TECHNICAL DUST SUPPRESSION METHODS IN COAL MINES IN THE FEDERAL REPUBLIC OF GERMANY DEPENDING ON THE CONDITIONS OF THE DEPOSITS AND THE MINING DEVELOPMENT

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In the Federal Republic of Germany, mining techniques and dust suppression measures must take into consideration the following important characteristics of the deposits:

- Great depth
- Simultaneous mining in several seams
- Mining in level and inclined formations and the occurrence of rock strata in the seams.

Conditions of the Deposits and of the Mining Technique and Dust Suppression Measures

The average mining depth in West German coal mines in 1986 was 902 m. By the year 2000, an increase in depth to around 980 m is anticipated.

The control of high temperatures requires large volumes of mine air. The results is an increased inlet of dust into the ventilating air current at the dust generation point and hinders dust sedimentation. An important planning principle in all mines is to have both the coal and the ventilating air moving in the same direction (homotropal ventilation) wherever possible. Antitropal ventilation must be avoided.

In order to avoid dust raising in the transport area, transfer points and crushers in particular must be carefully surrounded. Where the belt conveyors have to pass through air locks, covering belts (see Figure 1) are a good method of preventing the dust swirling at these points of high ventilation air velocity.

In some cases, an increasing gas content has been observed with increasing mining depth. In these cases too, large quantities of ventilation air are required in order to keep the CH_4 concentrations within permissible limits. Homotropal ventilation here is an important precondition for preventing dust raising.

Figure 1. Covering belts at air locks.

The depth of the mining operations and the associated overburden pressure demand special measures for roof control at the faces. All faces in level and inclined formations are fitted with shieldtype supports.

Cushions of rock on the shield canopy are the primary causes of dust development at the support and of the dust concentration in the mine air. A further reduction in dust can be achieved with slide bars moving in the same direction (see Figure 2) and dampening of the cushions of rock using water under high pressure (see Figure 3).

A face with a roof which is difficult to control can be effectively improved by a high rate of face advance. All the faces

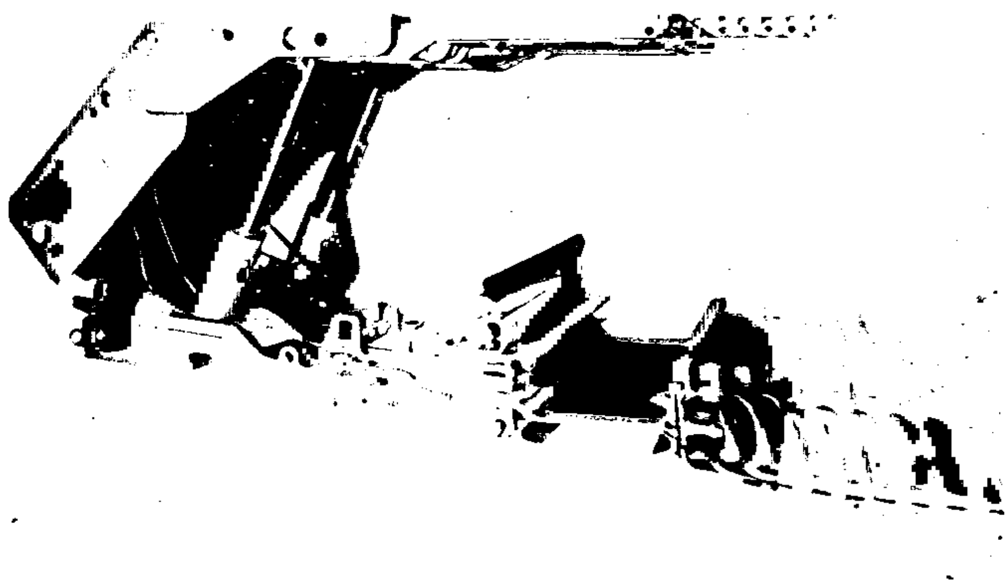

Figure 2. Shield-type support with slide bars.

