

Analysis on Dust Control Technology in Open-pit Quarry

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To cite this article:

Changfu Zou. Analysis on Dust Control Technology in Open-pit Quarry. *Journal of Energy and Natural Resources*.

Vol. 10, No. 1, 2021, pp. 28-32. doi: 10.11648/j.jenr.20211001.13

Received: January 29, 2021; **Accepted:** March 8, 2021; **Published:** March 10, 2021

Abstract: In order to analyze the present situation of dust hazards in the process of mining in the open-pit quarry and solve the problem of dust pollution, according to the production process characteristics of the open-pit quarry, the characteristics and dust properties of the open-pit quarry were analyzed and studied, and the rules of dust production in the open-pit quarry were obtained. Based on the basis of the research on the law of producing dust and dust properties, in view of the blasting operation, drilling, crushing screening operation and blanking operation and so on various production technology, respectively, puts forward the demolition operations fog gun dust suppression technology, drilling rig drilling dust removal technology, dump truck, crusher airtight spray dust spray dust suppression technology, screening airtight smoke dust purification technology and scale blanking dust removal technology such as prevention and control technology, through the technical mechanism of dust and dust efficiency of experimental research, formed a set of suitable for quarry dust control technology parameters, through the production process in the open air quarry in practical applications, It realizes the dust control in the whole process from mining to production of finished products in the open-pit quarry, greatly reduces the dust concentration in the production process of the open-pit quarry, and the comprehensive dust removal efficiency reaches more than 85%, which provides the basic basis for dust control in the open-pit quarry.

Keywords: Open-pit Quarry, Dust Control, Spray Dust Suppression, Dust Concentration, Ust Reduction Efficiency

1. Introduction

The number of open-pit quarries in China is huge, with about 30,000 as of 2019. A quarry in the process of sand production will produce large amounts of dust, the main producing dust link for truck unloading, crushing, screening, reproduced and belt blanking, normal production total dust concentration is as high as 100 ~ 800 mg/m³, beyond GBZ 2.1-2007 "workplace harmful factors in the occupational exposure limit chemical harmful factor" prescribed limit (8 mg/m³) dozens of times. The experimental study shows that in the production dust of open-pit quarry, the dust with particle size less than 20 μm accounts for 89%, the dust with particle size less than 6 μm accounts for 20.1%, and the content of free SiO₂ is 4%~6% [1-3]. Therefore, the dust dispersion and free SiO₂ content are both high. High concentration of dust will not only affect the air quality of the quarry working place and its surrounding environment, but also cause pneumoconiosis, seriously endanger the health and life safety of workers, damage machinery and equipment, cause a variety of accidents, and thus affect the economic

benefits of production and enterprises [4, 5].

In recent years, under the blue sky battle, etc. The influence of the environmental supervision, more attention paid to the quarry dust prevention, quarry dust prevention and control technology, to protect workers' health, prevention of pneumoconiosis occurrence has done a lot of work, has obtained certain achievements, but due to high dust removal technology and equipment investment, domestic small-scale quarries, homework personnel idea consciousness, dust prevention and related management system is not perfect at the same time, rather than the coal mine, and wide type complex, regulation is difficult, lack of effective regulatory control measures and techniques, led to the dust removal technology are not comprehensive promotion use [6, 7].

Therefore, this paper discusses the current situation of dust control technology in open-pit quarry combined with technology and examples, points out the dust control technology corresponding to each production process in open-pit quarry, provides the basis for dust control in open-pit quarry, and makes the better dust control technology can be promoted comprehensively.

2. Production Process and Characteristics of Dust Production in Open-pit Quarry

The main production processes of open-pit quarry include production blasting, crawler drill drilling, truck loading and unloading, crusher crushing, vibrating screen sorting, belt transportation, reloading and unloading, scraper loading, truck transportation, etc., as shown in Figure 1.

