Introduction to Petroleum Waxes

THE SCIENCE OF WAX

- *Types of waxes*
- *Physical properties of natural and synthetic petroleum waxes*
- *Test methods*
- *End-use applications*

WHAT IS WAX?

- *Can be described as a solid substance at room temperature, that becomes a low viscosity liquid when heated*
- *Is it natural?*
  - *Is it animal, vegetable, or mineral?*
- *Is it synthetic?*

NATURAL WAX TYPES

- *Animal*
  - *beeswax, shellac wax, spermaceti*
- *Vegetable*
  - *carnauba, candelilla, ouricury, jojoba*
- *Mineral*
  - *montan, ozokerite, ceresin, PETROLEUM*

PETROLEUM WAXES

- *Paraffins*
  - *melt range approx. 38°C - 71°C*
  - *very crystalline, mostly linear hydrocarbons*
  - *low affinity for oil*
  - *high oil content unless semi or fully refined*
  - *fully refined paraffins can be very hard*
  - *usually very light in color*

PETROLEUM WAXES

- *Microcrystallines*
  - *melt range approx. 68°C - 91°C*
  - *much higher percentage of non-linear hydrocarbons, therefore not as crystalline*
  - *can be soft and flexible, or hard and brittle*
  - *better affinity for oil*
  - *up to 2.0% oil, but not noticeable*
  - *can be black, brown, amber or white*

SYNTHETIC WAXES

- *Synthetic polyethylene (C4040)*
  - *highly linear hydrocarbons*
  - *very high melting and hard*
- *Synthetic copolymer (SP200)*
  - *ethylene and propylene create branches which make it more like a "synthetic" micro*
  - *still higher melting, but not as hard*
- *Fischer-Tropsch wax (PX-100)*
  - *synthetic polymethylene derived from natural gas or coal*
  - *very high melting and hard*

ASTM TEST METHODS

- *ASTM D 87, D 127 (melting point)*
- *ASTM D 938 (congealing point)*
- *ASTM D 1321 (penetration)*
- *ASTM D 88, D 445 (viscosity)*
- *ASTM D 156, D 1500 (color)*
- *ASTM D 721 (oil content)*
- *ASTM D 92, D 93 (flash point)*

ASTM Melting Point

- *D 127*
  - *drop melt point method*
  - *measures temp at which a solid film of wax on the end of a thermometer melts enough for one drop to fall*
  - *more suitable for microcrystalline and synthetic waxes*

ASTM Melting Point

- *D 87*
  - *cooling curve method*
  - *measures temp at which change in cooling rate reaches a plateau*
  - *more suitable for highly crystalline waxes, like paraffins*

ASTM Congealing Point

- *D 938*
  - *measures the point at which a liquid drop of wax on the end of a thermometer, held horizontally, has solidified (congealed) enough to rotate to the top of the bulb*
  - *suitable for most types of wax*

ASTM Penetration

- *D 1321*
  - *needle penetration*
  - *measures the depth in 0.1 mm that a needle with total weight of 100g will penetrate a wax sample in 5 seconds*
  - *must be stated with appropriate testing temperature, usually 25, 43.3, 60°C*
  - *higher temp = higher penetration =softer*

ASTM Viscosity

- *D 88*
  - *Saybolt viscosity (can be converted to D445, kinematic viscosity)*
  - *measures the number of seconds for a sample to pass through an orifice of specified size and fill a 60 ml flask*
  - *must be stated with testing temperature, usually 99°C*
  - *higher temp = lower viscosity = less time*

ASTM Color

- *D 1500*
  - *measures pale yellow to dark orange/brown colors*
  - *used to measure amber wax colors*
  - *lower number is lighter color*
- *D 156*
  - *measures various shades of white waxes*
  - *higher number is lighter color*

ASTM Oil Content

- *D 721 measures the amount of low molecular weight, liquid oil in a wax sample*
  - *Wax is dissolved in solvent and then cooled to -32°C to precipitate the wax*
  - *Evaporate solvent from filtrate and weigh to get oil content*
  - *Usually critical for paraffins only, because they do not “hold” oil well*

