# Pot Still Distillation of Ethanol–Water (Rayleigh)

Residue, distillate and average distillate strength when a pot still charge is boiled down to a final strength, by the Rayleigh equation with ethanol–water VLE.

**Method:** Ethanol–water VLE at about 1 atm: Wilson equation (Perry's Chemical Engineers' Handbook, 9th ed., sec. 4) with energies 399 and 933 cal/mol fitted to FireCAD ethanol–water x–y–T data at 101.325 kPa; ethanol vapour pressure Perry's 9th ed. Table 2-8; water IAPWS-IF97; Checked against Gmehling and Onken; ...

## Input parameters

Unit system: SI

| Parameter | Value | Unit |
|---|---|---|
| Charge mass | 1,000.0 | kg |
| Strengths entered as | % vol at 20 °C | |
| Initial strength of the charge | 25.000 | % |
| Final strength in the pot | 2.0000 | % |
| Pressure<br>Model fitted at 1 atm; use 0.9–1.2 atm. | 101.33 | kPa |

## Calculated results

| Parameter | Value | Unit |
|---|---|---|
| Initial mole fraction | 9.0993 | % |
| Final mole fraction | 0.62626 | % |
| Moles left in the pot | 68.332 | % |
| Residue mass | 604.35 | kg |
| Distillate mass | 395.65 | kg |
| Average distillate mole fraction | 27.382 | % |
| Average distillate strength | 56.961 | % |
| Ethanol recovered in the distillate | 95.297 | % |

**Notes for this case**

- A plain pot gives one equilibrium stage: real pots with a helmet and lyne arm reflux a little and do slightly better.

## Formula and method

$$\ln\frac{H_i}{H_f}=\int_{x_f}^{x_i}\frac{dx}{y^*(x)-x},\qquad \bar{x}_D=\frac{H_i x_i-H_f x_f}{H_i-H_f}$$

### Variables

| | | |
|---|---|---|
| $M_i$ | Charge mass | kg |
| $\mathrm{basis}$ | Strengths entered as | - |
| $s_i$ | Initial strength of the charge | - |
| $s_f$ | Final strength in the pot | - |
| $P$ | Pressure | Pa |
| $x_i$ | Initial mole fraction | - |
| $x_f$ | Final mole fraction | - |
| $H_f/H_i$ | Moles left in the pot | - |
| $M_f$ | Residue mass | kg |
| $M_D$ | Distillate mass | kg |

| | | |
|---|---|---|
| $\bar{x}_D$ | Average distillate mole fraction | - |
| $\bar{q}_D$ | Average distillate strength | - |
| $\eta$ | Ethanol recovered in the distillate | - |

### Method and standards

Rayleigh equation integrated by Simpson's rule (200 intervals) on the fitted Wilson equilibrium.

### Assumptions and limits

- Wilson energies fitted at 1 atm; 0.9–1.2 atm only.
- Binary ethanol–water; congeners and dissolved solids ignored.
- One equilibrium stage; no reflux.
- Compositions and recovery do not depend on the charge size; with a zero charge the masses are zero.

### References

• Ethanol–water VLE at about 1 atm: Wilson equation (Perry's Chemical Engineers' Handbook, 9th ed., sec. 4) with energies 399 and 933 cal/mol fitted to FireCAD ethanol–water x–y–T data at 101.325 kPa; ethanol vapour pressure Perry's 9th ed. Table 2-8; water IAPWS-IF97
• Checked against Gmehling and Onken
• DECHEMA Chemistry Data Series vol. I/1
• as quoted in Perry's 9th ed. sec. 13 (simple batch distillation example)
• Rayleigh equation
• Perry's 9th ed. sec. 13
• Eq. (13-124)

## Report details

| | |
|---|---|
| Report reference | FCC-4MA7-KJKM (the same inputs always give the same reference) |
| Generated | 17 November 2026, 19:50 UTC |
| Calculator | Pot Still Distillation of Ethanol–Water (Rayleigh) |
| Method last reviewed | 13 November 2026 |
| Software release | FireCAD Calc, release of 17 November 2026 |
| Release checks | 2 reference cases of this calculator, computed independently, are checked on every release |

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

### This calculator online

https://calc.firecad.com/sugar-ethanol/ethanol-distillation/pot-still-rayleigh-ethanol

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.