THREE TOPICS

1. BENEFITS OF USING LOW PRESSURE STEAM IN HEAT EXCHANGER
2. WHAT TO DO IF LOW PRESSURE NOT AVAILABLE OR MAY BE NECESSARY TO PRODUCE THE DESIRED TEMPERATURE
3. CHECKING FOR SUPERHEAT

BENEFITS

1. USE LESS STEAM
2. BETTER CONTROL
3. ELIMINATE FLASH LOSS

WHY DO WE USE LESS STEAM?

30psig (44.7 psia)	h_g= 1172 BTU/LB
	h_f= 243 BTU/LB
	h_{fg}= 929 BTU/LB
	TEMP= 274 °F
15psig (29.7 psia)	h_g= 1164 BTU/LB
	h_f= 219 BTU/LB
	h_{fg}= 945 BTU/LB
	TEMP= 250 °Fh_g= 1150 BTU/LB
0 psig (14.7 psia)	h_f= 180 BTU/LB
	h_{fg}= 970 BTU/LB
	TEMP= 212 °F

TOO MUCH ENERGY LEFT IN THE LIQUID HAS NEGATIVE CONSEQUNCES

1. DIFFICULT TO PUMP
2. DIFFICULT TO GET THE ENERGY BACK I.E. SUBCOOL THE LIQUID
3. IF WE DO NOT SUBCOOL WE HAVE FLASH LOSS

FLASH LOSS

$$\text{FLASH LOSS \%} = \frac{h_{\text{HiTempLiquid}} - h_{\text{LowTempLiquid}}}{h_{fg} \text{ of low temp}}$$

FOR 30 PSIG STEAM TO 0 PSIG:

$$\frac{243-180}{970} = .0649 \text{ OR } 6.5\% \text{ FLASH LOSS}$$

15 PSIG STEAM= 4% LOSS

0 PSIG STEAM= 0.4% LOSS

COST OF FLASH LOSS

TO PRODUCE 1LB OF 100 PSIG STEAM

TEMP OF 100 PSIG STEAM= 338 °F

TEMP OF MAKE UP WATER= 60 °F

h_{fg} OF 100 PSIG STEAM = 880.6 BTU/HR

$$(338\text{-}60°F)\left(\frac{1\ BTU}{LB\times°F}\right)(1LB) = 278\ BTU$$

h_{fg}

$$= \frac{880.6}{1158.6\ \frac{BTU}{LB}}$$

COST OF FLASH... CONTINUED

TO PRODUCE 1000 LBS/HR = 1158600 BTU/HR

1 THERM = 100000 BTU/HR

∴ 11.586 THERMS/1000 LB/HR

AT 0.50 PER THERM = $5.79/ 1000 LBS/HR

$$\therefore \frac{.00579}{LB} \times \frac{65LBS}{1000LBS/HR} \times \frac{8760\ HRS}{YR} = \$3297/YR$$

