

Reform Exploration for Safety Course System of Oil and Gas Storage and Transportation Facilities

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ABSTRACT

In recent years, the safety of oil and gas storage and transportation facilities has been paid more attention by the state and enterprises due to frequent accidents. The oil and gas storage and transportation facilities safety courses in China University of Petroleum (Beijing) includes “Engineering mechanics”, “Strength design of pipelines and tanks” and “Safety and integrity management of oil and gas storage and transportation facilities”. The three courses lack relevance and the teaching mode is too rigid, resulting in students losing their initiative in learning. If students can't use the knowledge flexibly, it will affect the achievement of the objectives of the training program. Therefore, oil and gas storage and transportation facilities safety courses are reformed, training plans are adjusted and teaching methods are improved. The practice shows that the reform enriches the teaching content, improves the teaching quality, stimulates classroom activity and gets a good evaluation of students. The reform of safety courses has a certain significance for cultivating compound talents who have the ability to solve practical problems in engineering.

1. Introduction

In 1952, China's first oil and gas storage and transportation engineering was founded in Tsinghua University. The major is the link connecting production, processing, distribution and sales of oil and gas. Oil and gas storage and transportation system is not only an important part of oil and gas industry, but also an important infrastructure of national economy, which is closely related to people's lives. As oil and gas is flammable, explosive and volatile^[1], it is subject to key state supervision. Once it is leaked, it may cause fires, explosions and other major accidents^[2]. According to GB18218-2009, oil and gas storage and transportation facilities are prone to pose major hazards. The safety of oil and gas pipelines is an important part of

environmental policy^[3] and has been paid more and more attention^[4]. In the China University of Petroleum (Beijing), the safety of oil and gas storage and transportation facilities is also one of the key teaching contents. However, the education ability in this aspect is far less than that in other directions which can meet the requirement of cultivating compound, innovative and strategic engineering talents. The specific problems are mainly reflected in the following aspects: the requirements for safety education are the same as those of other majors and not further improved. Under the latest training scheme, only three required courses are required, including “Engineering mechanics”, “Strength design of pipelines and tanks” and “Safety and integrity management of oil and gas storage

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and transportation facilities”.

The strength design and the safety evaluation of in-service pipelines are introduced in different courses, which is inefficient. At present, the teaching method of the three courses is purely theoretical teaching with miscellaneous contents, so students can only learn some basic concepts of strength and safety. For many years, the assessment method of the course is only some filling in the blank, right and wrong, selection and very simple calculation. The method of engineering analysis by students is deficient, only the simplest problems can be calculated, which can't meet the requirements of complex analysis of practical engineering. There is no teaching link of strength design and check in the course design practice. Due to the above reasons, the graduates of oil and gas storage and transportation have not been well trained in the safety of facilities, which is difficult to adapt to the current safety requirements of pipeline industry. In view of the above problems, we have carried out reform and exploration in the aspects of course system, course teaching content, teaching methods, and practice links. Practice has proved that the reform method can achieve the reform goal in a relatively short time and meet the ability needs of the industry.

2. Curriculum System Reform Combined with Training Plan Adjustment

Before the reform, there were three compulsory courses related to safety in the training plan: “Engineering mechanics”, “Strength design of pipelines and tanks” and “Safety and integrity management of oil and gas storage and transportation facilities”. “Engineering mechanics” includes theoretical mechanics and material mechanics, which enables students to master the solutions to the problems of strength, stiffness and stability of equipment. The purpose of “strength of pipelines and tanks” is to enable students to have a comprehensive understanding of the strength of oil and gas pipelines and storage tanks through mastering the basic concepts, principles and methods of strength analysis of various pressure pipelines and tanks. The course includes underground pipelines, above ground pipelines, submarine pipelines, buckling analysis of pipelines, seismic design calculation of underground pipelines, and strength design knowledge of vertical cylindrical oil tanks; “Safety and integrity management of oil and gas storage and transportation facilities” has established the knowledge system of oil and gas pipeline integrity management course, including the construction of oil and gas pipeline integrity management system, the composition of oil and gas pipeline system and the identification of its hazard factors, so that students can master the relevant

