Abstract. The article presents the results of a study of the influence of the width of the stope on the choice of drilling and blasting parameters in the development of thin veins of the Akbakay field. The dependences of the specific consumption of explosives and borehole meters on the width of the face are established.

Keywords: vein, blasting, specific consumption, borehole meter.

At present, over 40% of non-ferrous, rare and precious metals extracted by underground mining are mined from vein deposits with ore body thickness from 0.2
to 2 m [1, 2]. When excavating, the width of the working face, according to the safety regulations [3], should be at least 0.6 m, but in practice it is usually determined by the condition of the ore, based on the thickness of the vein, the mineral content in the vein and side rocks, and for the most part ranges from 1 up to 2 m.

The practice of work and studies [2, 3] show that drilling and blasting in the technological cycle of ore breaking in the development of thin veins takes from 40 to 60% of the cost and labor costs. At the same time, it was noted that the smaller the width of the stope, the greater the specific consumption of materials, cost and labor costs per 1 m$^3$ of rock mass breaking.

To study the influence of the working face width on the choice of parameters for drilling and blasting, experimental work was carried out in the Akbakay mine, which develops a thin-veined deposit with an ore-storage mining system.

The rocks of the deposit are represented by granite, granodiorite and quartz veins with a hardness coefficient according to the scale of prof. M.M. Protodyakonov 14–16.

The studies were carried out directly in the working blocks. Breaking was carried out by a small-hole method.

The studies were carried out with a working face width of 1.2 to 3.0 m, which was taken constant in each series of experiments. Variable factors were: explosives, the size of the charge and the strength of the rock. The initial data was taken as the results obtained during the explosion of charges of ammonite 6ZhV with a diameter of 36 mm and a weight of 1.5 kg. Holes with a diameter of 43 mm were arranged in 2–3 rows depending on the width of the stope and rock hardness. The rational number of rows was determined by sighting explosions.

Studies have established that with a decrease in the width of the stope, with other constant values of the parameters of drilling and blasting, the consumption of explosives and borehole meters per 1 m$^3$ of broken rock mass increases.

From fig. 1 shows that with a decrease in the width of the working face by 3.7 times (from 3 to 0.8 m), the specific consumption of explosives and borehole meters increased by 3 times, respectively. However, the change in the specific consumption of explosives and borehole meters per 1 m$^3$ of blasted mass with a change in the
width of the working face occurs unevenly. If with an increase in the width of the working face from 1 to 2 m (2 times), the specific consumption of explosives and borehole meters decreases by a factor of 2 and 1.8, respectively, then with an increase in the width from 2 to 3 m, the decrease in these values is only 20 and 15%, respectively. A sharp increase in the specific consumption of explosives and borehole meters is observed when the width of the stope is reduced to less than 1.5 m.

Fig. 1. Graph of the dependence of the specific consumption of explosives and borehole meters on the width of the face

To determine the effect of explosive power on the specific consumption of explosives, the drilling volume and the distance between the holes, experimental explosions were carried out. When loading holes, ammonite 6ZhV and detonite M were used. The results of the experiments showed that the use of more powerful explosives such as detonites helps to increase the optimal distance between holes and, consequently, reduce the specific consumption of explosives and hole gauges. So, for a face width of 1.2 m, when using ammonite 6ZhV for loading holes in rocks \( f = 15 \), the optimal distance, between the holes was 1 m, while the specific costs of explosive and drilling were equal to 2 kg/m\(^3\) and 2.7 m/m\(^3\). When using detonites, these values were 1.2 m; 1.67 kg/m\(^3\); 2.4 m/m\(^3\).
The conducted studies have established that the optimal distance between holes in a row ($l_h$) depends on the hardness of the rocks and the type of explosive and can be expressed through the width of the stope ($m$). The distance between boreholes for bottoms 1.0–1.6 m wide is shown in Table 1.

**Table 1**

<table>
<thead>
<tr>
<th>Strength coefficient according to the scale of prof. M.M. Protodyakonov</th>
<th>Distance between holes in a row $l_h$ depending on the width of the stope ($m$), m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonite 6ZhV</td>
<td>Detonit M</td>
</tr>
<tr>
<td>14</td>
<td>$l_h = m$</td>
</tr>
<tr>
<td>16</td>
<td>$l_h = m - 0.2$</td>
</tr>
<tr>
<td>16&lt;</td>
<td>$l_h = m - 0.5$</td>
</tr>
</tbody>
</table>

The use of these dependencies for 2 m wide faces, as shown by the experimental work, causes a significant increase in the output of oversized.

The rational distances between holes in a row ($l_h$) established by experimental work, depending on the width of the stope ($m$), can serve as the basis for compiling a passport and simplify the marking of the grid of holes in the face.

On the basis of the obtained data, calculations were carried out to determine the specific consumption of explosives per 1 m$^3$ of rock mass, depending on the width of the stope, explosives and rock hardness according to the formula:

$$q = \frac{k_1f}{10.5k_2m^{1/4}} \text{, kg/m}^3,$$

where $f$ - coefficient of rock strength according to the scale of prof. M.M. Protodyakonov;

$k_1$ - coefficient taking into account explosives (taken for detonite - 1.0, for ammonite - 0.9).

$k_2$ - coefficient depending on the strength of the rocks (taken 1.0÷4.0).

To calculate the specific consumption of borehole meters, depending on the width of the stope m and the hardness coefficient of the rocks, the following formula was derived:
\[ n = \frac{f}{5.6m^{1.2}} \text{, } m/m^3. \]  

When developing thin veins, the diameter of the hole also affects the calculation of rational parameters of drilling and blasting [4]. The use of large diameters predetermines an increase in the charge of explosives, expansion of the hole network. However, at the same time, the impact of the explosion on the side rocks increases, which, due to the increase in pins and delaminations, causes an increase in the impoverishment of the ore.

In the process of carrying out experimental work, it was found that for each diameter of the hole (charge value), the specific consumption of explosives and hole meters is different and depends both on the width of the stope and on the hardness of the rocks. It has been established that with an increase in the charge diameter from 36 to 45 mm, the specific consumption of explosives increases. However, this increase is different and depends on the width of the stope. So, if for a working face width of 1.2 m in rocks \( f = 15 \), the increase in the specific consumption of explosives with an increase in diameter up to 45 mm is 20\%, then for a face with a width of 2 m - only 5\%.

Based on the conducted research, the following conclusions can be drawn:

1. The width of the stope is of great importance in determining the value of specific costs, explosives, and drilling volume.

2. For rocks \( f = 14–16 \) with a working face width of 1–2 m, it is advisable to break the ore using a small hole method, with a charge diameter of 36 mm.

3. In hard rocks, it is advisable to blast with ammonites and detonites.

4. The calculation of the specific consumption of explosives and the volume of drilling, depending on the width of the stope and the hardness of the rocks, is carried out according to the formulas (1, 2).

References: