scientific research in the college, and get the training of scientific research thinking or temper themselves in the scientific research and practice, the road of cultivating innovative talents will be wider. Teacher Jiao Jianli in the school of educational information technology of south china normal university said: classroom today is to train students to engage in occupations that do not exist currently after graduation, and apply technologies that have not been invented yet, then solve problems we can't imagine right now.

In classroom teaching, teachers bring the thinking of scientific research into it, which will promote the development of students' thinking and make students realize that thinking is the process of approaching the goal by integrating the existing cognition. Teachers show the process of scientific research in the course content, students know the process that specific knowledge is applied to actual work, which makes students feel that scientific research is no longer out of reach and theoretical knowledge is no longer so empty and abstract. Students find the essences of knowledge and realize its scientific significance and guidance.

In addition, students can get innovation thinking training when engaged in relatively simple scientific research activities. It is possible that teachers may be inspired by students. Perhaps students may think in a more innovative way, and may be bolder than a teacher. If teachers are inspired to produce better research results, it is worthy more. After all, in a group, learning is always mutual and the influence is mutual too.

On the other hand, college students are guided by the spirit of concerted efforts and constant exploration in a team. The wisdom of scientific research is collected, and students are in the face of difficulties together, their motivation from the common goal, those above help students to be a human who explores the unknown with enthusiasm, to be a human who dedicates continuous efforts for scientific career, to be a human who desires to win honor for country, to be a human who is

longing to learn from others. This plays a very important role in shaping the healthy and positive personality, and is of great benefit to the later career development of students.

#### VI. SUMMARY

Scientific research is a difficult and continuous process, and teaching reform is a long-term and complex task. Teaching reform is inseparable from teachers and students, and so is scientific research. In the research of GIS substation, the teaching of high voltage technology course provides a solid theoretical foundation, and in the teaching reform of high voltage technology course, many materials of GIS substation research are permeated in the course, so that the class becomes vivid and wonderful. Through scientific research, we can accumulate teaching materials, thus opening up problem-oriented teaching and learning. Through the study of GIS substation, some projects and relative graduation thesis can be set up for students to explore and practice. Scientific research and teaching promote each other and the topics are worthy of discussion in teaching reform.

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