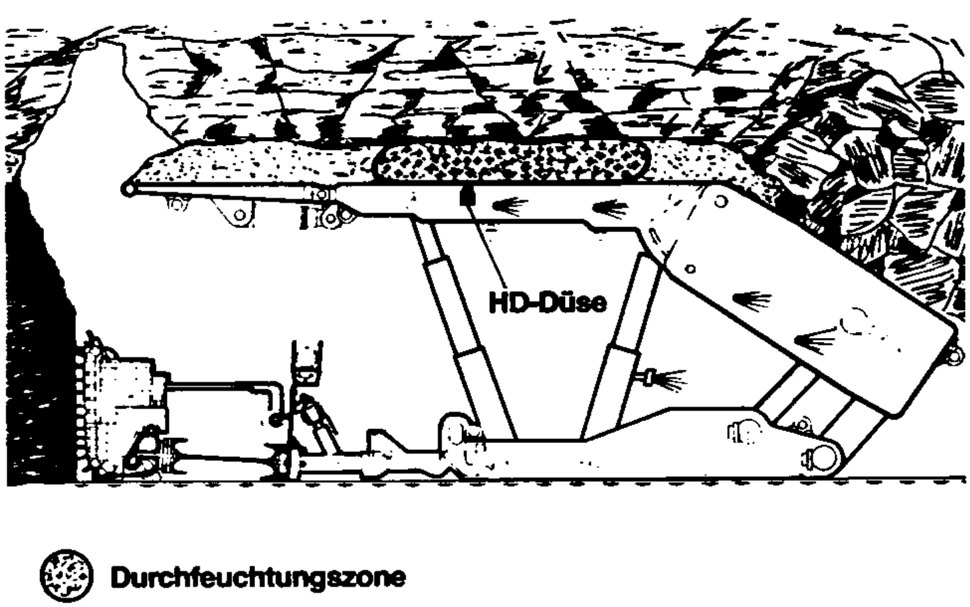

Figure 3. Dampening of the rock cushion with high-pressure water.

are operated in several coaling shifts. This multiple shift mining means, however, that only a limited time is available per night for coal face infusion from the face area, demonstrably the most effective method of dust suppression in West German coal mines. "Longwall face infusion" is therefore becoming more widespread. "Longwall face infusion" can be performed as a process of advance infusion through long boreholes from one or both gate roads. The infusion of 3–4 l/min of water with the necessary pressure is commenced several months before the actual start of mining.

High rates of face advance and the consequent demands for gate roads require a high-performance road heading system. In 1987, 100 cutting head machines and 36 impact rammers were used for this purpose (see Figure 4). The high level of dust created by the cutting head machines necessitates the use of dedusters with high extraction rates.

Mining depth and overburden pressure require special measures to maintain the cross-sections in the gate roads. These measures include back-filling of roadway supports and production of roadside packs using hydraulically bonding materials to increase the strength of the roadway supports on the side of the worked seam. The materials are transported pneumatically in pipelines. Dusts can be created if these materials are sprayed with the incorrect water content. This problem can be avoided, however, by applying the material hydro-mechanically.

These great mining depths and increasing overburden pressures have, however, also resulted in convergence-reducing road heading methods being more widely used. This has led in some cases to a move away from the gate roads being headed in front of the coal face so that the gate roads are now kept with or kept behind the line of the coal face. In 1986, 59 gate roads were kept with and 6 gate roads kept behind the line of advance of the coal face. With this method of road heading, impact rammers (see Figure 5) have proven to be effective, since they show clearly the benefit of reduced cutting into the surrounding rock and thus less dust development. In gate roads headed with the advance of the coal face, face conveyors with supporting sheave curves (see Figure 6) are used. This provides for a sliding transfer of the material conveyed during the deflection through 90°. A free fall of the material from one means of transport to the next is thus avoided.

In the vast majority of pits in West German coal mines, several seams with differing thickness are mined simultaneously in level, gently sloping and sharply sloping formations.

During this multiseam working, the horizontal development is primarily effected by excavations in the surrounding rock of the deposits. In 1986, in addition to the widely practiced heading by blasting, seven full-thickness headers were used for developing hardheads (see Figure 7). During this year, 14 km of roadway were developed. The dust production is controlled by the use of high-performance dedusters.

In the majority of cases, *headings parallel to the face* have to be developed by overcutting and undercutting due to the lack of seam thickness or the non-horizontal position of the seams in the heading area.