HEAT EXCHANGER SELECTIONS

300 GPM, 160-180°F

30 PSIG STEAM IN THE SHELL:

SUI03-2 - $3500

3156LBS/HR

$$\frac{\$3297}{4R \times 1000LBS} \times 3156 = \$10{,}405$$ FLASH LOSS COST

HEAT EXCHANGER SELECTIONS

15 PSIG STEAM IN THE SHELL:

SUIO4-2 -$3900

3100LBS/HR

$$\frac{\$2283}{YR \times 1000LBS/HR} \times 3100 = \$7077$$ FLASH LOSS COST

0 PSIG STEAM IN THE SHELL:

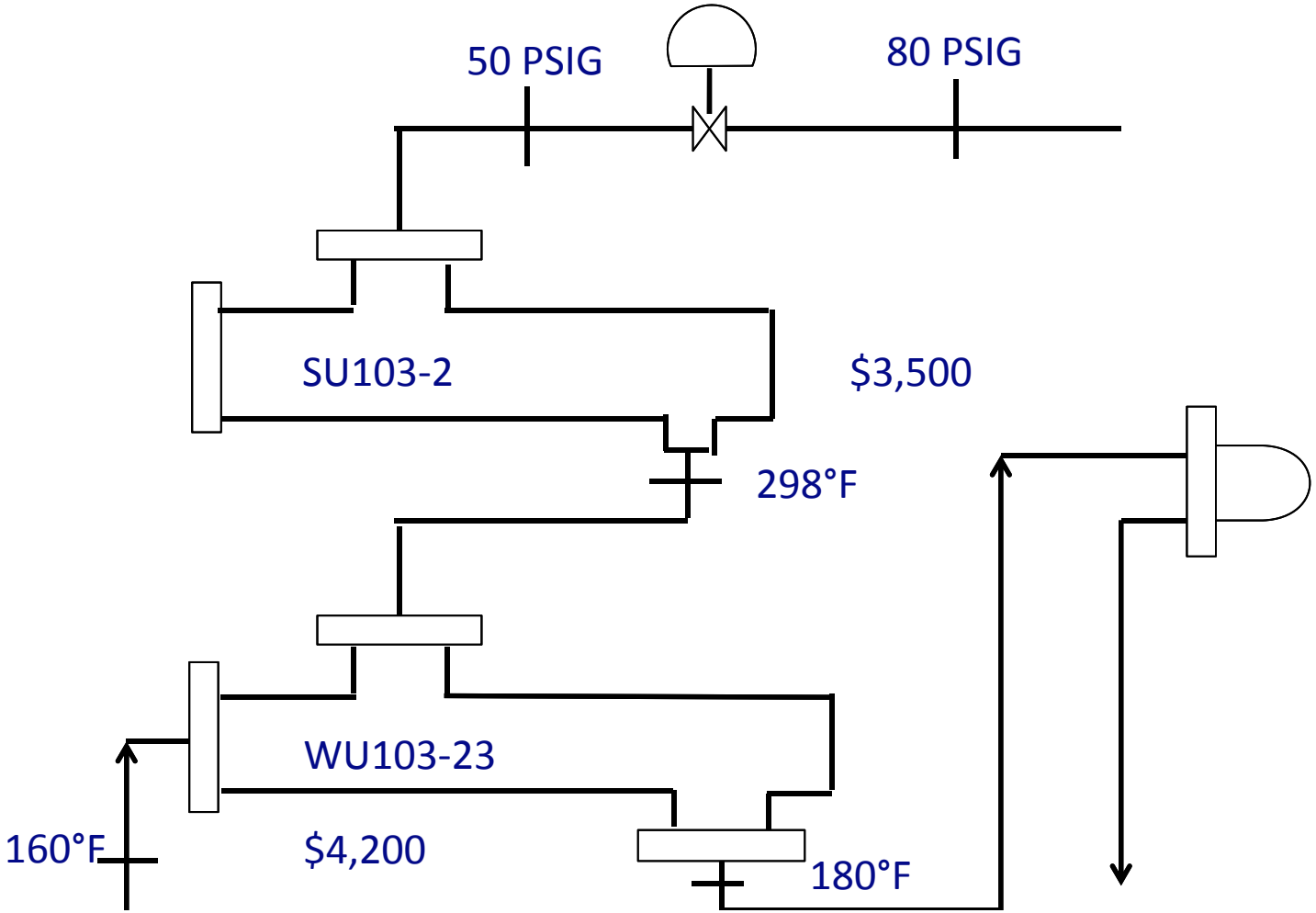
SUIO7-2 -$5100

3022LBS/HR

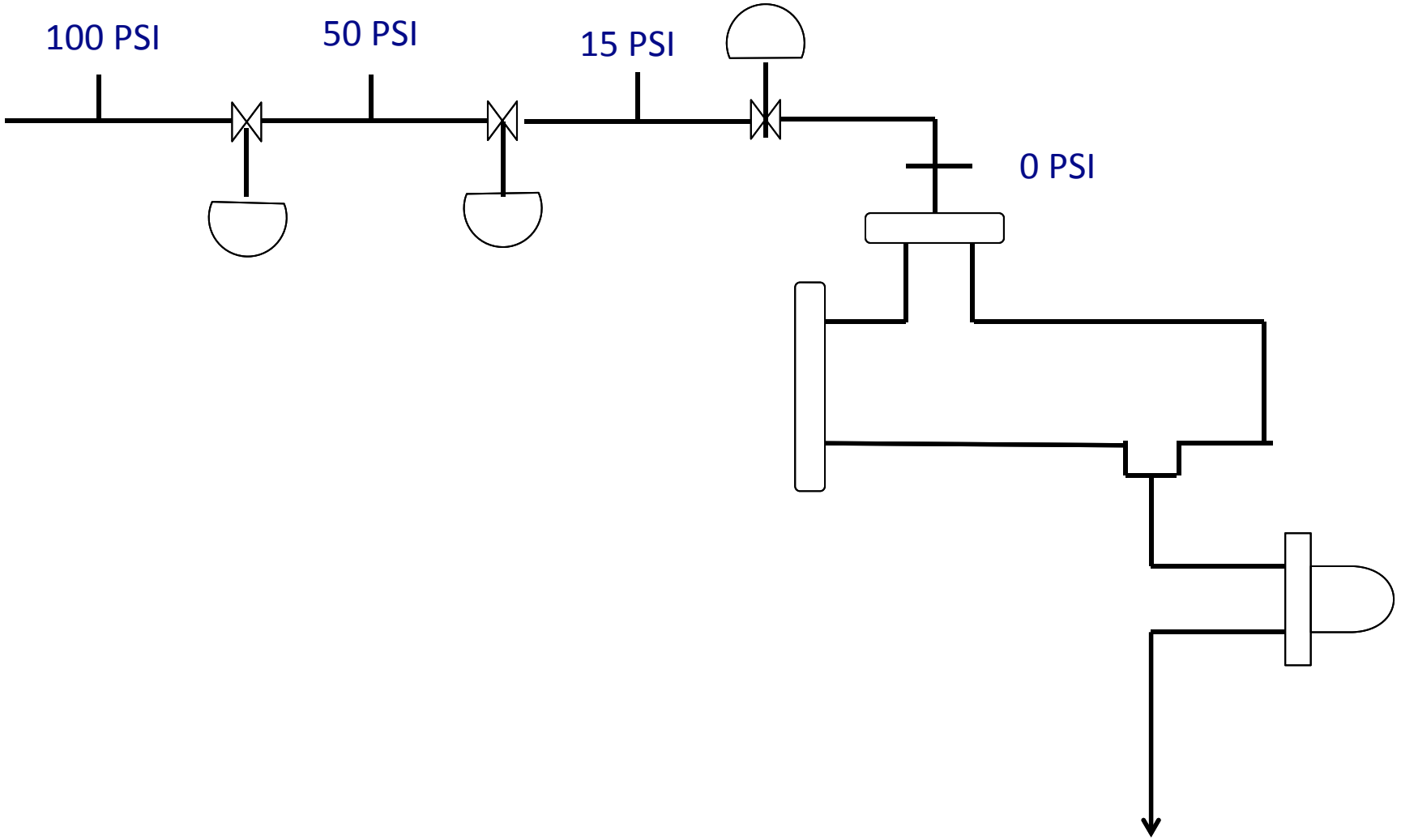
$$\frac{\$197.82}{YR \times 1000LBS/HR} \times 3022 = \$598$$ FLASH LOSS COST

