Sequence - Sequence Fundamentals Of Experimental Problems In Thermodynamics And Thermal Engineering

Jurayev Farkhod Niyozovich
Navoi State University of Mining and Technologies, Lecturer of
“General Physics” department

Abstract. In the realms of exact and natural sciences, empirical experimentation forms the cornerstone of profound understanding and advancements. This intrinsic dependence on experimental validation underscores the indispensable role of laboratory work as a complementary and integral format of practical exploration. This article aims to delineate the systematic methodology employed in conducting experimental research within the domains of thermodynamics and thermal engineering, providing insights into the procedural sequence that ensures the integrity and reproducibility of scientific investigations in these fields.

Key words: Problem, experiment, piston compressor, hydraulic circuit, pneumatic circuit, kinematic circuit, combined circuit, receiver, construction.

Despite the significant focus on theoretical disciplines within universities in Uzbekistan and other countries, a substantial portion of each curriculum is dedicated to practical components. In the fields of socio-humanitarian studies and economics, these practical elements are predominantly comprised of seminars, discussions, and research projects. In the realms of exact and natural sciences, experiments stand as the foundational pillars, indispensable for a profound comprehension of one’s field. Thus, laboratory work emerges as an essential adjunct to theoretical study. From an educational standpoint, the quintessential objective lies not in mere evaluation but in examining the application of theoretical knowledge in practical scenarios. This approach is designed not for oversight, but to fortify acquired skills and facilitate the internalization of information [1].

In the educational journey, a mistake is not merely an error but a valuable experience, one that can be rectified with ease. However, in the professional realm, the stakes are exponentially higher. Take biological research, for instance, where the acquisition of costly equipment and samples signifies a significant investment, and research endeavors may span several months. A single misstep in the workflow could necessitate starting from scratch, resulting in substantial losses for research institutions. The ramifications extend further in fields like medicine, where errors can have life-or-death consequences. Thus, bypassing laboratory work is a luxury students cannot afford, even if they wish to. Laboratory sessions are crucibles, shaping and honing the critical skills indispensable for their future careers. Moreover, participation in these practical engagements is often a prerequisite for undertaking tests and exams, underscoring their non-negotiable importance.

While experiments share a kinship with practical exercises, the distinction between the two is pronounced. Seminars serve as crucibles for the consolidation or enhancement of knowledge acquired during lectures, often allowing for preparation in the sanctuary of one's home. This preparation might include composing lectures or essays, delving into supplementary literature, or grappling with probing questions. However, experimental work stands apart, adorned with unique attributes that set it distinctively aside from the usual gamut of student tasks:

- The essence of experimental work lies in its ability to transcend mere rote memorization, offering a profound application of knowledge. In this dynamic process, theory learned in academic settings is not only consolidated but mastered in scenarios mirroring the real-world challenges faced by professionals in the field.

- Engaging in experimental training is not merely beneficial; it is imperative for achieving exemplary outcomes. While a student may forgo seminars without consequence, experimental tasks demand hands-on participation—remote execution is not an option. Completion of the written component requires a nuanced understanding of the experiment's progress, coordination with laboratory personnel, and dedicated effort outside of scheduled sessions.
- The culmination of experimental work in its defense is a critical juncture for evaluation. Students may present their findings orally or in written form. However, throughout the semester, the opportunity for direct, in-person inquiry ensures that students must be prepared to engage with and respond to the instructor's queries on the spot.
- Undertaking experimental work is not without its hazards; thus, adherence to all safety protocols is not just advisable—it is mandatory. This commitment to safety underscores the serious nature of these endeavors, where the real risks involved necessitate a vigilant and disciplined approach.[6]

Students who pursue graduate studies driven by a genuine passion for their chosen field often find this class format more captivating than traditional lectures and seminars. The allure of experimentation lies in its ability to deeply engage students, providing them with authentic tasks that mirror the challenges and rewards of real-world applications:

- Identifying the Inquiry: Establishing the research goal and selecting methodologies for resolution;
- Strategizing: Crafting a detailed plan, including the allocation of time and resources;
- Mobilizing Equipment: Setting up the laboratory, engaging with tools and machinery;
- Executing the Experiment: Performing essential experiments, scrutinizing outcomes;
- Analyzing Data: Processing and elucidating gathered data, constructing graphs and charts;
- Drawing Insights: Synthesizing findings, aligning them with theoretical frameworks, substantiating deductions;
- Showcasing Discoveries: Compiling a comprehensive report on experimental endeavors, exhibiting findings to peers.[7]

