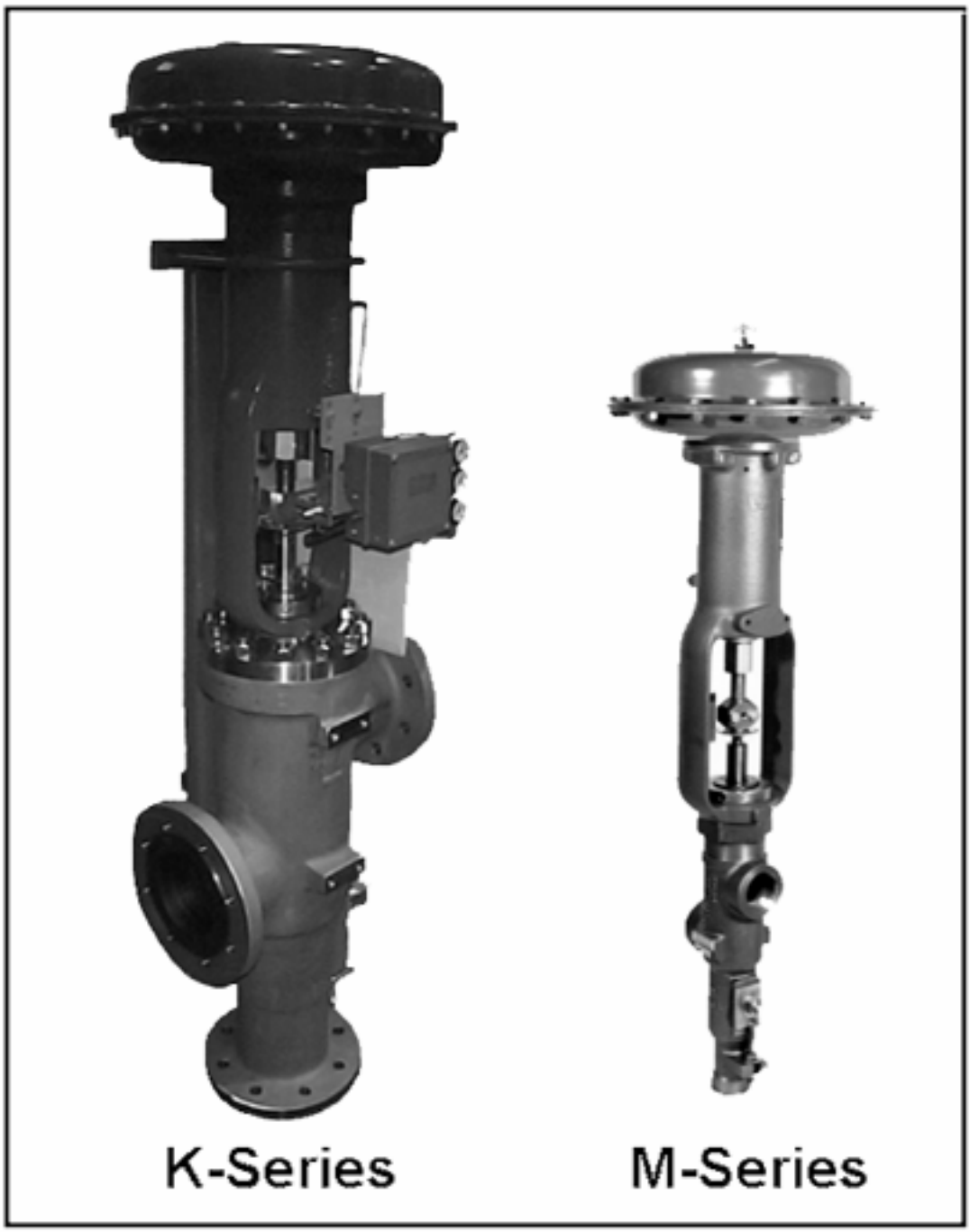
Version 2.2

Automatic Hydroheater®

Operation and Technical Manual



The Leader in Engineered Liquid Heating Systems

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1 General

1.1 Purpose of the Manual

This manual is intended to provide the information necessary to correctly install, operate, troubleshoot, and maintain the Hydroheater.

1.2 Series Designations

The series designation for the Hydroheater is derived as follows:

K	410	A	S
K (Flanged) M(Threaded)	103(Smallest) 104 • • •		
Connection Type	M110 K410 K411 • K417(Largest)		
		A (Automatic) M (Manual)	S (316 SS) K (WCB Steel) H (Hastelloy) L (316L SS) etc.

Ex. K410AS

1.3 Theory of Operation

The Hydroheater is a sophisticated heat transfer device capable of 100% heat transfer efficiency and extremely precise temperature control. Its rugged design will provide day-in day-out operation without scaling, fouling or plugging. A basic understanding of the Hydroheater and its operating characteristics will ensure a successful application and complete user satisfaction.

The Hydroheater is a direct contact steam injection (DCSI) heater. DCSI devices heat liquids or slurries by mixing steam directly with them. This provides for instantaneous transfer of heat from steam to the liquid. This rapid heat transfer causes the steam to condense and be dispersed into the fluid very quickly, eliminating the hammer and vibration associated with less sophisticated DCSI heaters.

The Hydroheater employs a unique internal geometry to control the steam injection process. A variable area plug / nozzle combination (internal modulation) is used to precisely regulate steam flow. A moveable combining tube offers an adjustable steam condensing region which maintains hammer-free operation as well as providing additional control of liquid pressure or flow.

Because the Hydroheater injects steam directly into the process fluid, the total heating capacity of the steam, both latent and sensible, is utilized, yielding 100% heat transfer efficiency. Indirect methods of heat transfer (heat exchangers) utilize only the latent heat of the steam, and can be as much as 15-20 % less efficient than the Hydroheater in transferring energy from the steam. This lower operating efficiency means that more steam will be required for the same heating application. (increased boiler load).

1.3.1 Hydroheater Control

Unlike indirect methods of heating, the Hydroheater does not have a "heat transfer barrier" such as the wall separating the steam and the fluid in a heat exchanger. Heat transfer barriers have a specific rate of heat conduction which can reduce the response time of the device to process changes. The Hydroheater has no such barrier, and consequently can respond instantly to signals from the temperature controller. In effect, there is almost no lag time in the Hydroheater. The fluid temperature will change immediately with changes in stem position. As a result, the Hydroheater will control as fast and precise as the control loop is capable of measuring and responding to changes in temperature. When incorporating a Hydroheater into a control loop, care should be taken to measure temperature quickly and accurately, eliminating as much "deadband" as possible. For more information on instrumentation and temperature control, see section 3.4.2

2 Safety Precautions

WARNING!
This section must be read carefully before installation and operation of your Automatic Hydroheater to prevent conditions and procedures that could result in injuries or death.

2.1 General

It is the user's responsibility to conform to all applicable local, state, and federal laws, codes and standards.
Complete systems incorporating a Hydroheater should be designed to meet or exceed the Hydroheater temperature, pressure and flow ratings as specified under the **DESIGN CONDITIONS** on the **EQUIPMENT SPECIFICATIONS** sheet included with this manual.

2.2 Specific

The Hydroheater is not designed to provide tight shutoff of steam flow. If the heater or its associated piping is to be disassembled in any way, the steam supply should be isolated from the Hydroheater by closing a steam shutoff valve located on the steam line upstream of the Hydroheater.

To ensure stable operation of the Hydroheater, the steam pressure should exceed the liquid back pressure according to the following formula:

$$P_b \leq \{(P_{st} + 14.7) \times 0.6\} - 14.7$$

Equation 1

Where:
P_b = Back pressure present at Hydroheater discharge (PSIG)
P_{st}= Steam pressure at Hydroheater inlet (PSIG)

If the process requirements exceed this limit, contact Hydro-Thermal technical service at the phone number listed on the front cover of this manual.

Never pressurize the Hydroheater if the actuator is not fully assembled and connected to the steam stem. Internal pressure may force the steam stem to be ejected rapidly through the head, creating the potential for severe injury.

Combining tube adjustments on M series and K4 series heaters should not be made with liquid or steam flowing under pressure through the Hydroheater.