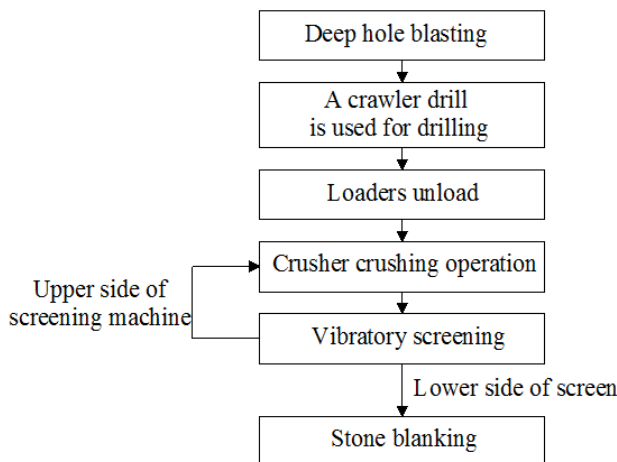


Figure 1. The process flow of Open-pit quarry.

Among them, the amount of explosive bankruptcy dust is large, and the range of dust producing space is wide, and

serious environmental pollution; The dust particle size produced by the crawler drill drilling is small, and it spreads in the sky through the pressure air discharge slag, which is harmful to the drill driver. A large amount of impact dust is produced when the truck is unloaded. The dust escape is serious in the process of crushing and vibrating screening of the crusher, and the working personnel are concentrated, so the dust hazard is serious [8, 9]. The vibration of belt transport causes the dust to fly in the sky, and the height difference of transfer and blanking is high, which produces a lot of impact dust and airflow dust. When the scraper is loaded, the impact dust is large and has parochiality, which is a movable dust source and is difficult to control.

In terms of dust properties, the raw materials mined in open-pit quarries are mainly limestone, whose main components contain 56% CaO and 44% CO₂, with a density of 2.715g/cm³ and a Mohs hardness of 3. The properties are brittle and generally lumpy, and the pure white is pale gray or pale yellow when containing impurities [10-12]. The wetting Angle of limestone dust was determined to be about 5° in the laboratory. The dust had good wettability and was hydrophilic dust. The particle size distribution of dust is shown in Table 1. It can be seen that the particle size of dust is mainly less than 20μm, accounting for 89% of the total. The proportion of dust with particle size less than 6μm was 20.1%, indicating that the proportion of respirable dust was relatively high. The particle size distribution of limestone dust is shown in Table 1.

Table 1. Limestone dust particle size distribution table.

Particle size distribution (d/μm)										
>80	>60	>50	>40	>30	>20	>10	>8	>7	>6	>5
0	0.7	1.6	2.3	4.7	10.8	43.8	55.6	62.1	79.9	84.5

The cumulative frequency distribution is shown in Figure 2.

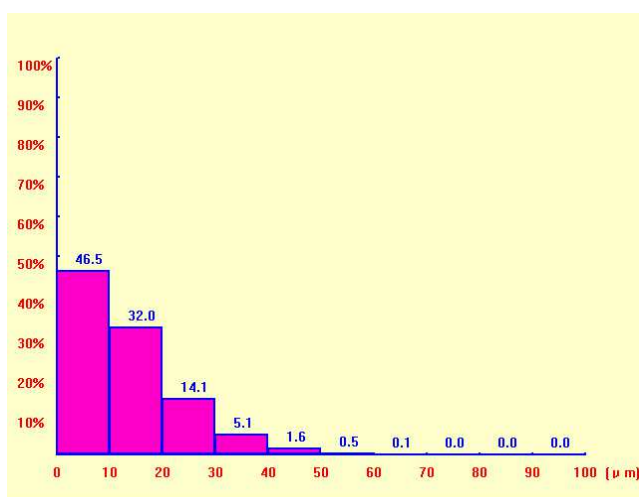


Figure 2. Frequency cumulative profile.

3. Status of Dust Control Technology

Taking the production process of open-pit quarry as the

main line and combining with the law of dust production at dust source points, the technical measures for dust control are as follows [13-15].

(1) Dust suppression technology with fog gun in blasting operation.

