

measure of the X–M bond strengths while the strengths of CO–X bonds are related to both the magnitude and direction of the shifts. As metal M moves to the right in the Periodic Table, bimetallic X–M bonds weaken progressively when X = Pd, weaken to a minimum around Re and then strengthen again when X = Cu, and strengthen progressively when X = Zn. At the same time CO–Pd/M and CO–Cu/M bonds become progressively stronger.

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Auto Catalysis — an Unrecognized Pioneer

One normally considers auto catalysis to have its origins in the U.S. in the 1950s [1]. However, the subject dates at least to a patent issued in 1931 (application filed August 12, 1929), and reading this patent should provide great respect for the far-sighted vision of the inventor, Professor Joseph C.W. Frazer.

Professor Frazer, in a short text of less than five pages and four figures, provides a surprisingly accurate and detailed description of both the science and technology of his invention. Professor Frazer indicates that various earlier attempts had been made to eliminate carbon monoxide from the products of combustion of internal combustion engines by the use of catalysts. He also indicated that various catalysts had been tried or suggested but he does not give references to earlier work.

Professor Frazer notes that the earlier catalysts lacked stability because of, among other reasons, the high temperatures which necessarily prevailed. In addition, some of the prior catalysts were poisoned by various constituents, including

water, that were present in the combustion products. A further cause of loss of activity was the alteration between high and low temperatures that the catalysts are subjected to when used in autos.

A surprising feature of the patent is that Professor Frazer offered the view that the carrier was preferably a heat conducting metal that is capable of resisting corrosion under the operating conditions that prevail. He found Monel metal particularly suitable but indicated that other metals, such as high chromium irons and steels, may be used. Those who follow auto catalysis will realize that the support that Professor Frazer proposed is now being considered as an attractive approach to enable the catalytic converter to be mounted close to the manifold where high temperatures will be encountered [2].

Professor Frazer utilized a non-noble metal catalyst. His preferred catalyst was an iron chromite, formed by the reduction of an iron chromate solution applied as a coating to a suitable carrier. He stated that, "In the event that the chromite catalyst is capable of existing in several stages of oxidation, it is preferably present in its highest stage, the most suitable catalyst being, as far as I am now aware, an artificially prepared product." While the environmental concerns for chromium would eliminate Professor Frazer's catalyst from consideration today, there is currently a drive to develop non-noble metal catalysts.

Professor Frazer provided an approach to obtain conversion during the cold start conditions. He suggested using a spark plug for the purpose of preheating the air and/or fuel. Alternatively, Professor Frazer proposed using resistance heating of the catalyst support as a means of heating the

catalyst to a temperature adequate to effect catalytic conversion during the cold start period.

Professor Frazer constructed a suitable apparatus and fixed it to a six-cylinder automobile. His convertor, containing an arrangement of woven screens of Monel metal coated with iron chromite, operated satisfactorily while the auto travelled over *1500 miles*, somewhat short of the 50,000 required today in the U.S. His demonstration model included a spark plug for pre-heating the gases. Thermocouples were placed at various locations to make temperature readings during operation and samples were taken to be subjected to analysis for CO. The 1500 mile run was over "both level and mountainous country roads, and through cities" and the temperature in the catalytic zone was on "several occasions as high as 1130C".

Professor Frazer's name can be found in the literature associated with many areas of catalysis research. A notable one was the co-development of Hopcalite (an abbreviation of The Johns Hopkins University and the University of California), a catalyst for use in gas masks and this was a significant development during WWI.

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References

- [1] G.R. Lester in B.H. Davis and W.P. Hettlinger, Jr. (Editors), *Heterogeneous Catalysis. Selected American Histories*, Am. Chem. Soc. Symp. Ser., 222 (1983) 415-431.
- [2] *Appl. Catal.*, 127 (1995) N7-N8.

Nomenclature and Terminology in Catalysis

A recent issue of *Appl. Catal. A*, (135 (1996) N2-N14) provides a very long list of Acronyms. This list grows in number at an alarming rate. Most of us need this listing to recognize many of the instrumental approaches.

Another group of publications offers some hope for eliminating many of the problems and ambiguities concerned with reporting results of catalytic studies. These IUPAC reports are also formulated to encourage a standardization of procedures and the terminology encountered in descriptions of catalysis.

One of these publications is entitled 'Reporting Physisorption Data For Gas/Solid Systems with Special Reference to the Determination of Surface Area and Porosity' and was published in *Pure & Appl. Chem.*, 57 (1985) 603-619. As just one example, the writer is often confused concerning the usage of particle. This paper provides a footnote to the effect that "an *agglomerate* is defined as an assemblage of particles rigidly joined together and an *aggregate* as an assemblage of particles which are loosely coherent". One is still left to decide what the extent of division in order for one to have a particle; likewise, rigidly joined and loosely coherent will be seen differently by individuals in the various disciplines, as well as by individuals in catalysis. However, the paper provides an excellent beginning.

Three papers deal with catalyst characterization: A survey of Experimental Techniques in Surface Chemical Physics [*Pure & Appl. Chem.*, 62 (1990) 2297-2322]; Manual on Catalyst Characterization [*Pure & Appl. Chem.*, 63 (1991) 1227-1246]; and