A. V. GONCHARENKO

AIRCRAFT ENGINES
LECTURE NOTES
(First Preliminary Edition)

Section A. Nomenclature Topics

Part I. Thermodynamic Processes, Real and Ideal Gases

Chapter 2. Basic Considerations of Thermodynamic Processes

LECTURE 3. MAIN THERMODYNAMIC PROCESSES

§ 1.4. Thermodynamic process

Under thermodynamic process it is understood a sequence of states (series, complex (the whole collection) of sequential states), through which a thermodynamic system undergoes at its interaction with the surrounding medium [113, pp. 12-14].

The state of a thermodynamic system can be equilibrium or non-equilibrium (disequilibrium). The **equilibrium state** it is called the such one of a system when in all points of the volume of the system there are the same all parameters of state (state variables) and physical properties (pressure, temperature, specific volume and others). It is postulated in the thermodynamics, that an isolated system in the course of time always comes to the state of thermodynamic equilibrium and never can go out of it by itself (on its own).

All processes, that occur (happen, go by) in a thermodynamic system, are subdivided into equilibrium and non-equilibrium (disequilibrium). The **equilibrium processes** are called such ones when the system in the course of the process undergoes a series of sequential equilibrium states. If a process goes by so slowly that at every moment of time it is stabilizes the equilibrium, then such processes are called **quazystatic**. These processes have properties of **reversibility**.

The **non-equilibrium (disequilibrium) processes** are called such ones at going of which the system is not in the equilibrium state. The process of transition of

a system from a non-equilibrium (disequilibrium) state into the equilibrium one is called a **relaxation**, and the time of that transition into the equilibrium state – the **time of relaxation**.

All real processes, going in nature, are non-equilibrium (disequilibrium).

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Any arbitrary taken equilibrium state in the three-axis coordinate system of pvT is pictured by (gives a picture of) the point, and the combination (whole complex) of these points at the continuous change of states – is illustrated by some certain curve, representing by itself the graphical image (picture, portray) of the equilibrium process.

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In engineering thermodynamics for the purpose of research (investigation) of equilibrium thermodynamic processes there most often applied (used) the two-axis coordinate system of p-v. In this coordinate system, the vertical line images **isochoric process**, the horizontal – **isobaric**, the curve in the view of a hyperbole – **isothermal** (fig. 2.2), [113, fig. 2.2]. Besides (moreover), in thermodynamics it is considered processes the **adiabatic**, carried on at the absence of the heat-exchange $(dq = 0)$ and the **polytropic**, the generalizing process, the partial cases of which are the first four processes.

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Computer simulation can be conducted in the view of the modeling proposed in papers [14, 27, 29, 31].

