

KILN CONDENSATE AND STEAM SYSTEMS

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Characteristics of Condensate

Two phase flow, flash steam and water

By weight water is 75% to 98% of condensate

By volume, steam is ~99 % of condensate

Flash Steam, Percent by Weight

PERCENT FLASH STEAM (% BY WEIGHT)											
Steam Press psig	Flash Tank Pressure										
	0	2	5	10	15	20	30	40	60	80	100
300	22.5	22.0	21.2	20.1	19.1	18.2	16.8	15.5	13.4	11.7	10.2
250	20.8	20.2	19.4	18.2	17.3	16.4	14.9	13.6	11.5	9.8	8.2
200	18.7	18.1	17.3	16.2	15.2	14.3	12.8	11.5	9.4	7.6	6.0
160	16.9	16.2	15.4	14.3	13.2	12.4	10.8	9.5	7.3	5.5	3.9
125	14.9	14.3	13.5	12.3	11.3	10.4	8.8	7.5	5.3	3.4	1.8
100	13.3	12.7	11.8	10.6	9.6	8.7	7.1	5.8	3.5	1.6	
80	11.8	11.2	10.3	9.1	8.1	7.1	5.5	4.2	1.9		
60	10.0	9.4	8.5	7.3	6.2	5.3	3.7	2.3			
40	7.8	7.2	6.3	5.1	4.0	3.0	1.4				
30	6.5	5.8	5.0	3.7	2.6	1.7					
20	4.9	4.2	3.3	2.1	1.0						
15	3.9	3.3	2.4	1.1							
10	2.9	2.2	1.3								
5	1.6	0.9									

Cond Prop @ Inti Pr				Condensate			Steam	Water
Init Pr	Enthalpy	Sp Vol	Density	End Pr	Sp Vol c	Moisture	Sp Vol-s	Sp Vol-w
psig	Btulb	cf/lb	lb/cf	psig	cf/lb	Wt Basis	cf/lb	cf/lb
25	235.7	0.0171	58.3372	2	1.22221	5.1%	23.7884	0.0168
50	267.3	0.0174	57.3869	2	2.00123	8.3%	23.7884	0.0168
75	290.5	0.0177	56.6491	2	2.57071	10.7%	23.7884	0.0168
100	309.1	0.0178	56.0304	2	3.02842	12.7%	23.7884	0.0168
125	324.8	0.0180	55.4894	2	3.41558	14.3%	23.7884	0.0168
150	338.6	0.0182	55.0037	2	3.75371	15.7%	23.7884	0.0168
				Condensate	Steam	Water	% Vol	% Vol
Init Pr	Enthalpy	End Pr	Sp Vol c	Quality	Sp Vol-s	Sp Vol-w	Steam	Water
psig	Btulb	psig					in Cond	in Cond
25	235.7	2	1.22221	5.1%	23.7884	0.01676	98.70%	1.30%
60	277.3	2	2.24659	9.4%	23.7884	0.01676	99.32%	0.68%
75	290.5	2	2.57071	10.7%	23.7884	0.01676	99.42%	0.58%
100	309.1	2	3.02842	12.7%	23.7884	0.01676	99.52%	0.48%
125	324.8	2	3.41558	14.3%	23.7884	0.01676	99.58%	0.42%
150	338.6	2	3.75371	15.7%	23.7884	0.01676	99.62%	0.38%
Example of flow velocity								
	Flow	Pipe Size	Pipe ID	Flow Area	Sp vol c	Velocity	Vel Pr	
	pph		in	sf		fps	psi	
80# to 2 #	24,000		4.03	0.0884	2.57071	193.9	1.576	
80# to 2 #	24,000		6.07	0.2006	2.57071	85.4	0.306	
40# to 2 1/3	40,000		6.07	0.2006	1.22221	67.7	0.404	
60# to 2 1/4	40,000		8.106	0.3584	2.24659	69.7	0.233	

Condensate System Functions

- ▶ Remove condensate without affecting coil heat transfer
- ▶ Separate water from flash steam
- ▶ Vent flash steam that cannot be used elsewhere
- ▶ Return condensate as hot as possible to boiler plant.

Remove Condensate From Coils

- ▶ Traps are required to allow water (condensate) to escape while minimizing escape of steam.
- ▶ Piping from the trap to condensate receiver must be adequately sized for low resistance to flow.

Condensate Pipe Sizing Recommendations

Size for flow velocities less than 80 fps; lower if the condensate receiver is above grade.

If distance is large (>100') it may also be necessary to increase the pipe size.

