SECONDARY FRAGMENTATION OF ANTONOVSK QUARTZITES BY AIR-FLAME-JET BURNERS

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The quartzites of the Antonovsk mine have the external appearance of light gray rock with a conchoidal fracture. They are divided up by a system of fissures of various widths and directions. Their hardness is 15-17 on the Protod'yakonov scale.

After blasting, the rock includes 10-20% of oversize quartzite pieces which are subjected to secondary fragmentation. This is done by means of laid-on charges. But this method has some drawbacks - delay in drilling owing to blasting operations, contamination of the atmosphere, flight of fragments, excessive consumption of explosives, etc.

In the Siberian Metallurgical Institute we have studied secondary fragmentation of quartzites by means of air-flame-jet burners designed at MIRCEM.* This method is based on intense local heating of the oversize pieces by a high-temperature gas jet from a burner nozzle. The sharp local heating causes internal stresses in the rock, resulting in deep fractures which cause the rock to fall apart.

The process of rock breaking by an air-flame-jet burner was investigated in two stages: formation of holes in the rock and local heating of the oversize pieces until they break up. The essence of our method was to establish how the characteristics of flame drilling depend on the burner operation and rock properties, and then to study the influence of these characteristics on the efficiency of rock fragmentation.

We measured the depth drilled after 1, 5, and 10 min, the direction of the hole in relation to the stratification, the distance from the burner to the face, the drilling speed, the volume of oversize fragments, the time of breakup, etc. To study various fragmentation conditions we planned and built an experimental rig consisting of an air-flame-jet burner, a system for feeding in the fuel components (air and gasoline), a mechanism for rotational and forward movement of the burner, measurement systems, and other necessary devices.

The air-flame-jet burner, which was the main unit of the rig, had the following characteristics: diameter 45 mm, pressure in combustion chamber 0.5-0.6 MN/m², air flow rate 140 nm³/h, gasoline flow rate 12 liter/h.

Gasoline and air are fed to the burner, well atomized and mixed so as to form an easily-ignited mixture which is ignited electrically via a nozzle. The products of combustion, which takes place in the combustion chamber, are ejected under pressure through a nozzle at supersonic velocity [1, 2].

Figure 1 shows the apparatus diagrammatically. The gasoline flow rate is measured by a remote-reading electrical flowmeter 21 connected via a secondary differential transformer to ÉPID-02 instrument 17. The air flow rate is measured by differential manometer 8 (type DPP-280) with diaphragm 7. The air and gasoline flow rates are controlled by valves 4, 10, 14, 16, and 26. The gasoline is fed from tank 15 to the combustion chamber by compressed nitrogen fed from cylinder 31 via reducing valve 30. The pressure in the reducer chambers is measured with manometers 28, 29. To monitor the operation of the apparatus we used spring manometers 5, 6, 9, 12, 13, 24, 25, 27, which measured the following pressures, respectively: fuel before reaching atomizer, air leaving diaphragm, fuel in tank, air in reservoir, air in first stage of compressor 11, air before reaching atomizer, mixture in combustion chamber, and fuel in main pipe.

The burner 2, fastened through disk 3, is rotated by dc electric motor 23. The disk, together with the burner and UR-6P motor, can be moved forward smoothly by means of differential screw 22 and belt drive 20, driven by

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Fig. 1. Apparatus for investigating secondary fragmentation of rocks.