LOW PRESSURE STEAM NOT AVAILABLE

300 GPM 160-180°F



CHECKING FOR SUPER HEAT



1. THROTTLING PROCESS

2. ADIABATIC- NO HEAT TRANSFER

3. NO SHAFT WORK

4. STEADY FLOW ENERGY EQUATION IS BALANCED, CHANGES IN POTENTIAL ENERGY, KINETIC ENERGY AND HEAT TRANSFER ARE NEGLIGABLE

5. WE ARE LEFT WITH $h_1 = h_2$

WE CAN EVALUATE EACH STAGE AS FOLLOWS:

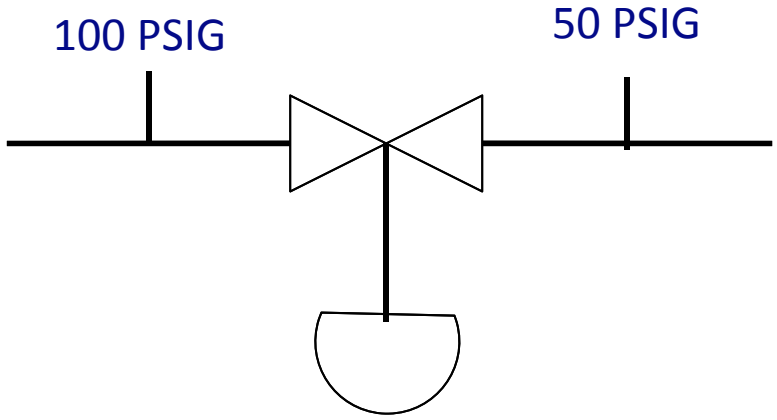
H_f = ENTHALPY OF SATURATED LIQUID

H_g = ENTHALPY OF SATURATED VAPORS

STEAM QUALITY = PERCENTAGE OF VAPOR

$$x = \text{STEAM QUALITY} = \frac{\text{WEIGHT OF VAPOR}}{\text{WEIGHT OF MIXTURE}}$$

