Y

yard An Imperial unit of length equal to three feet (36 inches). It is equal to 0.9144 metres.

yeast A fungus that forms single cells that reproduce by budding or binary fission. They are exploited commercially as biocatalysts in biotechnological processes such as in the production of alcoholic beverages wine and beer, as well as for the production of bioethanol, which is used as a motor fuel or petroleum additive. Fungi have the ability to convert sugars to alcohol through the process of fermentation. They are also used in single-cell protein production as well as in baking. They are also a dietary source of protein and vitamin B. There are many genera and important yeasts used in biotechnological processes include *Saccharomyces*, *Kluyveromyces*, and *Candida*.

yield The amount of a product that is recovered from a process or chemical reaction. It is usually expressed as a fraction or a percentage based on the raw materials used or as a ratio of the final product to the starting materials without considering any *side reactions. The **yield coefficient** is a measure of the amount of product produced to the raw materials consumed. In a biotechnological process such as fermentation, the yield coefficient is used to express the amount of microbial cells produced per amount of substrate consumed. It is expressed on a weight per weight basis such as kilograms of cells or product produced per kilogram of substrate consumed. The yield coefficient can also apply to the production of a biochemical such as ethanol to the substrate.

yield per pass The net yield of any product in a chemical reactor effluent with a recycle stream back to the reactor feed. It is expressed as a percentage of the limiting reactant in the combined reactor feed. Yields are expressed on a molal, weight, or volume basis.

yield point The stress that is required to be applied to a fluid such as a *Bingham plastic in order for it to begin to flow. Paints, gels, and toothpaste all have a yield point that must be exceeded in order for them to flow.

yield stress 1. The lowest stress that is applied to a material at which extension increases without an increase in applied load. **2.** The shear stress that is required to be applied to a fluid to make it begin to flow. *See* HERSCHEL–BULKLEY FLUID.

Young, James (1811–83) A Scottish chemist noted for his 1852 patent for the distillation of shale, and as the founder of the paraffin industry. Born in Glasgow, James (Paraffin) Young began his career working for his father's carpentry business and at a young age chose to attend evening classes on chemistry delivered by Thomas *Graham at the Andersonian Institution (now the University of Strathclyde). Graham recognized Young's talents and offered him a position as assistant in his laboratory in 1832. When Graham went to University College London in 1837 he took Young with him. There Young distinguished himself as a technical chemist not only in terms of producing chemicals but also in the difficult task of avoiding nuisance and injury, which is a precursor to health and safety. Young's career

took him to St Helens College, and then on to Manchester where he became interested in oil that was found flowing from a pit in Derbyshire. This led to his work on oil production by the low-temperature distillation of shale. When the oil seepage ran out, he returned to Scotland in 1851 to set up a works near Bathgate to produce and refine oil from a rich coal seam, which was being mined nearby. Young patented his method, which earned him a considerable fortune. Today, the Grangemouth refinery nearby is a lasting legacy of oil processing and refining.

SEE WEB LINKS

- Official website of the Museum of the Scottish Shale Oil Industry, page devoted to James Young biography.

Young–Laplace equation An equation used to determine the difference in pressure between either side of a curved surface such as a bubble of radius r_1 and r_2 due to *surface tension:

$$\Delta p = \sigma\left(\frac{1}{r} + \frac{1}{r}\right)$$

where σ is the surface tension. It is named after the British scientist Thomas Young (1773–1829) and the French mathematician Pierre-Simon, Marquis de *Laplace (1749–1827).

Z

zenith process A process used for refining vegetable oils. It involves passing droplets of oil down a column of aqueous sodium hydroxide.

zeolite A natural or synthetic material used to selectively separate substances from mixtures such as water from alcohol. They have an open three-dimensional crystal structure that naturally contains water molecules. Synthetic zeolites include hydrated aluminosilicate. The water can be released by heating and the zeolite can be used to absorb other substances of an appropriate molecular size. Literally meaning 'boiling stone', they are often called **molecular sieves**. They are also used in sorption pumps for vacuum systems, separating organic compounds such as high-octane petroleum for lead-free petrol, and in ion exchange for applications such as in water softening. Zeolites are one of the most diverse and industrially useful mineral groups.

zepto- (Symbol z) A prefix used to denote 10^{-21}.

zero energy state A term used to denote that all stored or residual energy within devices such as rotating flywheels, hydraulic and pneumatic systems, and springs has been dissipated.

zero order reaction The rate of a chemical reaction that is independent of the concentration of a particular reactant. *See* ORDER OF REACTION.

zeroth law of thermodynamics A law which states that if two bodies are in thermal equilibrium with a third body at the same time, then all three are in thermal equilibrium with each other. Essentially, it means that all the bodies are at the same temperature and therefore form the basis for the comparison of temperatures. It is known as the zeroth law since it precedes the first and second laws of thermodynamics.

zetta- (Symbol Z) A prefix used to denote 10^{21}.