3 Installation

3.1 General

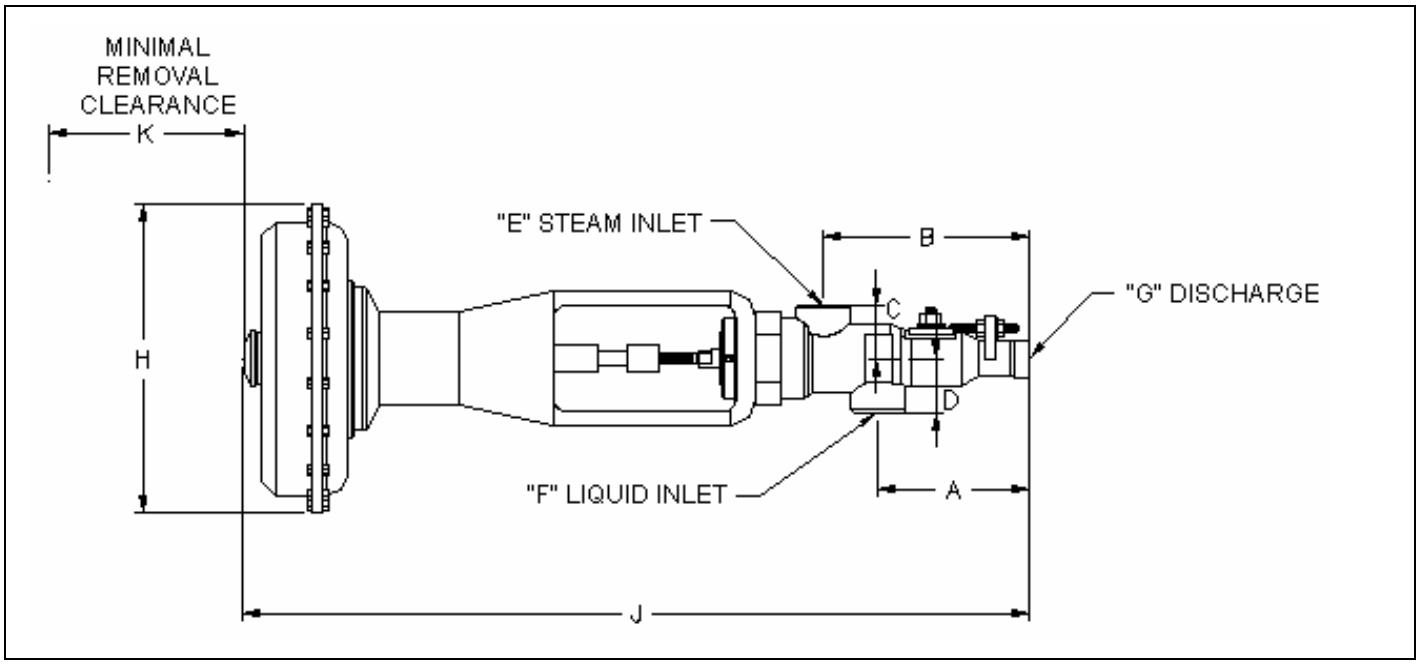
CAUTION!

If your Hydroheater cannot be installed in accordance with these recommendations, please contact Hydro-Thermal Technical service for assistance.

3.2 Before Installing

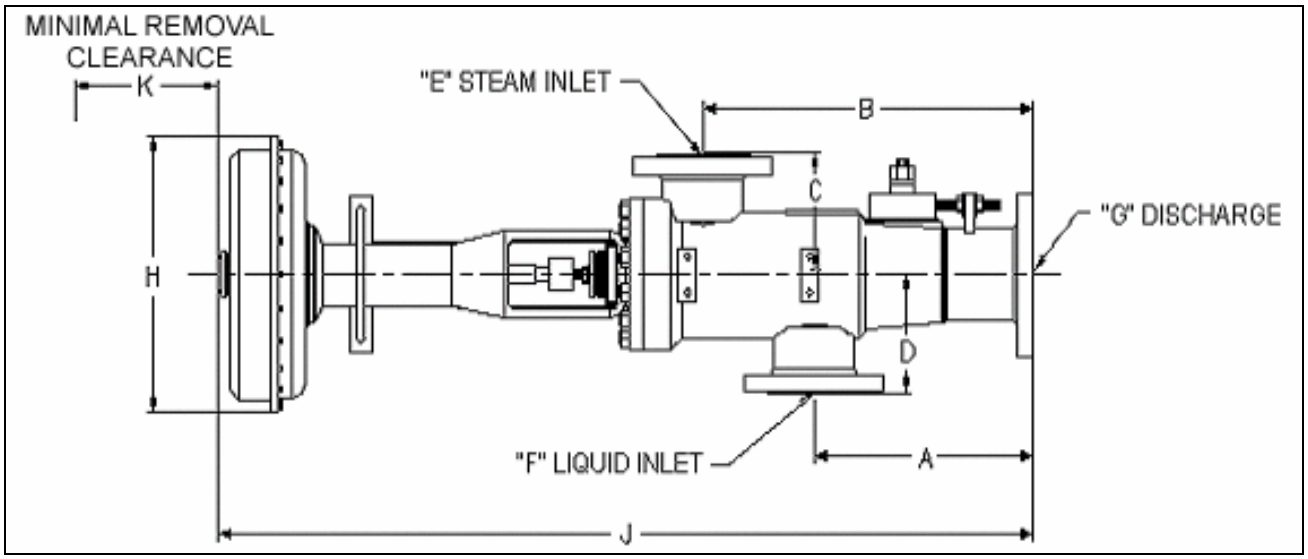
Prior to installing a Hydroheater into the system piping, please refer to the succeeding sections for information necessary to install the Hydroheater in a manner appropriate to its successful use.

3.2.1 Hydroheater Dimensions



Dimensions are in inches												
Model	A	B	C	D	E	F	G	H	J	K	Weight	Flow Rate GPM
M103	4 13/16"	6 9/16"	1 1/2"	1 1/2"	3/4" NPT	3/4" NPT	1/8" NPT	8 1/2"	16 5/8"	4"	18 lbs.	1.5-10
M104	4 13/16"	6 9/16"	1 1/2"	1 1/2"	3/4" NPT	3/4" NPT	1/4" NPT	8 1/2"	16 5/8"	4"	18 lbs.	
M105	5 9/16"	7 1/2"	2"	2"	1" NPT	1" NPT	3/8" NPT	11 1/2"	28 13/16"	6"	48 lbs.	2.4-25
M106	5 9/16"	7 1/2"	2"	2"	1" NPT	1" NPT	1/2" NPT	11 1/2"	28 13/16"	6"	48 lbs.	
M107	7 3/8"	10 1/4"	2 1/4"	2 1/4"	1 1/2" NPT	1 1/2" NPT	3/4" NPT	13 1/8"	36 13/16"	8"	72 lbs.	6.5-46
M108	7 3/8"	10 1/4"	2 1/4"	2 1/4"	1 1/2" NPT	1 1/2" NPT	1" NPT	13 1/8"	36 13/16"	8"	72 lbs.	
M109	11 1/8"	15 3/16"	3 3/4"	3 3/4"	2" NPT	2" NPT	1 1/4" NPT	13 1/8"	42 9/16"	9"	116 lbs	16-138
M110	11 1/8"	15 3/16"	3 3/4"	3 3/4"	2 1/2" NPT	2 1/2" NPT	1 1/2" NPT	13 1/8"	42 9/16"	9"	116 lbs	

Table 1 M-Series Dimensions



150 PSI Flanged Dimensions (in)												
Model	A	B	C	D	E	F	G	H	J	K	Weight	Flow Rate GPM
K410	13 3/16"	17 5/16"	5"	5"	2 1/2"	2 1/2"	2"	16"	45"	4"	160 lbs.	28-174
K411	16"	21 1/8"	6"	6"	3"	3"	2"	16"	55 3/4"	4"	297 lbs.	40-402
K412	16"	21 1/8"	6"	6"	3"	3"	2 1/2"	16"	55 3/4"	6"	305 lbs.	
K413	15 3/8"	22 3/8"	7 9/16"	7 9/16"	4"	4"	4"	18 5/8"	58 3/8"	6"	447 lbs.	120-750
K414	19 1/2"	29 1/2"	8 7/8"	8 7/8"	6"	6"	6"	21 1/8"	73 1/8"	8"	704 lbs.	300-1800
K415	25"	37"	10 3/4"	10 ¾"	8"	8"	8"	21 1/8"	82 1/8"	8"	934 lbs.	400-2500
K416	37 7/8"	51 7/8"	12 9/16"	10 11/16"	10"	10"	10"	21 1/8"	102"	9"	1060 lbs	625-3900
K417	30"	49"	16 1/4"	16 ¼"	12"	12"	12"	21 1/8"	103 3/4"	9"	1990 lbs	1800-6700
300 PSI Flanged Dimensions (in)												
Model	A	B	C	D	E	F	G	H	J	K	Weight	Flow Rate GPM
K410	13 3/16"	17 5/16"	5"	5"	2 1/2"	2 1/2"	2"	16"	45"	4"	160 lbs.	28-174
K411	16"	21 1/8"	6"	6"	3"	3"	2"	16"	55 3/4"	4"	297 lbs.	40-402
K412	16"	21 1/8"	6"	6"	3"	3"	2 1/2"	16"	55 3/4"	6"	305 lbs.	
K413	15 3/8"	22 3/8"	7 9/16"	7 9/16"	4"	4"	4"	18 5/8"	58 3/8"	6"	447 lbs.	120-750
K414	19 11/16"	29 11/16"	9 1/16"	9 1/16"	6"	6"	6"	21 1/8"	73 5/16"	8"	704 lbs.	300-1800
K415	25 1/2"	37 1/2"	11 1/4"	11 ¼"	8"	8"	8"	21 1/8"	82 11/16"	8"	934 lbs.	400-2500
K416	38 9/16"	52 9/16"	13 1/16"	11 3/16"	10"	10"	10"	21 1/8"	102 11/16"	9"	1060 lbs	625-3900
K417	30"	49"	16 1/4"	16 ¼"	12"	12"	12"	21 1/8"	103 3/4"	9"	1990 lbs	1800-6700

Table 2 K-Series Dimensions

3.3 Installation

CAUTION!
If the Hydroheater cannot be installed in accordance with these guidelines, please contact Hydro-Thermal technical service for assistance.

