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DRILLING AND DUSTINESS OF METAL-MINE AIR.

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Notwithstanding all the effort made to introduce wet drills to prevent dustiness of air of metal-mine working places, there has during the past few years arisen in Australia and South Africa an impression that wet drills, including the Leyner type, actually cause undue quantities of finely divided ore and rock to rise into the air, these fine particles being chiefly attached to particles of fog or spray escaping from holes using water drills. This is said to have created consternation in the ranks of the mine operators who have complied with drastic wet drilling regulations, and purchased and operated various types of wet drills at no inconsiderable expenditure in both money and effort.

In view of this situation and the fact that wet stopers are being rapidly introduced with considerable success in many of the metal mines of the United States, the writer, who has for the past five years been engaged largely in studying the dust problem in the metal mines of the West for the U. S. Bureau of Mines, has compiled the dust sampling of air of drilling places in 214 working places in 13 mines at time of drilling, using various types of wet and dry drills with upper, inclined, horizontal and some down holes.

The result of these tabulations indicates that irrespective of the conditions in South Africa and Australia, the use of wet drills in the United States results in a decided decrease of dustiness of the surrounding air as compared with dry drilling, whether the holes are upper, or inclined or horizontal, and practically irrespective of the types of drill used. Nevertheless, there are some dangers from dust in air surrounding wet drilling operations unless certain precautions are taken.

Table 1 gives data for air dustiness in 105 places in 13 mines with holes drilled at an inclination less than 60°, and hence likely to cause minimum dustiness of surrounding air from the falling of cuttings through the air. All samples were taken by the standard sugar-tube method of the U. S. Bureau of Mines for sampling mine-air dust, with the sugar tube held as close as feasible to the driller's head and with air being drawn through the tube at approximately the rate a worker breathes. Data were obtained for 9 places in four mines using piston drills (dry), for 24 places in five mines using dry "jackhammer" type of machine, 14 places in seven mines with dry stopers, 5 places in one mine using wet stopers, 52 places in ten mines using Leyners, and 1 place in a mine using auger or twist drills.

As might be expected, the dry jackhammer type of machines are by far the worst dust producers, the average quantity of dust per cubic meter of air for 24 samples being 765.2 mg. (It may be interesting to note here that the maximum allowable dustiness in South African mines is 5 mg. per cubic meter of air); the old type of heavy piston drill, now rarely used, came next in dustiness with 98.5 mg. for nine samples; dry stopers came third with 62.8 mg. as average for 14 places; wet stopers showed 15.0 mg. as average for five places; and Leyners had an average of 17.5 mg. for 52 places. Hence, for holes less than 60°, Leyners and wet stopers gave an air dustiness less than 1/3 as great as in regions near dry stopers, and less than 1/20 of the dust of places using the jackhammer. In Mines 3 and 5 some of the readings of air where Leyners were running were fairly high in dust, owing to the fogging of air from machines working poorly and in poor repair. In Mine 4 external sprays were used with jackhammer drills and while the dustiness was somewhat reduced, it continued to be excessively high, three samples giving an average air dustiness of 263.2 mg., indicating the difficulty of "killing" dust by use of external spray with dry jackhammer.

Table 2 covers only air dustiness of places where holes were being drilled with inclination above 60°, hence may be classed as "uppers", and this type frequently gives maximum air dustiness. 107 samples from 12 mines are given, these mines being the same as listed in Table No. 1. Again the dustiest places were those using dry jackhammers, they had an average of 210.6 mg. of dust per cubic meter of air, (however, only two samples were taken as uppers are rarely drilled by jackhammers); the dry stoper averaged 159.7 mg. for 87 places in 11 mines, against 54.1 mg. for 16 places in five mines using wet stopers, and 39.9 mg. for sample where Leyner was in use. It will be noted that dry stopers gave practically three times as much air dustiness as wet stopers, and in Mines 5, 6, 7, and 9, where samples were taken for both dry and wet stopers, the air of the places using wet stopers was only about 1/6 to 1/15 as dusty as that of places using dry stopers. In Mine 9, three holes were drilled vertically with dry stopers using external spray and the average air dustiness was 458.9 mg., hence the spray method was by no means a success for controlling dust with these uppers. In Mine 12, wet stopers in poor repair and operated by men unfamiliar with them made the air about the drill very dusty; this proves that wet machines must be kept in repair and be operated intelligently, or they will give poor results as to dust prevention.

