

History of Cobalt Catalyst Design for FTS

Calvin H. Bartholomew

BYU Catalysis Lab, Department of Chemical Engineering, Brigham Young University,
350 CB, Provo, UT 84602, email: bartc@byu.edu

Cobalt catalysts for Fischer-Tropsch synthesis (FTS) of liquid and waxy paraffins from syngas were first discovered more than 90 years ago. Indeed, the production of liquid hydrocarbons over cobalt catalysts was first reported in 1913 in a patent granted to BASF. In the subsequent nine decades, catalyst technology has advanced from a simple moderately-active Kieselguhr-supported cobalt promoted with thoria to sophisticated, high-activity, highly-optimized cobalt catalysts supported on carefully-designed alumina, silica, or titania and promoted with noble metals and basic oxides. Catalyst design has evolved from trial and error art based experimentally reactor tests of activity and selectivity to a scientific, nanoscale design founded on activity-structure relationships and computerized theoretical models.

Advances in cobalt catalyst design can be conveniently discussed in the context of five historical periods: (1) discovery (1902-1932), (2) commercial development of cobalt and iron catalysts (1933-1954), (3) the iron age (1950-1985), (4) rediscovery (1973-1990), and (5) GTL and the return to cobalt (1990-present). During the first period, cobalt catalysts were established as the most active and selective for FT synthesis; during the second, commercial processes based on cobalt catalysts technology were developed in Germany and contributed significantly to their ability to produce gasoline and chemicals from coal. Documentation of this early work has been until recently somewhat sketchy and during the iron age was largely forgotten; nevertheless, the recently available web site containing a large data base of Fischer-Tropsch literature, including technical files of the Allied Technical Mission following World War II, provides new perspectives of the extensive work on FT catalysts carried out during the 1930's and 1940's in Germany. These documents provide evidence that some of the later developments, i.e., the explosion of patents and processes during Periods 4 and 5, are to some extent based on the prior art. Once again the importance of knowing our history, including the history of technology, is well illustrated.

The first GTL plant was constructed by Shell in Malaysia about 10 years ago; approximately 8-10 additional plants are in either in construction or planning and by 2007 could be producing two million barrels per day of premium sulfur-free diesel.