Beeswax Adulteration Detection: Thermochemical Analysis

EDMONDS COLLEGE

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Abstract

During the production of beeswax products, specific synthetic chemicals may be introduced to reduce manufacturing costs. These "adulterants," often derived from petroleum and related byproducts, reduce the quality of the product and may represent health risks when used in the food and cosmetic industry.

Current methods for in-situ purity analysis often rely on Gas Chromatography and Mass Spectroscopy (GC/MS) to detect additives. While accurate, this approach is prohibitively expensive and time-consuming.

We present an alternative approach to purity analysis employing Differential Scanning Calorimetry (DSC) to achieve an acceptable approximate of beeswax purity.

Methods and Procedures:

To develop a standardized approach for beeswax purity analysis, multiple baseline samples were prepared through remelting of waxes.

- Specimens ranging from 0-100 wt% beeswax.
- Paraffin wax (Gulf Wax) is used as an example adulterant.
- Natural beeswax derived from Apis mellifera honey bees kept on Edmonds College grounds.

A small amount of each wax blend is mounted into specimen pans and analyzed by a TA Instruments Q20 Calorimeter.

- Basic thermal analysis, monitoring heat flow (W/g) versus specimen temperature (°C) from -40 to 90 °C.

Differential Scanning Calorimetry (DSC):

Differential Scanning Calorimetry is a method of analysis where a sample is characterized through plotting of heat flow (W/g) as the sample is raised in temperature.

- This functions due to materials requiring excessive energies to overcome phase changes. Each material has specific behaviors as a function to temperature.

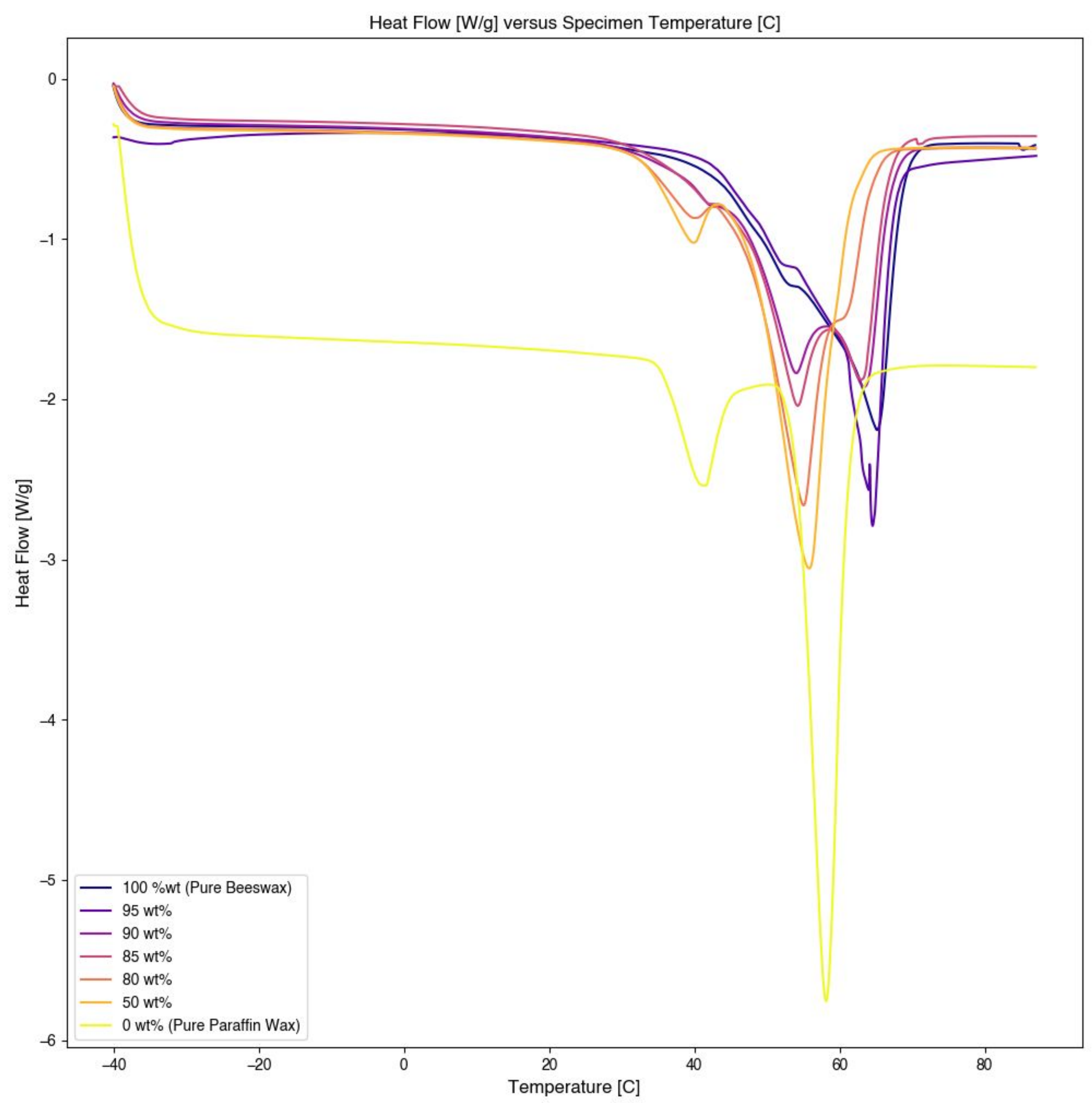

Figure 1: Thermal data from each specimen plotted in relation to each other. Despite pure paraffin providing outlier data, a clear qualitative relationship between purity and phase-change heat flow is apparent.

