> $restart;$

>

use ideal gas equation of state to determine the specific volume of air in the cylinder

> $v := combine\left(\frac{R_{specific,\ air}\ T0}{p}, 'units'\right);$

$$v := \frac{R_{specific,\ air}\ T0}{p} \tag{1}$$

air intake mass per crank revolution:

> $mAir := combine\left(\frac{V}{v}, 'units'\right);$

$$mAir := \frac{V\,p}{R_{specific,\ air}\ T0} \tag{2}$$

energy stored in air per crank revolution,
minus energy removed due to vaporization of a certain mass of water per crank revolution,
minus the energy required to heat up that mass of water from its original temperature to the new intake temperature:

> $eAir := mAir\ T0\ c_{p,\ air} - mWater\ \Delta H_{vap,\ water};$

$$eAir := \frac{V\,p\,c_{p,\ air}}{R_{specific,\ air}} - mWater\,\Delta H_{vap,\ water} \tag{3}$$

with the above calculated air energy, calculate new air temperature:

> $eq1 := T0 + \Delta T = \frac{eAir}{mAir\ c_{p,\ air}};$

$$eq1 := T0 + \Delta T = \frac{\left(\frac{V\,p\,c_{p,\ air}}{R_{specific,\ air}} - mWater\,\Delta H_{vap,\ water}\right) R_{specific,\ air}\ T0}{V\,p\,c_{p,\ air}} \tag{4}$$

> $\Delta T := simplify(solve(eq1, `\Delta T`));$

$$\Delta T := -\frac{T0\,R_{specific,\ air}\ mWater\,\Delta H_{vap,\ water}}{V\,p\,c_{p,\ air}} \tag{5}$$

> $c_{p,\ air} := 1.0035e3\ [[J]]\ [[kg]]^{-1}\ [[K]]^{-1};$

$$c_{p,\ air} := \frac{1003.5\ [[J]]}{[[kg]]\ [[K]]} \tag{6}$$

> $c_{p,\ water} := 4.1813e3\ [[J]]\ [[kg]]^{-1}\ [[K]]^{-1};$

$$c_{p,\ water} := \frac{4181.3\ [[J]]}{[[kg]]\ [[K]]} \tag{7}$$

> $\Delta H_{vap,\ water} := 2257e3\ [[J]]\ [[kg]]^{-1};$

$$\Delta H_{vap,\ water} := \frac{2.257\ 10^{6}\ [[J]]}{[[kg]]} \tag{8}$$

> $R_{specific,\ air} := 287.04\ [[J]]\ [[kg]]^{-1}\ [[K]]^{-1}$

$$R_{specific,\ air} := \frac{287.04\ [\![J]\!]}{[\![kg]\!]\ [\![K]\!]} \tag{9}$$

displacement per crank revolution -- divide by two as this is a four-stroke engine

> $V := \frac{1.9e-3\ [\![m]\!]^3}{2};$

$$V := 0.0009500000000\ [\![m]\!]^3 \tag{10}$$

assumed pressure in cylinder

> $p := 2.0 \cdot 100035\ [\![Pa]\!];$

$$p := 2.000700\ 10^5\ [\![Pa]\!] \tag{11}$$

express water mass in terms of flow j (mass over time) and crank velocity ω (1 over time)

> $mWater := \frac{j}{\omega} [\![kg]\!];$

$$mWater := \frac{j\ [\![kg]\!]}{\omega} \tag{12}$$

> $T0 := (273 + 100)\ [\![K]\!];$

$$T0 := 373\ [\![K]\!] \tag{13}$$

> $simplify(\Delta T);$

$$-\frac{1.266951115\ 10^6\ j\ [\![K]\!]}{\omega} \tag{14}$$

>