3.3.1 Mounting the Hydroheater

The Hydroheater may be oriented in any position. However, when mounting the heater vertically, discharging downward is preferred.
The supports for the Hydroheater should be designed to support the dead load weight of the heater, and dynamic loads due to fluid velocity. Pipe network expansion due to heating of the pipe should be taken into consideration.
In all heater sizes, the center of gravity will be located on the axis parallel to the Hydroheater discharge, and will most often be located near the steam inlet.

Refer to the ASME power piping code B31.1 for specific guidelines on pipe supports and nozzle loading information.

CAUTION!
The Hydroheater, like any fluid heating device, may experience severe water hammer if improperly installed or operated. Rigid support is recommended to ensure the integrity of the Hydroheater and the attached piping network.

3.3.2 Special Piping Considerations

Please refer to the **Equipment Specification Sheet**, included with your order paper work, for Hydroheater design conditions.

Figure 1 shows a typical Hydroheater installation. The components shown indicate the recommended minimum piping and instrumentation devices necessary to ensure proper Hydroheater operation. See Section 3.4.2 for more details on instrumenting a Hydroheater for specific process requirements.

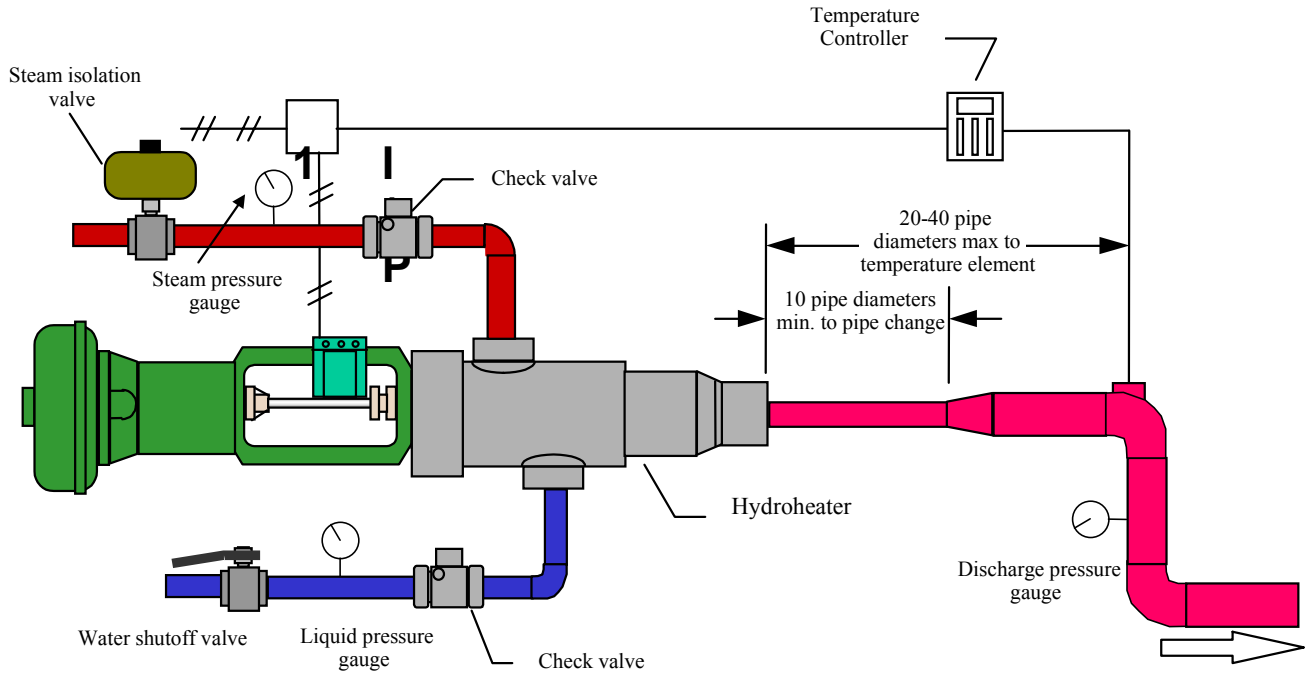


Figure 1 Recommended Hydroheater Layout

Positive shutoff valves and check valves should be installed on both the steam and the liquid supply lines. These supply line valves should be closed to isolate the supply line from the Hydroheater when the Hydroheater is not in operation for an extended period.

3.3.2.1 Steam Line Requirements

In general, steam inlet piping to the Hydroheater should be at least as large in diameter as the Hydroheater steam inlet connection, possibly larger. Steam inlet piping should be designed to minimize pipe losses and ensure an adequate steam supply to the Hydroheater that meets the design steam pressure **at** the design steam flow rate.

The Hydroheater is designed to utilize the full design steam pressure over its entire heating range. (0-100% of Hydroheater stem travel)

CAUTION!

IT IS NOT NECESSARY OR DESIRABLE TO PLACE A MODULATING STEAM CONTROL VALVE ON THE INLET PIPING TO THE HYDROHEATER.

A **check valve** should be placed approximately 5 pipe diameters from the Hydroheater steam inlet. During times of Hydroheater shutdown, if fluid pressure is maintained in the Hydroheater, the fluid will flood the steam piping if no check valve is present. Upon opening the steam block valve when restarting the system, steam hammer may occur in the inlet piping.

A tight shutoff **block (on/off) valve** should be used to provide complete shutoff of steam during extended down periods. A full port valve, such as a ball or butterfly valve, sized for low pressure drop is recommended. The trim in the Hydroheater is not designed to provide tight steam shutoff and should not be used for such.

A **steam trap** and **drop leg** with blow down valve should be installed on the steam inlet piping, upstream of the check valve. Steam piping should be blown down after any extended shutdown to insure all condensate has been purged from the steam line.

3.3.2.2 Liquid Line Requirements

The liquid supply line may be sized to the system requirements, however, the following guidelines should be followed.

Any liquid control valves upstream of the Hydroheater should be located at least 10 pipe diameters away from the Hydroheater to minimize the flow disturbances present at the Hydroheater inlet.

A **check valve** is recommended as close to the Hydroheater inlet as practical. 5-10 pipe diameters upstream of the Hydroheater inlet is recommended.

3.3.2.3 Discharge Piping Requirements

As shown in Figure 1, the discharge piping immediately downstream of the Hydroheater should be the same pipe size as the Hydroheater discharge connection for a length of at least 10 pipe diameters before any elbows, tees, reducers, etc. Any reducers or expansion of pipe sizes within 40 pipe diameters downstream of the Hydroheater should be gradual to minimize the detrimental effect of flow disturbances on steam condensation.

The temperature sensor should be located in the discharge piping between 20 and 40 pipe diameters of the Hydroheater discharge. (see instrumentation section 3.4.2 for more details)

It is highly recommended that a pressure gauge or sensor be located in the discharge piping. The downstream pressure is an important parameter in troubleshooting operational difficulties.

If a flow control valve is located in the discharge piping, care must be taken not to allow the Hydroheater discharge pressure to exceed the limits given in Equation 1.

If the Hydroheater is to be designed to discharge to atmospheric pressure (e.g. into a tank or open vessel), the piping should be arranged to assure the Hydroheater is flooded upon startup.

3.4 Control Instrumentation

3.4.1 Hydroheater Control Characteristics

The Hydroheater is a sophisticated temperature control device capable of repeatable, very precise temperature control. Successful operation of the Hydroheater in any application is solely dependent on the design, installation, and tuning of its instrumentation loop. Because the Hydroheater responds instantaneously to changes in temperature controller output (i.e. virtually no dead band across the Hydroheater), it will typically be the fastest element in the control loop. If the system incorporating the Hydroheater is either intermittent or prone to upsets, care should be taken in the design and tuning of the control loop to prevent overshoot of temperature. For this same reason the placement of the temperature sensor in the Hydroheater discharge piping is critical.

