Identification and Analysis of Main Harmful Factors in Tailings pond

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Abstract: Combined with the particle size classification of the tailings pond, according to the corresponding laws and regulations of the safe production process, the tailings pond is identified and analyzed from four aspects: human, material, environment and management. From the source, the possible harmful factors in the tailings pond are pointed out, which will provide reference for the safe and effective operation of the tailings pond in the future.

1. Preface
The safe operation of tailings ponds is closely related to people's survival and social stability. The amount of metal and non-metallic ore produced in china is huge each year, and the corresponding waste rock and tailings are even worse. Tailings can be reused in addition to some. In addition, the rest are stored in the tailings pond [1]. According to incomplete statistics, there are more than 7,000 tailings ponds in china, and there are few such large-scale tailings ponds in the world [2]. However, in recent years, the tailings pond instability has occurred frequently, resulting in huge loss of people's property and at the same time causing irreversible effects on the environment [3]. Therefore, the early detection of the harmful factors of the tailings pond and the prevention of tailings of accidents from the source are the main concerns of the people [4].

2. tailing pond library
Tailings are useless slag mined by mining and are usually discharged in the form of pulp. Most of the tailings come from ores with different performances. Before analyzing the characteristics of the tailings pond, it should be classified first, but there is no clear standard for the classification of tailings particle size. Tailings are classified from the perspective of particle size of tailings [5].

| Category       | Judgement standard | Tailings name           |
|----------------|--------------------|-------------------------|
| Tailings Sand  | >2.0mm             | 10%~50%                 | Tail gravel             |
|                | >0.50mm            | >50%                    | Tail coarse sand        |
|                | >0.25mm            | >50%                    | Tail sand               |
|                | >0.10mm            | >75%                    | Tail fine sand          |
| Tailings       | <0.005mm           | >30%                    | Tailings mud            |
|                | <0.005mm           | >15%~30%                | Tail heavy sub-stick    |
3. Identification and analysis of harmful factors in tailings

Harmful factors refer to factors that may cause diseases and injuries of the human body. This article is based on the classification and codes of dangerous and harmful factors in production processes (GB/T13861-2009) [6], of men-machine-environment-management. Four aspects are to study the possible harmful factors in the tailings pond.

3.1 Identification and analysis of harmful factors caused by humans

The operation and effective management of tailings ponds are inseparable from human beings, and people often cause serious consequences due to psychological, physical, behavioral and other reasons, which makes the tailings pond unstable [7]. Harmful factors caused by humans refer to the harmful factors that may affect the normal operation of the tailings pond due to the unsafe behavior of managers and operators during the operation of the tailings pond. There are five main reasons for this result:

1) Overload limit: The load overrun mainly means that the work requirement exceeds the physical limit of the staff. This situation is usually caused by unreasonable scheduling and staffing, excessive overtime hours, or continuous long-term operations in an emergency. If the employee's long-term overload work not only greatly affects the staff's body, it is more likely to cause an accident due to the employee's attention and physical strength.

2) Identification function defects: physiological defects such as sensory, cognitive delay or recognition errors caused by alcohol abuse, illness or poor working environment, which may cause accidents due to inadequate supervision or work.

3) Psychological anomalies: abnormalities in the staff's psychology, such as irritability, emotional abnormalities, poor psychological quality, etc. Which may lead to accidents [8].

4) Operation error: due to professional safety training or other reasons, the staff may cause damage or injury to the equipment during the inspection, monitoring and maintenance of the safety facilities of the tailings mine.

5) Guardianship error: During the work process, the operator in charge of monitoring may not be in a position due to improper monitoring, misjudgment or misconduct, resulting in an accident.

3.2 Identification and analysis of harmful factors caused by materials

Various facilities and equipment are required in the operation of the tailings pond. The harmful factors caused by the materials mainly refer to the dangerous and harmful factors that may be generated under different conditions of various facilities, equipment and materials.

1) Failure of flood discharge facilities: drainage towers, drainage culverts and other flood discharge facilities do not meet the design requirements and actual flood discharge capacity, and cannot discharge floods in the reservoir; or flood discharge facilities are located on poor foundations, or the intensity of flood discharge pipelines cannot suspension of design maximum load, rupture, blockage, etc. During construction and operation, loss or reduction of flood discharge capacity, flooding in the reservoir can not be discharged in time may lead to flooding accidents; or no flood storage capacity and safety reserved during operation excessively high or insufficiently reserved, resulting in flooding, threatening the stability of the tailings bank slope and even causing the dam.

2) Mechanical damage: The working environment is poor during the dam operation. If the equipment protection measures fail, or the operation is wrong, or the equipment is not properly maintained, it may cause mechanical damage to the operator.

3) The design of the dam slope is unreasonable: the width and slope of the dam road do not meet the requirements, and the lack of road lighting is likely to cause vehicle injury accidents. The dam slope does not have a built-in sidewalk, and the operator may inadvertently inspect the dam slope to
cause personnel.

4) Vehicle damage: Construction vehicles during construction of piled dams, vehicles used for transportation of materials, such as irregular inspection, repair and maintenance of vehicles, poor safety conditions, lighting, brakes and other safety devices, and poor operating conditions may cause vehicle injury accidents.