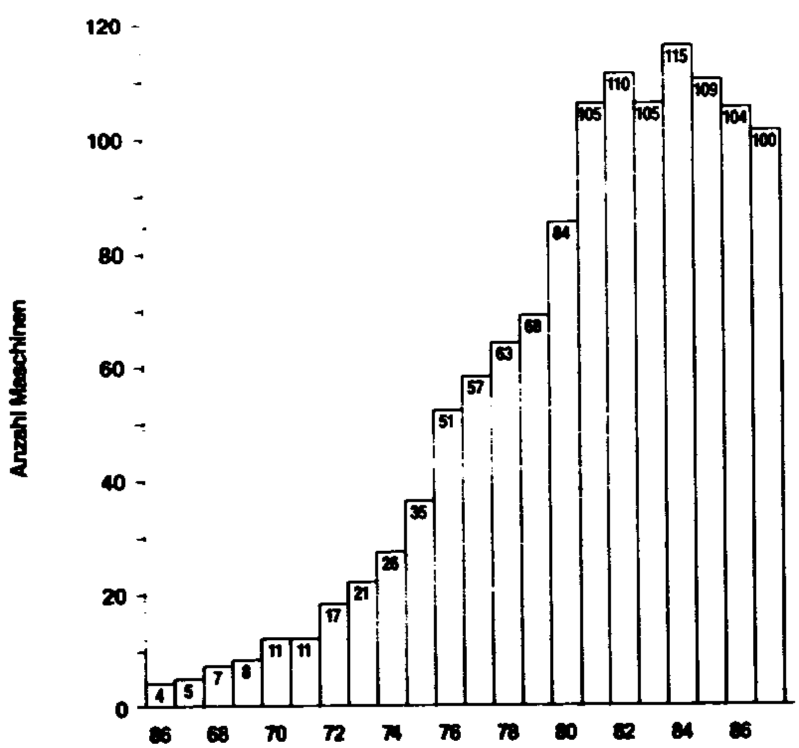

Figure 4. Use of road headers.

Figure 5. Impact rammer.

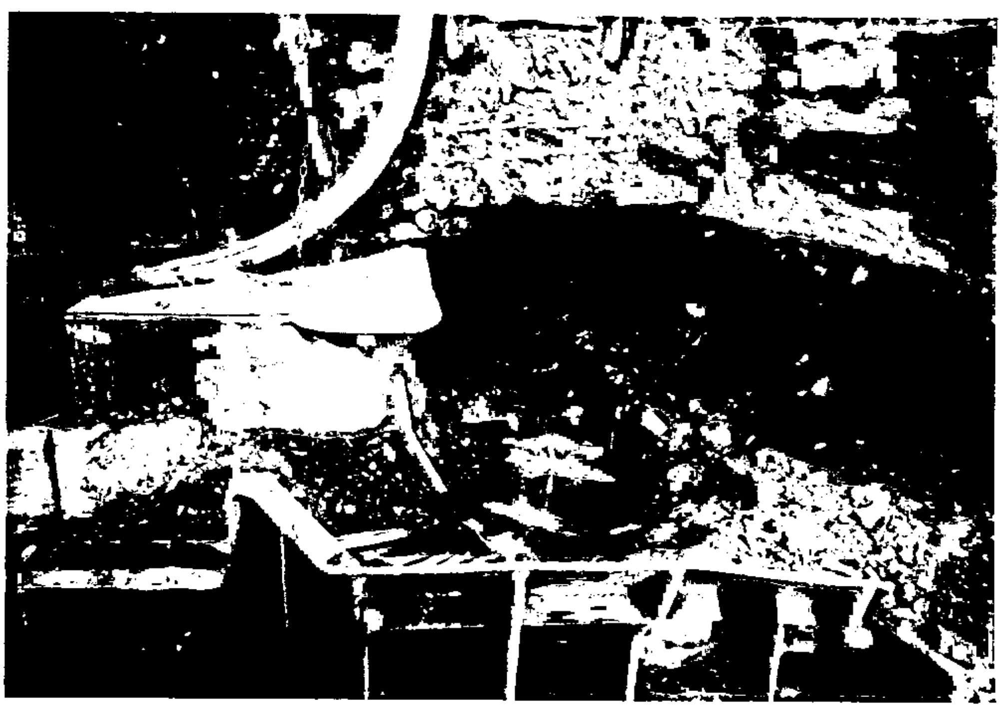

Figure 6. Face conveyor with supporting sheave curvers in the coal haulage road.