Note:
To minimize lag time and optimize control of the Hydroheater, the temperature control sensor should never be located more than 40 Hydroheater pipe diameters from the Hydroheater discharge without first consulting Hydro-thermal technical service.

3.4.2 Control Instrumentation Requirements

The instrumentation necessary to properly operate an Automatic Hydroheater will vary based upon the type of system in which it is implemented. The following sections will detail the types of control systems used and the special requirements of each.

3.4.2.1 General Requirements (Apply to all systems)

Figure 1 illustrates the equipment necessary to properly instrument an automatic Hydroheater.

Pressure Gauges: Should be installed on all three connection lines to the Hydroheater. The gauges should be installed between any valves, reducers, etc. and the Hydroheater to assure the gauge pressure is equal to the pressure at the Hydroheater. It is important to install gauge cocks on each pressure tap to isolate the gauge from the process when measurements are not required. If the process fluid is a slurry or contains suspended solids, a diaphragm sealed gauge should be used to reduce the probability of plugging. Fluid filled gauges are recommended.

Temperature Sensor: Should be installed in a thermowell on the discharge line at a distance of 20-40 pipe diameters from the Hydroheater discharge. The location and type of temperature sensor should be selected to reduce the time required to sense and accurately transmit the process temperature. The Hydroheater has virtually no lag time (i.e. discharge temperature is solely dependent on Hydroheater plug position). As a result, it is quite possible to overheat and flash the process fluid if the controller response significantly lags behind the actual process temperature. See Figure 2 for a typical Hydroheater system temperature profile.

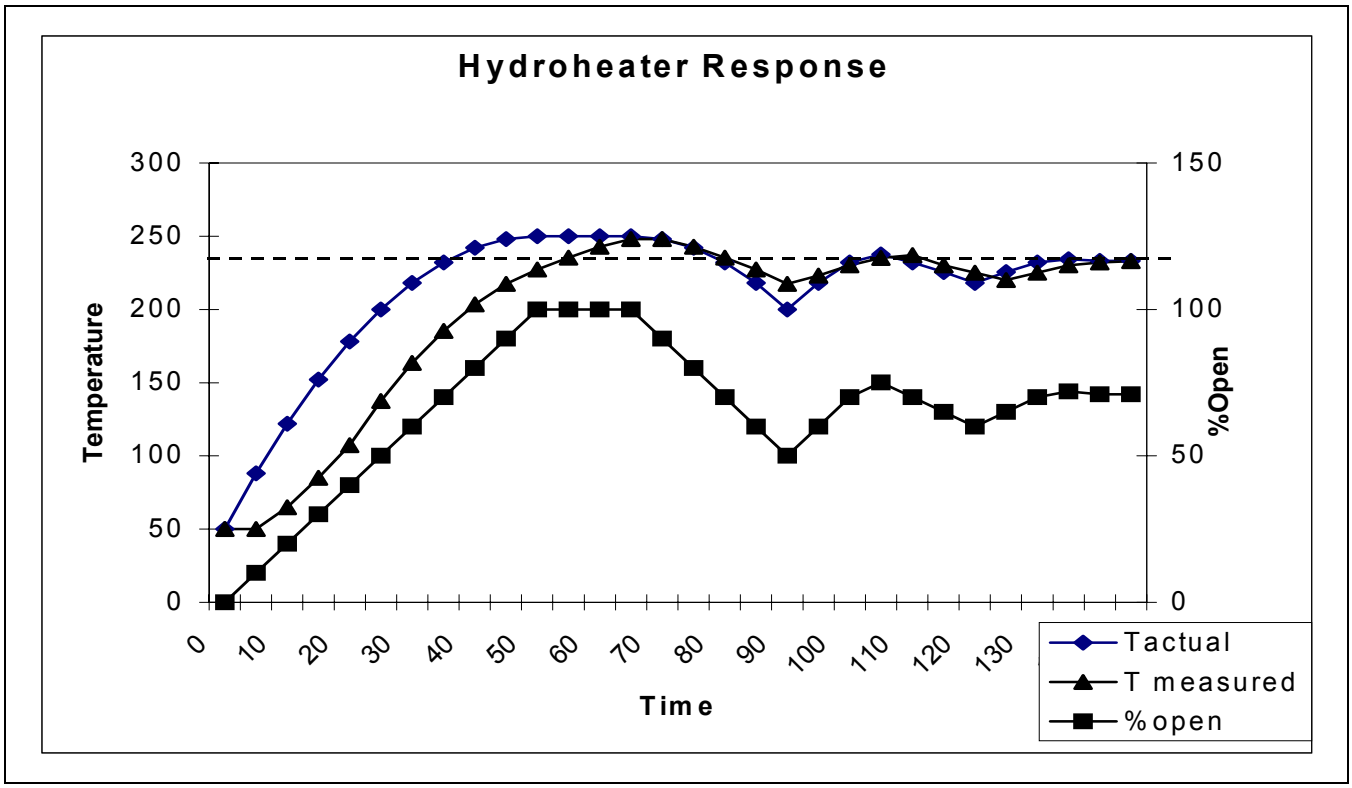


Figure 2 Typical Hydroheater response profile

Temperature Controller: A 2 mode (Proportional/Integral) or 3 mode (Proportional/Integral/Derivative) controller is recommended for most applications. A single mode (proportional only) controller may be used; however, in very stable systems with small flow rate or temperature variations.

Overshoot Protection: To minimize the chance of overshoot or flashing in the discharge piping upon Hydroheater startup, an interlock should be provided to close both the Hydroheater actuator and the upstream steam block valve if there is no liquid flow through the Hydroheater. Depending upon system control complexity, this may take several forms.

A 3-way, bleed to atmosphere solenoid air valve may be installed on the air supply line to the actuator, allowing air to the actuator only if liquid is flowing through the Hydroheater. This "permit to run" signal may come from a flow switch on the liquid inlet, a Programmable Logic Controller, or a simple switch.

Note: It is very important that the Hydroheater control system be designed to ramp the Hydroheater to setpoint from a fully closed position upon startup.

3.4.2.2 Continuous Operation

A continuous process is designed to operate with liquid flowing through the Hydroheater at all times (with the exception of scheduled, periodic downtime for maintenance, etc). The important requirement for this type of system is that the down periods are infrequent enough that the system may be shut down manually. The instrumentation needs of a continuous system are generally the simplest, with the only automated device necessary being the Hydroheater. During system operation, flow rates of both liquid and steam may vary, but the process is essentially continuous.

The variance in flow of steam or liquid is called the system turndown. Turndown is defined as a ratio of the maximum and minimum flow rates for steam or liquid.

Example 1: A system with a maximum liquid flow of 600 GPM and a minimum flow of 200 GPM will have a liquid turndown of 600/200 = 3:1.

Steam turndown may be a function of both liquid turndown and a variance in discharge temperature.

Example 2: The system in Example 1 uses a Hydroheater to raise the temperature of river water to 120° F. In the winter, the river water is 40°F, so the Hydroheater raises the river water 80°F. In the summer the river water is 80°F so the Hydroheater is only required to raise the water temperature 40°F. This results in a steam turndown at any given flow rate of 2:1. Because the system flow also has a turndown ratio of 3:1, the total steam turndown for the system is 6:1.

Generally continuous systems with steam and liquid turndown ratios less than 2:1 requires only simple control schemes. As the ratios increase, typically so does the need for more sophisticated instrumentation.

3.4.2.3 Intermittent Operation

An intermittent process is one in which the liquid or steam flow is frequently interrupted as part of the normal operation. Intermittent processes are the most demanding applications for any automated system due to the difficulty of maintaining stable operation during startup and shutdown where the processes generally experience the widest swings in process variables. When the Hydroheater is included in an intermittent application, the following guidelines should be followed to ensure a successful application.

3.4.2.3.1 Intermittent/Attended Operation

The equipment specified in the installation section of this manual, (Section 3.3.2), should be considered the minimum equipment necessary to operate an Automatic Hydroheater in an intermittent process.

If the intermittent process is automated in any way the following is recommended:

1. A safety interlock should be installed between the liquid and steam block valves to insure that the steam block valve is not able to be opened unless liquid is flowing through the Hydroheater.

2. A 3-way bleed to atmosphere solenoid valve should be installed in the air piping to the Hydroheater actuator so that the actuator will close at the same time (or preferably before) the steam valve is closed.

The equipment and procedures described above will allow the Hydroheater to operate intermittently provided there is a trained operator present to monitor the heater operation.

