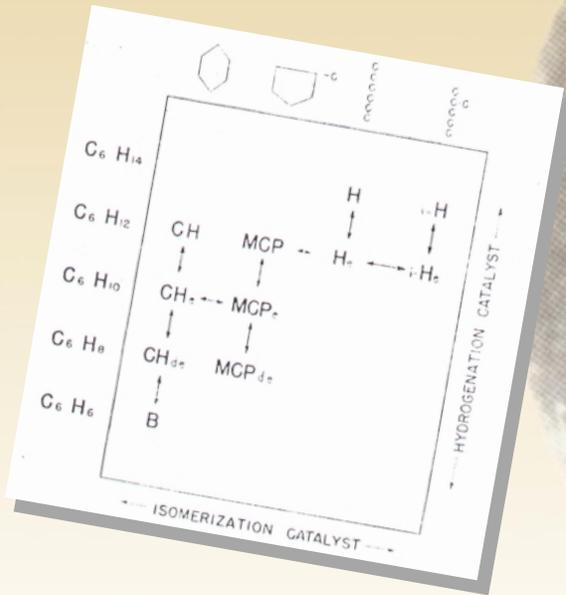


6 Reforming C_6 hydrocarbons with dual function catalysts



1953: Naphtha reforming involves dual functional catalysts - mechanism for reforming with these catalysts - G. A. Mills, H. Heinemann, T. H. Milliken and A. G. Oblad, *Ind. Eng. Chem*, **45**, 124 (1953).

1953: Karl Ziegler discovers a catalyst system for polymerizing ethylene at low temperature and pressure to produce linear, crystalline polyethylene- Nobel Prize awarded to Ziegler in 1963.

1954: Giulio Natta invents stereospecific polymerization of propylene to produce crystalline polypropylene- Nobel Prize awarded to Natta in 1963.

1954: “Beginning” of catalyst characterizations using instruments with i.r. spectra for CO adsorption on copper (R. P. Eischens, W. A. Pliskin and S. A. Francis, *J. Chem. Phys*, **22**, 1786 (1954)). This pioneering work soon included approaches to characterize active sites for adsorption on metal, metal oxide and acidic sites as well as distinguishing Brønsted and Lewis acid sites.

1954: John P. Hogan and R. L. Banks, Phillips Petroleum, discovers chromia catalyst for polyethylene production.

1954: B.F. Goodrich (S. E. Horne) and Gulf Oil announce use of Ziegler catalyst to polymerize isoprene to duplicate natural rubber.

1955: Sasol begins commercial operation of Fischer-Tropsch circulating fluid bed reactors.

1956: Phillips Process - high pressure (500 psi) in hot solvent with supported chromia catalyst did not, on the surface, look attractive compared to Ziegler-Natta; however, engineering advances, cheap and high activity catalyst, and ever increasing scale made the Phillips Process the world’s leading source of polyethylene.

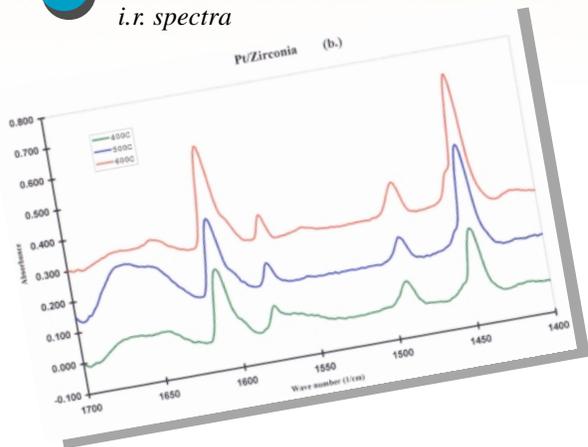
1956: First International Congress on Catalysis held in Philadelphia - more than 600 attendees. This has become an independent organization and the 11th ICC will be held during 2000 in Granada, Spain.

1957: On June 18, Hercules opens the first Ziegler catalyst based plant in the U.S.

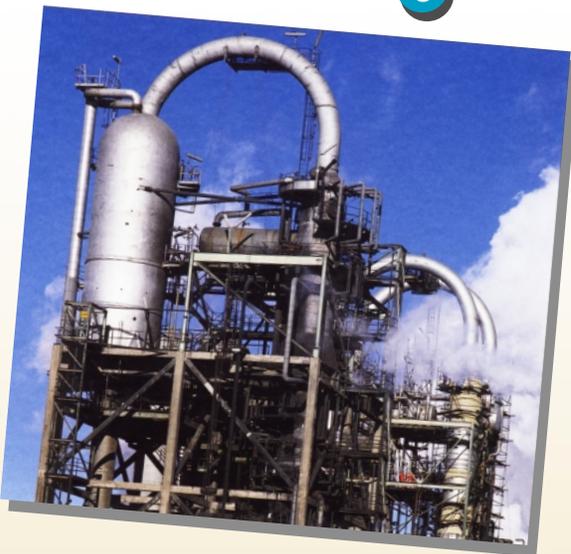
1958: Merox Mercaptan Oxidation Process – UOP

1953 - 1959: Patents granted in these years led to the commercial production of three significant linear polyolefins: high-density polyethylene (1955-56 by Hoechst, W.R. Grace, Hercules and Phillips), polypropylene (1957-8 by Hercules, Montecatini and Hoechst) and stereospecific rubbers (1958-9 by Goodrich-Gulf, Phillips and Shell).

7 Catalyst characterizations using instruments with i.r. spectra



Sasol begins commercial operation of Fischer-Tropsch circulating fluid bed reactors.



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