CHEMISTRY SEMINAR

Synthesis of biomass-derived aromatic compounds using tandem Diels-Alder dehydrative aromatization

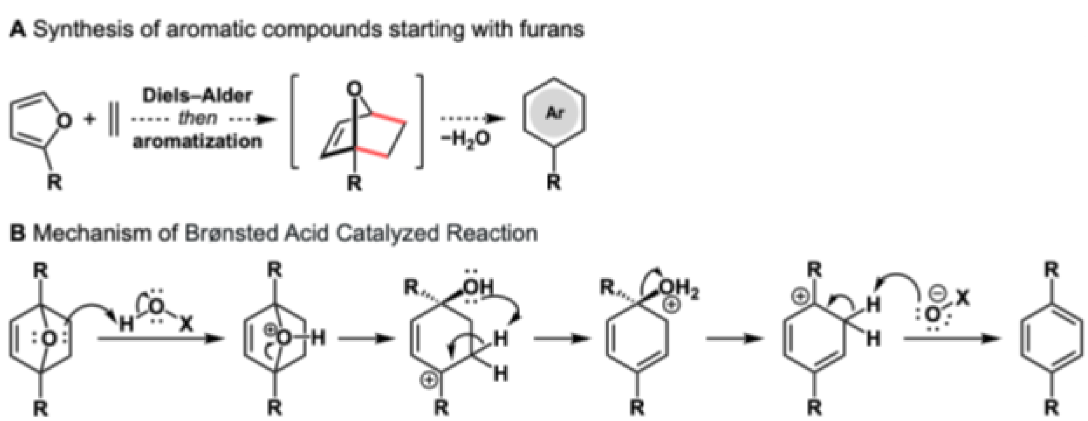
by Dat Dam ‘25 Chemistry/Psychology

11:30 a.m. **March 27, 2025** **Darrah Auditorium**
McCreary Room 101

Abstract:
Aromatic compounds are indispensable and play key roles in several aspects of life, including producing drugs, solvents, materials, fuels, dyes, plastics, etc. Industrial techniques of making aromatic compounds largely involve petroleum and have been refined to be very effective. However, the petroleum approach is not sustainable as fossil fuels are non-renewable, not to mention its harmful effects on the planet, namely greenhouse emissions. Consequently, more recent research is motivated to focus on developing syntheses and productions of aromatic compounds using sustainable resources and chemicals.

In the green chemistry of making aromatic compounds, especially benzene derivatives, Diels-Alder (DA) reactions are often utilized to synthesize important intermediates, which can be readily dehydrated to form desired compounds (Scheme 1). Furanic compounds are one of the most crucial reagents in DA reactions because they often have moderate to high DA reactivity and are readily accessible from abundant biomass-derived materials, such as glucose. In this seminar, the potential of DA reactions in making aromatic compounds using biomass as sustainable starting materials is reviewed, with the purpose of showing that this strategy can be an alternative approach to the traditional petroleum-refinery approach in the future.

Scheme 1. Overall synthesis of aromatic compounds with furans as the starting material (A) and dehydration of DA cycloadduct to form the aromatic product (B).



CHEMISTRY SEMINAR

Phthalates Everywhere: The Effect of Plasticizers on Human Health

By Sofia Dubois '25 Chemistry/Math

11:30 a.m. **March 27, 2025** **Darrah Auditorium**
McCreary Room 101

Abstract:
Plasticizers are esters of phthalic acid that are used to improve plasticity of industrial polymers. Plasticizers reduce costs and are unavoidable in virtually every industry, as they are present in medical appliances, food processing, packaging applications, toys, and even personal care items. This results in extensive human exposure to plasticizers. Phthalates are classified as endocrine disrupting chemicals (EDC) and have been shown to affect the development of non-mammalian aquatic species by altering the thyroid and growth hormone, cholesterol transport through the mitochondrial membrane, which leads to reduced steroid production, and a decrease in the ability to cope with augmented oxidative stress that causes reproductive organ malformations and decreased fertility.

