

CRITICAL INVESTIGATIONS ON FIRES IN INDIA COAL MINES

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ABSTRACT: Fire may occur in coal mines due to exogenous and endogenous causes. The causes of fires in Indian Coal Mines are critically analysed by taking the detailed informations from Coal Industry. Proper precautionary measures against fire will increase the safety of mines and hence the sterilization of resource will be minimum. Proper identification of fires and its dealing, will reduce the overall lost of coal production.

INTRODUCTION

The problem of mine fire is as old as the history of the mine. The fires in coal mines are posing great hazard due to its increasing trend in the worked and much more so in our country, while mining of thick and thin seams under difficult geo-mining conditions. Due to fires in underground as well as surface mines, not only a considerable amount of resources is lost, but the entire mine environment is badly affected. So long as the fires are restricted to underground working only, these do not pose very serious threat because of their comparative ease in tackling but once these become surface fire, impacts are very severe and the control measures are very difficult. As India is planning to double the coal production by the turn of 2005 AD (present rate is 250 MT/annum) so it has become necessary to analyse critically the fire problems in Indian coal mines.

CONCEPT OF MINE FIRES

It is well known that mine fires are associated mostly with coal mines, though fires in pyrite mines and occasional timber fires in certain metal mines are not unknown. An analysis of the causes of coal mine fires reveal that they may start either from an open fires

over the external mining agencies or originate due to very nature of coal. The propensity of coal liberating heat when come in contact with oxygen of air and its poor thermal conductivity favouring heat accumulation, may give rise to latter kind of heating. The former type of fire from external agencies are known as Exogenous Fires and the latter type i.e. due to self-heating characteristics of coal is called Endogenous Fires or Spontaneous Combustion.

CAUSES OF MINE FIRES

The exact causes of mine fires are till date unknown. Researchers said there are (A) Geological factor (Seam thickness, seam gradient, caving characteristics, faulting, coal outbursts, friability, rider seams, depth of cover, geo-thermic gradient etc.), (B) Mining factors (mining methods, rate of advance, pillar conditions, roof conditions, packing, leakage, multi-seam working, coal losses, main-roads, worked-out areas, heat from machines, ventilation pressure differential, barometric pressure, changes in humidity etc.), (C) Seam factors (rank, petrographic composition, temperature, available air, particle size, moisture, sulphur, interfering minerals, physical properties, effect of previous oxidation, heat due to earth movement, bacterial effect etc.)

[1]. The importance of each factor is yet to be analysed. Jharia coalfield result show that factors like shallow depth working, thick seam mining and multi-seam contiguous panel working had created very complex situations which not only initiated the start of the fires but also speeded up their spread. The unscientific and slaughter mining had taken a toll of the reserves particularly before nationalization of Indian coal industry [2,3].

STATUS OF FIRES IN INDIAN COAL MINES

The dangerous occurrence of fires in Indian coal mines (in cause-wise and coalfield-wise), are shown in Table 1. Critical investigations reveal that fires due to Endogenous cause (spontaneous heating) are more severe than Exogenous one. Further it is observed that the occurrence of spontaneous heating in underground workings got reduced considerably in 1969 to 1972, thereafter started increasing giving the peak maxima in 1977 (Table 2). Though in 1981-82, it further reduced but again increased till 1987, whereas surface fires got reduced considerably after 1976. Spontaneous heating in open-cast working, mostly remain unchanged. Cause-analysis revealed that premature collapse of pillars, extraction of shallow seams by caving and not providing the isolation/preparatory stopping at the proper place are the main reasons for these underground fires. Spontaneous heating on surface are mainly in coal stocks and washery rejects. Bord and pillar working without slowing shows much higher rate than proper slowing, though longwall retreating shows the least. Coal sample analysis shows that high ash coals are more susceptible to spontaneous heating [5].

