Topic Page: Crystal

Definition: **crystal** from *Processing Water, Wastewater, Residuals, and Excreta for Health and Environmental Protection: An Encyclopedic Dictionary*

A solid, homogeneous chemical substance that has a definite geometric shape and a characteristic internal structure, with fixed angles between its faces and distinct edges or faces.

Summary Article: **crystal**
From *The Columbia Encyclopedia*

a solid body bounded by natural plane faces that are the external expression of a regular internal arrangement of constituent atoms, molecules, or ions. The formation of a crystal by a substance passing from a gas or liquid to a solid state, or going out of solution (by precipitation or evaporation), is called crystallization.

Classification of Crystals

The particles in a crystal occupy positions with definite geometrical relationships to each other. The positions form a kind of scaffolding, called a crystalline lattice; the atomic occupancies of lattice positions are determined by the chemical composition of the substance. A crystalline substance is uniquely defined by the combination of its chemistry and the structural arrangement of its atoms. In all crystals of any specific substance the angles between corresponding faces are constant (Steno's Law, or the First Law of Crystallography, published by the Danish geologist Nicolaus Steno in 1669). Crystalline substances are grouped, according to the type of symmetry they display, into 32 classes. These in turn are grouped into seven systems on the basis of the relationships of their axes, i.e., imaginary straight lines passing through the ideal centers of the crystals.

Crystals may be symmetrical with relation to planes, axes, and centers of symmetry. Planes of symmetry divide crystals into equal parts (mirror images) that correspond point for point, angle for angle, and face for face. Axes of symmetry are imaginary lines about which the crystal may be considered to rotate, assuming, after passing through a rotation of 60°, 90°, 120°, or 180°, the identical position in space that it originally had. Centers of symmetry are points from which imaginary straight lines may be drawn to intersect identical points equidistant from the center on opposite sides.

The crystalline systems are cubic, or isometric (three equal axes, intersecting at right angles); hexagonal (three equal axes, intersecting at 60° angles in a horizontal plane, and a fourth, longer or shorter, axis, perpendicular to the plane of the other three); tetragonal (two equal, horizontal axes at right angles and one axis longer or shorter than the other two and perpendicular to their plane); orthorhombic (three unequal axes intersecting at right angles); monoclinic (three unequal axes, two intersecting at right angles and the third at an oblique angle to the plane of the other two); trigonal, or rhombohedral (three equal axes intersecting at oblique angles); and triclinic (three unequal axes intersecting at oblique angles). In all systems in which the axes are unequal there is a definite axial ratio for each crystal substance.

Physical Properties of Crystals

Crystals differ in physical properties, i.e., in hardness, cleavage, optical properties, heat conductivity, and electrical conductivity. These properties are important since they sometimes determine the use to

which the crystals are put in industry. For example, crystalline substances that have special electrical properties are much used in communications equipment. These include quartz and Rochelle salt, which supply voltage on the application of mechanical force (see piezoelectric effect), and germanium, silicon, galena, and silicon carbide, which carry current unequally in different crystallographic directions, as semiconductor rectifiers.

See solid-state physics.

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