Discussion on the Teaching of "Engineering Materials" with Philosophy Thoughts

Yan Liu, Yanpeng Qu*, Qinghua Song and Songying Chen
Department of Process Equipment and Control Engineering, School of mechanical engineering, Shandong University, Jinan 250061.
First author email: liuyan_2006@sdu.edu.cn
*Corresponding author email: dania_qyp@sdu.edu.cn

Abstract. The college students in engineering can improve their professional level and comprehensive ability through learning the knowledge with philosophical ideas. In the teaching practice on the course of engineering materials, the authors constructed the contents including the ideological and political factors, and linked the philosophy thoughts with the professional education. The main results are as follows. We understand the similarities of engineering materials and life connotation, and clarify the internal relation and interaction mechanism between materials and objective environment through explaining the environmental theory; We know that we should find out the principal contradiction during the engineering materials selection and life path selection through the contradiction theory; We understand the influence of various factors on the change of material performances and the influence of creative tools on the development of disciplines through the things correlation theory; We recognize that we need to sum up the historical experiences and learn the failure analysis methods to reduce the probability of disaster accidents through the philosophy methodology. Some relevant teaching cases are introduced in this paper.

1. Introduction
High-quality and compound "new engineering disciplines" talents with creative ability, engineering practice ability and international competitiveness are desired in the emerging industries and new economies [1,2]. The college students in major of engineering should have better professional quality and comprehensive ability to adapt to the development of the industry.

The college students in engineering can improve their professional level through the curriculum learning. Philosophy is related to all fields and courses, and the course contents involved philosophy thoughts can help students to understand the lives, jobs and careers from a deeper level, a wider perspective and more diverse dimensions, and in turn, to strengthen their cognition of professional fields.

"Engineering Materials" is a compulsory course for the four-year "Mechanical engineering" major. The students should master the basic knowledge and principles of Engineering materials, especially metal materials, and the basic skills of selecting materials. And the course lay the foundation for the students to engage in the professional and technical work in the future. The course objects focus on the students' understanding and practical application ability involved the materials during the design, manufacture, installation, inspection, use and overhaul of the equipment.

Through the teaching practices of "Engineering Materials", the authors try to make some discussions on the role and function of philosophy thoughts in the course teaching, and present some teaching ideas.
2. Understanding the Connotation of Human Lives and Engineering Materials through Practical Environmental Theory

Human beings exist in different environments, some people strive to be heroes, some people are willing to be ordinary. Are the situations to create the heroes, or the heroes to build the situations? We regard that the heroes and situations are interdependent, and the situations means the environment. Engineering materials serve in a certain chemical and mechanical environment, and should also maintain a good relationship with the environment. We think the similarities of human Lives and engineering materials with the environment in at least five aspects as follows[3].

1) Adapt to the environment

Human beings follow the survival competition rules, and as the saying goes, "Do in Rome as the Romans do". People should adapt themselves to the local environment. The demand of many kinds of engineering materials is also to meet the needs of different environments.

2) Change the environment

In ancient times, Mother Meng moved house three times to change the learning environment and make Meng Ke study hard; At present, one of the purposes of the institutional reform is to change the environment of talents and distribute the human resource more reasonable. An example for the materials is the coating on the metal surface, which changes the chemical environment in order to reduce corrosion; Another example is applying the residual compressed stress on the metal surface, which changes the mechanical environment to reduce the risk of material fatigue.

3) Utilize the environment

There are the libraries, sports fields, internet and other generous learning utilities at school, students should learn to make good use of the resources and environments, and enhance their abilities and qualities. The environment of chemical corrosion is generally harmful to the materials, but the corrosion can also be utilized, for example, etching the surface of the metallographic specimen makes the observation more easily.

4) Learn from the environment

Human beings can be inspired through observing, and learning from the environment. For example, the emergence of bionics and biomimetic materials is based on learning from the biological functions in the environment; Another example is that the anticrossoption techniques and the construction qualities is promoted through the investigation of the Egyptian mummies and pyramids.

5) Protect the environment

Human beings must protect the environment, and live with the nature in harmony, and avoid to overexploit the resources. The development and use of materials must meet the requirements of resources, energy and environment. For example, if the pollution problem of a steel plant was not be solved effectively, the plant would be threatened with closure.

3. Application of Contradiction Theory in the Selection of Personal Problems and Engineering Materials

How to choose at the crossroads of the individual life, or how to choose the correct materials from hundreds of available materials? The Contradiction Theory in philosophy can be used in solving above problems.

A human’s life is always faced with a variety of choices, such as what primary or secondary school is it to go to? what college major is it to choose? What career is it to start with? These choices are full of contradictions. For examples, the choice of a boarding school means that there would be a space distance with parents, and personal freedom rises, but the comfort of life declines; the choice of an ideal major may not be that of the ideal school; if a big city were chosen to live in after graduation, the living cost might increase, but the career opportunities might rise. Most choices are not perfect. People should learn to grasp the principal contradiction, take into account the secondary contradiction, ignore the minor ones.

The materials selection is also involved some contradictions as follows.

