Improving the quality of learning discipline “Technical thermodynamics and heat exchange” at ONMU

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Abstract. Discipline «Technical thermodynamics and heat exchange» creates a theoretical basis for students of ship-engineering faculty of Odessa National Maritime University to learn special subjects such as: Internal Combustion Engines, Steam and Gas Turbines, Steam Boilers, Refrigerating Plants. This course forms future specialist and provides the deep understanding of essence of thermodynamic processes which run in machines and apparatus of ship. Also different kinds of heat exchange in solid, liquid and gaseous bodies which take place almost in all technological processes are considered. The quality of training ship engineers depends on the knowledge of mentioned discipline.

1. Introduction
For better mastering of educational material by students the discipline «Technical thermodynamics and heat exchange» is divided on three modules: processes and cycles in ideal gas, processes and cycles in real gas, fundamentals of heat exchange. There are known textbooks on discipline [1,2] which contains professionally stated material on each theme. In addition the tutorials were published [3,4,5] in which the theory on all three modules is set up and questions for self-control and examples of problem solving are given.

2. The methodic of teaching the discipline “Technical thermodynamics and heat exchange”
The program of studying the discipline built in such a way that the students in the first module learn the main thermodynamic notions during the studying of properties and processes in ideal gas. In the second module the students work with the equations of state, diagrams and cycles in real gas. And in third module the basics of heat and mass exchange are learnt. Both basic textbooks and addition tutorials help students in studying process.

In the tutorial [3] the first and second laws of thermodynamics are considered. On their base thermodynamic processes and cycles in ideal gas are examined. Main attention is devoted on cycles of interna combustion engines and gas turbines. The comparison of various cycles of mentioned engines is fulfilled. On figure 1 the cycle of combined engine which unite the internal combustion engine with gas turbine is presented.

In the tutorial [4] thermodynamic properties of real gas and processes and cycles in this gas are examined. Great attention is devoted on various cycles of steam turbines and on influence of parameters of vapor on their efficiency. On figure 2 the scheme of steam turbine plant with intermediate overheating of vapor and regenerative heating of feeding water is presented. In this tutorial the processes in refrigerating plants and in wet air are also considered.
The third tutorial [5] contains the description of main processes of simple and complex heat and mass exchange. Also processes of boiling and condensation are disclosed in detail. Most details the processes in heat exchangers are described in this tutorial because heat exchangers are in the nearly all systems which service the ship power plant. On figure 3 the traffic patterns of coolants and nature of their temperature changing in heat exchangers are presented where the left part of figure corresponds to straight flow and the right part corresponds to counter flow. It should be noted that, in contrast to thermodynamic processes in describing the processes of heat and mass transfer it is necessary to take into account the time factor.

The quality of teaching depends on:
- completeness of material statement;
- fastening of theoretical knowledge on practical and laboratory employments;
- availability of methodical manuals;
- objectivity of control of students’ knowledge.

![Figure 1. The cycle of combined engine.](image1)

![Figure 2. The scheme of steam turbine plant with intermediate overheating of steam and two regenerative heaters of feeding water.](image2)
Figure 3. Traffic patterns of coolants and nature of their temperature changing in heat exchangers:

Lections on discipline are read with using of multimedia tools. Each lecture is a presentation in which the conforming definitions, schemes, graphics and diagrams are given. Students on their places are watching presented material on manuals and doing only necessary marks on their writing-books. Full texts of lectures are in electronic variants of manuals which students are provided with.

Theoretical material is fixed during the laboratory works performance and solving of typical tasks on practical employments. The discipline «Technical thermodynamics and heat exchange» is provided the performance of five laboratory works in which are the tests on deriving of properties of ideal and real gases and which obviously presents the fulfillment of main laws of thermodynamics. During the laboratory work students experimentally verify the correctness of the equation of state of an ideal gas for an isothermal process, determine the heat capacity of an ideal gas at the isobaric process, plot the boiling curve of a real gas and determine the heat of vaporization of water. One of laboratory works is devoted of learning of process of complex heat exchange. On each laboratory work students obtains conforming data, process it themselves and justify the results to the teacher.

On practical employments students solve the tasks which provide calculation of thermodynamic processes in such plants as internal combustion engines, steam boilers, turbines and refrigerating plants. For fastening the practical skills students receive individual tasks on each module. Practical preparation of student is controlling by solving of control tasks by him. Only those students who have completed the laboratory works on the module are allowed to perform the control work. As control tasks, students solve the problem of determining the values of thermodynamic properties at characteristic points and the efficiency of the cycle of the internal combustion engine on the basis of the equation of state of the ideal gas, the values of the properties and the efficiency of the cycle of the steam turbine plant according to the equation of state for water and vapor, and the problem for heat exchange. After the performance of task the student must to explain the teacher how he realize the calculations and to prove the engineer solutions accepted by him.

Control of theoretical knowledge of students is caring out by testing on computer. Testing is carried out in a special computer classroom. The database on the host computer contains two hundred questions for each module. On each of the questions four or five variants of answers are provided. The right answer is the most complete of the proposed ones. If the chosen variant only partially answers the question, then it is not counted as correct and is estimated at zero points. The student must answer...
during forty minutes on fifty questions which are choosing optional from two hundred ones. If the student does not have time to answer all questions within the allotted time, then the mark for the unanswered questions also corresponds to zero points. Testing works are usually conducted at the penultimate or at the last week of each module.

The total mark on each module is derived by summation the marks on all types of control. The maximum result which is 100 points is formed as follows: 10 points for attending classes, 10 points for performing laboratory works, 10 – performing an individual homework, 30 – solving a control task and 40 – testing on a computer.

As a result, students are assessed on each kind of activity: theoretical preparation, individual task fulfilment, laboratory works performance and solving of control tasks by them. This multi-level control ensures the objectivity of assessment of student knowledge. So thanks to comprehensive learning of discipline «Technical thermodynamics and heat exchange» and major check-up the deep level knowledge of fundamental disciplines is provided.

Improvement of students’ knowledge is facilitated by their preparation of reports at student scientific conferences under the guidance of teachers. The main topics of the reports are analysis of cycles of heat power plants and improvement of heat transfer processes. The best reports are then submitted to the competition of scientific student works. Students participate not only in university conferences, but also in international ones, which are held both in Ukraine and abroad.

References
[1] Kirillin V A, Sychev V V and Sheindlin A E 1983 Technical thermodynamics. The textbook for high school (Moscow: Energoatomizdat) p 416
[2] Mikheev M A and Mikheeva I M 1977 Fundamentals of heat exchange (Moscow: Energiya) p 344
[3] Vasserman A A and Slinko A G 2013 Thermodynamic processes and cycles in ideal gaze (Odessa: Phoenix) p 198
[4] Vasserman A A and Slinko A G 2015 Thermodynamic processes and cycles in real gaze (Odessa: Phoenix) p 194
[5] Vasserman A A, Slinko A G and Malchevsky V P 2011 Fundamentals of heat exchange (Odessa: Phenix) p 150