At this point, it is very important to follow the rules for working with electrical devices. The following are prohibited in electrical devices:

Activating or Deactivating Power and Light Sources without explicit authorization from an instructor or laboratory assistant;

Engaging in Repairs on Energized Electrical Systems;

Leaving Experimental Apparatus Energized and Unsupervised;

Tampering with Warning and Prohibition Signs;

Disabling Device Safety Lockouts;

Navigating Obstructions or Reaching Over Equipment During Setup;

Disconnecting Ground Wires or Operating Electrical Equipment Without Proper Grounding;

Making Contact with Exposed Conductors, Metal Connectors, Rheostat Coils, or Other Components of Electrical Circuits. [3]

The results of the study show that each stage of basic concepts with experimental work requires a certain amount of time. As an example, let's consider the case of tajhiba on the following topic. The subject of the experiment: Studying the principle of operation of the piston compressor and obtaining the structural dimensions of the oscillating block.[5]

1st step. Problem formulation:

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a) Conducting a visual examination of the piston compressor's functionality and apparatus, observing the systematic arrangement of the vibration block components, measuring the primary geometric dimensions of the vibrational trajectory, and calculating the operational volume derived from these measurements;

b) Delving into the theoretical underpinnings.

2nd step. Planning: Working with educational laboratory assistants after class in the allotted hour in the auditorium.

3rd step. Use of equipment**:**

a) Learning the elements of the device, the measurement range and level values of measuring instruments.

TTsPM-011-05LR-01 experimental device, a demonstration of a piston compressor, a cut-out model and a pneumatic circuit are placed on the front of the device panel (Fig. 1). 1. The Base: Providing stability to the entire setup.

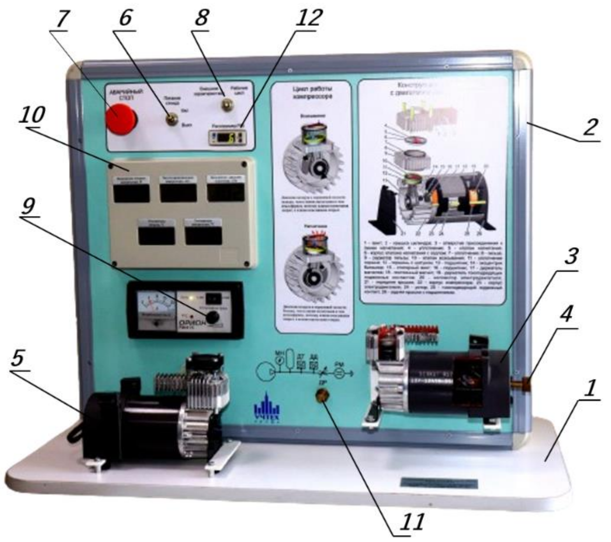


Figure 1. Experimental device TTsPM-011-05LR-01

1. Device Frame: Houses the front-facing test measurement instruments, with the receiver and connecting pipes nestled inside.

2. Compressor's Sectional Model (First Instance): A detailed cutaway view for in-depth examination.

3. Compressor's Sectional Model (Second Instance): Showcases the flywheel that drives the moving parts.

4. Piston Compressor: The heart of the operation, facilitating compression.

5. Power Supply Switch: Controls the electrical power to the unit.

6. Emergency Stop Button: A crucial safety feature allowing immediate cessation of all operations.

7. Compressor Shutdown Button: Enables controlled shutdown of the compressor.

8. Operating Mode Selector: Features three positions - left for "Operating Characteristic," right for "Obtain Indicator Diagram," and middle for turning off.

9. Compressor Current Source Adjuster: Fine-tunes the compressor's electrical input.

10. Measurement Display Windows: Offers real-time data insights.

11. DR Throttle Adjuster: Manages the throttle's positioning for optimal control.

12. Air Consumption Meter Display: Monitors and displays air consumption rates.

b) Learning the scheme of the experimental device.

A scheme is a design document that shows the components of the product, their mutual location and connections in the form of conditional images or symbols. Schemes are divided into the following depending on the type and type of elements (Table 1):

Table 1.

Scheme groups		**Types of schemes**	
Groups	**determination**	**Type**	**determination**
Electric	E	Structure	1
Hydrolic	G	Functional	2
pneumatic	P	Principal (main)-	3

Kinematics	K	connective	4
Combined	C	connector	5
		General	6
		locator	7

The principle pneumatic scheme of the exhibition stand (powered by compressed air) is presented in Fig. 2 with the relevant designations.

