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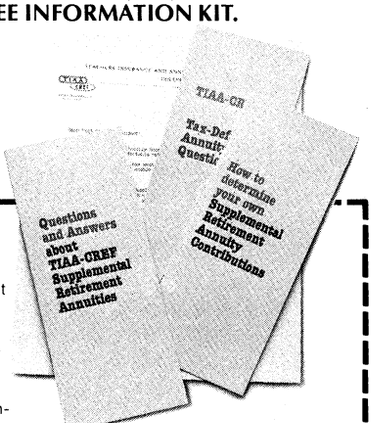

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COVER

Rat cortex showing autoradiographically labeled nerve fibers which appear as whitish bands by dark-field illumination through the microscope. The amino acid isotope marker was injected into the lateral posterior nucleus of the thalamus. The labeled thalamocortical fibers terminate in cortical layers I and VI of the peristriate visual area (top and bottom) but in layers I and V of the striate area (center) (about × 62). See page 532. [Miles Herkenham, National Institute of Mental Health, Bethesda, Maryland]

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Synthetic Chemicals from Coal

An historically important event occurred 9 January 1980 when Tennessee Eastman, a subsidiary of Eastman Kodak Corporation, announced plans to construct a major plant to synthesize acetic anhydride from coal. This announcement was the first of what are likely to be many similar ones as the American chemical industry shifts away from dependence on natural gas and petroleum, which now constitute about 85 percent of their carbon-containing feed stocks. Acetic anhydride, now derived by petrochemical processes, is used in numerous ways such as the synthesis of cellulose acetate which, in turn, takes many forms including rayon and photographic films. The Eastman announcement is especially significant for an additional reason: their synthetic process employs CO as a crucial ingredient. In future CO is likely to become one of the most important building blocks for industrial chemical synthesis.

Neglecting energy considerations, the steps of the process may be summarized as follows:

$$2C + 2H_2O \rightarrow 2CO + 2H_2 \quad (1)$$

$$CO + 2H_2 \rightarrow CH_3OH \text{ (methyl alcohol)} \quad (2)$$

$$CH_3OH + CH_3COOH \rightarrow H_2O + CH_3\text{-}O\text{-}\overset{\overset{O}{\|}}{C}\text{-}CH_3 \text{ (methyl acetate)} \quad (3)$$

$$CH_3\text{-}O\text{-}\overset{\overset{O}{\|}}{C}\text{-}CH_3 + CO \rightarrow CH_3\text{-}\overset{\overset{O}{\|}}{C}\text{-}O\text{-}\overset{\overset{O}{\|}}{C}\text{-}CH_3 \text{ (acetic anhydride)} \quad (4)$$

Note that in reaction 4, CO is inserted into the methoxy moiety in a carbon chain lengthening step. The acetic anhydride reacts with cellulose to form cellulose acetate plus free acetic acid (CH_3COOH), which is then recycled. Thus a material balance is achieved in which carbon plus water plus cellulose gives rise to cellulose acetate.

In principle the steps are simple, and all of them have been previously carried out by others. However, there are problems in conducting the various reactions on a large scale. This is especially true of the gasification step. To obtain $CO + H_2$ from the reaction of coal with water requires the addition of energy, which is obtained by oxidizing part of the coal.

Gasification reactions are carried out at moderately elevated pressures by a variety of schemes for introducing the reactants and removing the products. The Lurgi process which was invented in Germany is the one that has been most widely used. But it has been criticized as not being adaptable to very large units. Its reported reliability is not very good and it cannot be used with all coals. Accordingly, substantial efforts have been made to achieve a more satisfactory process. One effort that shows considerable promise for improved performance has been conducted by Texaco. In this scheme, a jet of a slurry of coal is brought into juxtaposition with a jet of oxygen. Their process will be used by Eastman.

Following gasification of coal, impurities such as sulfur compounds are removed and the ratio of hydrogen and carbon monoxide is adjusted to a desired value by a reaction that converts part of the CO to CO_2 while producing an equivalent amount of H_2. Depending on the relative concentrations of H_2 and CO, pressures, temperatures, and catalysts, thousands of different chemicals can be synthesized from the original constituents. One example is methyl alcohol, which is used in the Eastman process, but which has many other applications. In future, huge quantities of it will be produced by many companies, to be burned as an automotive fuel or converted by a process developed by Mobil into gasoline-type hydrocarbons.

Time will be required to develop processes and to build plants, but the conversion of the chemical industry away from natural gas and petroleum is inevitable. With new and better processes that will be engineered to be energy-efficient and that will use cheaper feed stocks, the American chemical industry will be able to continue to compete favorably in domestic and world markets.—PHILIP H. ABELSON

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