3.4.2.3.2 Unattended operation

In order to safely and reliably operate the Hydroheater in an unattended mode, the following components are necessary in addition to the above mentioned items.

A flow sensing device (flow switch, pressure switch, flow meter, etc.) should be employed to verify flow in the liquid line before the steam block valve and Hydroheater can be opened.

If the Hydroheater is part of a temperature control loop with either a pneumatic or electronic controller, a provision should be made to drive the output of the controller to 0% so that reset windup problems are eliminated during times of shutdown.(See section 3.4.2.1)
Note: This procedure replaces #1 above.

Example: An automatic Hydroheater is controlled by a pneumatic controller receiving temperature feedback from a filled capillary tube. During periods of shutdown, the controller would receive a low temperature signal from the temperature sensor and would raise its output to the Hydroheater to 100% in an attempt to attain setpoint. Since there would be no steam present, the controller would remain in this saturated position until the process was restarted. Depending on the operating conditions at the time of startup (i.e. flow rate, inlet temp. etc) the potential exists for overheating the liquid, possibly above the boiling point of the liquid. This in turn could cause steam hammer to occur with the danger of injury to equipment or personnel.

This situation can be avoided as follows:

A. **Electronic Controller** - These controllers can typically be either programmed or set up to respond as described above. Typically, a switch or jumper is set to toggle the controller output or setpoint during down periods to force the Hydroheater steam stem closed. Regardless of the method chosen, controller output should be driven to 0% during periods of shutdown.

B. **Pneumatic Controller** - Incorporate a remote or secondary setpoint that would be activated during periods of shutdown. This setpoint would be lower than the shutdown conditions the temperature sensor would see. Thus, when the system was restarted, the controller would cause the Hydroheater to reach setpoint by opening from the fully closed position rather than closing down from the fully open position. This represents a much safer, more reliable method to restart the temperature loop.

3.5 Special Installation Requirements for Operating Temperatures Above 212°F (100°C)

3.5.1 Back Pressure Valve

A back pressure valve is required to prevent flashing on all high temperature liquid heating applications. This valve should be located in the Hydroheater discharge piping as close as possible to flashing area. The actual back pressure setting should be at least 5 psi above the saturation pressure of the heated liquid at the Hydroheater discharge temperature.

3.5.2 Pressure Gauges

In addition to the supply line gauges, high temperature applications require a pressure gauge installed upstream of the back pressure valve. It is necessary to read these pressures in order to properly adjust the heating system.

3.6 Suggested Optional Accessories

3.6.1 Steam Strainers

In keeping with good piping practice, install a steam strainer in the supply line to prevent any rust or scale from entering the Hydroheater and downstream piping.

3.6.2 Steam Trap

Install a trap in the steam supply line close to the Hydroheater to remove any condensate before it can cause noise and vibration in the Hydroheater.

4 Operation

4.1 Prestart Checklist

Prior to initial operation or restart after extended shutdown:

- Check that both liquid and fluid supply pressures are within original Hydroheater design specifications.
- If desired discharge temperature is to be above 212°F (100°C) use steam tables to find minimum necessary Hydroheater discharge pressure required to prevent flashing of liquid in discharge piping.
- Verify air supply to Hydroheater actuator. For heaters with a positioner, ensure supply air exceeds minimum requirements.
- Crack manual steam shutoff valve on steam inlet line, and purge condensate through steam blow down valve.
- Verify Hydroheater valve stem is closed.
- Verify all system components are in proper working order.

4.2 Operation

4.2.1 Actuators

Automatic Hydroheaters are supplied with air diaphragm or cylinder type steam flow adjustment. On most applications, the control signal is 3 to 15 psig (0.2 to 1.0 bar). Maximum steam flow occurs at 15 psig (1.0 bar), while flow is zero at 3 psig (0.2 bar). In the event of control signal failure, the spring-opposed actuator automatically closes. Actuators with other pneumatic control signal range, as well as electronic and electro-pneumatic actuators, are also used. For electronic controllers, the signal range of 4-20 mA represents 0-100% of actuator travel.

4.2.2 Before Starting

CAUTION

In high temperature applications (above 212°F - 100°C), the back pressure required to prevent flashing should be at least 5 psig (0.3 bar) higher than the saturation pressure given in the Steam Tables in Appendix A. Both the steam and the liquid supply pressures must be constant for the heating systems to operate with a uniform discharge temperature.

Be sure the steam and liquid supply line valves are fully closed. The position of the combining tube is factory-set to 50% open, unless stated otherwise on the Equipment Specifications sheet included in this manual. Aligning one of the multiple marks scribed on the sliding block with the fixed mark on the heater body indicates the position of the combining tube; the mark on the sliding block closest to the discharge connection indicates the fully closed position of the combining tube, the mark closest to the steam inlet connection indicates its fully open position, and the mark in the middle indicates 50% open.

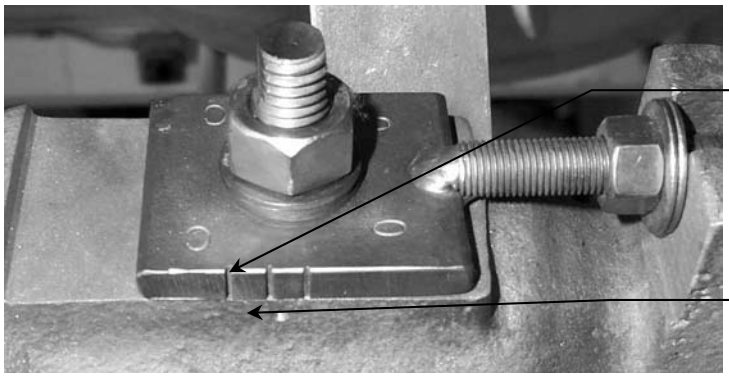


Figure 3 Combining Tube adjustment marks

4.2.3 Initial Startup

1. In high temperature applications (above 212°F -100°C), set the downstream back pressure valve about 50% open.
2. Open the liquid supply valve to its fully open position, or start the pump.
3. Adjust supply pump speed or set the centrifugal pump throttling valve to obtain the desired flow rate.

CAUTION

The combining tube position in high temperature applications (above 212°F, 100°C) is adjusted only if necessary for smooth, stable operation. The liquid flow rate must be set upstream of the Hydroheater by adjusting the supply pump speed or positioning a throttling type valve on the discharge side of the centrifugal pump. Steps 4,5 and 6 do not apply to high temperature applications.

4. To increase liquid flow, loosen the yoke locknut furthest from the discharge connection and tighten the other yoke locknut to move the combining tube toward the discharge connection (see Figure 4).

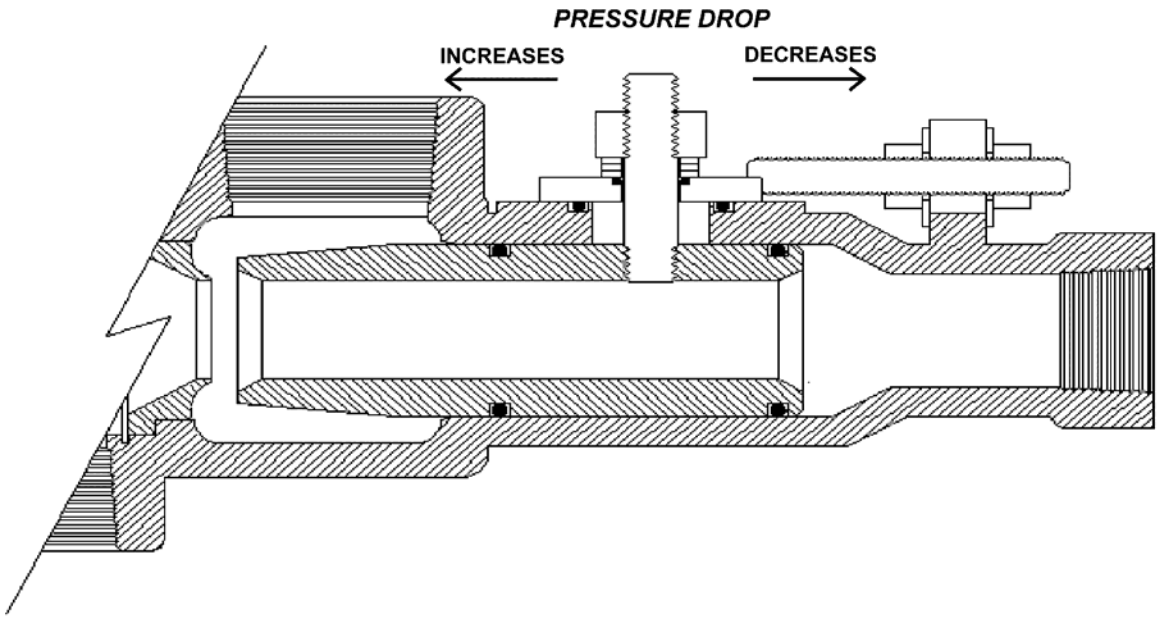


Figure 4 Combining Tube adjustment

5. To decrease liquid flow, loosen the yoke locknut closet to the discharge connection and tighten the other yoke locknut to move the combining tube away from the discharge connection.

