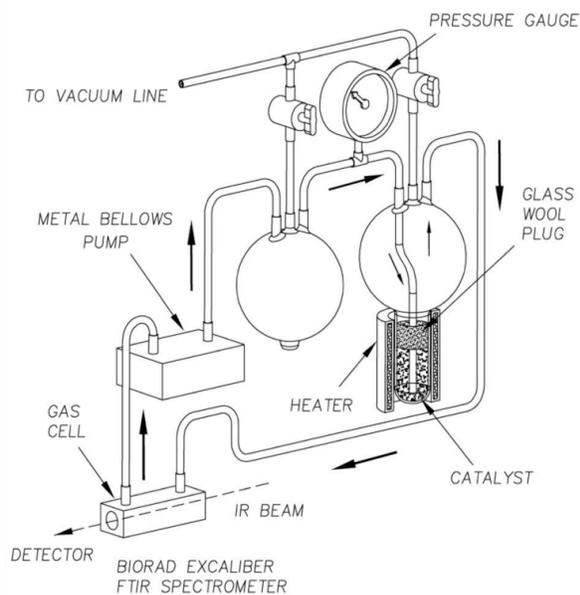


**RATE COMPARISONS OF MAGNETITE AND IRON CATALYSTS DURING FISCHER-TROPSCH-TYPE REACTIONS.** N. M. Johnson<sup>1</sup>, M. McCarthy<sup>2</sup> and J. A. Nuth III<sup>1</sup>, <sup>1</sup>NASA's Goddard Space Flight Center, Astrochemistry Laboratory, Code 691, Greenbelt, MD 20906, [natasha.m.johnson@nasa.gov](mailto:natasha.m.johnson@nasa.gov), <sup>2</sup>Harvard University, Cambridge, MA.

**Introduction:** The how, when, and where about solar system organics has been a hot topic of debate since organics were first discovered in meteorites and detected in comets. One of the early proposed methods to form organics was via Fischer-Tropsch-type (FTT) synthesis brought forward by Studier et al. (1965) [1]. This type of synthesis is catalyst based and requires only carbon monoxide and hydrogen for the reaction to proceed in its most basic state. FTT reactions are well known in the chemical engineering literature as the preferred mechanism to convert CO and H<sub>2</sub> into more complex hydrocarbons [2]. Hill and Nuth [3] expanded upon these reactions by including nitrogen gas into the system, a technique that hydrogenates nitrogen via catalysis also known as the Haber-Bosch processes. Their results included the production of nitrile forming compounds as well as trace amounts of methyl amine. Previous work has also revealed that the organic coating deposited on the catalyst grains serves as an efficient catalyst [4]. In order to better understand the FTT reactions and potential mechanism, this study explores the production rate of organics using different commercially available Fe- based catalysts.

**Experiments:** The FTT reactions are conducted in a closed gas circulating system that monitors the evolved gases in real time using Fourier Transform infrared (FTIR) spectroscopy. The system is shown in Figure 1.



**Figure 1:** FTT system experimental setup

Each series of experiments at a particular temperature begins with the same starting materials: a powdered catalyst, 75 torr CO, 75 torr N<sub>2</sub> and 550 torr H<sub>2</sub> (all ultra-high purity gases). These gases are the most cosmologically abundant reactive solar system gases as well as the basic components in the FTT system. For each FTT experiment, the catalyst is placed at the bottom of a quartz reaction finger and the system is evacuated at room temperature. The system is filled with the desired gas mixture, gas circulation begins, and the sample heated to the desired temperature. Using the FTIR spectrometer, the depletion of CO and the formation of CH<sub>4</sub>, NH<sub>3</sub>, CO<sub>2</sub>, and water are measured in real-time. The circulation of the gas continues until the evolved CO<sub>2</sub> abundance reaches equilibrium. This usually coincides with a ~90% decrease in the CO abundance. At this point in the reaction, the system is cooled, evacuated, refilled with a new aliquot of the same gas mixture, and the cycle can begin again. Fifteen to twenty such cycles are done at each reaction temperature. A more complete description of experimental procedure and apparatus can be found in publications [3, 4].

For these sets of experiments, we used the following catalysts: Fe and magnetite (Fe<sub>3</sub>O<sub>4</sub>). Both samples are in powder form (40 mesh) and were run separately. The temperatures used were 400C, 500C, and 600C.

**Results:** It was anticipated and borne out that these reactions would proceed faster than the 'smoke' analogs (synthesized iron-silicate grains [3]) that we previously used for our FTT studies. This assumption was based on that pure metals are primarily used for commercial catalysts. What was not anticipated was the increasingly faster reaction rate of reaction with each consecutive cycle.

**Discussion:** These results reinforce our previous conclusion that the deposited organic coating serves as a more efficient catalyst than the original surface. Also, the iron oxide reaction rate, while still rapid, is slower than the pure iron but faster than our synthesized Fe-silicate smoke analogs. Results from these experiments will be presented at the conference.

**References:** [1] Studier M. H., R. Hayatsu and E. Anders (1965) *Science*, 149, 1455-1459. [2] Schulz, H. (1999) *Appl. Catal. A*, 186, 3-12. [3] Hill, H. G. M., and J. A. Nuth, III (2003) *Astrobiology*, 3, 291-304. [4] Nuth, J. A. III, N. M. Johnson, and S. Manning (2008) *Ap. J. Letters*, 673, L225-L228.