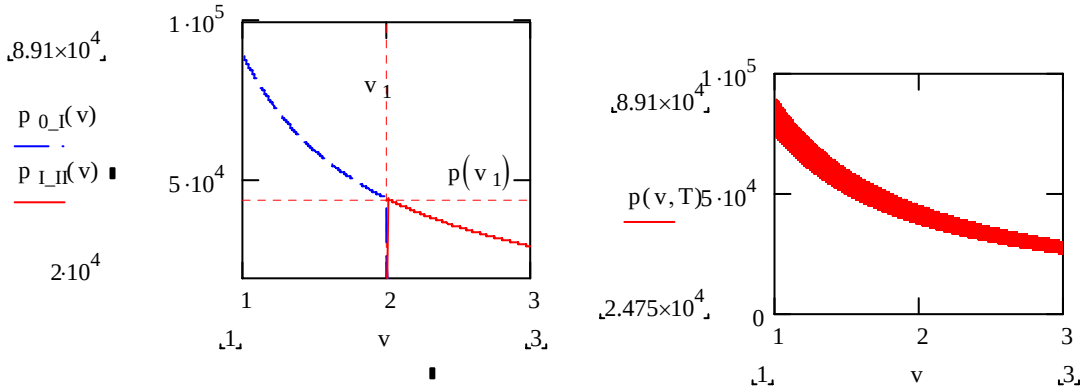
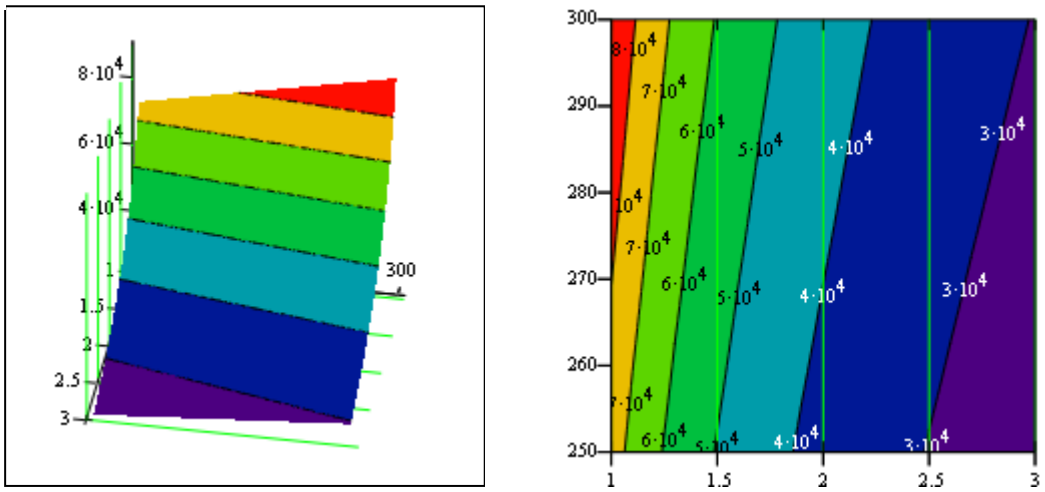


Fig. 2.2

The simulation is presented for nitrogen.



p p

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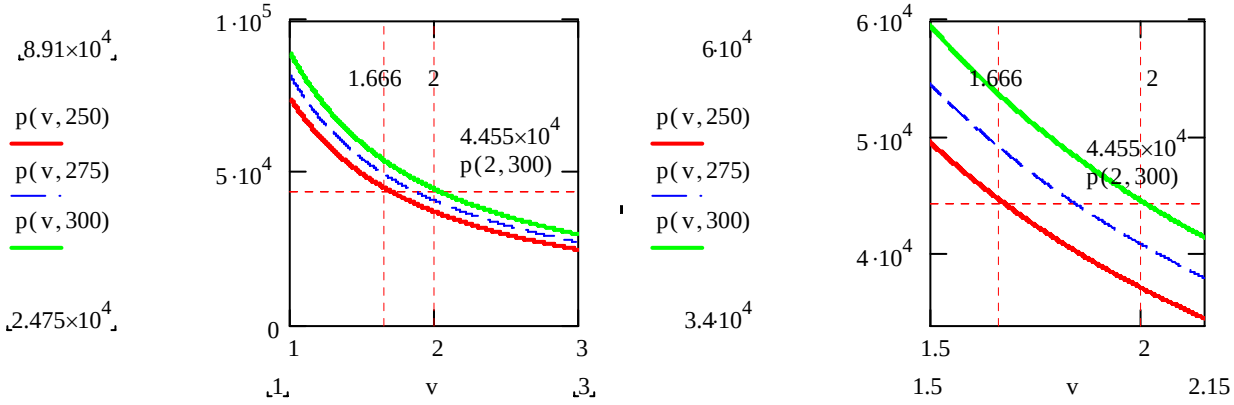

Any parameter of state (state variables) is also the function of state, because its change in any thermodynamic process does not depend upon the view of the process, but is determined just by the beginning and the end state.

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A **circle process** or a **cycle** is also pertaining (relevant) to thermodynamic processes. A combination (whole complex) of processes, returning the system into its initial state is called a **cycle**.

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[113, pp. 12-14].