1) The principal contradiction between environmental requirements and material properties

During the materials selection, the proposed requirements from the service environments, which include the medium, temperature, pressure and so on, constitutes the spear in the contradiction; And
the optional material’s properties, such as plasticity, toughness, processability, and high- and low-temperature performances, constitutes the shield in the contradiction. The shield should fit the spear suitably. If the requirements exceed the material’s properties, means it is used the sharp spear and insufficient shield, which would cause the material or parts failure easily; However, if the material’s properties far exceed the requirements, which would cause the waste of the materials.

2) The sub-contradiction between Material performances and economy

Economic factors are important in material selection, the cost of completing the product is primarily considered, and there should be a better combination of the performances and the performance - to - price ratio is relatively high in the selected material. Economic factors often become decisive when there are some alternative materials.

3) Minor contradictions among performances of Engineering Materials

Under the service conditions, the materials performances include the mechanical properties such as strength, plasticity, toughness, wear resistance, and fatigue resistance; and chemical properties, such as corrosion resistance, and heat resistance; and functional properties, such as sound, light, electrical, and magnetic properties. Only in rare cases does one material have an optimal combination of the performances. Therefore, a trade-off between one performance and another may be very often and necessary. A typical example is the strength and toughness, there is usually a very limited toughness in a high strength material. A reasonable compromise between them is necessary in this case [4].

4. Understanding the Development of the Discipline and the Influence of Various Factors on the Changes of Materials Properties through Dialectics

There is a universal connection between things, and a phenomenon may be the result of a variety of reasons. For example, a decline in someone’s memory, as a result, may be due to the short sleeping time, or longtime video-game playing, or academic and financial stress, or physical deterioration. During learning, we should fully understand the universal connexion of things and recognize the results from different angles, aspects and levels of the objects [5].

Different scientific fields are closely linked, and new discoveries or inventions in one scientific field will certainly have an impact on other fields. For example, the invention of the electron microscope, an observation tool, has enabled the study of materials to break through the original scale; The materialists can clearly observe the arrangement of molecules and atoms, and further discover the microscopic world of materials, and then may create more powerful new materials.

The deterioration of the materials’ performances under the services is inevitable, and it results from many interrelated factors, that should be fully considered in predicting the safety and service life of the equipment. Some factors are summarized as follows.

1) Materials’ nature

The deterioration of materials’ performances are mainly determined by the materials’ nature, including material composition, impurity content, micro-structure and grain size.

2) Service conditions of the Equipment

Process equipment is widely used in petroleum, chemical industry, energy, light industry, medicine, aerospace and other fields, such as heat transfer equipment, mass transfer equipment, chemical reaction equipment and various storage tanks. The service conditions include temperature, pressure, load and medium properties, which may be flammable, explosive, toxic and so on. These external factors are interrelated, and affect the microscopic and macroscopic properties of the materials over the service time.

3) Materials’ processing

Most of the materials have to be rolled, punched, rolled and welded, and; It is easy to produce cracks and various defects during the processing, and the possibility and degree of performance deterioration in service would be increased easily in these cases.

4) Other possible contingencies or anomalies

Sudden changes in the environment, such as sharp changes in temperature and pressure, and abnormal shutdown of the equipment, would cause damage to the materials.
5. Methodology of Failure Analysis of Equipment Materials

Human experience tells “do not fall in the same place twice”, or do not make the same mistake. However, there is a curse on human: someone always falls down where it is easy to fall down. How to break this curse? It is truly necessary to summarize and analyze the experiences and lessons in time. Failure analysis of materials is often used to find the failure causes, reduce the failure risk, improve the product quality and reliability, and avoid the catastrophic accidents. The failure analysis process generally includes the following steps.

1) Accepting the task, and investigating of the accident
   The primary investigation includes the process background, the service conditions, and the records of the accident.

2) Testing of the failed parts
   The tests generally includes the material identification, the metallographic analysis, the microstructure inspection, and the mechanical properties testing.

3) Comprehensive analyzing of the failure
   The root causes of material failures can be summarized from four aspects: design, material selection, processing and installation. The causes can be obtained through comprehensive theoretical analysis and test results.

4) Advising of prevention measures
   Specific improvement measures are proposed to avoid the recurrence of the similar accidents. In the methodology of failure analysis, the idea of failure-based design and failure-based inspection is established. The installation, operation, inspection, inspection and maintenance are carried out strictly in accordance with the rules; and the equipment and device systems are designed and manufactured under the essential safety.

6. Conclusions

In this paper, the authors presents some teaching contents involved philosophy thoughts, such as environmental theory, contradiction theory, dialectics and methodology. It shows that the close combination of the teaching contents on engineering materials with the philosophy thoughts can help the students to ignite their thinking spark and infiltrate them into the other courses. Genuine knowledge comes from practice, and the truth can be tested only by practice. The rich experience and deep thinking of the teachers in teaching, scientific research and production practice are encouraged to integrate into the course. We think that the course content from the production practice, the historical background, the development of international and domestic research is of great enlightenment to the students' learning and work.

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8. References

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