$$H = (\text{MIXTURE}) = \frac{x h_g + (1-X)\, h_f}{h_{fg}}$$



$h_{100} = h_{50}$

$h_{g100} = 1190$ BTU/LB

$T_{100} = 338°F$

IF ASSUME NO TEMP DROP

$h_{g50} = 1201$ BTU/LB – NOT POSSIBLE–

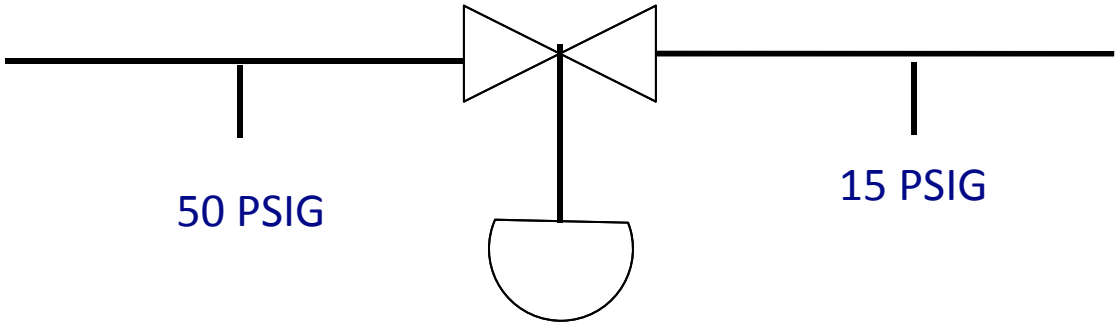
T OF 50 PSIG SAT STEAM = 298° F

AT 300° F $h_{50} = 1180$ BTU/LB

$$x_{100} = \frac{1180-309}{881} = .989$$

h_g OF 50 PSIG SAT STEAM = 1179 BTU/LB

$$x_{100} = \frac{1179-309}{881} = .988$$



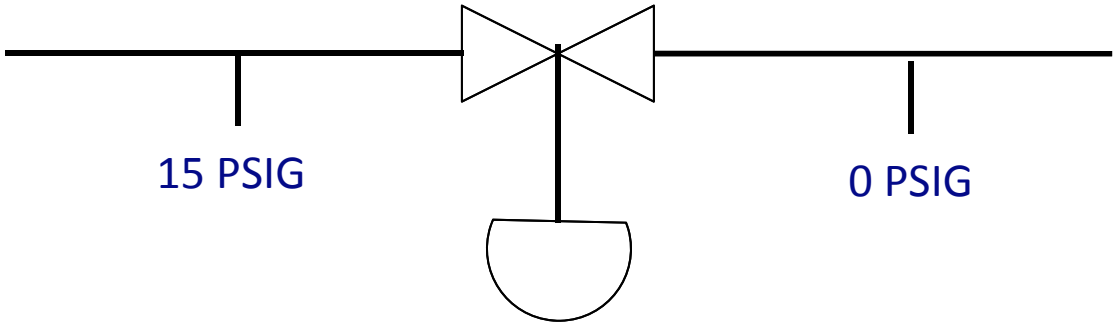
$h_{50} = h_{.5}$

h_{50} SATURATED = 1179 BTU/LB

T_{50} SATURATED = 298°F

h_{15} SUPERHEATED = 1179

T_{15} SUPERHEATED = 280°F



$h_{15} = h_0$

$h_{15} = 1179$ BTU/LB

$h_0 = 1179$ BTU/LB & $T_0 = 271°F$

h_0 SUPERHEATED = 1179 BTU/LB

h_0 SATURATED = 1150.4 BTU/LB

$1179.0 - 1150.4 = 28.6$ BTU/LB

WHY IS THIS IMPORTANT

OVERALL “U” FACTOR FOR LATENT CONDENSING PROCESS RANGES FROM 500-700

OVERALL “U” FACTOR FOR SENSIBLE COOLING OF A GAS RANGES FROM 40-50

THEREFORE ON AVERAGE IT REQUIRES ABOUT 12 TIMES AS MUCH SURFACE AREA TO REMOVE SUPERHEAT, I.E. COOL A GAS

FOR 0 PSIG HEAT EXCHANGE SELECTION

LOAD= 2,931,624 BTUH

SURFACE AREA= 101.6 SQ FT

BTUH PER SQ FT = 28,855

FOR SENSIBLE LOAD= 2405 BTUH/SQ FT

SENSIBLE LOAD= 28.6 BTUH/ X 3022 LBS/HR

SENSIBLE LOAD= 86,429 BTUH

SURFACE AREA=86429 ÷2405

ADDITIONAL SURFACE AREA= 36 SQ FT