Although the influence of EDCs on human fertility is not fully understood, recent rodent studies show that most EDCs interfere with or mimic steroid hormone action predominantly by engaging oestrogen, androgen, and thyroid hormone signalling pathways. This often leads to disruption of oogenesis and folliculogenesis, induction of deoxyribonucleic acid damage in oocytes, and altered estrogen/androgen receptor signaling. Individuals who have had trouble conceiving often exhibit higher EDC concentrations, which implies a strong relationship between EDC exposure and sub-fertility. This proves to be an important avenue for future research to fill a current gap in knowledge.

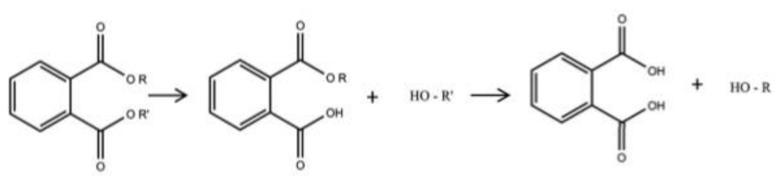


Figure 1. Esterase-catalyzed degradation pathway of *ortho*-phthalate diester. The diesters are metabolised into monoesters and alcohol, further degradation yields phthalic acid and alcohol.

Mathieu-Denoncourt, J. et al. *Gen. Comp. Endocrinol.* 2015, *219*, 74–88. https://doi.org/10.1016/j.ygcen.2014.11.003.

CHEMISTRY SEMINAR

Helium Pycnometer in Materials Engineering

by Andrew Luu ’26 Chemistry/Math

11:30 a.m. **March 27, 2025** **Darrah Auditorium**
McCreary Room 101

Abstract:
Accurate material characterization is fundamental in materials engineering where physical properties such as density and porosity directly influence performance and application suitability. A helium pycnometer is a precision engineering instrument used for achieving the goal of determining true density for solids and powders. It operates on the principle of gas displacement, using helium due to its small atomic size and its ability to penetrate the finest pores of a material for being inert. Using inert gas such as helium also offers an additional advantage in eliminating surface chemistry effects unlike fluid displacement with the Archimedes principles. The helium pycnometer has advantages in being non-destructive, producing highly repeatable results and being applicable to a wide range of materials from metals and ceramics to polymers and pharmaceuticals.

At the core of the helium pycnometer lies the ideal gas law: $pV= nRT$, which governs the behavior of gases under controlled conditions. A typical helium pycnometer consists of a sample chamber and a reference chamber connected by a high-precision digital pressure gauge. The measurement process involves 3 key steps: Pressurization, Expansion and Depressurization. Hence, by performing multiple measurement cycles, a highly repeatable and statistically reliable density value can be obtained.
During the summer of 2024, I conducted research using a Helium Pycnometer in Purdue University's Indoor Air Quality Lab to measure the bulk density of indoor dust samples collected from New York City, NY, and West Lafayette, IN. The experimental findings contribute to simulations of dust resuspension dynamics on robotic platforms for 2 different environmental conditions. An experimental result that I have found over the course of the summer is: True dust density results show a particle size dependency.

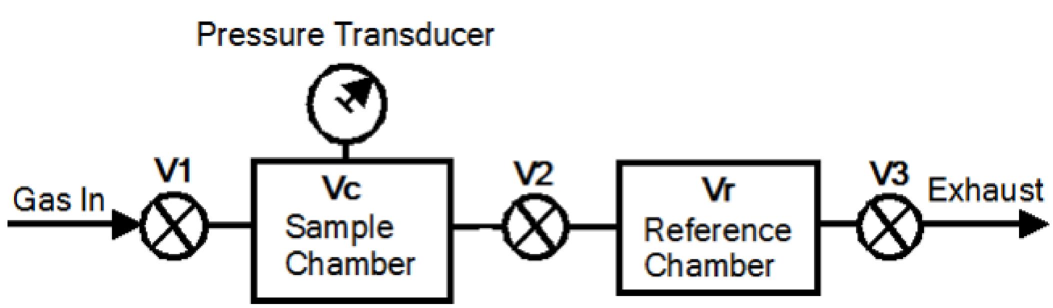


Figure 1: Simplified flow scheme of a helium pycnometer design