1 Ideal gas mixer

1.1 Utility functions

For emptying the input pipe I into the furnace

```
fillFurnace:
yield
s Furnace SettingInput 100
l x IAnalyzer TotalMoles
brgtz -3
s Furnace SettingInput 0
j ra
```

And for emptying the furnace into the filtration system, which filters all CO_2 back into the input pipe.

```
emptyFurnace:
yield
s Furnace SettingOutput 100
l x Furnace TotalMoles
brgtz -3
s Furnace SettingOutput 0
j ra
```

1.2 Mixing algorithm

Considering a system of only one gas g with a hot source H of temperature t_H and a cold source C of temperature t_C, we can calculate an optimal formulation for bringing a furnace F (with volume $v_F = 1000$, initial pressure p_F and initial temperature t_F) to a desired pressure p_T and temperature t_T. This is accomplished by removing an amount n_R from the furnace and/or adding an amount n_I at a specific temperature t_I, where I is composed from amounts n_H and n_C from the H and C sources. Several gas-law derived equations constrain this process:

$$t_T n_T = t_F(n_F - n_R) + t_I n_I \tag{1}$$

$$n_T = n_F - n_R + n_I \tag{2}$$

$$t_I n_I = t_H n_H + t_C n_I \tag{3}$$

Where n_R, t_I and $n_I = n_H + n_C$ are to be determined. Note the constraint for pressures and temperatures in this system for specific volumes or an arbitrary volume M:

$$t_C \leq t_M \leq t_H, \quad 0 \leq n_M, \quad 0 \leq n_R \leq n_F.$$

Solving Equation 1 for n_I provides a surface bounded in two dimensions by $0 \leq n_R \leq n_F$ and $t_C \leq t_I \leq t_H$, but where $0 \leq n_I$ is potentially unbounded (Figure 1).

$$(n_R, t_I, f): \quad f(n_R, t_I) = n_I = \frac{t_T n_T + t_F(n_R - n_F)}{t_I}.$$

Equation 2 further restricts potential solutions. Given a satisfactory n_R, $n_I = n_T - n_F + n_R$. Then we instead solve Equation 1 for t_I. As a result, these restricted solutions lie within a curve embed-

$p_F = 4000$, $t_F = 500$, $p_T = 9000$, $t_T = 700$

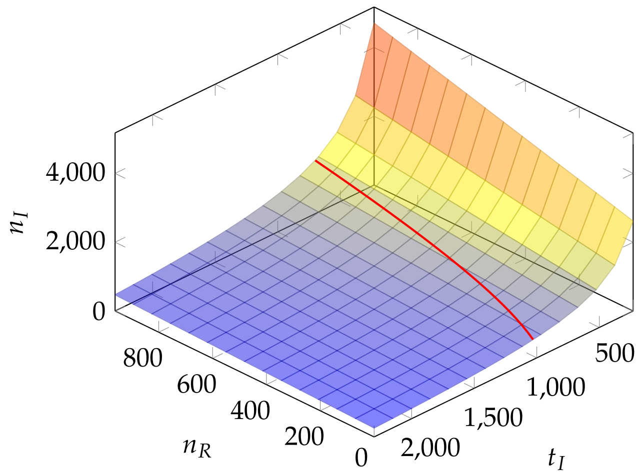
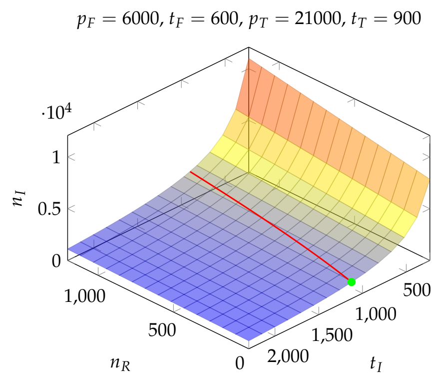


Figure 1: The (n_R, t_I, f) solution surface and (n_R, h, g) embedded curve.

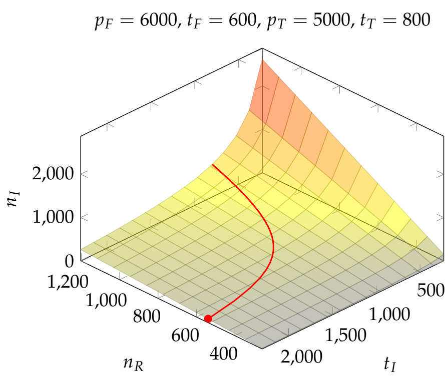
ded within the surface.

$$(n_R, h, g): \quad g(n_R) = n_I = n_T - n_F + n_R, \quad h(n_R) = t_I = \frac{t_T n_T - t_F(n_F - n_R)}{n_T - n_F + n_R}$$

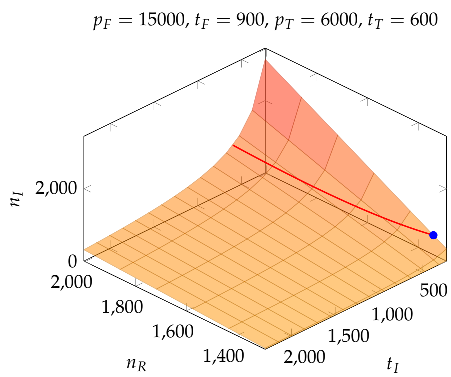
With respect to n_R, h is monotone increasing; thus



(a) H and C mixture added.



(b) Volume removed, H added.



(c) Volume removed, C added.

Figure 2: Example solutions.