3.3 crushing equipment

Bond's Law:

- Bond's Law states that the work required to form particles of a certain size from a very large feed is proportional to the square root of the surface-to-volume ratio of the product particles.
- Mathematically, it is expressed as where: $W = -C \cdot (D11 - D21)$

  Where:

  - W is the work input (energy) required for size reduction,
  - C is a constant,
  - $1D1$ is the initial diameter of the feed,
  - $2D2$ is the diameter of the product.

Kick's Law:

- Kick's Law postulates that the energy required for size reduction is proportional to the reduction ratio, the ratio of the initial particle size to the final particle size.
- Mathematically, it is expressed as $2W = K \cdot D11 - D21$,

  where:

  - W is the work input (energy),
  - K is a constant,
  - $1D1$ is the initial diameter of the feed,

- $2D2$ is the diameter of the product.

Size Reduction Equipment:

Crushers:

Crushers are machines designed to reduce the size of large rocks, ores, and other materials into smaller, more manageable particles.

Various types of crushers are employed in size reduction processes, each suitable for specific applications.

Jaw Crusher:

A jaw crusher is a common type of size reduction equipment widely used in mining and recycling applications.

It consists of a fixed jaw plate and a movable jaw plate that form a V-shaped crushing chamber.

The feed material is fed into the chamber and crushed between the jaws, producing smaller-sized particles.

Types of Crushers:

Jaw Crushers: Ideal for primary crushing of hard materials.

Gyratory Crushers: Employed for coarse crushing and often used in large mining operations.

Cone Crushers: Suitable for secondary and tertiary crushing stages.

Impact Crushers: Utilize impact force to break materials.

Working Principle of Jaw Crusher:

The motor drives the eccentric shaft to rotate through the belt and pulley, causing the movable jaw to move back and forth along a predetermined track.

The material is crushed in the crushing chamber as the movable jaw approaches the fixed jaw.

The crushed material is discharged through the discharge opening at the bottom of the crusher.

Advantages of Jaw Crusher:

High reduction ratio and uniform product size.

Simple structure and reliable operation. easy maintenance and low operating costs.

Limitations of Jaw Crusher:

Ineffective for reducing sticky or wet materials.

Not suitable for fine crushing.

Applications of Jaw Crusher:

Primary crushing in mining and quarrying.rRecycling of construction and demolition waste.

Reduction Equipment:

Crushers:

Crushers are classified into various types based on their working principles and applications.

Common types include jaw crushers, gyratory crushers, cone crushers, and impact crushers.

Jaw Crusher:

Operating Principle: The material is fed into the crushing chamber between a fixed and a movable jaw. The movable jaw reciprocates, crushing the material against the fixed jaw.

Advantages:

Well-suited for hard and abrasive materials.

High reduction ratio.

Limitations:

Ineffective for sticky or wet materials.

Not suitable for fine crushing.

Types of Crushers:

Gyratory Crushers: Feature a conical-shaped crushing head gyrating inside a bowl. Suitable for primary crushing.

Cone Crushers: Utilize a gyrating cone for secondary and tertiary crushing.

Impact Crushers: Operate on the principle of impact, suitable for softer materials.

Working Principle of Jaw Crusher:

The crushing process involves the movement of the jaw plates, creating a squeezing and grinding action on the material.

The closed side setting (CSS) determines the product size, and the adjustable discharge opening controls the material output.

Applications of Jaw Crusher:

Widely used in mining, quarrying, and recycling industries for primary crushing.

Efficiently handles various materials, including hard rocks and recycled concrete.

Crushing Efficiency:

Factors Affecting Crushing Efficiency:

Feed Characteristics: Size, hardness, and moisture content of the feed material influence crushing efficiency.

Operating Conditions: Adjustable parameters such as CSS, eccentric speed, and chamber design impact efficiency.

Machine Design: The geometry of the crushing chamber and the kinematics of the moving jaw affect efficiency.

Optimization Strategies:

Continuous monitoring and adjustment of operating parameters.

Regular maintenance to ensure optimal machine performance.

Use of advanced control systems and automation.

Additional Considerations:

Particle Size Distribution (PSD):

Controlling PSD is crucial for achieving desired material properties.

Crushers play a role in determining the final PSD of the comminuted product.

Sustainable Practices:

Advancements in crusher design and technology aim at improving energy efficiency and reducing environmental impacts.

Advanced Crushers:

Ongoing research focuses on developing advanced crushers with enhanced performance, energy efficiency, and adaptability to different materials.

The principles of comminution, the characteristics of crushers, and the factors influencing crushing efficiency is essential for optimizing size reduction processes in various industries. Advances in technology and sustainability practices continue to shape the landscape of size reduction equipment and processes.