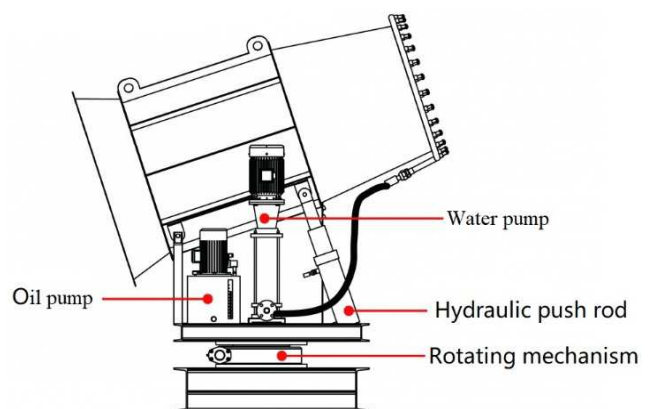


Figure 3. The Air-driven sprayer to spray dust.

According to the characteristics of blasting debris dust, the

spray machine is used to carry out regional spray dust removal within the blasting operation range. The spray machine has the characteristics of long range, wide coverage area, good atomization effect, etc., which can better suppress

and suppress the dust generated by settling blasting, and the dust removal efficiency reaches about 80%. The fog gun dust suppression system is shown in Figure 3, and the technical parameters are shown in Table 2.

Table 2. Technical parameters of air - fed sprayer.

Technical parameters	Effective range/m	Water consumption/(L/min)	Power/kW	Voltage/V
Air-driven sprayer	60~120	50~100	11~15	220

(2) Drilling rig drilling dust removal.
Drilling construction adopts compressed air to discharge slag. The particle size of dust produced by drilling is small, and the dust concentration is very high, which does great harm to the health of drivers and the environment. According

to the characteristics of dust production in boreholes, the combination of orifice sealing and dry dust collector is adopted to treat the dust, and the dust removal efficiency reaches about 95%. The dust removal system is shown in Figure 4, and the technical parameters are shown in Table 3.

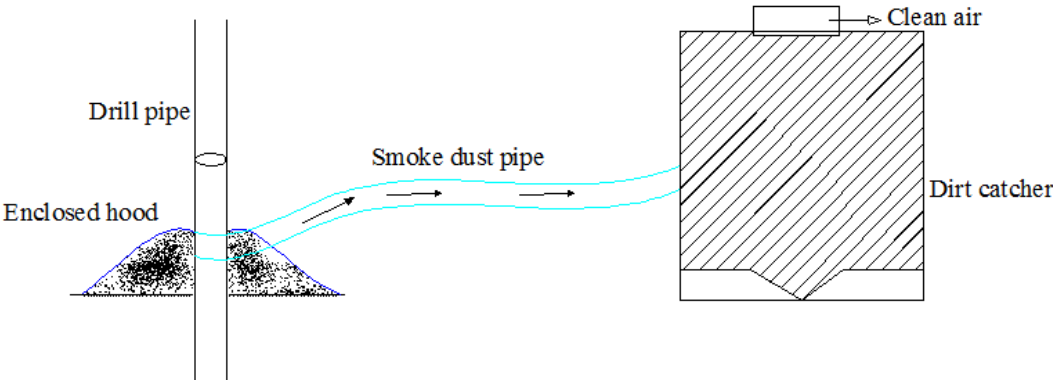


Figure 4. The technology of drilling dust removal.

Table 3. Technical parameters of drilling dust removal.

Technical parameters	airflow dealer/ (m³/h)	Air pressure/MPa	Power/kW	Voltage/V
Drilling dust removal	4000~10000	0.2~0.5	5~15	220

(3) Truck unloading spray dust suppression technology.
According to the characteristics of the truck unloading producing dust, use the most economical spray dust measures to governance, effectively sealed on both sides of truck unloading groove, and increase the block dust curtain, inhibit the truck shock producing dust, using spray to dust float in

the sky of settlement, to insure the effect of spray in at the same time, effectively avoid the water too much belt creep and vibrating screen plugging problem, dust efficiency up to 85%. Dust suppression by truck unloading spray is shown in Figure 5, and the technical parameters are shown in Table 4.

