tekmar® - Essay

Balancing On / Off Injection Mixing Systems

E 022

03/97

ON / OFF INJECTION MIXING

Operation

In an On / Off Injection mixing system, an on / off injection device, such as a zone valve or a pump, is used to inject bursts of hot water into a constantly circulating system loop. The injected hot water mixes with the cool system loop water to provide a warm mixed temperature in the system. The water temperature can be controlled by varying the on time of the injection device and therefore changing the amount of hot water injected into the system loop.

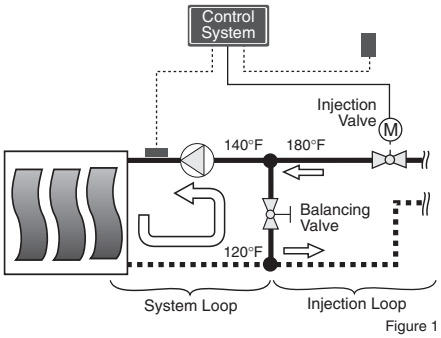


Figure 1

In order for the system to operate properly, a few considerations must be taken into account. The amount of water injected into the system loop must be large enough to provide the required water temperature during design outdoor conditions, but the mixed supply water in the system loop should not exceed the maximum temperature allowed by the tubing, etc. A balancing device and a proper piping arrangement is necessary to provide the appropriate injection flow rate for different systems.

Piping Requirements

The piping requirements are dependent on the type of injection device used. If an injection pump is used, refer to the piping and sizing section in essay E 021. On / Off Injection systems with a pump are generally recommended only for single large zone applications.

When using a zone valve as an injection device, the system may have single or multiple zones. The balancing valve located between the tees in the system loop provides a pressure drop to induce flow through the injection loop. (See Figure 2) If system flow rate changes occur, due to zones opening or closing, the balancing valve self regulates the injection flow rate. (See Figure 3)

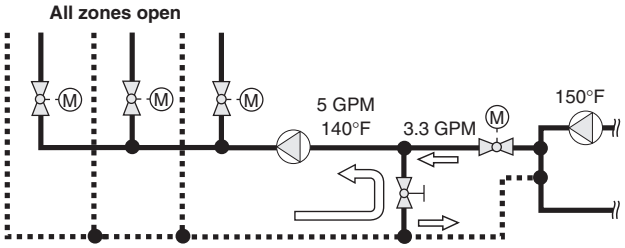


Figure 2

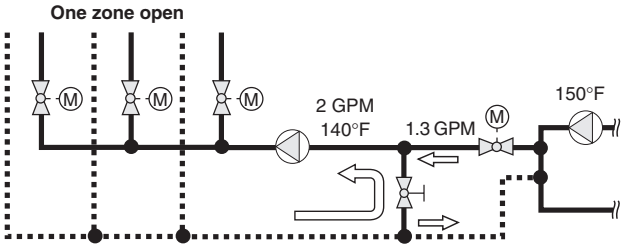


Figure 3

Note Do not pipe the balancing valve or diverter tee in the boiler loop due to the following reasons:

- The injection flow rate will not change as low temperature zones open and close. This will cause larger supply water temperature fluctuations.
- In applications where hot water (baseboard) zones are combined with on / off injection, the flow rate in the boiler loop changes as the hot water zones open and close. These flow rate changes will affect the injection flow rate.

To hydraulically isolate the injection loop from the boiler loop, standard primary-secondary piping techniques should be used as shown in Figure 4.

- There must be less than 4 pipe diameters between the tees in the boiler loop (Note 1) in order to prevent injection flow rate changes when boiler loop flow rate changes occur.
- There must be at least 6 pipe diameters of straight pipe on either side of the tees (Note 2) in order to prevent the momentum of water in the boiler loop from pushing flow through the injection loop.

Injection systems can suffer from unwanted heat transfer due to gravity flow. Since hot water is less dense than cold water, the hot water within the pipes tends to rise, while the cold water tends to fall. This is especially true in vertical injection loops. There should be a minimum of 1 foot drop on the open (no valve) line of the injection loop in order to create a thermal trap (Note 3) and prevent this unwanted heat transfer.

In applications where DHW tanks are used as heat sources, the primary-secondary piping arrangement is eliminated. Refer to Application Drawing A 352-3 (12/96). To balance this kind of system, follow the same design procedure explained in this brochure. Check local codes for whether such applications are permitted.

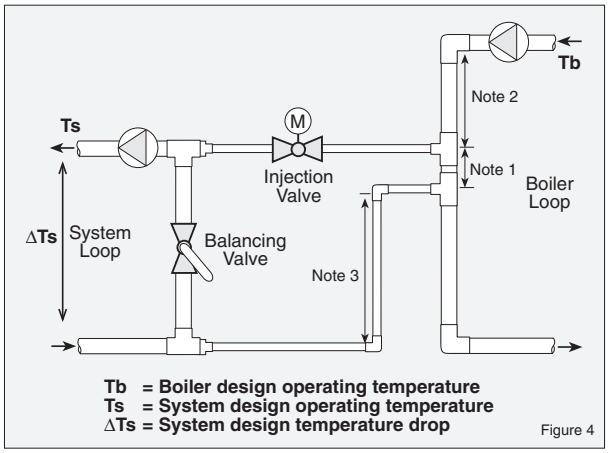


Figure 4

SYSTEM BALANCING

One of the most important steps in the design of an injection loop is to calculate the required pressure drop created by the balancing valve. It is important to balance the valve properly in order to provide accurate temperature control. The following design procedure assists the designer in selecting the required Cv value of the balancing valve. It assumes the injection valve has a Cv of 3.5 and the injection piping includes 5 feet of pipe, 2 elbows, 4 tees and the required reducers/enlargers.