5) Failure of the observation facility: the depth of the observation facility or the location of the installation is unreasonable, which makes it impossible to determine the position of the immersion line in the dam through the change of the water level of the section.

6) The pipeline setting is unreasonable: the tailings conveying pipeline crossing the road lacks the height limit and anti-collision facilities, and the pipeline safety is dangerous.

7) Electric shock: The local area is dry and windy, and the electric line is in danger of being blown off by the wind. If the human body accidentally touches the live line, it may cause electric shock. Or electrical equipment, line installation is not standardized, the safety distance is insufficient, the grounding device is unqualified, and the protective screen, protective cover or protective fence is defective, which may cause electric shock.

8) Non-standard electrical work: electrical welding equipment will be used for equipment and facilities maintenance. Incomplete cleaning of welding slag caused by electric welding may cause ignition of flammable materials near the working place, causing fire.

9) Missing warning signs: There is no warning sign in dangerous equipment such as power distribution cabinets and switchboards, and electric shock may occur. There is no warning sign in dangerous places such as high-steep and steep slopes on the tailings back. Pedestrians may fall in high places when walking on the top of the slope.

3.3 Identification and analysis of harmful factors caused by the environment

The environmental factors that pose a hazard to the tailings pond are: geological structure, hydrogeology, hydrometeorological conditions, earthquakes, lightning strikes, high and low temperatures, and wind power. These kinds of accidents are caused by various factors, including collapse, dam break, landslide, leakage, etc. [9]

3.3.1 Harmful factors caused by hydrology and meteorology

Hydrological and meteorological conditions have a great impact on the tailings pond. Rainstorms can form floods. Flooding natural hazards are one of the main factors affecting the safety of tailings ponds. Rainfall will increase the wetting line of the dams, resulting in higher immersion lines of the dams. The design limit even makes the water content of the dam surface saturated, reduces the anti-sliding stability of the dam body, and causes the dam slope to collapse; the heavy rain can cause the dam surface to wash the ditch and destroy the integrity and stability of the dam.

3.3.2 Harmful factors caused by bad weather

1) The electrical equipment in the warehouse is in danger of being struck by lightning. Lightning strikes can cause casualties, damage to equipment and buildings.

2) The maximum outdoor temperature in the local hot summer season can reach 38°C. If the outdoor operation is carried out in hot weather, the operator may be at risk of dizziness and heatstroke when the exposure time is too long. The local minimum temperature in winter is -18°C. The outdoor tailings conveying pipeline and valve insulation are damaged. After the deactivation, the tailings in the pipeline are not evacuated in time, there is danger of valve freezing and freezing and blockage of the pipeline.

3) Lightning can generate atmospheric over voltages on electrical equipment, causing insulation damage, damage to equipment, and damage to buildings and structures. Lightning strikes can also cause casualties. There is a risk of lightning strikes on the tailings of the tailings dam. Lightning strikes can cause fire, personal injury, damage to electrical equipment and buildings.

4) The local climatic characteristics are dry and windy in spring. If the dam body slope and beach
surface are not properly protected, it will form dust and pollute the surrounding environment.

5) The dam body of the tailings pond is an earth dam, and the outer slope surface lacks protection. The outer surface of the dam and the dry shoal will form dust due to the surface dryness. The local maximum wind speed is 28.0m/s, and the dust generated by the strong wind will not only pollute the surrounding environment of the reservoir area, but also affect people's health.

3.3.3 Floods
1) During the flood season, a large amount of rainwater is poured into the reservoir or the water is accumulated in the reservoir. The drainage capacity is insufficient, and the water level in the reservoir is extremely high. The flooding tops and the dam crests and slopes occur, resulting in a flooding landslide.

2) The flow of objects such as tailings from the reservoir area causes the water level in the reservoir to soar, causing flooding of the dam.

3) Insufficient flood storage capacity or no reserve flood storage capacity during operation.

4) The operation and management of the tailings pond is improper. When the top of the reservoir is close to the designed stacking height, there may be a flooding phenomenon when a sudden heavy rain or drainage system blocks the high safety warning water level in the reservoir.

3.4 Identification and analysis of harmful factors caused by management
Improper management can also cause greater harm, and preventive measures should be taken to understand the distribution and correlation of management factors.

The main reasons for mismanagement are as follows:
1) Manager dereliction of duty;
2) The tail miner dereliction of duty;
3) The arbitrariness of project changes;
4) The corresponding qualifications are not available;
5) Security funds are not implemented;
6) Human disturbance in the reservoir area;
7) The rules and regulations are not perfect;
8) The disaster emergency plan is not prepared or drilled;
9) Lack of technical information, etc.

4. Conclusion
In summary, for any mining enterprise, it is an arduous task to make a safe production of the tailings pond. Through the above analysis, it can be seen that the harmful factors of the tailings pond are not alone in one aspect, but are implemented in all aspects of tailings pond production. If it can grasp every link of men-machine-environment-management, then it will maximize the safe production of the tailings pond and provide security for the people and the property of life.

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