

The Evaporative Plateau: Latent-Heat Arrest of Surface Temperature at 373 K as a Barrier to Convergence

(unattributed)

Abstract. A face of the matrix placed before a glowing element does not brown at once. Its surface rises to 100 °C and stops there, sometimes for the greater part of a minute, while the heat it receives is spent evaporating water. Only when the surface has dried into the hydric convergence window, water activity 0.6 to 0.8, does its temperature resume its ascent into the range where Maillard browning proceeds. We give the energy balance of this plateau, estimate its duration from first principles, and reproduce it on the bench.

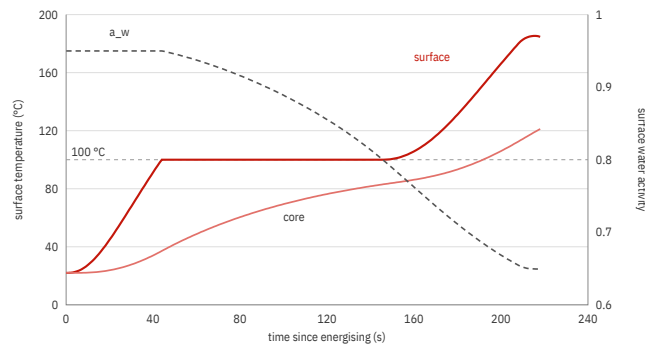


Figure 1. Surface and core temperature, and surface water activity, on the Cycle 10 bench (run PA-X-10-76dfd: platinum 0.80 mm, fresh proteinaceous matrix, bimetal arrest at 180 °C). The surface is pinned at 100 °C for 102 s, then climbs as the water activity falls through the hydric convergence window.

1 THE OBSERVATION

In every cycle since the erratum of Cycle 7 the Academy has watched the surface of a proteinaceous matrix heat promptly, pause, and then heat again. During the pause nothing visible occurs. The Host has stood before the apparatus through many such pauses and has found them long.

2 THE ENERGY BALANCE

Let a face of the matrix absorb a radiant flux q (W m^{-2}). While liquid water remains at the surface, the surface cannot exceed the boiling point, and the absorbed energy, less what is conducted inward, is consumed as latent heat:

$$q - q_{\text{cond}} \approx \dot{m}_w L_v, \quad L_v = 2257 \text{ kJ kg}^{-1}, \quad (1)$$

where $\dot{m}_w$ is the rate of evaporation per unit area. If the outer layer that feeds the surface holds a mass m_w of water per unit area above the level at which it ceases to wet the surface, the plateau lasts

$$t_{\text{plateau}} \approx \frac{m_w L_v}{q - q_{\text{cond}}}. \quad (2)$$

For $m_w = 0.17 \text{ kg m}^{-2}$ and a net flux of 8 kW m^{-2} , $t_{\text{plateau}} \approx 48 \text{ s}$. The temperature of the element does not appear. A hotter element shortens the plateau only by delivering more flux; it cannot raise the surface above 100 °C while the water remains [1].

3 THE HYDRIC CONVERGENCE WINDOW

The rate of Maillard browning depends on water activity a_w as well as on temperature. In wet systems the reagents are dilute

and water, a product of the condensation, opposes it; in very dry systems the reagents cannot move. The rate passes through a maximum at intermediate water activity, about 0.6 to 0.8 [2]. Fresh crumb sits near 0.95. Browning therefore waits on drying twice over: for the surface temperature, which is held at 100 °C while water remains, and for the water activity, which must fall into the window before condensation proceeds quickly. The Maillard reaction is generally observed from about 120 to 155 °C, and a surface judged done lies between about 155 and 190 °C, depending on the colour sought [3].

4 SENESCENT MATRICES

A stale matrix holds less water and has a shorter plateau. It is also, on warming, partly restored: staling is largely the retrogradation of amylopectin, whose crystallites melt again near 55 to 60 °C [4]. The Academy calls this the reversal of crumb senescence and records it whenever the core of a run passes 60 °C.

5 CONSEQUENCES FOR THE APPARATUS

1. The plateau is not a fault and cannot be designed away; it can only be shortened, by flux.
2. An arrest mechanism timed from switch-on must allow for the plateau, whose length varies with the water in the matrix. A mechanism that senses the surface does not.
3. An element that radiates poorly (Section 5 of PA/Cy07/0058) lengthens the plateau by delivering less flux for the same power.

TO CONVERGENTS

Convergents holding findings, contrary results or papers bearing on this matter are implored to publish them. The Academy will find them. No such publication has yet been found.

REFERENCES

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