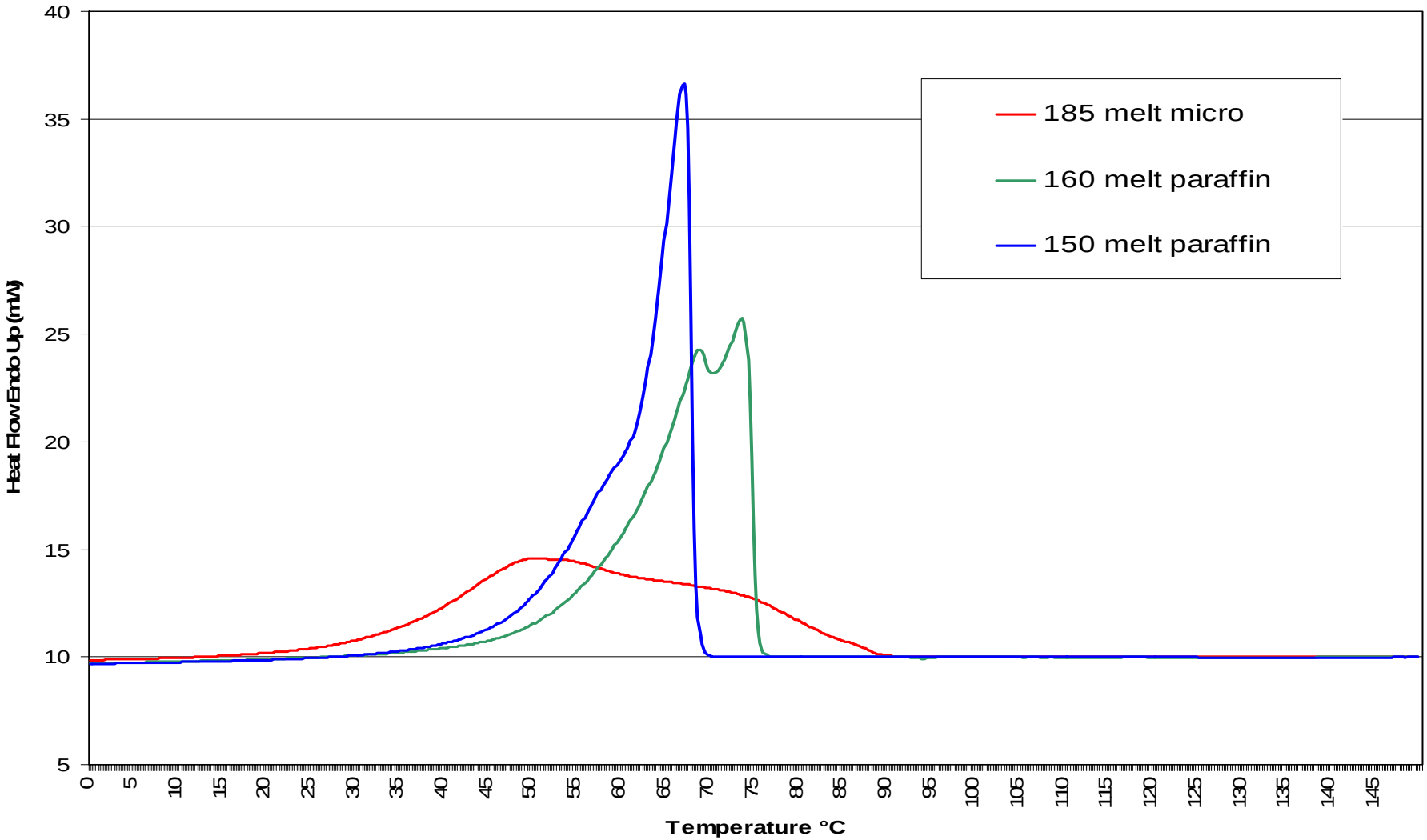
ASTM Flash Point

- *D 92 (Cleveland Open Cup) and D 93 (Pensky-Martens Closed Cup)*
  - *measures the point at which a test flame passed over the sample will ignite the vapors*
  - *usually only critical with high oil content semi-refined paraffin waxes*