MN - monometer; DR – throttle; RM - consumption meter (Rashodomer); To prevent overloading and overheating of the compressor and the device stand, the following are connected to the device; DT - temperature relay (a device that connects and disconnects an electric circuit, an automatic switch), disconnects the compressor from the power source if the temperature rises above the temperature required for the safe operation of the compressor body; DD - pressure relay, disconnects the compressor from the power source if the pressure in the compressor receiver exceeds the required pressure for safe operation.

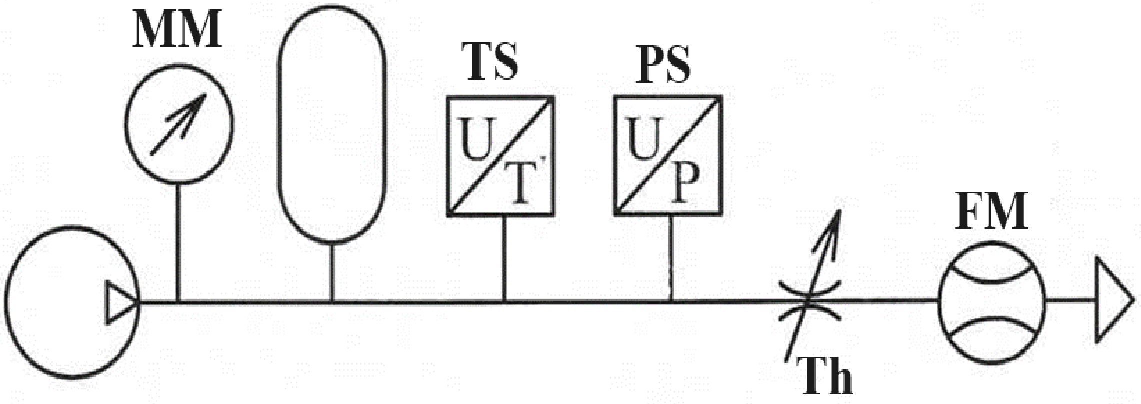


Figure 2. Pneumatic scheme of the experimental device.

4th step. Eksperiment: to conduct the necessary experiments, to evaluate the obtained results, it is necessary to learn the procedure for performing the work and perform the work.

1. To study the construction of the compressor according to the cut-out model and drawing placed in the front part of the panel of the reciprocating compressor device.

2. After studying the construction of the compressor, compare the elements according to the diagram in Fig. 1.

3. By turning the flywheel 4 by hand, measure Ln - the piston path (the distance between the highest and lowest points of the compressor piston).

4. Calculation of the geometric working volume of the piston compressor:

$$q_n = \frac{\pi \cdot D_p^2}{4} \cdot L,$$

D_n =30 mm; compressor piston diameter.

5. Making appropriate conclusions and writing reports.

5th step. Data analysis - processing and interpretation of received data, drawing up graphs and tables;

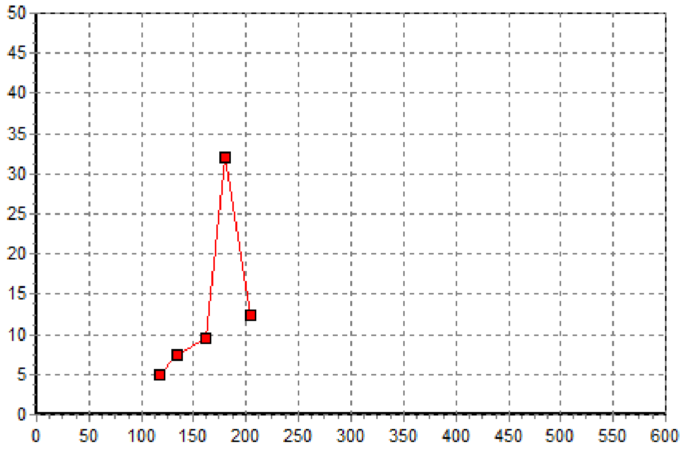
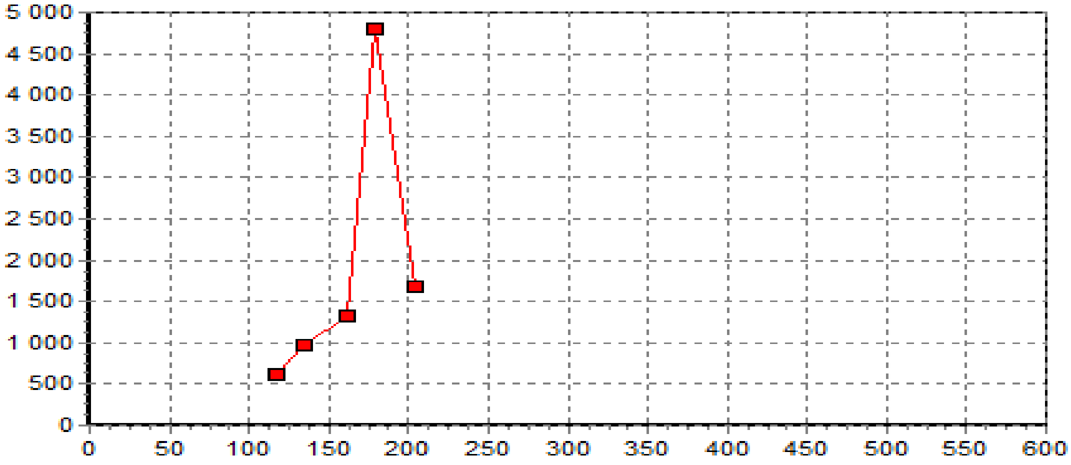


