

COAL STOCKPILE MANAGEMENT SELF COMBUSTION CONTROL

1. Stockpile Temperature Monitoring



1.1 Temperature measurement frequency

- a) In general, each Coal stockpile temperature should be measured 1 (one) time /day
- b) However, in case of increasing temperature or suspected combustion in the stockpile, measuring frequency should be increased to 3 (three) times per day (1 (one) time per every shift)

1.2 Temperature monitoring locations

- a) 12 points: incline of stockpile and edge, where it is easier to gain access to inside of stockpile (standards for 50,000 ~ 100,000 tons)
- b) 3 points: at the center of the compacted strategic (long-term) stockpile, per pile with regular interval (standards for 50,000 ~ 100,000 tons)
- c) The measuring locations and frequency should be increased if there are suspected points of temperature increase, because internal temperature can rapidly increase due to long-term stocking.

1.3 Method of Thermometer installation

- a) Thermometers are installed at 2.0 ~ 5.0 m above ground level and approximately 1.5 ~ 2.0 m depth in the Coal stockpile
- b) Thermometers are to be installed at the intervals of about 10 m

2. Prevention of Spontaneous Combustion



2.1 Process of spontaneous combustion at the stockpile

Duration	Temp. (°C)	Phenomenon	Generating Gas
General Oxidation period	25~30	Partially temperature increase	Exhalation of moisture and gas in coal
	30~40	Generation of moisture	
	40~50	Dry, decomposition of wood	
	50~69	Generating of paraffin smell	
Early Heating Period	60~100	Quickly increasing temperature (especially promptly increasing nearby 84°C)	H ₂ O, CO (about 80°C)
	100~150	More rapidly increasing temperature (increase of spontaneous combustion gas)	CO ₂ (about 150°C)
	150~200	Rapid increase of temperature	CH ₄ (about 250°C)
	200~300	Slight decomposition of coal and more strong of simulative smell	Generation of Ethane, Ethylene gas is in proportion to temperature increase
Initial Heating Period	300~500	Ignition and Carbonization of coal	A great increase in amount of Smoke Various gas (H ₂ Gas Generation)
Latter Heating Period	500~800	2 nd decomposition of coal, Coalition and combustion of gas	Huge amounts of gas and smoke, Fire of stock coal

❖ **Stock of Coal** → Heating and accumulation by oxidation (internal temperature increase) → Exhalation of heat → internal temperature increase and maintain fixed temperature → drying of internal moisture and rapidly increasing temperature → spontaneous combustion.

2.2 Pre-caution to take for prevention of Spontaneous combustion and effect

a) External precautions

(i) Condition of Stock

- Factors affecting spontaneous combustion: storage method, storage quantity, storage period, stockpile structure, occurrence of free water (ponding), etc.
- Initial occurrence: Approximately 1.0 ~ 1.5 m from the surface of the land

(ii) Circumstantial pre-cautions

- Ambient temperature, moisture, wind direction, wind velocity, etc
- Continuous evaluation of the exact impact of each factor is difficult, but should be applied

b) Internal precautions

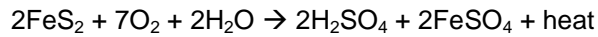
(i) Volatile component and oxygen component

Maximum absorption of oxygen points: over 36% volatile component and over 90% oxygen component.

(ii) Moistures especially more prone to absorb oxygen at total moisture of 10 ~ 15%

(iii) Particle size of coal: the larger surface area which has small particle size of coal will speeds up the oxidation rate

(iv) Foreign materials: spontaneous combustion occurs more readily by the oxidation of Iron Sulfide (FeS₂) and Phosphorus (P)



2.3 Measures to prevent spontaneous combustion

- a) Prevention of combustion by air isolation
 - Making low incline plane, compaction of stock by bulldozer and vibrating roller
 - Stock altitude of below 12m
 - Don't blend of lump coal and fine coal
- b) Cooling by water injection
 - Around 60°C water injection by fire fighting hose after digging up with bulldozers and compaction of stock by bulldozers
- c) Don't stock long-term of high volatile coals
 - Elevated temperature of coal received, or receiving coal in season prone to easy temperature rises (dry season) should be given priority reclaiming over other coals
 - Coal identified to have elevated temperature should be used earliest or moved to another stocking area and apply compaction of the stock by bulldozer and vibrating roller

2.4 Applicable actions per measure temperatures



- a) The first (1st) boundary temperature (40 ~ 50°C)
 - Increase of patrol times and monitoring the status of temperature conditions
 - Compaction of stock at surface by bulldozer or vibrating roller
- b) The second (2nd) boundary temperature (50 ~ 60°C)
 - Increase of patrol times and monitoring the status of temperature conditions
 - Water injection and priority loading over the coals
 - After digging up with bulldozers, compaction of stock at surface by bulldozer in case of temperature spread
- c) The first (1st) dangerous temperature (60 ~ 80°C)
 - Greater increase of patrol times and monitoring the status of temperature conditions
 - Highest priority of loading of coal and compaction of stock at surface by bulldozer
 - Continuous water injection to the spot of temperature increase

- Compaction of stock at surface by bulldozer and vibrating roller and continuous water injection until reclaiming completion of the combustion coal. If the water injection stopped, temperature can rise very sharply by increased air flow through the internal voids within coal piles
- d) The second (2nd) dangerous temperature (>80°C)
- Bulldozer should dig the spot of temperature increasing and moving to other stock locations as well as applying water injection action should be continuously carried out until enough cooling is experienced
 - Thereafter dig up with bulldozers the compacted stock at surface and remove by bulldozer in case of increased temperatures have spread
 - The increased temperature of coals should be perfectly separated and moved to other stock areas, and monitored that it does not flare up again.