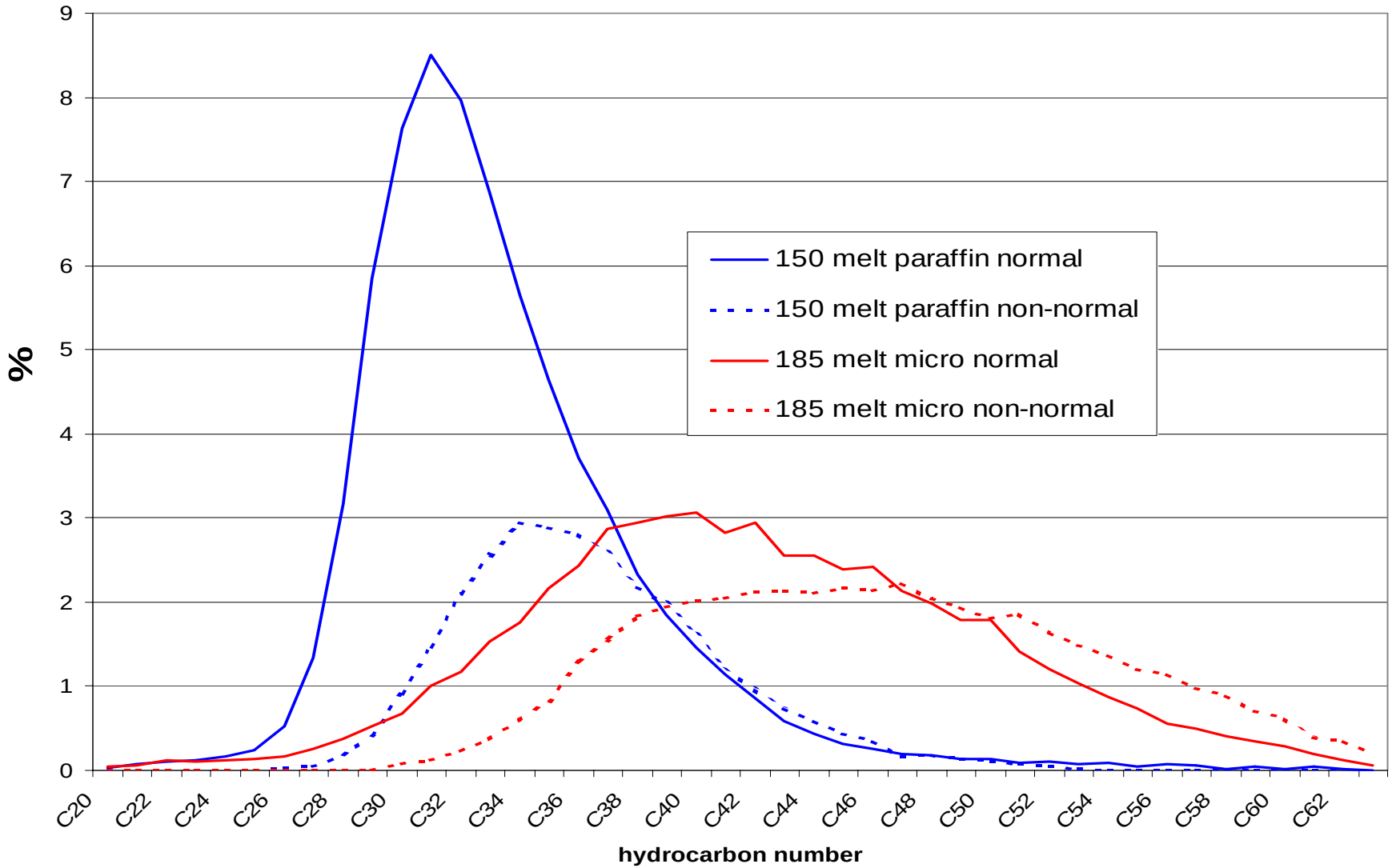
Other investigative techniques

- *Differential Scanning Calorimetry*
  - *measures "thermal fingerprint" of a material which goes through a solid-liquid-solid cycle*
  - *can be very unique depending on type of wax*
  - *overlays can give easy, visual comparison of products*
  - *is not used as QA tool, and is not guaranteed unchangeable*
- *Gas Chromatography*
  - *splits the mixture of hydrocarbons into individual chain lengths for relative measure of percentage in composition*
  - *non-linear will elute before linear hydrocarbons of same C number*
  - *does not quantify chemical type*
  - *is not used as QA tool, and is not guaranteed unchangeable*

