FISCHER-TROPSCH REACTIONS: NOT THE SIMPLE CHEMISTRY WE WERE ALWAYS LED TO BELIEVE.

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Introduction: Fischer-Tropsch-Type (FTT) reactions have been invoked as a mechanism to produce organic molecules from the abundant hydrogen and CO in the protostellar nebula for many years [1]. The products of the FTT process were assumed to be simple hydrocarbons [2] (primarily methane or ethane) and the catalytic surfaces were thought to be iron grains based on the analogous chemical engineering literature [3]. Unfortunately, the chemistry that occurs in a highly controlled chemical reactor that has been optimized for production of a specific product is not particularly analogous to reactions in the nebular environment.

Previous Laboratory Studies: From our first study of FTT reactions [4] we knew that the simple picture of this reaction was really not representative of processes that occur in a protostellar system. A wide range of different products were formed in the gas phase and a carbonaceous coating was deposited that was a better catalyst for CO depletion or CH_4 synthesis than was the original catalyst used in the experiments [5]. Some of these coatings evolved to form highly filamentous carbon nanotubes [6].

More Recent Results: We have measured the reaction rate and gas/solid product ratio for FTT reactions on iron, magnetite and amorphous iron silicate smokes as a function of temperature, time and run number. The results indicate the interplay of a range of processes, beginning with the FTT and Boudouard reactions that produce gaseous hydrocarbons and solid carbon from CO, to the hydrogen reduction of the magnetite and the diffusion of the C into the iron to produce complex carbide. Continued C diffusion then leads to the production of "buds" that increase the surface area of the catalyst. In general, reactions producing gaseous products are gradually overtaken by carbon deposition with rising temperature as might be expected from thermodynamic calculations [7]. The additional surface area increases the overall reaction rate and will eventually change the product distribution as the original catalyst is either converted to a new form or is coated by new materials. Experimental data illustrating all of these processes will be presented and discussed.

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