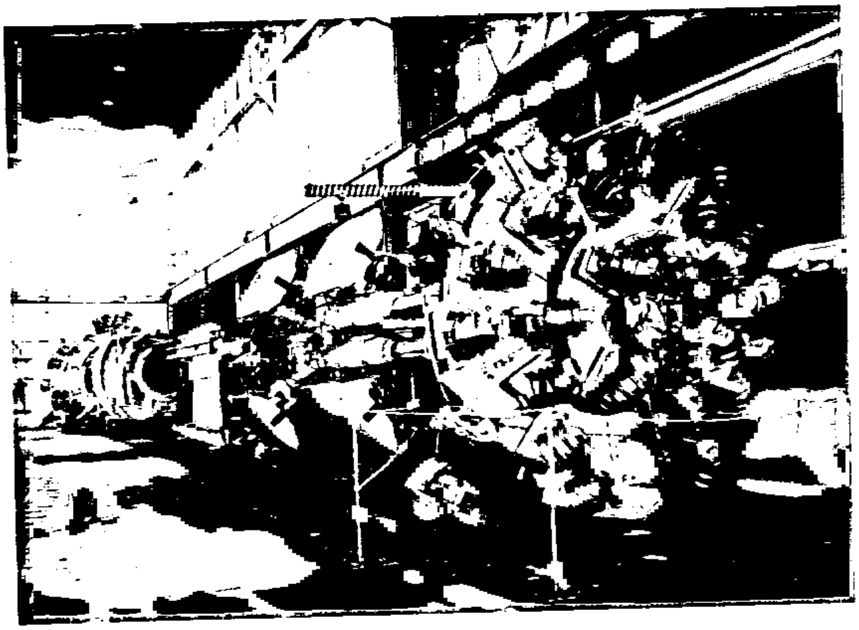

Figure 7. Full-thickness header.

Seams of greater thickness frequently contain intercalated rock materials. Coal dust and rock dust are produced when these intercalations are cut. This creates particular problems for the dust suppression. Since it is not possible to suppress the rock dust separately, the aim must be to make dust suppression so intensive that the total respirable dust content of the mine air is kept as low as possible.

Both plough-type and shearer-type machines are in operation for *mining*. The percentage of the production from 93 faces employing shearer-loader operation in 1986 was approx. 40 million tv = 48%. Shearer operation is used primarily in seams with solid coal with a thickness of greater than 1.90 m. Drum speed and pick lacing, pick length and cutting depth, drum shape, spray jet position and an adequate water distribution to the leading and trailing drums with the necessary pressure are among the most important preconditions for minimizing dust creation.[1] In 1987, good results were obtained during trials using the "coarse grain drum" (see Figure 8).[2]

In mines with gently sloping formations or mines with geological faults and high percentages of surrounding rock which is cut with the coal, no acceptable degree of dust suppression can be achieved using the measures described above. In such cases, the installation of separating elements between the conveyor track and the mining area ("dust flow separation") has proven to be an effective solution.[3,4] An effective deduster for 2/3 of the face air volume in the return air road is necessary.

In seams of lesser thickness and with soft coal, plough operation is employed. In 1986, approx. 37 million tv = approx. 45% of the total coal production came from plough-operated faces. Development of the sliding plough has now made it possible to extend the use of the plough to the tough/hard, thin and gently undulating seams of h.v. bituminous and long-flame coal. At plough-operated faces, sectional plough track spraying has been successfully used under automatic remote control for several years. In two of the mines, trials have been performed with a programmable track spray system which simultaneously monitors the pressure and volume of the spray water.

Optimization of the cutting depth, the number, shape and line of contact of the picks and, of course, the choice of the plough speed are important criteria for minimizing the respirable dust production.[5]

Applying the dust suppression measures described above, a high degree of success has been achieved in West Germany since 1952. The industrial health demands have been regularly increased since the beginning of systematic measurements of the respirable dusts. The annual number of new cases of compensation due to silicosis has decreased noticeably.[6] In order to achieve further successes in the reduction of total respirable dust concentrations, I would like to conclude by formulating a number of demands to be made on future development work on improving technical dust suppression:

1. Increased use of water under high pressure.
2. Planning of all dust suppression facilities as a complete system from the outset.
3. Greater use of remote control systems.
4. Research into the other physical properties of the dusts which would allow the dusts to be bound as a replacement, for the use of water.
5. Research into the surface physics and specific harmfulness of the individual particles.

These new developments in dust suppression measures must be put into practice as soon as possible in order to achieve a further reduction in the total respirable dust content in the mine dusts, and thus to improve the health-related working conditions of the coal miner.

Figure 8. Coarse grain drum.

SUMMARY

In the Federal Republic of Germany, the particular conditions of the deposits—average mining depth of 902 m, high overburden pressures, multiseam mining, sloping formations, developing of roads in the surrounding rock, mining of rock strata in the seam, etc.—and the mining techniques—mining using plough systems, shearer-loaders, use of road heading machines in the coal and in the surrounding rock, use of hydraulically bonding construction materials, etc.—demand intensive efforts in the development of technical dust suppression measures.

Specific planning principles, e.g., ensuring that both the coal and the ventilating air are moving in the same direction, must be observed wherever possible. Effective techniques, e.g., coal face infusion, programmable plough track spraying systems and shearer-loader spraying systems at the face, pick spraying systems on the road heading machines, must be applied.

In research and development, projects are being pursued which are aimed at extending our understanding of the surface characteristics of dust particles. The knowledge of these characteristics can then be used for even more effective dust suppression and for an assessment of the specific harmfulness of the dust particles.

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