Ziegler, Karl Waldemar (1898–1973) A German chemist noted for his work on the controlled polymerization of hydrocarbons through the use of organometallic catalysts. He developed a catalytic system enabling low-pressure polymerization of ethylene to linear polyethylene. He also worked on the development of plastics. He was awarded the Nobel Prize in Chemistry in 1963.

Ziegler–Natta A general name for processes used for the polymerization of olefins (alkenes) that were invented by the German chemist Karl Waldemar *Ziegler (1898–1973) and the Italian chemist Giulio *Natta (1903–79). They were jointly awarded the Nobel Prize in Chemistry in 1963.

Ziegler–Natta catalyst A type of catalyst used in the synthesis of polymers such as high-density polyethylene from olefins (alkenes). They are based on compounds of titanium

such as titanium (IV) chloride ($TiCl_4$) and organoaluminium compounds such as triethylaluminium ($Al(C_2H_5)_3$). They are named after the German chemist Karl Waldemar *Ziegler (1898–1973) and the Italian chemist Giulio *Natta (1903–79). They were jointly awarded the Nobel Prize in Chemistry in 1963.

Ziegler–Nichols tuning A tuning method used to select optimum controller settings. It is used for the control of complex systems where little is known of the dynamics of the system or where calculation of the response is too difficult or impractical. The method was developed by American control engineers John Ziegler and Nathaniel Nichols and is based on empirical tests that gave good performance for a step response of an *open loop system. It is based on the assumption that an open loop transfer function can be approximated by a first-order system with a time delay. The recommended controller settings have been proposed for proportional, proportional and integral, and proportional, integral, and derivative action control. Applied to both open and *closed loop systems, the settings are designed to give underdamped transient responses with a *decay ratio of a quarter.

Ziegler process 1. A process used for the manufacture of high-density polyethylene using catalysts known as *Ziegler–Natta catalysts. First introduced in 1953, they improved on the original manufacturing process and were able to use a lower temperature of 60°C and pressure of around one atmosphere. They are named after German chemist Karl Waldemar *Ziegler (1898–1973) and the Italian chemist Giulio Natta (1903–79) who developed the process further in 1954 for the use with other alkenes. They were awarded the Nobel Prize in Chemistry in 1963. **2.** A process used for the production of tetraethyl lead by electrolyzing a molten complex of ethyl potassium with triethyl aluminium. It was invented by Karl Waldemar *Ziegler (1898–1973) in 1963.

Zimmerman process A thermal process used for oxidizing aqueous organic wastes and waste sewage sludge. It involves pressurizing the sludge with air and heating with steam to a temperature of 250°C. The resulting sterile product is then filtered. It is named after its inventor J. F. Zimmerman who developed it in the 1950s. This has formed the basis of a number of related processes such as the **Zimpro process**.

zincex process A process used for the extraction of zinc from pyrite cinder leachate. It uses organic solvents to remove chloride leachate before an acid treatment is used to remove the iron. It is an abbreviation of **zinc ex**traction. The **zinclor process** is a modified version of the zincex process that uses dipentyl pentylphosphate (DPPP) as the extracting solvent.

zirpro process A process used to flameproof textiles by the treatment of aqueous solutions of zirconium complexes. The textiles, such as wool, are treated with potassium hexafluorozirconate and citric acid, while cotton is treated with zirconium acetate and citric acid.

zone levelling A process used to distribute a solute evenly throughout a purified solid material in the form of a single crystal. For example, in the preparation of a transistor or diode semi-conductor, an ingot of germanium is first purified by *zone refining. A small amount of antimony is then added into the molten zone, which is passed evenly through the pure germanium. This technique is also used for the preparation of silicon for use in computer chips.

zone refining A process used to reduce the impurities in certain metals, alloys, and semiconductors. It relies on the solubility of an impurity being different in the liquid and solid phases. The process involves a narrow molten zone being progressively moved along

the length of a specimen of the material such that the impurities are segregated at one end of the ingot and pure material at the other. Where the impurities have a lower melting point than the material being purified, the impurities travel with the moving zone, and vice versa.

Zone refining was developed by American materials scientist William Gardner Pfann (1917–82) as a method of preparing high-purity materials for the manufacture of transistors. Its early use was for purifying germanium, but it can be extended to any solute–solvent system having an appreciable concentration difference between the solid and liquid phases at equilibrium. It is also known as the **float zone process** used in semi-conductor materials processing.

z-value The temperature rise required in degrees Celsius that is able to bring about a ten-fold decrease in the thermal death time of microorganisms. It is used in the thermal sterilization process of foods that may be contaminated with harmful microorganisms. The thermal death time is the time required to reduce the number of surviving microorganisms to an acceptable level. A typical value for the thermal destruction of vegetative microorganisms is around 10°C.