COMMENTS ON MR. MORTIMER'S NOTES ON HONEY PROCESSING

G E N E R A L

The solubility limit of dextrose in honey is not constant, but varies with the composition of honey and ambient temperature. The most obvious related factors are temperature, water content, levulose content, content of other sugars and non-sugars. Most but not all honeys are supersaturated with dextrose and will tend to approach an equilibrium condition, probably rapidly at first, but more slowly as the equilibrium point is neared. The equilibrium point will differ for each individual honey, but some generalizations can be made.

The solid phase is always dextrose hydrate, 9.09% water. Crystal size depends upon area of crystal surface available for growth, and the growth time permitted by the available dextrose. The "hardness" of set depends on the amount of dextrose in the solid phase and the moisture level, other things being equal.

Although phase diagrams of levulose - dextrose - water system are available, they are not especially applicable in view of the complex composition of honey.

COMMENTS ON PART 2 OF MR. MORTIMER'S NOTES

A. F R O S T I N G

I propose that frosting becomes evident when the liquid phase of a crystallized honey withdraws from intimate contact with the surface crystals, and is replaced by air. Because of the small size of the crystals, a "snow-like" surface results. For this to take place, several conditions contribute:

1. An air-honey interface must be present or must form. This may be a) the upper surface of the set honey, b) bubbles within the mass, c) a surface created when the crystallized mass shrinks from its contact with the container.

2. A large relative amount of dextrose must crystallize. This contributes in two ways: a) a relatively large decrease in viscosity of the liquid phase due to its moisture increase takes place, allowing increased mobility of the liquid phase, and b) the amount of shrinkage resulting from crystallization is relatively greater. The only data in the literature (Thomson, New Zealand) record of shrinkage of 0.71%, but no data on composition of the sample are given.

3. Excessive exposure of a honey to crystallizing-inducing conditions, which could bring about a more nearly complete granulation than later desired.

Thus the frosting is not a change in the degree of hydration, but is an increased exposure, or visualization, of the crystals themselves.

It is doubtful that there is any loss of moisture from the solid phase in the frosting phenomenon. The levulose content of the honey fixes the equilibrium relative humidity of the air in contact with honey. Dextrose hydrate does not lose moisture below about 50°C in the absence of other solute. There is some opinion that the transition temperature can be as low as 30° in saturated levulose solutions (Kelley 1954).

B. FLOATING, OR SEPARATION OF SET HONEY INTO A LIQUID LAYER AND SOLID LAYER.

This is an insufficiency of solid phase to occlude the liquid phase. It may be caused by:

1. Dissolution of once-solid dextrose due to a)storage at elevated temperature, where solubility is higher; b) change of dextrose to other sugars. This is a long-term (6-12 month) effect but may be accelerated at higher temperatures (i.e. 25-30 degrees C) (Bull. 1261 P. 33); c) preparation from a honey not suitable for set honey in that it is excessive in moisture or levulose or deficient in dextrose: or possibly absorption of moisture at the surface.

The liquid phase is not levulose and water, but is a saturated solution of dextrose in the other honey constitutents. If your honey is fermenting only after the floating, it would imply an increase in moisture content of the liquid phase and improper pasteurization. The former cannot be the result of dissolution of dextrose hydrate, but implies absorption of moisture from the air.

The most obvious interconnection between floating and fermentation is that high moisture content encourages both. No packing operation can long be successful without control of moisture content.

C. C L E A N L I N E S S

For settling the 110°F temperature for five hours may be adequate. Most of the viscosity decrease from warming takes place below 110°F, and there is no problem of damage. Such settling would reduce the load on the screening equipment, but five hours is perhaps needlessly long.

Why change from nylon mesh to stainless mesh?

D. REGRANULATION

Five hour standing at 110°F is not sufficient to dissolve all dextrose crystals in honey. Breaking crystal aggregates by pumping and heating with agitation under conditions approaching 20 minutes or more at 140 degrees may be needed.

Your decision not to filter will increase your liability to regranulation due to extraneous materials or crystal particles. I would prefer a short time at 165° for this purpose. It will be important to assure dust removal from glassware.

E. CRYSTALLIZATION PROCESS - COMMENTS ON NUMBERED ASSUMPTIONS

1. Dextrose is only sugar granulating, and the "flux" contains all of the levulose and is saturated with dextrose. Crystal interlock does contributeto firmness.

2. The solubility of dextrose depends (among other factors) on temperature; the degree of granulation (proportion of solid to total dextrose in the honey) depends on inter-related factors as the gross amount present, the amount of moisture in the honey, the amount of levulose, the time allowed for granulation.

The effect of very cold storage (below the freezing point of water) on granulation may be almost entirely ascribed to the great increase in viscosity. Viscosity and diffusion become limiting to crystal growth well above the freezing point; crystallization is less rapid at temperatures below 55 - 57°F. No observation of a true freezing point for full density honey has been seen in the literature. In one approach Stitz and Szigvart reported a 68% solution of honey to freeze at -12°C. The total degree of crystallization of dextrose is regulated by storage temperature and several other factors (see above).

3. The rate of crystallization follows general laws of crystallization (Noyes-Nernst) as detailed by Dyce (Bull.528,P.68). It is directly proportional to 1) the diffusion coefficient, 2) the surface area of the solid phase, 3) the difference between the concentration of solute and its solubility (absolute supersaturation); and is inversely proportional to 4) the length of the diffusion path. Temperature affects the first and third items. The effect of large numbers of small seed crystals is to increase factors 2 and 4.

4. The erroneous concept that all of the dextrose in honey granulates leads to incorrect views on its stability. There is no temperature at which all of the dextrose granulates. If any mixture of various sized crystals is warmed, the smaller will disappear first because they are smaller. Rate of solution per unit area of crystal is probably independent of crystal size.

5. Two kinds of crystals are easily seen in honey; needles and plates. Probably plates are simply "grown-up " needles. I agree that rapid crystal growth is desirable. This implies a large amount of seed crystals, which is not synonymous with a large proportion (25%) of seed-bearing honey. Quality of seed is important and has been discussed in Guilbault's Thesis: different preparations can vary 10 or 100-fold in numbers of crystals, (i.e. quality).

PART 3

A. It works for Sioux.

B. See previous comments on settling, straining, heating.

C. More information needed. Consider later.

D. I believe 100°F is to low to pack clear honey. For set honey 145° may be adequate but exposure time data are necessary to judge.

E. I would think 70° is low enough for the blending. I think 25% of seed is excessive and indeed may contribute to texture problems; 5-10% is a reasonable amount.

How long is it held at 57° ? How long to reach 57° ?

F. Rather than prepare seed as described, consider letting it reach 70-72° for a few days before use, stir to break any interlocking texture, dilute it with the intended liquid honey and meter it in. Alternatively, grind the 70-72° seed through a grist type plate mill to reduce crystallization and make more fluid. Such mills are used to grind maize to meal. They may warm the honey however.

G. Moisture content must be controlled to produce stable, high quality products.