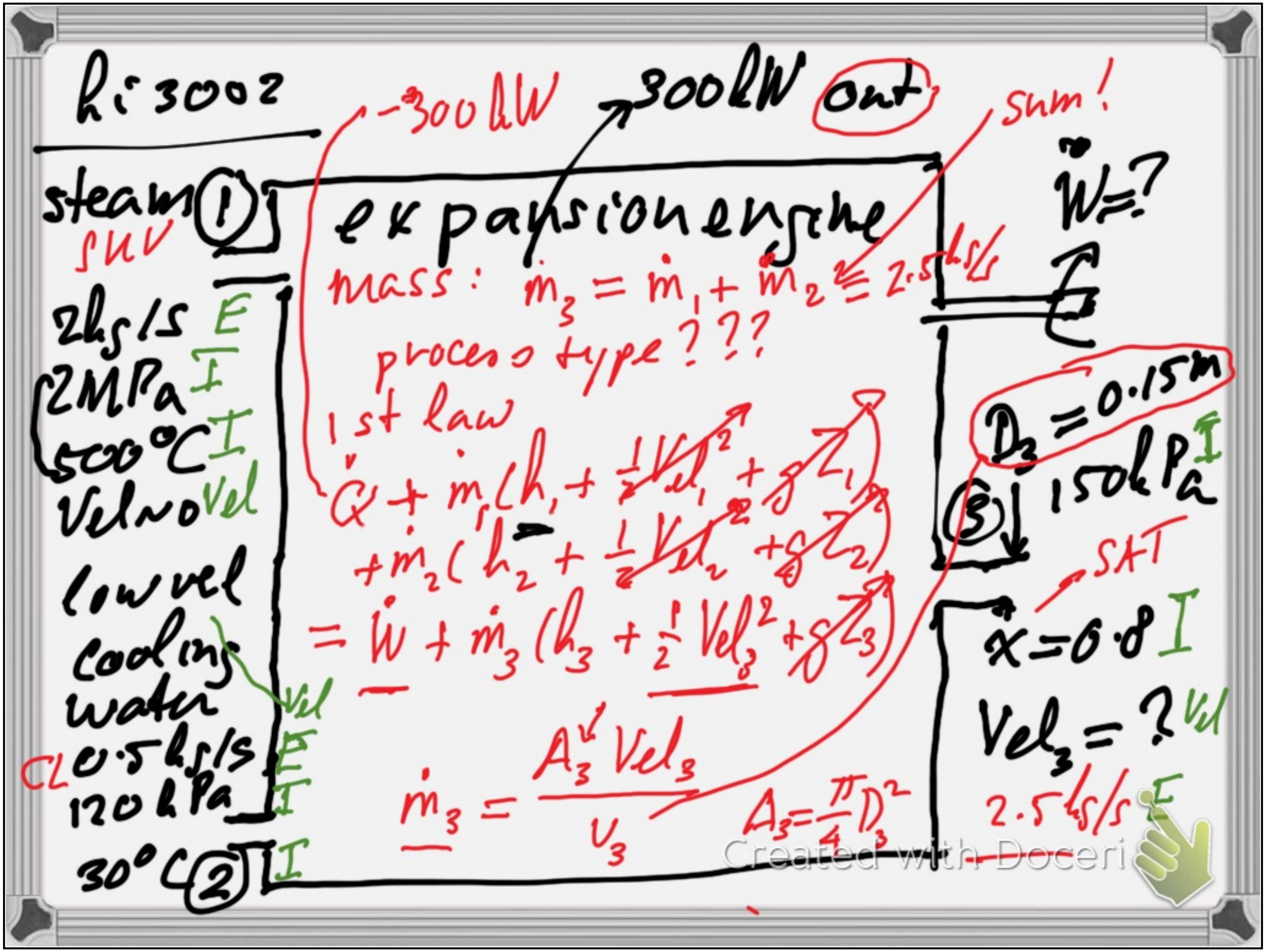

hi 3002
steam 1
SHV
2kg/s
2MPa
500°C
Vel~0
low vel
cooling water
0.5kg/s
CL
120kPa
30°C 2
expansion engine
-300kW
300kW out
sum!
mass: ṁ3 = ṁ1 + ṁ2 = 2.5kg/s
process type???
1st law
Q̇ + ṁ1(h1 + ½Vel1² + gZ1)
+ ṁ2(h2 + ½Vel2² + gZ2)
= Ẇ + ṁ3(h3 + ½Vel3² + gZ3)
ṁ3 = A3 Vel3 / v3
A3 = π/4 D3²
Ẇ = ?
D3 = 0.15m
3
150kPa
SAT
x = 0.8
Vel3 = ?
2.5kg/s
Created with Doceri