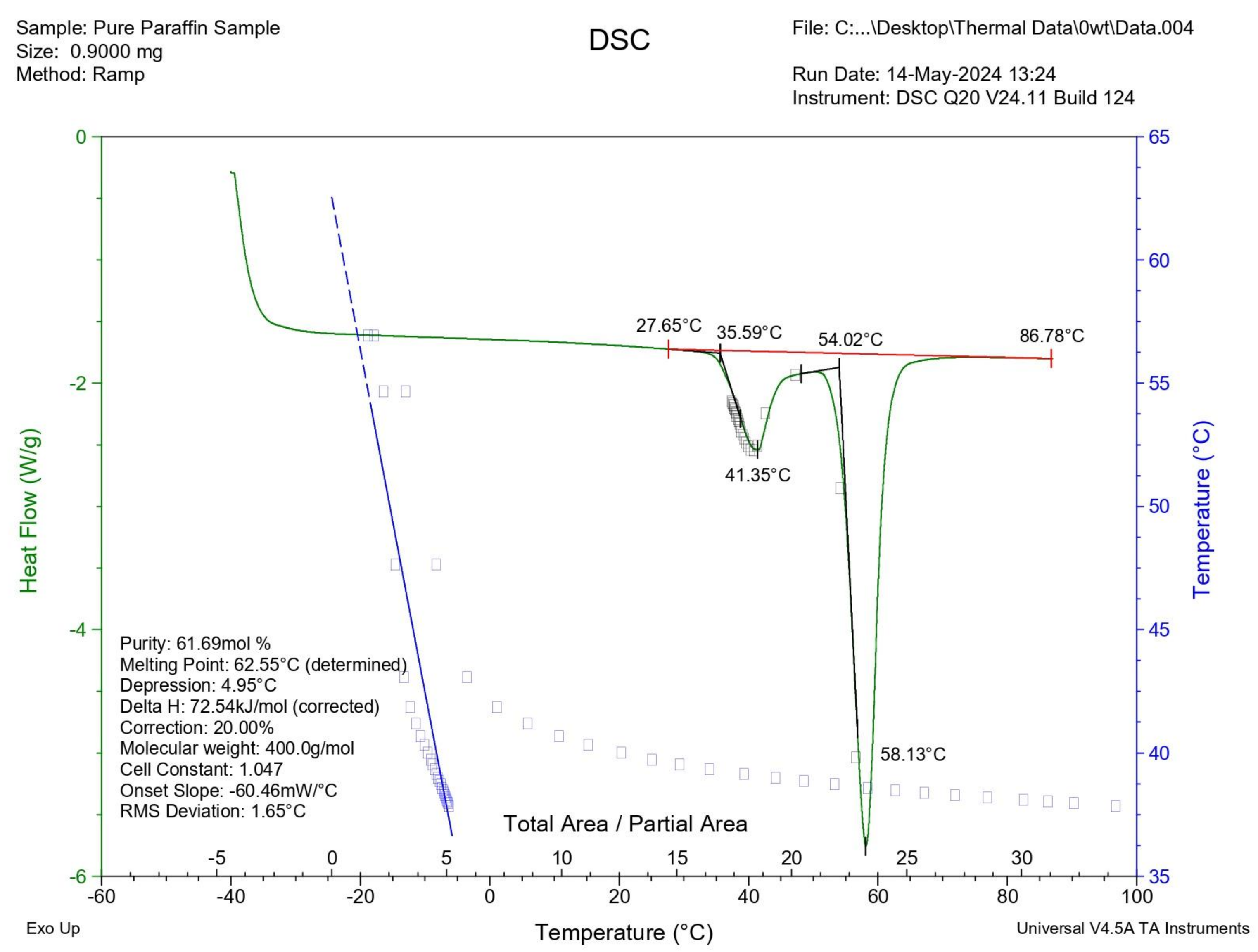

Figure 2: Raw DSC data plotted using software-included van't Hoff purity analysis. As evident by analysis, DSC thermal analysis has many complications that make purity analysis difficult.

Analysis/Discussion:

- Thermal data is input into van't Hoff analysis, which uses heat flow data and an assumed molecular weight to estimate the purity of specimens.
- Temperatures of phase change onset and total heat flow of each transition characterize each specimen.

Conclusions/Future Work:

Using current data, DSC analysis presents multiple complications with require further research before it can be used for accurate measurements.

- Each wax is not a singular compound, but a blend of unique chemicals with their own thermal properties. This in turn can present problems when using van't Hoff analysis to calculate purity.
  - Paraffin wax contains hydrocarbon compounds of greatly varying molecular chain lengths/weights, leading to a natural variation of thermal properties.
  - Beeswax, being of insect origin, is a complex blend of many organic compounds, many of which are volatile.

As of now, a positive trend can be qualitatively seen but analysis is complicated by aforementioned factors. For future analysis, using controlled samples with exacting chemical build will likely lead to more quantitative data and conclusions, as an analytical model can be constructed.

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