Design Procedure

1. Determine the following design parameters:
   - Boiler supply temperature **(Tb)**
   - System supply temperature **(Ts)**
   - System loop temperature drop **(ΔTs)**
   - Size of system loop piping **(Sys. size)**
2. Calculate **Tb - Ts**
3. Using **Tb - Ts**, look up the required **Cv of the Bypass Valve** in the graphs below. If the system loop temperature drop **(ΔTs)** is 10°F use graph 1, and if the system loop temperature drop is 20°F use graph 2. Choose the pipe sizes that best suit your system.
4. Look up the position of the handle of the balancing valve that is the same size as the system loop and that provides the required Cv value. Any other valve with the required Cv value may be installed instead of the ball valve.

Example

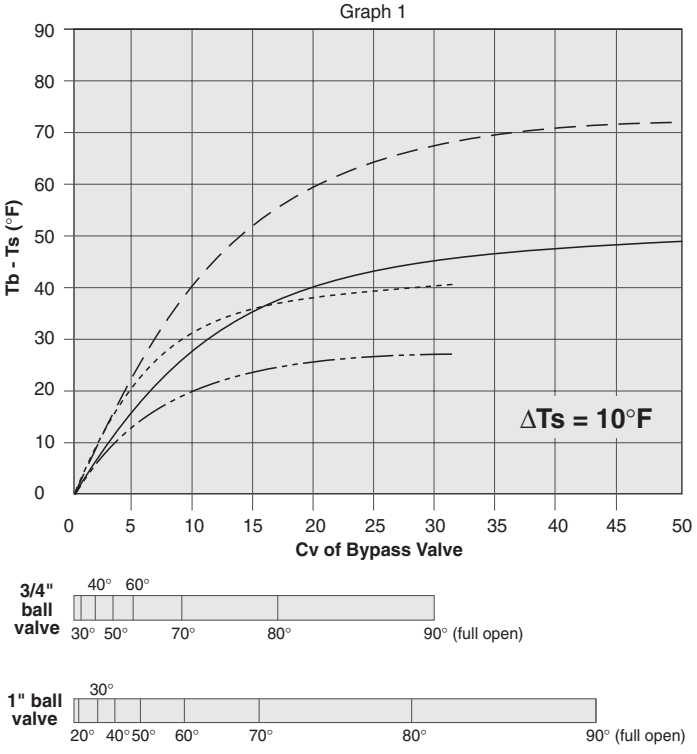
1.
Tb = 170°F
Ts = 130°F
ΔTs = 10°F
Sys. size = 1" pipe

2. **Tb - Ts** = 170°F - 130°F = 40°F
3. **Cv of Bypass Valve** = 10 with injection pipe size of 1/2"
   Cv of Bypass Valve = 20 with injection pipe size of 3/4"
4. Since the system loop pipe size is 1", a 1" ball valve should be used. When using a 3/4" injection loop size, the valve handle should be positioned to about 75° open. If the 1/2" injection loop is used, the position of the handle of the 1" ball valve should be about 60° open.

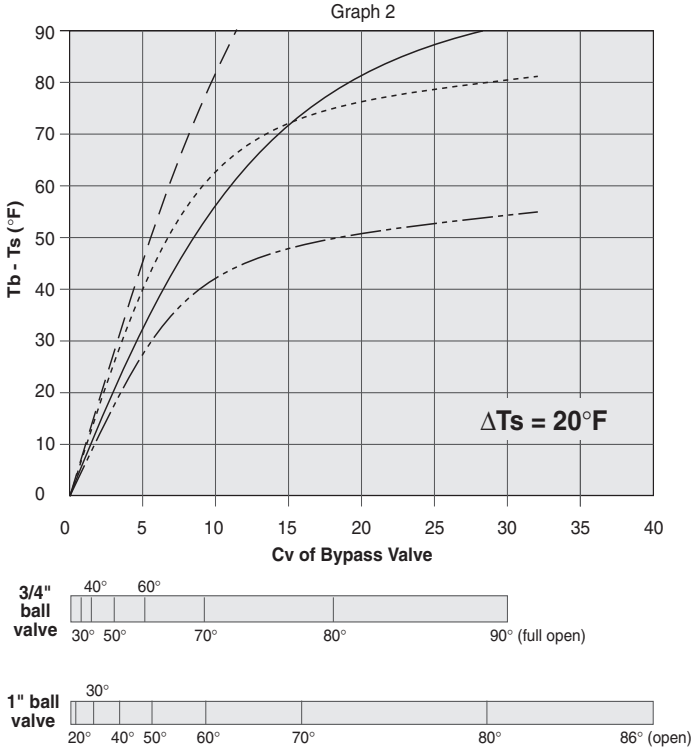
Legend

1" System loop, 3/4" Injection loop	1" System loop, 1/2" Injection loop	3/4" System loop, 3/4" Injection loop	3/4" System loop, 1/2" Injection loop

Graph 1



Graph 2



The Cv values of the ball valves shown are an approximation of a standard port ball valve. Actual values may vary based on different manufacturers. The drawings in this brochure are only concept drawings. The designer must determine which, if any, concept is best for his/her application and must ensure compliance with code requirements. Necessary auxiliary equipment and safety devices must be added.

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