① SUV 2 MPa, 500°C $h = ?$ P

B.1.3 @ 2000 kPa 500°C $h_1 = 3467.55 \frac{kJ}{kg}$

② C.L. 120 kPa 30° → B.1.4 X

→ 30°C Sat Liq B.1.1 @ 30°

$h_2 = h_f = 125.77$ kJ/kg

③ Sat 2P 150 kPa, $x = 0.8$ v_3? h_3?

B.1.2 (Sat) @ 150 kPa line

$v_f = 0.001053$ m³/kg $v_{fg} = 1.15828 \frac{m^3}{kg}$

$v_3 = v_f + x_3 v_{fg} = 0927\ 67$ m³/kg

$h_f = 467.08$ $h_{fg} = 2226.46$ kJ/kg

$h_3 = h_f + x\, h_{fg} = 2248.25$ kJ/kg

$$\dot{m}_3 = \frac{A\,Vel_3}{v_3} \qquad 2.5\,\frac{kg}{s} = \frac{\frac{\pi}{4}(0.15\,m)^2\,Vel_3}{0.92767\,m^3/kg}$$

$$Vel_3 = 131.24\ m/s$$

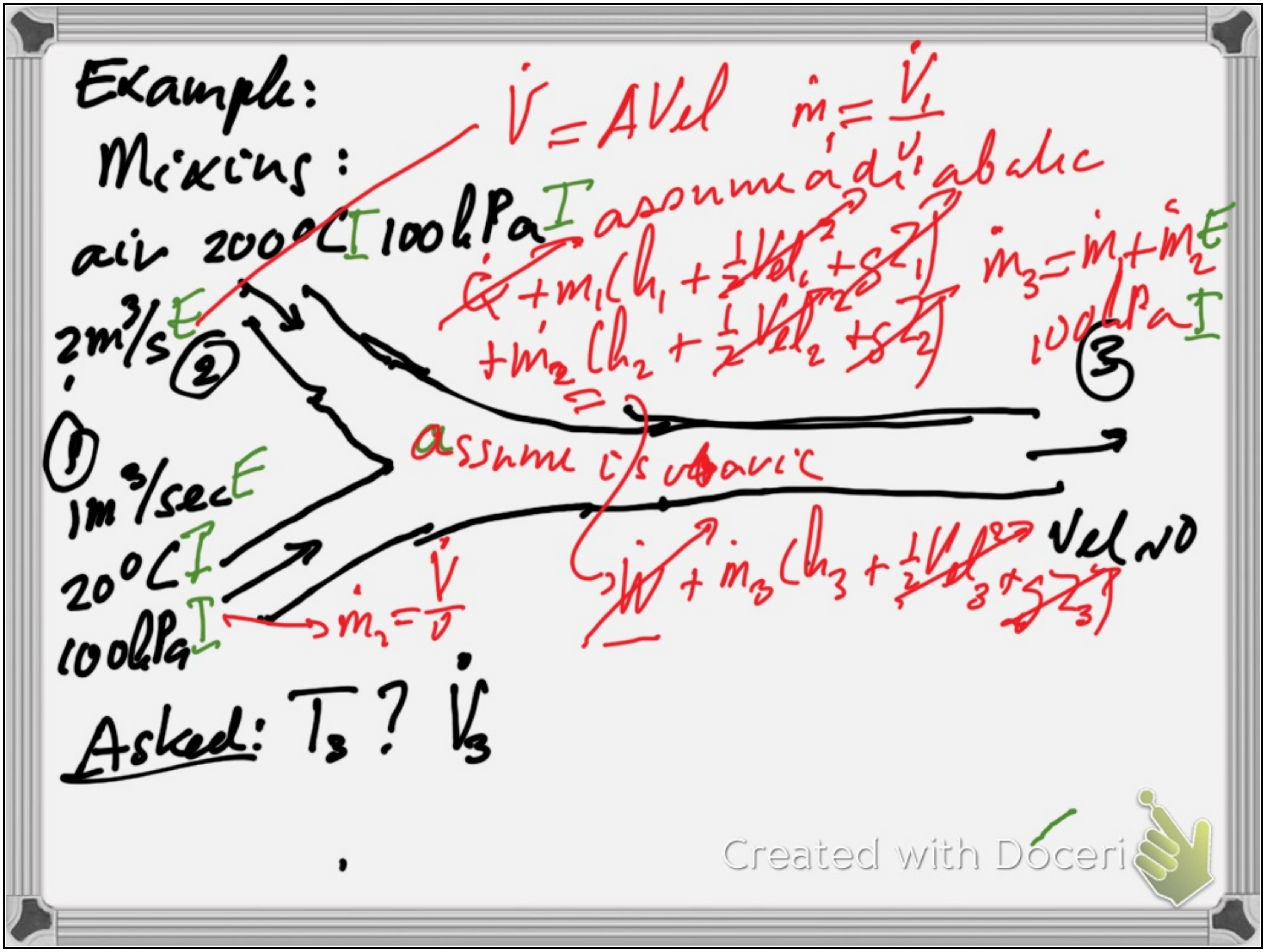
1st law

$$\dot{Q} + \dot{m}_1(h_1) + \dot{m}_2 h_2 = \dot{W} + \dot{m}_3\left(h_3 + \tfrac{1}{2}Vel_3^2\right)$$

$$-300\,kW + 2\,\frac{kg}{s}\,3467.55\,\frac{kJ}{kg} + 0.5\,\frac{kg}{s}\,125.85\,\frac{kJ}{kg}$$

$$= \dot{W}_{out} + 2.5\,\frac{kg}{s}\left\{2248.25\,\frac{kJ}{kg} + \frac{1}{2}\left(131.24\,\frac{m}{s}\right)^2 \frac{1\,kJ/kg}{1000\,m^2/s^2}\right\}$$

$$\dot{W}_{out} = 1056\,kJ/s = \underline{1056\,kW}$$


