Profiling Coffee / The Hidden Formula

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Espresso
Profiles

- Roasting: temp over time
- Burrs: coarse grabbing teeth to fine cutting edges
- Grinds: bell shaped size distribution
- Resting: declining CO2 pressure, improving, then declining taste
- Extraction temperature: declining
- Extraction pressure: declining
- Flow: increasing
- Temp in the cup: declining
Extraction temperature profile

The diagram shows a temperature profile over time, with two distinct phases labeled as "pre-infusion" and "extraction." During the "pre-infusion" phase, the temperature stays constant at 94°C. In the "extraction" phase, the temperature drops to 92°C. The legend indicates that the blue line represents "side of group" and the red line represents "inside PF." The time axis ranges from 112 to 138, and the temperature axis ranges from 80°C to 90°C.
Extraction flow profile

FLOW TREND

(g/s)

(g)

0.00
0.66
1.33
1.99
2.65
3.32

0
5
10
15
20
25
30

33.48 g
Total Weight

00:31
Total Time

1.29 g/s
Avg. Flow Rate
Recipe example

- Grind 14g beans rather fine and even
- Tamp flat and firm
- Water around 93°C raining down inside brew head
- Pre-infusion, soaking the puck 3–7 seconds
- Extraction of 20g espresso
Espresso
Stir espresso
Take sample in syringe
Screw on medical grade filter
Push out a few ml
Wait to cool down
Droplets on refractometer, start measurement
Read TDS = Total Dissolved Solids percentage
Calculate extraction rate of the puck
Coffee refractometer

![Image of a coffee refractometer and related items]

- Esp. % TDS: 9.8
- VST Filter: 9.5
- NO Filter: 9.6
- SG: 9.8
- Centrifuge: 9.0

Temperature: 19.5°C
Coffee refractometer app

**Design and Measures**

<table>
<thead>
<tr>
<th>Design</th>
<th>Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXT</td>
<td>19.29</td>
</tr>
<tr>
<td>% EXT</td>
<td>19.47</td>
</tr>
<tr>
<td>TDS</td>
<td>9.50</td>
</tr>
<tr>
<td>% TDS</td>
<td>8.63</td>
</tr>
<tr>
<td>BEV</td>
<td>27.0</td>
</tr>
<tr>
<td>g BEV</td>
<td>30.0</td>
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<tr>
<td>EBF</td>
<td>51.85</td>
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<tr>
<td>g EBF</td>
<td>46.67</td>
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<tr>
<td>LRR</td>
<td>1.20</td>
</tr>
<tr>
<td>g LRR</td>
<td>0.98</td>
</tr>
<tr>
<td>MOIST</td>
<td>3.0</td>
</tr>
<tr>
<td>% MOIST</td>
<td>2.0</td>
</tr>
</tbody>
</table>

**Extraction**

- **EXT (g)**: 19.29
- **TDS (%)**: 9.50
- **DOSE (g)**: 14.0
- **BW (g)**: 40.0
- **BEV (g)**: 27.0
- **MTDS (%)**: 8.63
- **MBEV (g)**: 30.0

**Dissolved Solids**

- **TOTAL DISSOLVED SOLIDS**: 19.3
- **DOSE WEIGHT**: 12 - 16
- **BREW WATER WEIGHT**: 38 - 42
- **BEVERAGE WEIGHT**: 25 - 32
Green coffee bean
Origin

- Ethiopia
- (Sub)tropics
- Best on high altitude
- Harvest berries 1–2 a year
- Picking, selecting: hard work
- Washing, drying, selecting and sorting
- Sample roast, cupping, trading, shipping
Cupping
Monsooned Mabalar from India
Roasting machines

- Keep the beans moving
- Add thermal energy
- Have probes ready to measure what’s happening
- Drum roasters like PROBAT
- Fluid bed roasters like Sivetz
- Others, like Tije’s *Roaster shaker*
Roastilino, a little *fluid bed* roaster
Tije's *Shake, Not Stir* roaster
Roasting phases

- Room temp to 150°C: drying
- 150°C to *First Crack*: Maillard
- *First Crack* (about 205°C) onwards: development

Smells like...

- Room temp to 150°C: hay, stable
- 150°C to *First Crack*: toast
- *First Crack* (about 205°C) onwards: coffee!
Roast profile
Profiling for taste

- **Drying**
  - Fast: simple and bright or defective
  - Slow: rich or dull

- **Maillard**
  - Fast: light, clear
  - Slow: full bodied

- **Development**
  - Fast: sweet, possibly grassy
  - Slow: complex and round or bitter and flat
\texttt{\LaTeX} in Artisan roast software

\begin{align*}
\text{square-symbol} &= \sqrt{x} \\
\text{integral-symbol} &= \int_{t=0}^{\infty} \frac{\log(t)}{dt} \\
\text{Sum-symbol} &= \sum_{t=0}^{\infty} \frac{1}{3^t} + \frac{2}{4^t} \\
\text{Greek-letters} &= \alpha - \beta - \gamma - \omega - \rho - \theta - \phi \\
\text{Fractions} &= \left(\frac{3}{4}\right) \\
\text{fonts} &= \text{CALIGRAPHY}, \text{ROMAN}, \text{ITALIC}, \text{TYPEWRITER}, \text{DEFAULT} \\
\text{ARROWS} &= 500 \leftarrow \text{your-value}
\end{align*}
Controlling the roast

- The Artisan application gets a roast profile
- Artisan controls the PID
- The PID controls the heating element
- Temperature probe sends Bean Temp to the PID
- Artisan reads Bean Temp, looks 10 seconds ahead, sends latest target to the PID
- Artisan alerts the operator with voice reports
Tonino roast color meter
Small machines can be temperamental

A PID can provide stability
PID in autotune

Fuji PXG4 auto-tuning with the probe drilled deep inside the cooling fin, touching the brew group. If the heater switches on, the effect on the cooling fin & lower brew group body takes some time to have effect. Here, a temperature of 78°C corresponds with the optimal brew temperature. The PID takes 15 minutes to find its optimal settings of P, I and D.

From then on, all is stable.
So now we know?

“After winning, I realized how little I knew”
Gwilym Davies, 2009 World Barista Champion

“Everyone is kind of bumbling along in the dark, looking for the light switch.”
Talor Browne, roastmaster and top barista

“I am lost, but others too.”
Marko Luther, coffee application and device innovator
The bean smiling back at us