6. If the combining tube does not move in the desired direction without forcing it, leave the yoke locknuts loose and loosen the combining tube stud by holding it with one wrench while loosening its nut with another wrench, only enough so that the combining tube moves freely. Now, increase or decrease liquid flow as described in step 2 or 3 above. Then, tighten both yoke locknuts to secure the combining tube position and re-tighten the stud nut to reseal the sliding block against the body.

7. Adjust the back pressure valve until the required back pressure is indicated on the back pressure gauge (see CAUTION under Before Starting above).

8. Open the steam line valve to its fully position. Blow down piping.

9. SLOWLY raise the temperature controller set point until the desired discharge temperature is reached.

NOTE
In high temperature applications (above 212°F, 100°C), if the operation of the Hydroheater is not smooth and stable it may be necessary to adjust the combining tube in small increments toward the actuator (see section 4.2.3 and step 5 above).

4.2.4 Shutdown

CAUTION
On slurry applications, flush out the Hydroheater and downstream piping with hot water at the end of each cycle.

Lower the temperature controller set point to the bottom of its range and close the steam supply line valve. Leave the combining tube position unchanged. Close the liquid supply line valve.

4.2.5 Subsequent Startup

Open the liquid supply line valve and the steam supply line valve to their fully open positions. Adjust the temperature controller for the desired discharge temperature. If operating conditions are not the same as before, adjustments may be required to re-establish optimum operation.

5 Trouble Shooting

5.1 Trouble, Probable Causes and Suggested Remedies

NOTE
Please refer to INSTALLATION for recommendations and piping diagram, if necessary.

5.1.1 No Liquid Flowing

1. Make certain the liquid supply line valves are fully open and any automatic valves are adjusted for the required flow.
2. Make certain the liquid supply pump is running and delivering liquid to the Hydroheater with sufficient pressure to provide flow through the Hydroheater to the point of use.
3. Check the position of the Hydroheater combining tube (as indicated by the alignment of one of the marks on the sliding block with the mark on the heater body). It should be open enough (usually 50%) to allow the required liquid flow rate. If necessary, adjust it according to the procedures in OPERATION, section 4.2.3, steps 4,5 and 6.
4. Remove any liquid flow restrictions downstream of the Hydroheater.
5. Make sure check valves are oriented properly.

5.1.2 No Steam Flowing

1. Check to ensure that the upstream supply line valve is fully open.
2. Raise the setpoint of the temperature controller to open the Hydroheater steam stem to allow steam to flow.

CAUTION!
Make sure liquid flow is established before opening Hydroheater steam stem.

3. Blow out the steam strainer (if one is installed) upstream of the Hydroheater.
4. Make certain the steam supply line check valve is open.
5. Visually verify Hydroheater stem position using scale on actuator yoke.

5.1.3 Rough Operation

1. Condensate not purged out of the steam supply line to the Hydroheater. Remove the condensate by slowly purging it out through the Hydroheater. Plan to install a steam trap or a drop leg with a shut-off valve.
2. The liquid flow rate is too low for the amount of steam flowing. Check the temperature controller (and the positioner if one is being used).
3. The liquid flow rate may be too low for the size Hydroheater being used. Check the Equipment Specifications sheet included in this manual for the correct flow rate range.
4. The liquid flow rate, liquid temperature, and/or steam pressure vary too rapidly for the temperature controller to maintain smooth, stable operation.

5. The liquid supply pressure is not enough to prevent flashing in the Hydroheater and the piping system. This occurs at operating temperatures above 212°F (100°C). Check the Steam Tables in Appendix A for the pressure required and reset back pressure valve if necessary.

6. Back pressure is not set high enough for the discharge temperature. Refer to the Steam Tables in Appendix A for the proper back pressure.

7. Temperature sensor is too far from Hydroheater. Refer to INSTALLATION, section 3.3.2.3 for guidelines on properly installing temperature sensor.

NOTE:
If following the procedures recommended in step 1 through 7 above does not eliminate rough operation, the combining tube may require adjustment; refer to the adjustment procedures in OPERATION, section 4.2 steps 4,5 and 6.

5.1.4 Noise Vibration

1. The liquid pressure is not sufficient to prevent flashing or two phase flow at the liquid discharge temperature. This condition usually occurs above 212°F (100°C). It can also occur at lower temperature if there is a vacuum in the discharge piping.

2. The liquid flow is turned off very rapidly, but the steam flow is not turned off at all, or is turned off much more slowly than the liquid flow.

3. The liquid pressure in the Hydroheater discharge piping exceeds the recommended limit SAFETY PRECAUTIONS, section 2.2.

4. Excessive condensate in the steam supply. This generally occurs only at startup or if steam trap is undersized.

5. Dissolved air or other gasses in the liquid vaporize (or small bubbles become much larger) when the liquid is heated. These bubbles implode against the walls of both the combining tube and the discharge pipe. Install air eliminator to remove gases in liquid.

6. Rapid liquid flow changes cause excessive swings in the discharge temperature that are not corrected fast enough by steam flow modulation. Check tuning of control loop.

7. Hydroheater plug is barely open. Heater trim may need to be downsized to meet new operating conditions.

6 Maintenance

6.1 Periodic Service

6.1.1 Lubrication

Using a standard grease gun, lubricate the seal and steam cavity of all series "K" and "M" Hydroheaters which have a grease fitting in the head. Apply a moderate amount of high temperature grease. For food industry applications use only FDA approved grease.

NOTE
Current series "K" Hydroheaters do not require lubrication and do not have grease fittings. Current series "M" Hydroheater built with optional packing do not require lubrication and do not have grease fittings.

For continuous service applications, lubricate at least once a week. For intermittent service applications, lubricate every three or four weeks.

CAUTION
Applying excessive grease could ruin BAL SEALS.

RECOMMENDED GREASES

Loctite Super Lube - #82328
Loctite Viper Lube (for incidental food contact) - #36782

CAUTION
Ensure that any grease used is acceptable for the intended use temperature. Contact Hydro-Thermal Corporation technical service for assistance if necessary.

6.1.2 Anti-Seize Compounds

Anti-seize compounds should be liberally applied to all threaded components of Hydroheaters when they are reassembled after parts replacement. This is particularly critical in models M103-M110 and K410 with threaded heads.

RECOMMENDED ANTI-SEIZE COMPOUND

Loctite Nickel Anti Seize - #77124

6.2 Disassembly and Re-Assembly of Series M103 Through M110 Hydroheaters for Parts Replacement (See Figure 10)

6.2.1 Remove Head Assembly

Use wrench to unscrew the head (2) from the body (1). Be careful not to damage the grease fitting (13) (no grease fitting is used on models with optional packing). Remove the head with the actuator attached, thereby eliminating the necessity of recalibrating the actuator (unless the actuator must be removed for replacement of the seals and/or the steam stem). The steam stem (3) will also remain in the head and attached to the actuator, as the head and actuator assembly are removed. The head o-ring (21) should remain with the head.

CAUTION

Do not mar or score the steam stem while handling the assembly of the head, actuator, and stem.

6.2.2 Remove Actuator (If Required for Seals and/or Steam Stem Replacement)

If the Hydroheater is equipped with a pneumatic positioner and filter/regulator, they are attached to the actuator body and connected to the steam stem clamp (not shown). To remove the actuator, proceed as follows:

1. Disconnect the positioner linkage from the steam stem clamp. Remove the two stem bolts that hold the two steam stem clamp halves together and remove the clamp. Remove the travel indicator from the steam stem (3).

2. Unscrew the actuator and the actuator locknut (8) from the head (2).

3. Remove the actuator from the head; the pneumatic positioner and filter regulator will come off as part of the actuator assembly.

6.2.3 Remove Steam Stem (If Replacement is Required and/or Seals are Being Replaced)

Measure and record the position of the steam stem nut and lock-nut from the end of the stem - this dimension will be used during re-assembly. Remove the stem nut and lock-nut. Remove the steam stem (3) carefully from the head to avoid damaging the seals (24).

NOTE

Previous models did not use packing (11) in the actuator side of the head; it's optional on current models.

6.2.4 Remove and Install Seals and Packing (When Steam Stem Is Removed)

Replace seals and packing (optional) as follows:

1. To remove the seals , first remove the retaining ring (23) with a snap ring pliers. Remove the seals (24) using a small hooked tool.