Table 3 summarizes Tables 1 and 2, taking into consideration air dustiness in drilling all kinds of holes and with practically all types of drills in general use. Jackhammers drilling dry gave the dustiest air comitions, 353.9 mg. per cubic meter of air as the average for 26 samples; with dry stopers second, 146.3 mg. as the average of 101 samples; old type piston drills (dry) gave 93.3 mg. as the average for 12 samples, while wet stopers had 44.8 mg. for 21 samples, and Leyners 17.9 mg. as average of 53 samples. The total number of dry drilling samples was 140, and the dust content of the air of these places averaged 179.4 mg. per cubic meter of air, while the total number of wet drilling places was 74 with an average air dustiness of 25.6 mg., or about 1/7 as great as the average dustiness of places with dry drilling; this certainly indicates that wet drilling does <u>not</u>, at least insofar as our investigations go, produce more dust than dry drilling, but as a matter of fact, produces <u>very</u> much less dust. Table 3 also gives data as to air dustiness of five mines for places where no dry drilling was in operation at time of sampling. Mines 1 and 2, with an average air dustiness of 45.2 mg. per cubic meter of air for 121 places not using dry drilling, show a

general average dustiness for all the places which is nearly double the average air dustiness of wet drilling places of 11 mines (25.6 mg.). On the other hand, Mines 4, 5 and 6 10.7, 10.0 and 20.0 mg., respectively, for places free of dry drilling, come well under the general average of 25.6 mg. for all places in 13 mines where wet drilling was in progress.

Conclusions:

The dust studies to date in metal mines of the United States by the U. S. Bureau of Mines indicate definitely that wet drills as used in drilling of all classes of holes aid decidedly in reducing dustiness of air in drilling places. However, it has been found that wet drills whether of the Leyner type or stopers, if not operating satisfactorily or if out of repair, may throw into the air of working places a mist or fog, laden with minute mineral particles which when breathed has the same effect as dry dust and is fully as dangerous. In addition to danger when wet drills are not efficiently used, if water or compressed air and water forced through the drill is under excessive pressure, say over 100 pounds per square inch, there may be danger of escape of mist or fog laden with mineral particles, hence these pressures should be held below 100 pounds per square inch which, in general, is the practice in the United States.

Wet drills must be kept in repair and must be operated with intelligence; as far as proved by the sampling of the U. S. Bureau of Mines, the wet drills, even when at their worst still give conditions much more healthful than do dry drills. - - Reports of Investigations, U. S. Bureau of Mines.

Table 1 - HOLES DRILLED WITH LESS THAN 60° INCLINATION UPWARDS

(Includes Horizontal Holes and Those With Downward Inclination)

Figures show milligrams of dust per cubic meter of air.

Mine	Piston Drills Mg. dust			Dry Jackhammers Mg. dust			Dry Stoper Mg. dust			Wet Stoper Mg. dust			Leyner Mg. dust			Hand Auger Mg. dust		
	Samples No.	Minimum	Maximum	Average	Samples No.	Minimum	Maximum	Average	Samples No.	Minimum	Maximum	Average	Samples No.	Minimum	Maximum	Average	Samples No.	Minimum	Maximum	Average
1	5	57.0	130.7	79.8	1	444.6	444.6	444.6	1	31.4	31.4	31.4					2	28.5	21.4	29.9
	2	39.9	413.3	226.6	1	353.4	353.4	353.4												
3	1	22.8	22.8	22.8	5	30.9	174.2	423.5	4	59.8	225.2	117.4					5	8.6	91.2	29.6
																	4	11.4	34.2	50.7
2	1	11.4	11.4	11.4													6	5.7	42.8	24.2
					3[b]	78.5	412.0	263.2												
4					4[c]	414.1	765.4	554.5									3	2.0	4.3	3.5
					1	178.8	178.8	178.8												
5																	7	3.7	49.4	13.1
6					1[d]	29.2	29.2	29.2												
					7	151.6	497.1	292.2	1	31.4	31.4	31.4					10	6.6	15.8	9.9
7					1	605.3	605.3	605.3	2[e]	75.8	87.8	81.8	5	6.6	25.9	15.0	2	7.9	9.6	8.5
																	2	18.7	20.4	19.6
8									2	17.1	90.8	54.0					1	13.6	13.6	13.6
9									1	13.9	13.9	13.9					1	8.1	8.1	8.1
10									3	9.6	37.1	20.4								
13																	9[f]	4.4	16.9	8.6
Total and Averages	9			95.5	24			365.9	14			62.8	5			15.0	52			17.5
																	1			25.6

Note: Maximum allowable dustiness of air of South African mines is 5 milligrams per cubic meter of air.