technical work of integrity management as soon as possible to meet the needs of enterprises. As the main compulsory courses in the training plan, the three courses have a great impact on students. Whether the students can understand and absorb the main content of the three courses determines whether they have the basic literacy and vision and meet the needs of industry and Society for relevant talents. However, in recent years, through the questionnaire survey, we found that the students were not clear about the safety concepts, the connection between several courses was not clear and the effect of training plan was not ideal, which was contrary to the original intention of the school when making the plan. In addition to some students' lack of interest, unclear goals, slack personality and other problems, which affect the teaching quality of the course, the relevant teachers found some problems in the curriculum design during the communication. Pipeline integrity is comprehensive and integrated management ^[5] for all factors affecting pipeline integrity, which is closely related to the design, construction, operation, and management of pipelines. The process is a continuous improvement process ^[6] (Figure 1). It can be seen that some elements in the circulation of pipeline integrity management elements are closely related to pipeline strength design. A series of integrity evaluations will be conducted to check the design quality. They are closely related, but the close relationship between them is weakened in the actual teaching. The “strength design of pipelines and tanks” separately introduces the knowledge of stress, embedding methods and anti-seismic in the design of new pipelines, while the “safety and integrity management of oil and gas storage and transportation facilities” focuses on the management system, technical system, laws and regulations related to in-service pipelines. That is to say, the two courses don't emphasize the relationship between the two courses, resulting in the students can't establish the safety system for oil and gas storage and transportation facilities. In addition, “Engineering mechanics” is taught earlier than the other two courses. The original intention was to lay a foundation, but there was a long time between them. As a result, students can't recall the knowledge learned in previous courses and build bridges between several courses when learning new courses. The above problems lead to the unsatisfactory teaching effect.

In view of the above problems, the college has organized many exchanges between teachers and students to discuss the curriculum reform methods. Given the need to integrate the structure of the professional curriculum system ^[7], we finally decided to adjust the training plan. “Strength design of pipelines and tanks” (32 class hours) and “Safety and integrity management of oil and gas

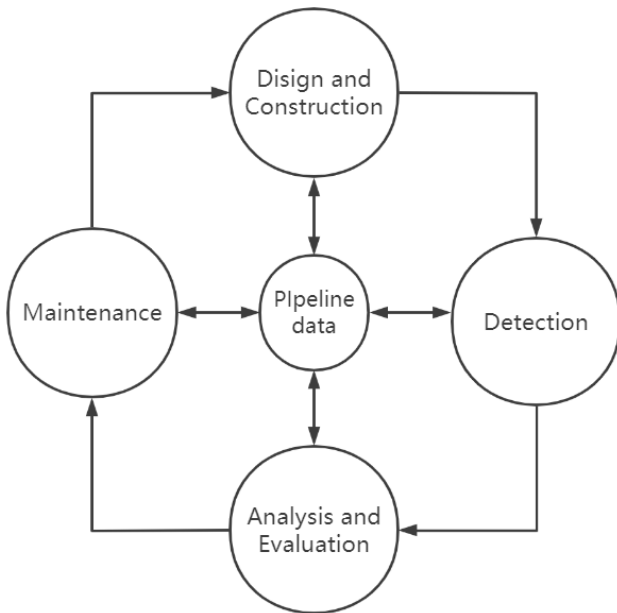


Figure 1. Circulation of pipeline integrity management elements

storage and transportation facilities” (32 class hours) are merged into “strength design and safety management of oil and gas storage and transportation facilities” (64 class hours). The repeated contents in the two courses are deleted and the teaching sequence of related content is rearranged. In addition, the schedule time of “engineering mechanics” ends together with “strength design and safety management of oil and gas storage and transportation facilities” (Figure 2). In this way, not only can the two courses which are not related be skillfully combined together to teach the students, so as to make the knowledge more systematic and three-dimensional. It gives students a comprehensive understanding of the different aspects of knowledge and urges them to review the concepts through assessments at the end of the two courses so that they can feel the subtle connections between the courses. After exploration and practice, the reform of curriculum system combined with the adjustment of the training plan has achieved initial success. Whether it is a random survey or

asking professors to summarize, the response is generally more enthusiastic than before, which is mainly reflected in students’ understanding and mastery of the whole system more clearly and logically. In addition, students pay more attention to the integration of subjects when they ask teachers questions after class.

3. Curriculum System Reform Combined with Teaching Improvement

As mentioned above, in order to build a closer relationship between several courses related to the safety of oil and gas storage and transportation facilities. The college has tried to adjust curriculum by merging courses. Then the teaching content of the course was adjusted accordingly. Before the adjustment, the teaching contents of the three courses are numerous, scattered and miscellaneous. The teachers are clear about the knowledge taught, but knowledge mastered by the students is distributed in Independent points. They may know the specific content of each point, but they can’t connect each point into a line. That is, they may be able to answer some basic knowledge such as the definition of strength, stress and integrity management. However, the results are not satisfactory when they are asked to describe course content in a systematic way.