CAUTION

The spring sides of the seals must face toward the pressurized cavity to seal properly.

2. Coat tip and outer surface of seals lightly with light grease and insert them into the body carefully to avoid damage; make sure they are seated properly. The seals will not seal properly unless the bore surfaces inside the head are perfectly smooth. Replace the retaining ring (28).

CAUTION
When replacing packing, the steam stem must be clean and free of nicks, burrs and scratches. A 16-20 Ra finish is required. If the steam stem is pitted, coat it lightly with Chesterton Nickel Anti-Seize or equivalent.

3. In current models equipped with packing, remove the cap screws (31) and lock washers (30), and the packing follower (29); then use a small hooked tool to remove the packing (27,28). Make sure no pieces of packing nor any foreign material remain in the counter bore in the head.

4. The packing consists of five rings, one rope type fiber graphite ring on each end, and three die formed graphite tape packing rings in the middle. See Figure 7. Install the rings one at a time with their joints staggered 90° apart. Seat each ring individually using a tamping tool, a hollow cylinder, or the packing follower. Each ring must be individually seated so the packing follower will be able to tighten the entire set of five. Replace the packing follower (29) and install the cap screws (31) and lock washers (30) finger tight.

6.2.5 Install Steam Stem

Install the steam stem (3) (coat lightly with light grease) in the head (2), being very careful not to damage or score the seals (24). Thread on the steam nut and locknut (6) until they are in the same location they were before removal (same distance from the end of the stem).

6.2.6 Remove Nozzle

1. Remove the nozzle retaining ring (27) using a snap ring pliers. The retaining ring fits fairly tight in its groove and may take some prying to remove.

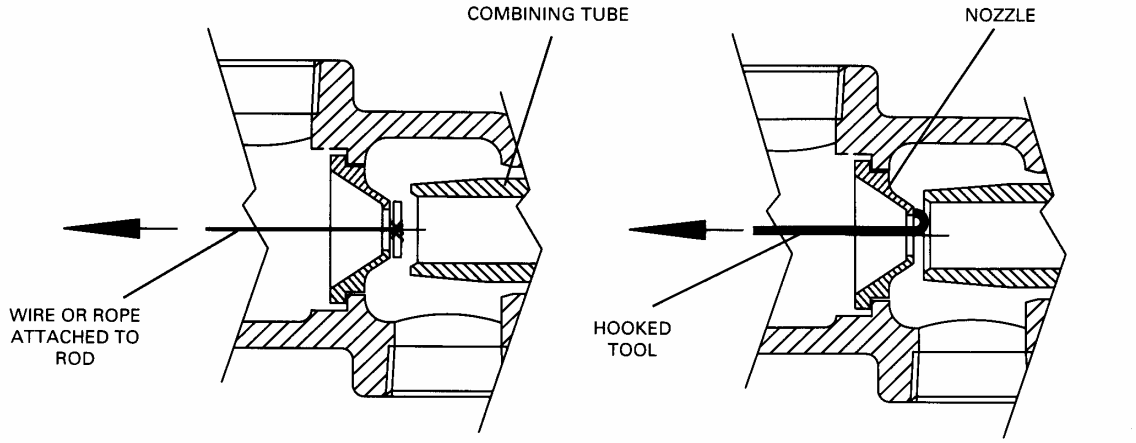


Figure 5 Nozzle Removal techniques

2. Use a small hooked tool to remove the nozzle (26) from the body (1). Because the nozzle and the body are machined for a close fit, the nozzle may not come out easily, particularly if cocked. If the nozzle resists, use the combining tube (24) to push it out as follows:

a. Match mark the sliding block (17) and the body (1) to allow reassembly with the combining tube in the same operating position.
b. Loosen the combining tube stud nut (18).
c. Loosen the yoke locknut (22) closest to the discharge connection.

d. Tighten the other yoke locknut, (also 22), against the slotted boss which is part of the body casting. Tightening this locknut against the boss, which now acts as a stop-block, will force the sliding block (17) and the stud (20) to move away from the discharge connection. Since the stud is threaded into the combining tube (24), the combining tube will also move away from the discharge connection toward the nozzle.

e. Continue alternately loosening and tightening the two yoke locknuts until the combining tube dislodges the nozzle from the body.

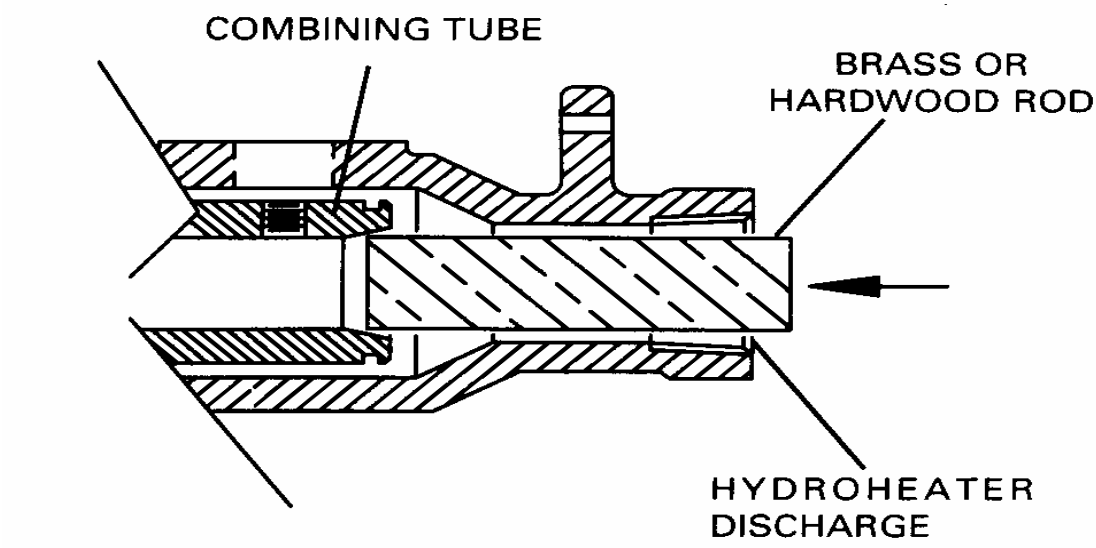


Figure 6 Combining tube removal

6.2.7 Remove Combining Tube

1. Remove the combining tube stud nut (18) and the flat washer (19).

NOTE
If the operating position of the combining tube was not match-marked as stated in step 2.a above, match mark it now.

2. Loosen both the yoke locknuts (22), and remove the sliding block (17), along with yoke locknuts, the washers (23), and the stud o-ring (21). Lift off the sliding block o-ring (16).

3. Unscrew the stud (20) from the combining tube using a wrench on the flats of the stud.

NOTE
If the Hydroheater has been removed from the system, it can be tapped gently against wood until the combining tube is dislodged. If this is not effective, the combining tube must be pushed out.

4. If the Hydroheater has not been removed from the system, disconnect the discharge pipe so a blunt push rod can be used to push the combining tube out the head end of the body. The combining tube may be difficult because of the close fit between it and the body, and the two o-rings (25). Also, depending upon what type of liquid (such as a slurry) has been pumped, the combining tube could be "frozen" in position.

CAUTION
Care must be taken not to damage any parts while pressing or hammering to free the combining tube. If a push rod is used, it should be either hardwood or soft brass.

6.2.8 Install Combining Tube

CAUTION
Examine o-rings (16,21, and 25) for cuts, nicks, and elasticity before installing them. Replace if damaged or hardened.

1. Install the combining tube o-rings (25) on the combining tube (24). They should be coated liberally with light, non petroleum based, grease.

2. Coat the outside of the entire combining tube liberally with light grease and slide it into the body (1) with the non-tapered (squared-off) end of the tube facing the discharge connection. Be very careful to align the combining tube properly with the body. The fit is snug because of the close tolerance. The first o-ring will also cause additional drag as the combining tube is inserted into the body. Be sure that the threaded hole in the combining tube is facing "up" toward the slotted hole in the body.

CAUTION
Care must be taken not damage any parts while inserting the combining tube. If a push rod is used, it should be either hardwood or soft brass.

3. Slide the combining tube into the body until the threaded hole in the combining tube appears in the slotted hole in the body.

4. Line up the combining tube carefully with the slot in the body, and using a wrench on the flats of the combining tube stud (20), thread it into the combining tube until tight.

5. Place the sliding block o-ring (16) in position in the groove on the body.

6. Install the sliding block (17) onto the stud (20) with the stamped letters and the counter-bore facing up. There must be one yoke locknut and washer on either side of the slotted boss on the body.