Table 4. Technical parameters of spray dust suppression.

Technical parameters	Pressure/MPa	Water consumption/(L/min)	Range/m	Cover/m²
Spray dust	2~6	4~10	3~8	1~4

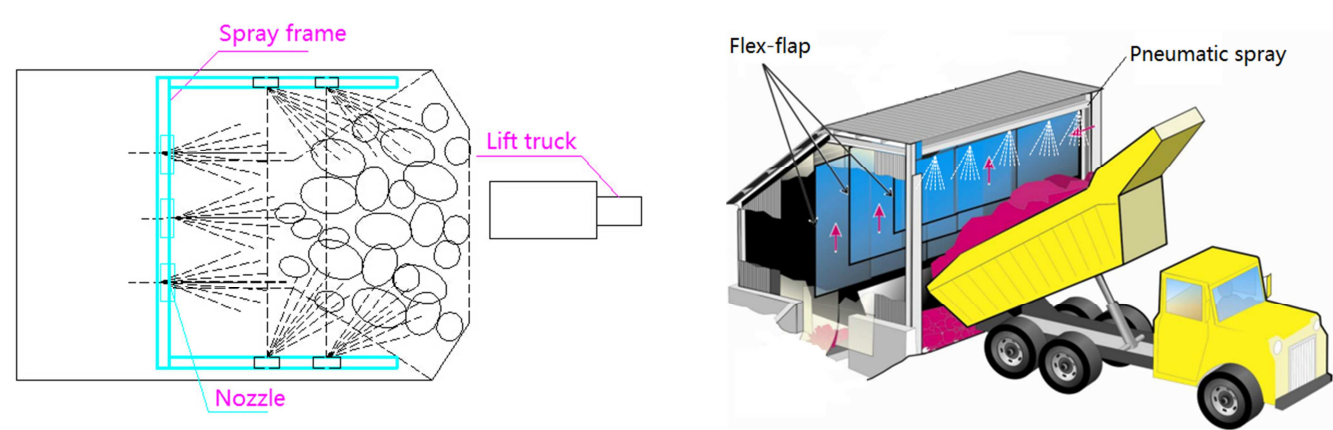


Figure 5. Spray to suppress dust in truck unloading operation.

(4) Closed spray dust removal technology of crusher.

In the process of crusher crushing, the dust produced mainly diffuses outward from the upper and discharging mouth to escape and cause pollution. In crusher location using spray dust measures are the most economical, and can greatly reduce the follow-up homework after wet process of rock, of producing dust capacity in quarry dust control engineering experience shows that the increase the humidity of the rock crusher position, can effectively reduce the

follow-up process more than 60% of the amount of producing dust, and at the same time increase the spray pressure, reduce the spraying flow, can effectively avoid the belt creep and vibrating screen blocking problem. Therefore, the upper and discharging mouth of the first-stage crusher is closed and a spray device is set for spray dust removal, and the dust removal efficiency reaches about 95%. The system is shown in Figure 6, and the technical parameters are shown in Table 5.

Table 5. Technical parameters of crusher sealed spray dust removal.

Technical parameters	Pressure/MPa	Water consumption/(L/min)	Range/m	Angle/(°)
Airtight spray	4~8	4~10	3~8	60~120

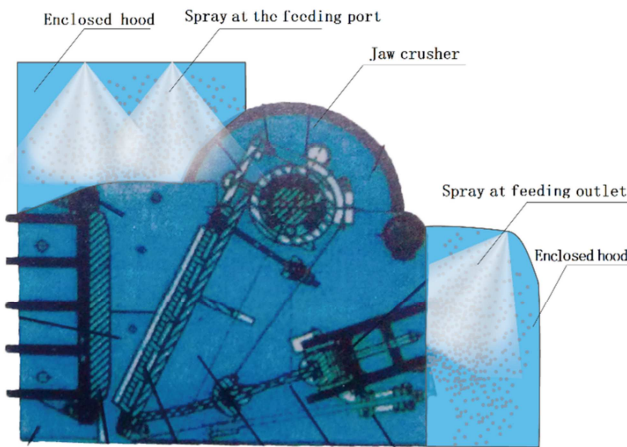


Figure 6. Crusher airtight spray dust removal system.