(a) Drilling with hand auger in old rob. (b) Drilling dry but using external spray. (c) Drills operating side by side. (d) Drilling dry with water jack-hammer in damp material. (e) Drilling dry with water stoper. (f) Ore pump

Table 2 - HOLES DRILLED UPWARDS 60° TO 90°

Figures show milli-rams of dust per cubic meter of air.

Mine	Piston Drills				Dry Jackhammers				Dry Stoper				Wet Stoper				Leyner			
	No. samples	Mg. dust Minimum	Maximum	Average	No. samples	Mg. dust Minimum	Maximum	Average	No. samples	Mg. dust Minimum	Maximum	Average	No. samples	Mg. dust Minimum	Maximum	Average	No. samples	Mg. dust Minimum	Maximum	Average
1	3	31.4	150.1	77.6					3	42.7	333.5	147.2								
2									11	14.3	456.8	160.1					1	39.9	39.9	39.9
3					1	407.6	407.6	407.6	33	25.7	344.8	111.7								
4									8	26.8	675.5	330.9								
5									6	52.4	201.9	128.8	5	13.2	36.1	26.1				
6									5	31.4	202.6	116.5	2	10.4	27.9	19.2				
7									2	244.2	489.7	367.0	3	20.5	93.9	46.4				
8									1	33.5	33.5	33.5								
c									b3	193.8	735.3	458.9								
									3	282.2	327.8	305.0	1	20.9	20.9	20.9				
11					1	13.6	13.6	13.6	9	17.9	116.8	68.5								
12									3	19.6	110.0	78.3	c5	13.2	263.2	107.3				
Total and Average	3			77.6	2			210.6	87			159.7	16			54.1	1			39.9

Note: Maximum allowable dustiness of air of South African mines is 5 milli-rams per cubic meter of air.

(a)--Drilled in wet place. (b)--Dry stopers with external spray. Holes vertical. (c)--Wet stopers in very poor condition.

Table No. 3 SUMMARY OF DUSTINESS FROM DRILLING IN THIRTEEN MINES.

	Piston Drills		Dry Jackhammers		Dry Stopers		Wet Stopers		Leyners		Dry Hand Twist Drills	
	No. of samples	Mg. of dust per cu. meter of air	No. of samples	Mg. of dust per cu. meter of air	No. of samples	Mg. of dust per cu. meter of air	No. of samples	Mg. of dust per cu meter of air.	No. of samples	Mg. of dust per cu. meter of air	No. of samples	Mg. of dust per cu. meter of air
Holes drilled upwards 60 to 90 degrees	3	77.6	2	210.6	87	159.7	16	54.1	1	139.9		
Holes drilled less than 60 degrees upwards	9	98.5	24	365.9	14	62.8	5	15.0	52	17.5	1	25.6
Totals & Averages	12	93.3	26	353.9	101	146.3	21	44.8	53	17.9	1	25.6

Total No. of all drilling samples..... 214 Average milligrams of dust per cubic meter of air...126.2

Total number of Dry Drilling Samples - 140 with Average Dust - 179.4 Mg. per cubic meter of air.
" " " Wet " " - 74 " " " - 25.6 " " " " " "
Maximum allowable dustiness of air of South African Mines - 5.0 Mg.

Below is found dustiness of metal mine air other than places with dry drilling (5 mines):
Mines 1 and 2 had 45.2 milligrams of dust per cubic meter of air as average for 121 places.
" 4 " 10.7 " " " " " " " " " " 33 "
" 5 " 10.0 " " " " " " " " " " 58 "
" 6 " 20.0 " " " " " " " " " " 55 "