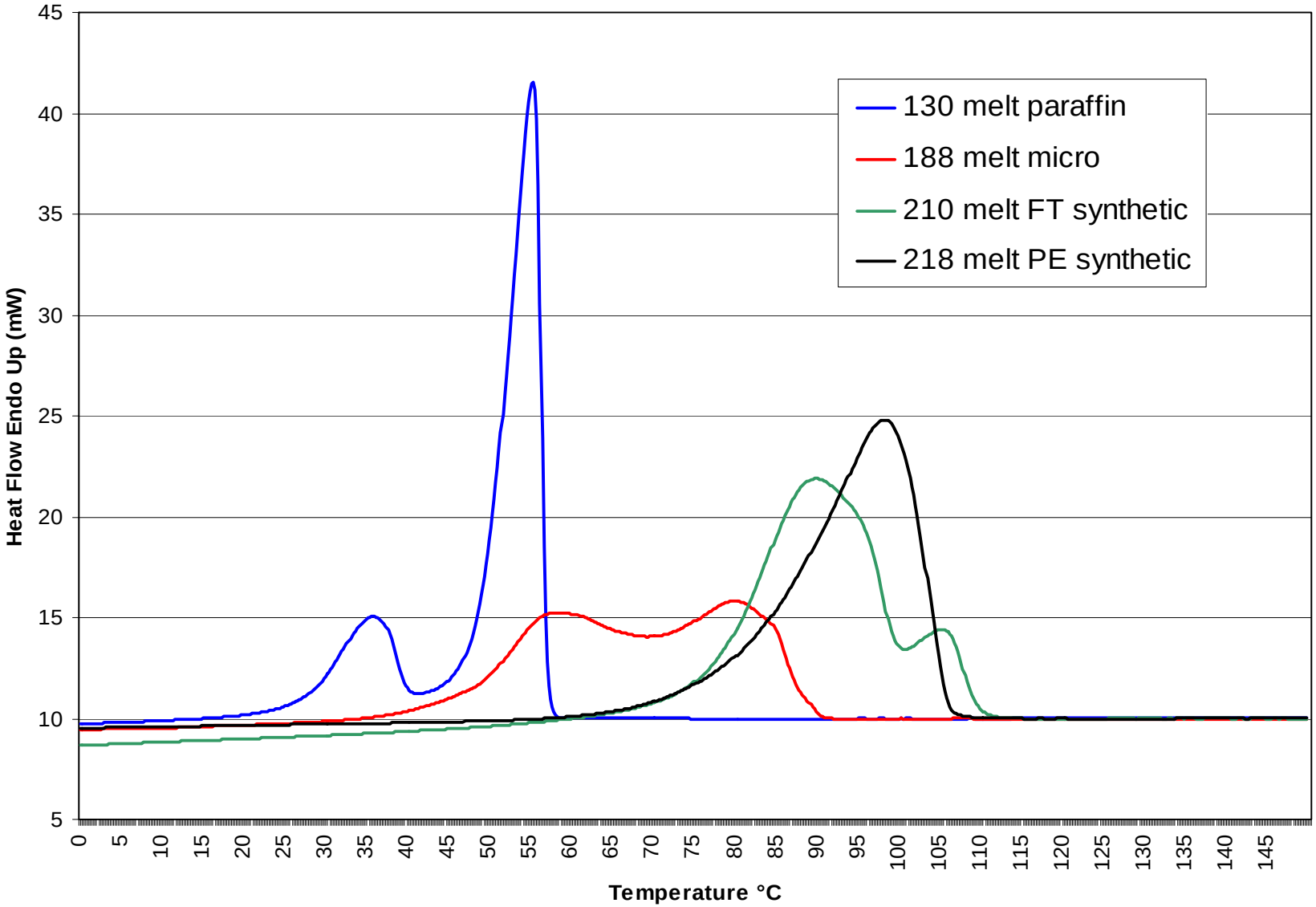
DSC comparison of paraffins and micro



GC comparison of paraffin and micro



DSC comparison of paraffin, micro, and synthetic



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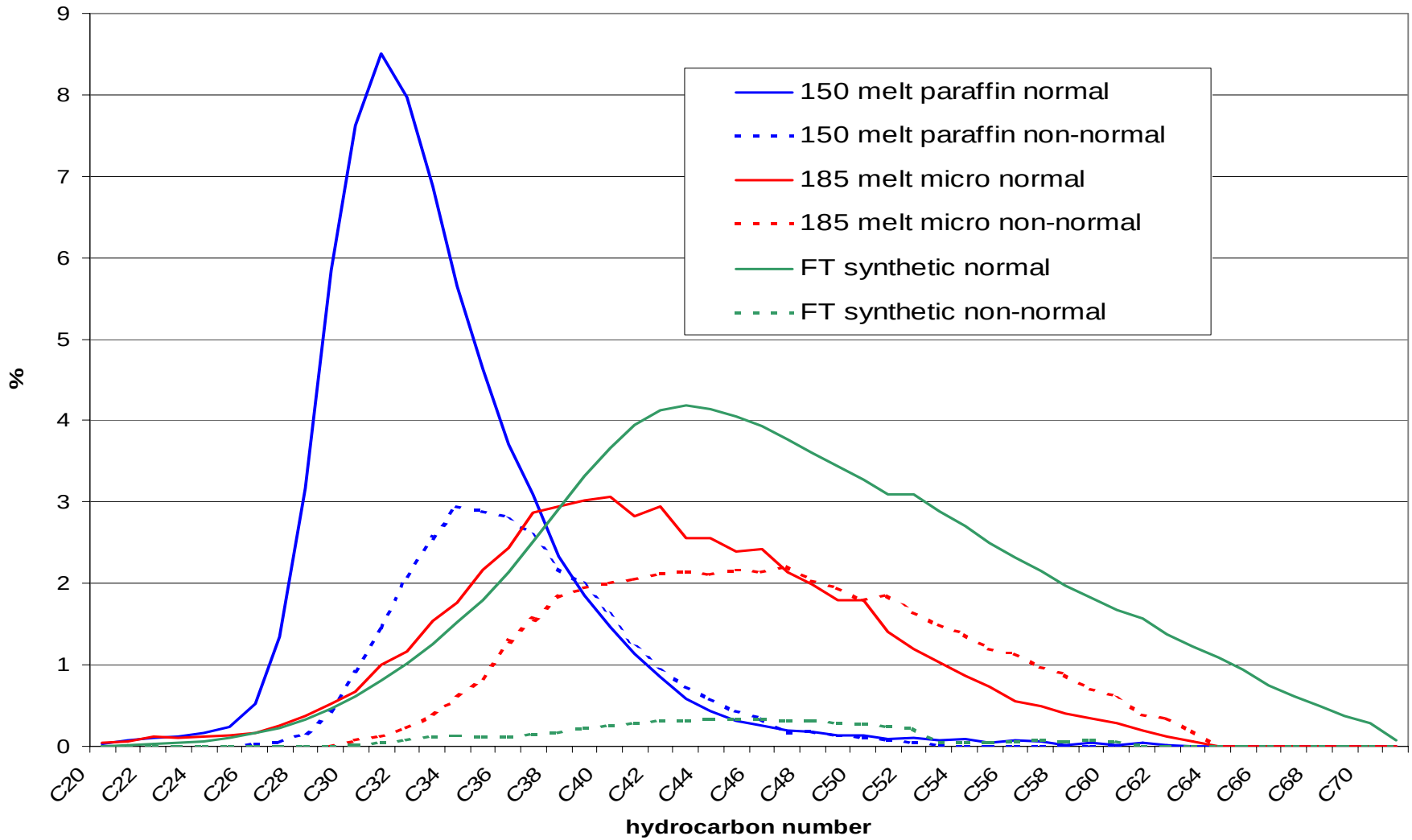

End-use applications

- *Hot melt adhesives (viscosity, melt-cool modifier)*
- *Chewing gum base (processing, chewing modifier)*
- *Candles (base ingredient for all types)*
- *Plastics (internal and external lubricants, processing aid)*
- *Inks & Coatings (scratch, scuff resistance)*
- *Laminates (moisture barrier, adhesive layer)*
- *Crayons (base material, or blend modifier)*
- *Investment casting (mold pattern can be melted out)*
- *Personal Care (lip balms, lotions, creams, etc.)*
- *Dozens of other uses, new ones developed every year*

CONCLUSIONS

- *Variety of wax types exist in nature*
- *Technology allows for “man-made” waxes*
- *Petroleum waxes are characterized by their physical properties*
- *Well established ASTM procedures exist specifically for the testing of wax*
- *Wax is used for dozens of different applications due to its unique physical properties*

Thank you for your interest in Bareco Products

We look forward to serving your wax needs