In view of the above problems, the research group carefully checked the syllabus of each course, and discussed the adjustment of course content. The merged course content in new syllabus was simplified and refined. The overlapping content of the two merged courses was deleted, the teaching order of the content was readjusted and the related content was rearranged according to the actual project implementation sequence. The purpose is to enable students to have a more intuitive understanding of the safety related contents and the relationship between them. In addition, the research group has drawn mind maps for each chapter and section. For example, when teaching integrity management technology system, students will first see the corresponding mind map (Figure 3) and follow

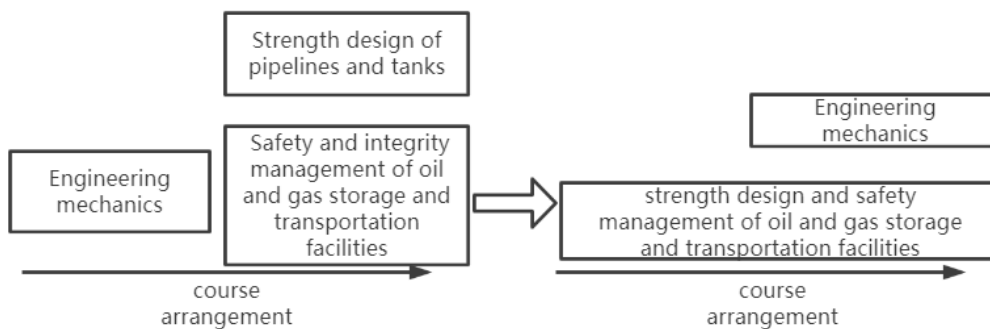


Figure 2. Schematic diagram of training plan adjustment

the teacher to clarify the knowledge to be learned. This should be a part of students' autonomous learning, but now students' learning ability is different and their subjective initiative is accompanied by students' personal vision. It is not guaranteed that every student can browse the content that has been learned or will be learned before and after class. The research group hopes that this can help students better grasp the knowledge system and realize the importance of taking notes and drawing mind maps, so as to make students' learning ability to a higher level.

In addition to some adjustments and supplements to the teaching content, the research group also improved the teaching and assessment methods of the course. In the past, these three courses were offered for a long time. After several years of exploration, the teachers have formed their own independent teaching system. Their characteristics are mainly pure theoretical teaching, that is, teachers actively teach knowledge while students listen passively and the effect is assessed by mid-term and final exams. This kind of teaching method is mostly used in the traditional classrooms nowadays. The teaching is carried out steadily, which can ensure a certain teaching quality. However, it also exposes some problems in practical practice, such as various theoretical knowledge and abstract concepts. When the class is in normal operation, it can be found that some students find it too boring. There are a few people who sleep and are busy with other things. Their learning initiative is low, and the quality of teaching

is worrying. Moreover, due to the complex relationship between the difficulty of test questions and the students' learning efficiency, for many years, the course assessment method can only be examinations. When the exam is around the corner, students just have to cram in order to pass it. The method of engineering analysis and calculation mastered by students is simple. After the examination, the knowledge of temporary forced stuffing will be forgotten by students, which is undoubtedly what the teachers do not want to see.

In view of the disadvantages of the above teaching methods, the research group carried out a series of reforms on teaching and assessment methods on the basis of learning from the reform methods of other organizations in petroleum related courses^[8-14]. "Strength design and safety management of oil and gas storage and transportation facilities" has become a combination of theoretical teaching and practical training projects, that is, practical design, actual evaluation and other training projects are added to the classroom while the curriculum content matrix is constructed. The ordinance is for various pipelines, pipe fittings and tanks, and the abscissa is the strength design, safety assessment, prediction and early warning. In the early stage of the course, theoretical teaching is still conducted to teach students the basic theory and basic requirements of analysis and the concept of relevant engineering design and evaluation standards. In the later stage, the class content is changed into group discussion of stu-

