

MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
NATIONAL TECHNICAL UNIVERSITY
KHARKIV POLYTECHNICAL UNIVERSITY

METHODOLOGICAL INSTRUCTIONS
FOR PRACTICAL WORK «EQUIPMENT PLACEMENT FOR FLOW
PRODUCTION WORKPLACES» FROM THE DISCIPLINE
«FUNDAMENTALS OF ENGINEERING TRAINING» FOR FULL-TIME
AND PART-TIME STUDENTS OF SPECIALTY J4 «OCCUPATIONAL
SAFETY»

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Methodological instructions
for practical work «Equipment placement for flow production workplaces»
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INTRODUCTION

A characteristic feature of mass production is the production of the same type of products of limited range in large quantities for more or less a long time. Large volumes of production and rather high stability of a design of a product do careful advantage of careful development of technological processes. Operations of technological processes are differentiated into individual transitions, labor methods and are performed on special high-efficiency equipment with the help of appropriate equipment. Jobs are narrowly specialized by assigning a limited number of detail operations to each of them.

Under such conditions, the most efficient form of production is the organization of synchronized, fairly stable over time production production and production lines.

Flow production is a highly efficient method of organizing the production process. Under the conditions of the flow, the production process is carried out in maximum accordance with the principles of its rational organization.

Improving the operation of production lines can take place in the following areas: improving working conditions in the workplace; stream synchronization; reduction of equipment downtime; streamlining workplace flow; timely supply of raw materials; conducting multi-machine service and combining professions.

Purpose: to gain skills in placing equipment for workplace production streams.

1. GENERAL INFORMATION

The development of modern production follows the path of mechanization and automation of production processes, in which their continuity is combined with automatic execution. In this regard, the issue of organizing flow production is quite relevant. Flow method of production is the most efficient and progressive form of organization of the production process, as it allows to ensure compliance with such basic principles of rational organization of production processes as continuity, parallelism, rhythm, accuracy and proportionality.

Flow production is a form of organization of production based on the rhythmic repetition of the time of execution of basic and auxiliary operations at specialized workplaces located in the course of the technological process.

The streaming method is characterized by:

- reducing the range of products to a minimum;
- division of the production process into operations;
- specialization of jobs to perform certain operations;
- parallel execution of operations at all workplaces in the flow;
- location of equipment in the course of the technological process;
- high level of continuity of the production process based on ensuring the equality or multiplicity of the duration of the flow flow flow operations;
- the presence of special inter-operational transport for the transfer of objects of labor from operation to operation.

The structural unit of flow production is the production line.

Production line – it is a group of jobs that are located in a strict sequence of operations of the technological cycle, which are assigned to certain operations. Several production lines make up the shop.

Main characteristics of the production line:

1. Assignment for each workplace only one operation for the manufacture of parts or assembly of products.
2. Location of jobs along the line.
3. After the operation, the details are transferred to the next workplace one by one.
4. Synchronization of the continuation of each operation of the technological process on the production line. That is, operations must be multiples of the clock cycle.
5. Mechanization of transfer of parts and products from one workplace to another.
6. Closed nature of production, which includes all work on the manufacture of parts and products.

Production lines may differ from each other in the following characteristics:

- nomenclature of manufactured products;
- the level of continuity of the process;
- level of mechanization and automation;
- equipment adjustment conditions, etc.

The economic efficiency of the flow method is ensured by the effectiveness of all principles of organization of production: specialization, continuity, proportionality, parallelism, accuracy and rhythm.

The disadvantages of the flow organization of production are:

1. The main requirements for the selection of products for the manufacture of the flow method include the durability and relative stability of their structures, large-scale production, which does not always meet market needs.
2. The use of conveyor lines increases the transport backlog (work in progress) and makes it difficult to transfer product quality information to other jobs and sites.
3. The monotony of work on production lines reduces the material interest of workers and increases staff turnover.

Measures to improve flow methods include:

- organization of work with variables during the day of the clock and the speed

of the production line;

- transfer of workers during the shift from one operation to another;
- the use of multi-operational machines that require regular switching of workers' attention to different processes;
- material incentives;
- introduction of aggregate-group methods of organization of the production process, production lines with a free rhythm.

The main direction of increasing the economic efficiency of flow production is the introduction of semi-automatic and automatic production lines, the use of robots and automatic manipulators to perform monotonous operations.

The main operating parameters of different types of production lines (conveyors) are determined using the following relationships:

- flow line clock r - the ratio of the actual time of the production line in the calculation period in minutes (F_p) to the volume of production for the same period in kind (N):

$$r = \frac{F_p}{N};$$

- rhythm R is the product of the flow line stroke (r) by the value of the transport batch n_T :

$$R = r * n_T;$$

- effective time line of the production line (F_p) (min.) determined by formulas:

a) per shift (variable):

$$F_{\text{var}} = T_{\text{var}} - t_{r.b.},$$

at T_{var} - duration of shift work, minutes;

$t_{r.b.}$ - regulated breaks for rest per shift, minutes;

b) per day (daily):

$$F_{daily} = (T_{var} - t_{r,b.}) * S ,$$

at S – number of work shifts per day;

B) per month or year:

$$F_{daily} = (T_{var} - t_{r,b.}) * S * Dy ,$$

at D_y – number of working days per month or per year;