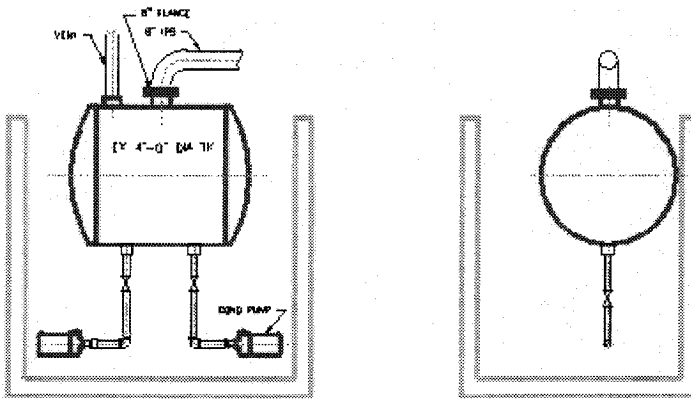
Minimize low points or traps that can collect water to avoid water slugging. Limit any lifts to one.

Consider stainless steel piping for long life and grooveless type clamping connectors for ease of installation.

Condensate Receiver Function

- ▶ Provides space (volume) to separate flash steam from water.
- ▶ Provides storage for water to absorb flow swings
- ▶ Provides for venting the flash steam
- ▶ Provides a means for returning condensate to the boiler plant
- ▶ Does the receiver need to be below kiln grade?
Preferably yes, if steam pressure > ~90 psig then it may be possible to be on grade.

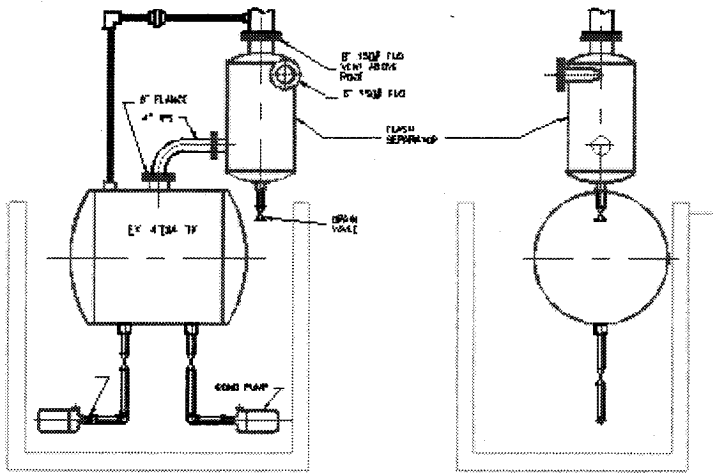
Condensate Receiver



Example of condensate receiver that was too small to provide adequate water/steam separation and flash steam venting.

Condensate Receiver with Flash Separator

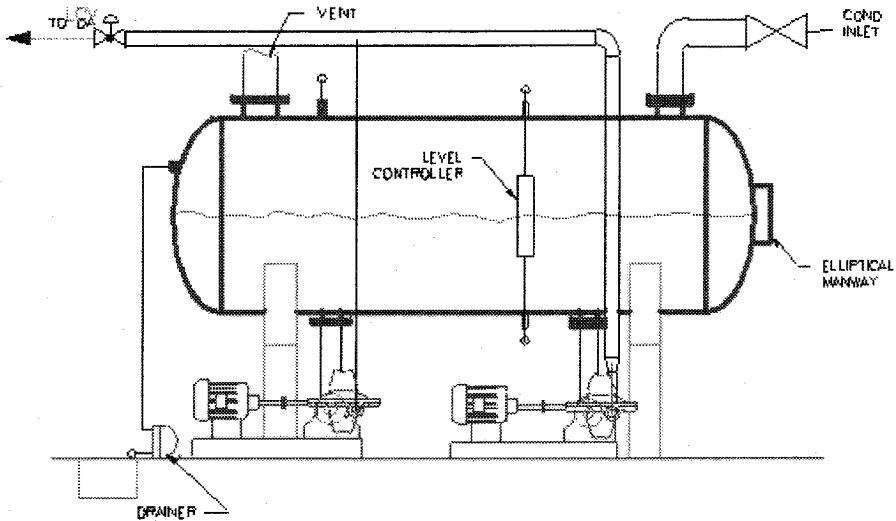
Cyclonic flash separator solves problem of too small a receiver.



Condensate Pump

- ▶ Select pump with NPSHR assuming saturated water. NPSHA then is height of water over the pump nozzle.
- ▶ Inlet pipe should be at least one size larger than the pump nozzle. Minimize tees and elbows.
- ▶ Provide continuous return flow to the boiler, i.e., a level controller and regulating valve. Throw out the on/off pumping system.
- ▶ The boiler, the piping and the pump will love it.

Receiver Arrangement



Steam Systems

- Pressure: what is the best pressure for operation?
- Line sizing: build for future expansion

Other Considerations

- Pressure regulating valve?
- Drip pockets?
- Flat or sloping pipe installation?

