Abrasives: Understanding the fundamentals of materials that smoothen surfaces

What are abrasives?

Abrasives are materials, often grains, that are used to grind or polish surfaces through friction. They are applied to the surface of another material, which does the grinding or polishing. Abrasives hold sharp grain particles or crystals that dig into, break, and crush the surface of the material being abraded when pressure is applied. Common abrasives include aluminum oxide, silicon carbide, diamond dust, garnet, and emery.

Classification of abrasives

Abrasives can be broadly classified into two types based on their properties and characteristics:

- Natural abrasives: These are minerals that naturally occur in nature in mineral/rock form such as emery, corundum, garnet, etc. Emery and corundum are harder than steel whereas garnet has a hardness between magnetite and corundum.

- Manufactured (synthetic) abrasives: These **Abrasives** are artificially made or produced through various processes. Examples include aluminum oxide (commonly known as alumina), silicon carbide, cerium oxide, cubic boron nitride, and diamond. Synthetic abrasives tend to be cheaper and offer more uniform size and shapes compared to natural abrasives.

Characteristics of a good abrasive

There are certain qualities that make an abrasive material suitable for industrial finishing and polishing applications:

- Hardness: It should be harder than the material being abraded for effective grinding or polishing. Diamond is the hardest known natural material.

- Uniform size and shape of grains: Regularly shaped grains of uniform size cut material at a consistent rate. Irregular grains create non-uniform abrasion.

- Durability: It should not break down easily during use and sustain abrasive properties for longer periods. Natural minerals tend to break down fast.

- Availability: It should be abundantly and economically available. Manufactured materials resolve the issue of limited natural resource availability.

- Bonding ability: It should bond properly to the backings or substrates on which they are coated for secure attachment.

Factors affecting abrasive performance

Besides the properties of abrasives, there are various factors that influence the effectiveness and efficiency of abrasion:

- Grain type: Abrasive grains play a major role like grit size and shape. Larger grit removes material faster but leaves poor finish.

- Grit size: Typical grit sizes range from very fine to very coarse. Finer grit provides better finishing but removes material slowly.

- Grit density: Denser configuration of grains/cm2 provides better material removal and finish.

- backing: It holds abrasive grains and transmits pressure. Different backings like paper, cloth, resin have distinct characteristics.

- Bonding material: It binds abrasive grains to the backing. Brittle bonds break grains easily while tougher ones last longer.

- Applying pressure: Optimum pressure ensures grain engagement without clogging or loading. Excess pressure burdens the machine.

- Wheel speed: Higher speed provides greater stock removal but risks burning surfaces at extreme speeds.

- Workpiece speed: Slower workpiece rotation permits higher wheel speeds for stock removal.

- Coolants: Lubricating coolants reduce friction, prevent loading, and prolong wheel life.

Abrasive tools and applications

A variety of tools integrate abrasives for various stock removal and surface finishing tasks:

- Abrasive belts: Made of abrasives bonded to flexible materials for deburring, blending contours.

- Abrasive sheets: Typically resin bonded abrasive sheets for rapid stock removal and finishing operations.

- Abrasive paper: Consists of abrasive grains bonded to paper backings, commonly used by hand for finishing.

- Abrasive cloth: Durable woven backing coated with abrasives employed for heavy-duty grinding operations.

- Abrasive stones: Natural or synthetic whetstones and oil stones are hand-held for sharpening blades.

- Abrasive cut-off wheels: Circular resin bonded cutoff wheels used in angle grinders for metal sections.

- Abrasive grinding and polishing machines: Surface grinders, belt grinders, and polishing machines help automate finishing tasks faster.

- Abrasive discs: Flap discs, abrasive Discs, and wire cups provide versatile stock removal and finishing in portable electric tools.

Surface preparation, finishing, and cleaning demand extensive use of abrasives in a wide range of industries like automotive, aerospace, metal fabrication, woodworks, electronics, etc. The article aimed to provide critical understanding of these coarse yet functional materials used almost ubiquitously in manufacturing processes.

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