– the number of jobs per operation C_{jpi} – the ratio of the complexity of the i -th operation t_i to the stroke of the production line r :

$$C_{jpi} = t_i / r ;$$

– the workload of the workplace on the i -th operation k_w – the ratio of the estimated number of jobs C_{jpi} to a larger number of accepted jobs on the i -th operation C_{aji} , ie:

$$k_w = C_{jpi} / C_{aji} ;$$

– conveyor length (production line) L_{pl} – the product of the distance between the centers of two adjacent products on the conveyor l_o and the number of jobs on it C_{aji} :

$$L_{PL} = l_o * \sum C_{aji} ;$$

– conveyor speed (production line) V - the ratio of the distance between two adjacent products l_o i conveyor stroke (production line) r :

$$V = l_o / r ;$$

– the length of the working area of the operation (segment of the conveyor on

which the operation is performed) l_{pi} – the product of the distance between the centers of two adjacent products on the conveyor l_o and the number of jobs on it C_{aji} :

$$l_{pi} = l_o * C_{aji};$$

– duration of technological cycle (min.) of production of details on the production line equipped with the conveyor:

a) working: $T_u = r * \sum C_{jpi}$;

б) non-working: $T_u = r * (2 * C_{jpi} - 1)$;

в) working (in the presence of a backup area of operation L_{ba}):

$$T_u = r * \sum C_{jpi} + L_{ba} / V .$$

The sequence of calculations is given in section 2.

2. EXAMPLE OF CALCULATION

Task 1. Calculate the stroke of the lines, calculate the required number of jobs and the degree of their loading, choose the type and determine the main parameters of the conveyor, its speed and duration of the technological cycle. Daily program for 450 lines; technological losses are 1.4%. The line works in two shifts, the duration of the shift is 492 minutes. Regulated breaks for rest in a shift - 40 minutes. Conveyor pitch - 1.5 m. Time norms for operations are given in table. 2.1.

Table 2.1 - Time norms

No operations	1	2	3
Norm of time, minutes.	6,5	4,3	8,7

Solutions

1. The program of launch taking into account technological losses:

$$N_{shed/d} = N_{r/day} * 100 / (100 - a) = 450 * 100 / (100 - 1,4) = 452 \text{ pieces.}$$

2. Tact line:

$$r = \frac{(T_{dur\ of\ change} - t_{r/b.}) * S}{N_{shed/d.}} = \frac{(492 - 40) * 2}{452} = 2 \text{ min.}$$

3. Conveyor speed:

$$V = l_o / r = 1,5 / 2 = 0,75 \text{ m/min.}$$

4. The calculation of the main parameters of the conveyor is summarized in table. 2.2.

Table 2.2 - Calculation of the main parameters of the conveyor

№ operations	t_{umi} , minutes	$C_{pi} = t_i / r$	C_{npi}	$k_3 = C_{pi} / C_{np}$	$l_{pi} = l_o * C_{npi}$
1	6,5	3,25	4	0,81	6
2	4,3	2,15	3	0,72	4,5
3	8,7	4,35	5	0,87	7,5

5. The length of the working part of the conveyor:

$$L_{wp} = l_o * \sum_{i=1}^3 C_{npi} = 1,5 * (4 + 3 + 5) = 18,0 \text{ m.}$$

We choose a continuous flow line with a working conveyor.

6. Total number of jobs on the line:

$$C_l = \sum_{i=1}^3 C_{npi} = 4 + 3 + 5 = 12.$$

7. The duration of the manufacturing cycle of parts:

$$T_{cycle} = r * C_l = 2 * 12 = 24 \text{ min.}$$

3. TASKS FOR INDEPENDENT CALCULATIONS

Task 1. Calculate the stroke of the lines, calculate the required number of jobs and the degree of their loading, choose the type and determine the main parameters of the conveyor, its speed and duration of the technological cycle. Daily program for lines ___pieces.; technological losses are ___ %. The line works in ___ changes, duration of change - 480 minutes. Regulated breaks for rest in shifts – ___ min. Conveyor step – ___ m. Time norms for operations are given in table. 3.1.

Table 3.1 - Time norms for the operation and the initial data for the calculation

Version	<i>No</i> operations				Daily program for lines, pcs.	Technological losses, %	Number of changes	Regulated breaks for rest in shifts, minutes	Conveyor step, m
	norm time, minutes								
	1	2	3	4					
1	2,0	3,1	4,3	4,1	400	1,1	2	30	1,25
2	4,2	3,5	3,7	6,0	410	1,15	2	35	1,5
3	3,3	3,7	5,5	7,6	420	1,2	2	40	1,75
4	2,2	3,2	4,4	7,8	430	1,25	2	30	2,0
5	7,8	6,2	2,3	4,4	440	1,3	2	35	1,25
6	2,2	3,3	4,4	5,5	200	1,35	3	40	1,5
7	8,2	2,1	4,5	5,2	210	1,45	3	30	1,75
8	6,1	3,1	4,8	5,3	220	1,55	3	35	2,0
9	7,6	3,2	2,3	4,4	230	1,6	3	40	1,75
10	4,4	3,8	2,9	4,7	240	1,65	3	30	1,5

TEST QUESTIONS

1. Define the concept of "Flow production".
2. What is the characteristic of the flow method of production organization?
3. Define the concept of "production line".
4. In which industries is streaming production the most widespread?
5. Define the concept of "Flow line stroke".
6. What characterizes the rhythm of the production line?
7. What indicators determine the speed of the production line?
8. List the shortcomings of the flow organization of production.
9. Specify measures to improve the flow methods of the organization

production.

10. Indicate the main direction of improving the economic efficiency of flow production.

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