Rules of Thumb

- Average efficiency of a steam boiler is 80%.
- 10 PSI drop in header pressure is 1% energy reduction
- Every 10.7 F rise in boiler feedwater temperature yields ~1% steam energy savings
- Unmaintained steam system - 15% to 30% of traps failed
- Ideal, maintained steam system - 5% of traps failed

Improve Boiler Combustion Efficiency

Excess (%)		Combustion Efficiency: Flue gas temp. minus combustion air temp (F)				
Air	Oxygen	200	300	400	500	600
9.5	2.0	85.4	83.1	80.8	78.4	76.0
15.0	3.0	85.2	82.8	80.4	77.9	75.4
28.1	5.0	84.7	82.1	79.5	76.7	74.0
44.9	7.0	84.1	81.2	782.2	75.2	72.1
81.6	10.0	82.8	79.3	75.6	71.9	68.2

Calculating Steam Cost

Energy required to produce one pound of saturated steam, BTU					
Operating Pressure (psig)	Feed water Temperature, F				
	50	100	150	200	250
150	1178	1128	1078	1028	977
450	1187	1137	1087	1037	986
600	1184	1134	1084	1034	984

$$\$/1000\ lbs\ of\ steam = \frac{\$/MMBTU \times 1000\ lbs \times Btu/lb}{Combustion\ Efficiency \times 10\text{^}6}$$

Insulate Steam and Condensate Lines

Heat Loss per 100 feet of Uninsulated steam, line, MMBTU/yr				
Line Diameter (in.)	Steam Pressure (psig)			
	15	150	300	600
1	140	285	375	495
2	235	480	630	840
4	415	850	1120	1500
8	740	1540	2030	2725
12	1055	2200	2910	3920

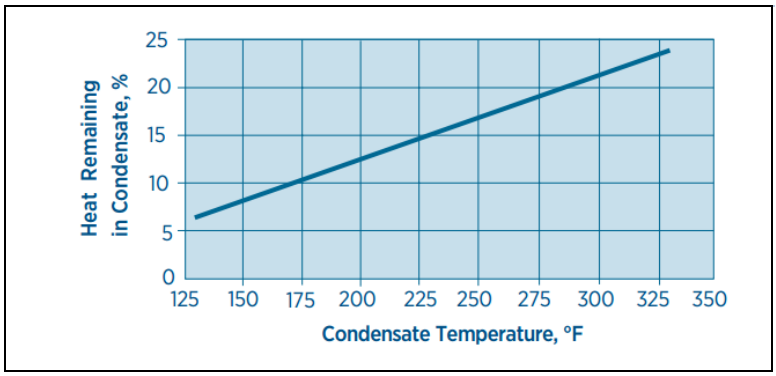
Heating Value of Fuels

Fuel Type	Units	LHV	HHV
Natural Gas	Btu/CF	983	1,089
Residual Oil	Btu/Gal	140,353	150,110
LPG	Btu/Gal	84,950	91,410
LNG	Btu/CF	74,720	84,820
Coal - Bituminous	Btu/lbs	11,230	11,723

Higher Heating Value (HHV): Total energy from combustion process

Lower Heating Value (LHV): Assumes eat of condensation cannot be recovered

Return Condensate to Boiler



Losses with steam Trap Failure

Trap Orifice Diameter (in.)	Steam Loss, lb/hr			
	15 psig	100 psig	150 psig	300 psig
1/32	0.85	3.3	4.8	-
1/16	3.4	13.2	18.9	36.2
1/8	13.7	52.8	75.8	145
3/16	30.7	119	170	326
1/4	54.7	211	303	579
3/8	123	475	682	1,303

Conversion Factors

$1\ boiler\ hp = 33{,}475\ Btu/hr$

$1\ boiler\ hp = 9.8\ kW$

$1\ lb/hr\ steam\ (300\ psi, staturated) = 1{,}202\ Btu/hr$

$1\ gal\ water = 8.35\ lb$

$1\ psi = 6.89\ kPa$

Steam Trap Failure

Obvious Signs	Less Obvious Signs
• Steam flashing • Water Hammer • Pump cavitation	• Higher than necessary pressure • Excessive condensate & chemical losses • Condensate water too hot • Boilers running continuously