PROCEDURE FOR DETERMINING LABOR-PRODUCTIVITY GROWTH FACTORS IN REFINERIES

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In petroleum refining, there is thus far no generally accepted procedure for factor-by-factor determination and analysis of labor productivity that takes into account the specific features of this branch of industry. This is one of the reasons why refineries do not perform any factor-by-factor analysis of labor productivity.

We are recommending a procedure for the quantitative evaluation of the most important factors in increasing the productivity of labor; the development of this procedure drew on other published works [1, 2] and on methodological studies that we carried out in the Branch of Economic Research of BashNII NP [Bashkirian Scientific-Research Institute for Petroleum Processing] in 1971 [3].

According to the existing procedure, the incremental labor productivity for a refinery in an accounting period, in comparison with a basis period, is defined by the following formula:*  

\[ \Pi = \frac{V_a}{T_a} - \frac{V_b}{T_b}, \]  

where \( V_a \) and \( V_b \) are the gross production volumes for the plant in the accounting and basis periods, rubles; \( T_a \) and \( T_b \) are the numbers of commercial production personnel in the accounting and basis periods.

Equation (1), for the purposes of factor analysis, is converted to the form  

\[ \Delta \Pi_i = \frac{\Delta V_i}{T_a} = \frac{\Delta T_i \cdot \Pi_b}{T_a}, \]  

where \( \Delta \Pi_i \) is the increment in labor productivity for the accounting period (in comparison with the basis period) that is due to the i-th factor, rubles/man; \( \Delta V_i \) is the increment in gross production volume due to the i-th factor, rubles; \( \Delta T_i \) is the change in number of personnel; \( \Pi_b \) is the productivity of labor for the plant during the basis period, rubles/man.

Equation (2) makes it possible to determine how the productivity of labor is influenced by each factor through changes in the gross production and number of personnel.

If only the gross production volume changes (i.e., with the same number of personnel, \( \Delta T = 0 \)), the increment in labor productivity can be determined from a simplified formula:  

\[ \Delta \Pi_i = \frac{\Delta V_i}{T_a}. \]  

*This procedure is acceptable for evaluating the factors in productivity growth calculated on the basis of standards for net (nominal-net) production and costs of direct and materialized labor, i.e., in those cases in which the production volume is calculated by multiplying the quantity of each type of article by an appropriate measure in value, or other index. Since the petroleum-refining branch does not currently have any approved standards for net (nominal-net) production, the production volume in our procedure is expressed in terms of average USSR prices. However, the proposed method of calculation is applicable with the methods mentioned above for determining labor productivity.

When only the amount of direct labor changes (i.e., $\Delta V = 0$), the formula has the form

$$\Delta P_i = \frac{-\Delta T_i H_i b}{T_a}. \quad (4)$$

In the following paragraphs we set forth a procedure for the quantitative evaluation of various factors in the change of labor productivity in a refinery.

**Introduction of New Processes or Units.** When new manufacturing processes are put into service in a refinery, both the gross production volume and the number of personnel are changed.

The incremental volume of gross production due to bringing new units on stream for the primary processing of crude oil ($\Delta V_p^P$) and secondary processes ($\Delta V_p^S$) is calculated through the use of Eqs. (5) and (6):

$$\Delta V_p^P = \sum_{i=1}^{n} A_i^a \bar{w}_i, \quad (5)$$

$$\Delta V_p^S = \sum_{i=1}^{n} A_i^a \bar{w}_i - \sum_{i=1}^{m} H_i^b \bar{w}_i, \quad (6)$$

where $A_i^a$ and $H_i^b$ are, respectively, the actual volumes of product output and feedstock processed during the accounting period in the new units, tons; $\bar{w}_i$ and $\bar{w}_i$ are the average USSR wholesale prices for each type of petroleum product and feedstock or intermediate that is processed [1], rubles/ton; $n$ and $m$ are the respective numbers of different petroleum products and feedstocks.

The formula for change in labor productivity due to the introduction of new units ($\Delta P_n$), taking into account the change in production volume ($\Delta V_n$) and number of personnel ($\Delta T_n$), has the form

$$\Delta P_n = \frac{\Delta V_n - \Delta T_n H_n b}{T_a}. \quad (7)$$

where $T_n$ is the number of personnel required for operation of the new units.

**Automation and Mechanization of Direct and Auxiliary Production Facilities.** The automation and mechanization of production gives mainly a reduction in the labor required for a given production volume ($\Delta T_{am}$). An increase in the level of automation furnishes the means for more precise maintenance of given process conditions, improvement in end-product quality and increases in yield, and extension of the operating periods between shutdowns for maintenance; the overall effect is to increase the gross production volume ($\Delta V_{am}$).

The change in labor productivity as a result of automation and mechanization ($\Delta P_{am}$) is characterized by the formula

$$P_{am} = \frac{\Delta V_{am} - \Delta T_{am} H_b}{T_a}. \quad (8)$$

**Change in Utilization of Process Units with Respect to Time and Capacity.** This factor influences the production volume. The change in gross production volume with respect to primary crude-oil processing ($\Delta V_{el}^P$) is determined from the formula

$$\Delta V_{el}^P = \sum_{i=1}^{n} \left( A_i^a - \frac{H_i^b a_i}{100} \right) \bar{w}_i. \quad (9)$$

and for the secondary process units, from the formula

$$\Delta V_{el}^S = \sum_{i=1}^{n} \left( A_i^a - \frac{H_i^b a_i}{100} \right) \bar{w}_i - \sum_{i=1}^{m} H_i^b \bar{w}_i (H_i^a - H_i^D), \quad (10)$$

where $H_i^b$ is the quantity of feedstock of each type processed in the primary crude oil units during the basis period, tons; $H_i^a$ and $H_i^D$ are the quantities of feedstock processed in primary crude oil units or secondary processes during the basis and accounting period, tons; $a_i^a$ is the actual yield of product of each type during the accounting year, %.

*Quantities are in metric tons throughout article – Translator.*