(5) Closed dust extraction purification technology for screening operation.

When the screening machine works, the material particles are fine, the vibration amplitude produced by the screening machine is large, the fine dust flying in the sky is serious, and the screen mesh of the screening machine is fine, the material humidity is too large and easy to cause the screen blockage, and it is not suitable to adopt the ordinary spray dust removal measures, therefore, the closed dust extraction purification measures are used to deal with the dust produced by the vibrating screen. The closed dust extraction system is composed of four parts: dust fan, dust collector, dust extraction pipeline and dust cover. Among them, the wet dust collector has the advantages of small volume, convenient

installation, high dust removal efficiency, low cost and low operating expenses, which is more suitable in the use process of open pit quarry, and its dust removal efficiency reaches about 98%. The dust extraction and purification system of screening operation is shown in Figure 7, and the technical parameters are shown in Table 6.

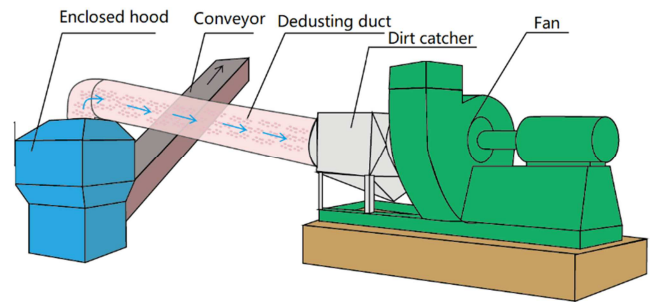


Figure 7. Closed dust extraction and purification system.

Table 6. Technical parameters of dust extraction and purification system.

Technical parameters	airflow dealer/(m ³ /min)	Water consumption/(L/min)	Dehydration efficiency/%	Power/kW
Dust purification	150~600	15~20	97	7.5~22

(6) telescopic blanking dust removal.

Blanking point is usually 10 ~ 15 m off the ground, head high, cause the blanking process, material falling from the sky and ground the impact of producing dust is bigger, and dust pollution by wind effect is bigger also, according to the characteristics of blanking points of producing dust using automatic telescopic tube of blanking blanking,

accompanied by blanking highly scalable drum automatic lifting, safeguard blanking tube is always located in the material at the bottom of the pile top, thus reducing the height of blanking, reduces the producing dust concentration, the dust efficiency up to 90% or so, telescopic blanking as shown in figure 8, technical parameters as shown in table 7.

Table 7. Technical parameters of telescopic blanking.

Technical parameters	Height/m	Diameter/mm	Number of wire ropes/a	control mode
Adjustable blanking	10~15	800~1500	2~3	automatic control

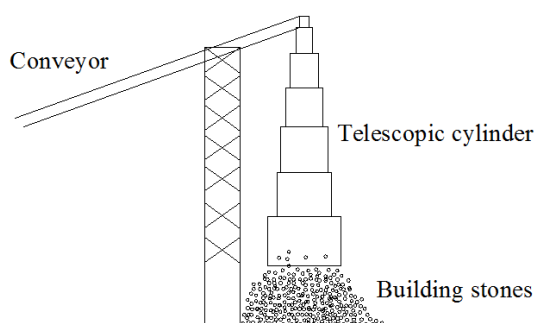


Figure 8. The system of telescopic blanking.

4. Conclusion

Respectively for quarry production process characteristics, puts forward the demolition operations fog gun dust suppression technology, drilling rig drilling dust removal technology, dump truck, crusher airtight spray dust spray dust suppression technology, screening homework airtight smoke dust purification technology and the expansion blanking dust removal technology, implements the quarry from dust control in the whole process to produce finished products of mining, quarry is greatly reduced the dust concentration in the process of production, the comprehensive dust efficiency above 85%, and protect the workers health, at the same time reduces the impact on the surrounding environment, economic and environmental benefit is remarkable, has higher application value.

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