Example:
Mixing:
air 200°C I 100kPa I
2m³/s E
1m³/sec E
20°C I
100kPa I
Asked: T3 ? V3
V = AVel
assume adiabatic
m3 = m1 + m2 E
100kPa I
assume isobaric
Vel ~ 0
Created with Doceri

$P_1 v_1 = RT_1 \rightarrow 20^\circ C = 293.15 K$

$\downarrow$ 100 kPa $\leftarrow$ A.5 $0.287 \, kJ/kg\,K$

$v_1 = 0.84091 \frac{m^3}{kg}$ $\dot{m}_1 = \frac{\dot{V}_1}{v_1} = \frac{1 m^3/s}{0.84091 m^3/kg}$

$\dot{m}_1 = 1.18919 \, kg/s$

same way $\dot{m}_2 = 1.4732 \, kg/s$

$\dot{m}_3 = \dot{m}_1 + \dot{m}_2 = 2.6625$

Table A.7.1 @ $(20 + 273) K$ $h_1 = 293.44 \, kJ/kg$

@ $(200 + 273) K$ $h_2 = 475.69 \, kJ/kg$

$\dot{m}_1 h_1 + \dot{m}_2 h_2 = \dot{m}_3 h_3 \rightarrow h_3 = 394.24 \, kJ/kg$

A-7.1 interpolate $T_3 = 393.02\,K$

If using $h_2 - h_1 = c_p(T_2 - T_1)$

$$\dot{m}_1 h_1 + \dot{m}_2 h_2 = \dot{m}_3 h_3$$

Trick:

$$\dot{m}_1 h_1 + \dot{m}_2 h_2 = \dot{m}_1 h_3 + \dot{m}_2 h_3$$

$$\dot{m}_1 c_p (T_3 - T_1) \qquad \dot{m}_2 c_p (T_3 - T_2)$$

$$\dot{m}_3 = \frac{\dot{V}_3}{v_3}$$