FIRE IDENTIFICATION

There are several methods through which fires can be detected in the underground mines. They are:

- a) **Production of toxic gases:** A fire produces CO, CO₂ and reduces O₂ content in the ventilating air.
- b) **Thermal effect:** The heating of ventilating current by the fire may cause thermal damage to the walls and ignition of flammable material outside the original fire zone.
- c) **Smoke production:** A fire may produce enough smoke to cause confusion and panic amongst the miners, even though toxic levels of CO may not have been achieved.
- d) **Pressure disturbances:** A fire acts as an aerodynamic disturbance in the mine ventilation and as such it can cause local reversals, complete reversals, reductions or augmentations in the ventilation, depending on circumstances.
- e) **Gas sample analysis:** A fire changes the composition of the return air.

PRECAUTIONARY MEASURES

Fire problem in coal mines can be solved by organising the work in such a way that there are no old workings in the mine. This is possible by ensuring that panel is extracted soon after its development is complete and the goaved out panel is isolated by stopping. If this is not possible, the developed old workings should be isolated by construction of fire stopping around then so that in the absence of fresh supply of oxygen, spontaneous combustion does not take place. Wherever isolation of fold workings are not possible, the old workings must be inspected regularly and if any spalling/weakening of pillars occurred, it should be reinforced by bolting. The galleries, particularly at junctions should be kept well supported. Exogenous fires can be controlled by providing the proper safety training to the miners.

Table 1: Incidence of mine fires cause-wise and coalfield-wise [4]

Sl. No.	Cause	COAL FIELDS							Total
		Jharia	Ranigunj	Ramgarh Karanpura Bokaro	Singareni	Madhya Pradesh	Talcher	Assam	
1.	Premature Collapse followed by spontaneous heating	10	8	—	—	—	—	—	18
2.	a) Spontaneous heating (U/G)	15	18	1	3	7	1	1	46
	b) Spontaneous heating (Surface)	4	—	—	—	—	—	—	4
3.	Bontulsi Conflagration	5	—	—	—	—	—	—	5
4.	Illicit Distillation	5	—	—	—	—	—	—	5
5.	Spontaneous heating in quarry overburden containing carbonaceous matter (dumped)	31	3	7	—	3	—	—	44
6.	Negligent acts e.g. dumping of hot ashes soft-coke making etc.	20	—	1	—	—	—	—	21
7.	Spontaneous combustion in washery rejects	—	—	1	—	—	—	—	1
8.	Other causes								
	a) Fire crossing from neighbouring mine/area	6	3	1	—	—	—	—	10
	b) Miscellaneous	—	3	—	—	—	1	—	4
	TOTAL	96	35	11	3	10	2	1	158

Table 2: Dangerous occurrences due to spontaneous heating between 1960 and 1974

Sl. No.	Cause	1960	'61	'62	'63	'64	'65	'66	'67	'68	'69	'70	'71	'72	'73	'74
1.	Spontaneous heating underground	9	5	10	12	8	10	10	11	10	8	6	3	6	11	11
2.	Spontaneous heating surface	10	22	11	22	26	10	19	9	14	9	13	11	16	17	20
3.	Spontaneous heating O.C. Workings	3	6	2	3	7	2	4	2	1	4	1	4	3	1	1
	TOTAL	22	33	23	37	41	22	33	22	25	21	20	18	25	29	32

Dangerous occurrences due to spontaneous heating between 1975 and 1990

Sl. No.	Cause	1975	'76	'77	'78	'79	'80	'81	'82	'83	'84	'85	'86	'87	'88	'89	'90
1.	Spontaneous heating underground	18	17	23	12	14	18	8	8	19	13	19	19	19	12	9	14
2.	Spontaneous heating surface	19	19	12	2	0	4	-	3	3	1	5	1	1	1	-	-
3.	Spontaneous heating O.C. workings	1	2	5	1	2	-	1	2	2	2	3	2	2	1	2	-
	TOTAL	38	38	40	15	16	22	9	13	24	16	27	22	22	14	11	14

CONCLUSION

Proper investigations on fire will reduce the sterilization of the coal resource/total resource and hence the production will increase. By taking proper precautionary measures against fire, the safety level will definitely improve.

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