Figure 3. Diagram of dependence of air consumption (l/min) on pressure (kPa).

Figure 4. Diagram of dependence of engine speed (rpm) on pressure (kPa).



Preliminary data for the calculation part of the experimental work to study the working principle of t sions of the oscillating block are presented i software included in the computer program during the execution o

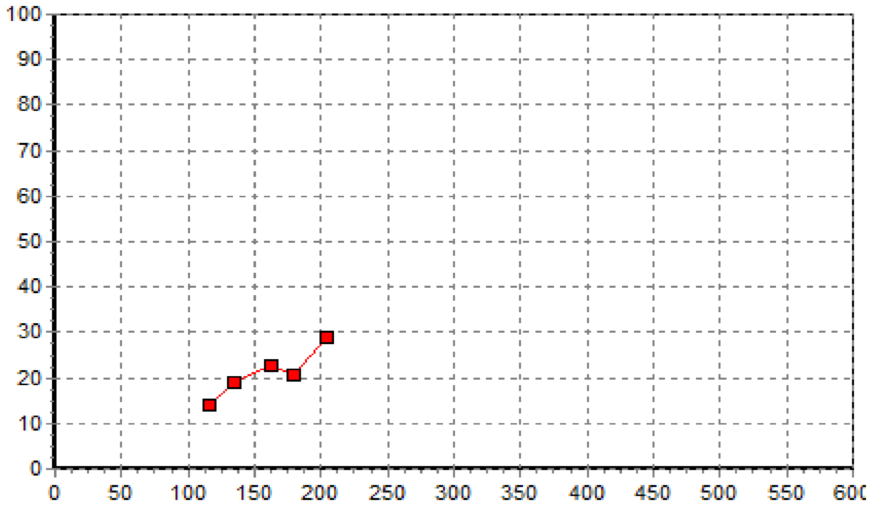


Figure 5. Diagram of dependence of useful work coefficient (%) on pressure (kPa).

Table 2.

Pressure, *kPa*	**Consumption, *l/min***	**Current, *A***	**Voltage, *V***	**Number of rotations, *r/min***	**CPI, %**
117	4.9	5.6	2.8	622.3	14
135	7.4	7.4	3.9	966.5	19

162	9.6	9.7	5.2	1320.4	23
204	12.5	12.6	6.5	1675.0	29
179	32.0	15.5	14.8	4807.7	21

6th step. Forming conclusions: In order to summarize the work results, compare them with theoretical knowledge and justify the conclusions, students will find answers to the following questions.

1. Explain the function of a single-stage piston compressor device;
2. What types of compressors do you know;
3. What thermodynamic processes occur in a piston compressor;
4. How is the theoretical power of the compressor determined, justify your answers;
5. How is the work performed on compressors determined;
6. Draw an indicator diagram of the compressor and explain the processes that take place in it;
7. What is the difference between a theoretical chart and an indicator chart.

7th step. Result presentation: In this part, students prepare a report on the experimental work. In doing so, they arrange the relevant accounting work and put it on paper. They make worker and heat diagrams for the studied work. The results of the prepared report will be presented to the students in writing or in a presentation.

Conclusion: Here it should be noted that the experience is not only interesting, but also a sum of knowledge, skills and abilities. In higher education, the credit-module system of teaching, most of the students' time is not in the classroom, but in independent hours. Taking this into account, preparation for experimental lessons should start a little earlier, from the first lesson. For this, for their learning, methodical instructions should be distributed or given in an electronic version. After all, it is impossible to learn perfectly in one lecture hour. Otherwise, production and industry mishaps and a single mistake can be costly.

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