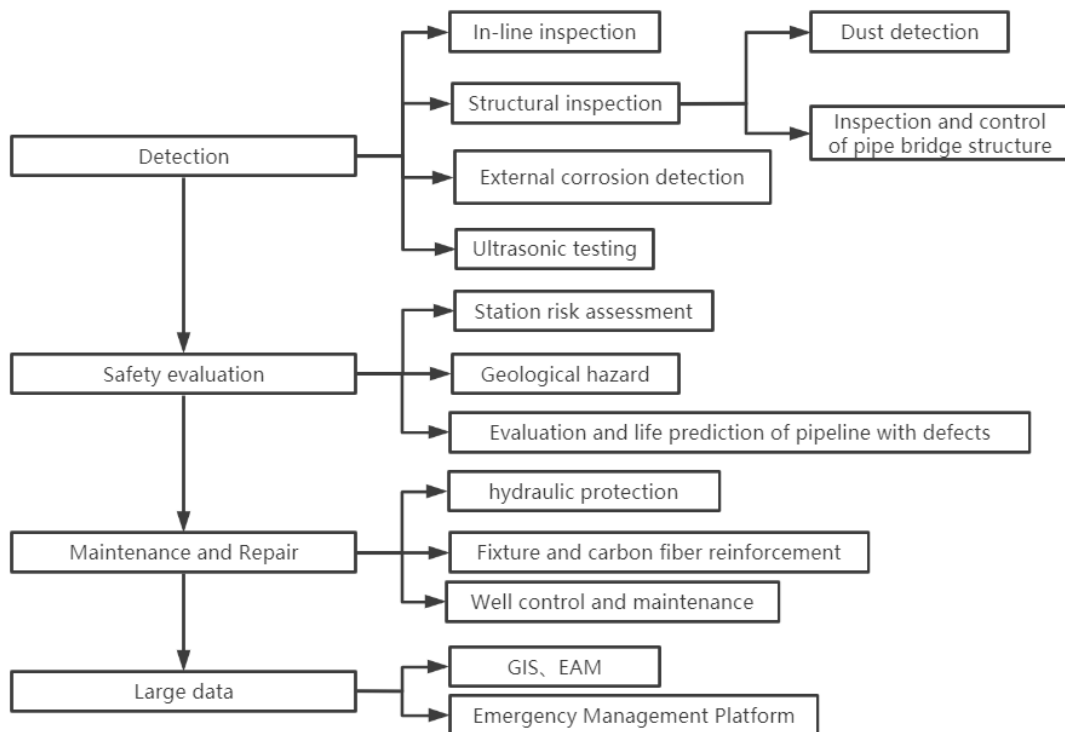


Figure 3. Integrity management technology system

dents. Finally, different groups exchange views with each other and teachers give comments. It aims to improve the level of interaction between students and teachers, as well as students' sense of classroom participation and learning initiative. "Engineering Mechanics" still focuses on theoretical teaching, with additional learning and application of finite elements. The extra-curricular hours are used to let students learn the operation of finite element software and the analysis and calculation of examples, so that students can feel the charm of practical applications behind the formula. The evaluation mode of "Engineering Mechanics" is divided into two parts. The mechanical theory part still adopts the examination. However, examination questions are more closely related to engineering practice. It not only puts pressure on the students, but also drives them to review the relevant knowledge after class and look at the learned knowledge from a new perspective of engineering practice. The finite element calculation part is a single large assignment assessment. The assessment content is to submit the calculation software compiled according to exercises, input data files and calculation results. But each subject generates relevant parameters according to the student number, that is, each student's big homework is a unique topic, so as to avoid the phenomenon of plagiarism among students. The usual performance of the course "strength design and safety management of oil and gas storage and transportation facilities" is to complete a number of design and evaluation reports in groups. At the end of the term, a comprehensive report and defense will be conducted for the reports completed in groups. The review teacher will ask members of the group random questions about the reports, the performance of the members will directly affect their final performance. In order to avoid the subjective will of the teacher and the limitation of his / her field of expertise, the research group will invite several experts from the engineering site to grade the students' report content and performance during the final report and defense, so as to cultivate students' sense of ceremony and make them pay attention to the quality of the selected report content.

Although the reform of teaching methods and assessment methods is still in the preliminary stage of exploration, the above-mentioned specific measures are not the final measures of curriculum system reform, it has achieved initial success. In the classroom, under the guidance of the teacher, students practice and discuss the training project. The classroom atmosphere is warm and the role of the teacher gradually changes from a single "narrator" to a "listener". This not only improves the students' learning initiative, but also timely feedback on the teaching effect to the teacher, so that the teacher can adjust the teaching

content and progress according to the learning effect. After class, when they know that temporary cramming at the last minute is not feasible, the student union is willing to spend more energy on the understanding of learning content, so as to lead some "lost Lambs" back to the correct path. Finally, students can see their original brilliance again in the defense, because they have prepared carefully. Students can talk about questions asked by teachers and experts. Although the answers are not necessarily correct, the confident attitude revealed by the students when they stand on the platform to answer the questions and the ability to search, sort out, process data and finally turn knowledge into their own use are undoubtedly valuable assets for them.

4. Conclusions

As an important part of the training plan for undergraduate students majoring in oil and gas storage and transportation engineering, the safety of oil and gas storage and transportation facilities has been paid more and more attention by the society. However, some existing problems have been reflected in the previous practical teaching activities, which have reduced the teaching quality and affected the realization of the objectives of the training plan for compound talents. By actively exploring solutions to problems, a set of curriculum system reform has been explored. Specifically, the teaching quality has been improved and the students' learning enthusiasm has been aroused by adjusting the training plan, merging courses, adding training items and making a flexible assessment system. The preliminary practice shows that the reform method has received good results. Students' understanding of the safety content of oil and gas storage and transportation facilities is more flexible, in-depth and systematic. They can draw inference from one instance and apply the knowledge to practical engineering cases, which is conducive to the realization of talent training objectives in the training plan. On this basis, the university will further explore the reform system. We should really guide the students to become the national pillars who can be competent for the safety of oil and gas storage and transportation facilities.

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