7. Install the stud o-ring (21) over the stud (20) and into the counter-bore in the sliding block (17).

8. Install the flat washer (19) and the nut (18). Tighten the nut "finger-tight" only.

6.2.9 Adjust Position of Combining Tube

1. Align the match marks added during disassembly on the sliding block (17) and the body (1) as follows:

   a. Tighten the yoke locknut (22) closest to the discharge connection against the slotted boss to move the combining tube TOWARD the discharge end. This moves the combining tube toward its fully open position.

   b. Tighten the yoke locknut (also 22) closest to the steam connection against the slotted boss to move the combining tube AWAY FROM the discharge connection. This moves the combining tube toward its fully closed position.

2. Tighten the combining tube stud nut (18) and the yoke locknuts (22) to lock the combining tube in the match-marked position it was in prior to its removal.

6.2.10 Install Nozzle

1. Insert the nozzle (26) into the body (1). Press or tap the nozzle until it is seated firmly in the body. The fit between the nozzle and the body will be very snug because of the close tolerance.

CAUTION
Care must be taken not to damage any parts while pressing or tapping the nozzle to seat it firmly. If a push rod is used, it should be either hardwood or soft brass.

2. Install the nozzle retaining ring (27) using a snap ring pliers.

6.2.11 Install Head Assembly

CAUTION
Examine head o-ring (21) for cuts, nicks, and loss of elasticity. Replace if damaged or hardened.

Install the o-ring in the groove in the head (2). Apply anti-seize compound (see section 6.1.2) to the head threads, and use a wrench to screw the head (2) (with the steam stem installed, and the actuator if it was not removed) into the body (1), being careful not to damage the grease fitting (13) (no grease fitting is used on models with optional packing). Tighten the head until snug and then one-half flat (30°) more. Push against the threaded end of the steam stem (if the actuator was removed) to be sure the plug end is up against the nozzle (26) in fully closed position.

CAUTION
Do not mar or score the steam stem while handling the head and stem assembly.

6.2.12 Refill Seal and Stem Cavity with Grease (If Applicable)

If your Hydroheater does not use the optional packing (11) in the actuator side of the head (2), there is a grease fitting (13) in the head. Use a standard grease gun to refill the seal and steam stem cavity through the grease fitting. Apply a liberal amount of high temperature grease, being careful not to over-pressurize the grease cavity (see section 6.1.1 for recommended grease).

NOTE
Current Hydroheaters which use the optional packing in the actuator side of the head do not have a grease fitting because they do not require lubrication.

6.2.13 Install Actuator

Attach the actuator (1) (if it was removed for seals and/or steam stem replacement) to the head (2) by screwing the actuator (7) on the threaded end of the head; leave the locknut about 1/4 turn loose. Place the travel indicator (4) over the end of the steam stem and up against the stem nut (6). Attach the actuator stem clamp (2) to the actuator stem and the steam stem (3). Attach the positioner linkage (if the unit is so equipped) and snug up the stem clamp bolts (3). Tighten the stem nut tight against the travel indicator; continue turning (the entire stem will turn) until resistance is felt, indicating that the steam stem is firmly seated against the nozzle (26). Tighten the stem locknut. Tighten the actuator locknut (8) the last 1/4 turn. Tighten the actuator stem clamp bolts (3).

6.2.14 Check Actuator Operation (for 3-15 psig Temperature Controller Signal)

Apply air pressure to the actuator. If the actuator stem moves with less than 3 psig applied air pressure, see the Fisher Instructions for calibration.

6.2.15 Tighten Packing (After Replacement)

After start-up, alternately tighten the packing follower screws (8) 60° until acceptable controlled leakage is obtained.

6.2.16 Remove and Install Packing (When Steam Stem IS NOT Removed)

Packing (11) can be replaced, if necessary due to steam leakage, without disassembling the Hydroheater and without removing the air actuator (1). Proceed as follows:

NOTE
In current Hydroheaters which are equipped with the optional packing, the seals (24) function as wipers and do not have to be replaced when the packing is replaced (without disassembling the Hydroheater) due to steam leakage.

1. Remove the two cap screws (8) and lock washers (9) and carefully slide the packing follower (10) up the steam stem (away from the head). If the Hydroheater is mounted upright, use a twist tie to prevent the packing follower from sliding down the steam stem.

2. Use a small hooked tool to remove the packing (11). Make sure no pieces of packing nor any foreign material remain in the counter bore in the head.

CAUTION
When replacing the packing, the steam stem must be clean and free of nicks, burrs, and scratches. A 16-20 Ra finish is required. If the steam stem is pitted, coat it lightly with Chesterton Nickel Anti-Seize, or equivalent.

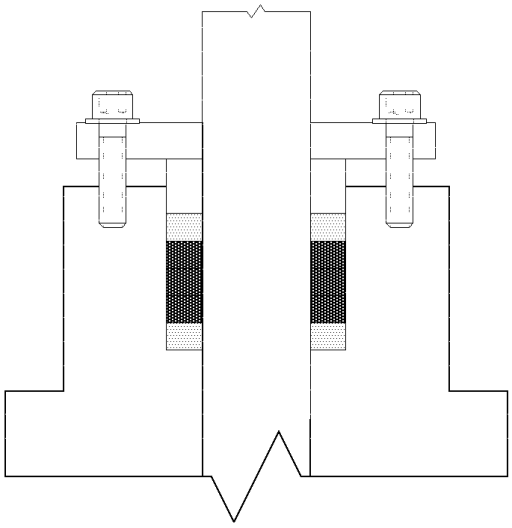


Figure 7 Packing arrangement

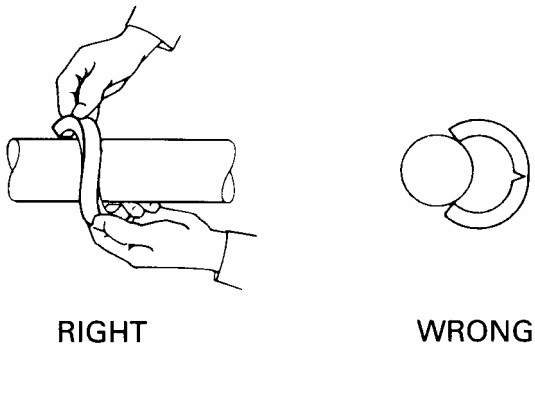


Figure 8 Proper packing installation

3. The packing consists of five rings, one rope type fiber graphite ring on each end and three die formed graphite tape packing rings in the middle. Install the rings one at a time with their joints staggered 90° apart. Rope type fiber graphite rings can be wrapped around the stem; die formed graphite tape rings must be installed by twisting them open and placing them over the stem (see Figure 8). Seat each ring individually using either a tamping tool, or a split hollow cylinder, or the packing follower. Each ring must be individually seated so the packing follower will be able to tighten the entire set of five.

CAUTION
Never mix different ring segments or half rings (rings installed as two halves.)

4. Replace the packing follower (10) in the head (2) and install the two cap screws (8) and lock washers (9) snugly. After start-up, alternately tighten the packing follower screws 60° until acceptable controlled leakage is obtained.

6.3 Disassembly and Re-Assembly of K410, K411, K412 Hydroheaters for Parts Replacement (See Figure 11)

6.3.1 Remove Head Assembly

Remove the 10 hex nuts (25) which attach the head (2) to the body (1) of Series K410 and K412 Hydroheaters. Remove the head with the actuator attached, thereby eliminating the necessity of recalibrating the actuator (unless the actuator must be removed for replacement of the seals and for the steam stem). The steam stem (5) will also remain in the head and attached to the actuator, as head and actuator are removed. The head o-ring should remain with the head.

CAUTION

Do not mar or score the steam stem while handling the assembly of the head, actuator, and stem.

6.3.2 Remove Actuator (If Required for Seals and/or Steam Stem Replacement)

If the Hydroheater is equipped with a pneumatic positioner and filter/regulator, they are attached to the actuator body and connected to the steam stem clamp (not illustrated). To remove the actuator, proceed as follows:

1. Disconnect the positioner linkage from the steam stem clamp. Remove the two bolts holding the two steam stem clamp halves together and remove the clamp. Remove the travel indicator from the steam stem.

2. Unscrew the packing gland nut (23) and the actuator locknut (9) from the head (2).

3. Remove the Fisher actuator (27) from the head; the pneumatic positioner and filter regulator will come off as part of the actuator assembly.

6.3.3 Remove Steam Stem (If Replacement is Required and or Seals are Being Replaced)

Measure and record the position of the steam stem nut and locknut (not illustrated) from the end of the stem this dimension will be used during reassembly. Remove the stem nut and locknut. Remove the steam stem (5) carefully from the head (2) to avoid damaging the seals (20).

6.3.4 Remove and Install Seals and Packing (When Steam Stem Is Removed)

Replace seals and packing as follows:

1. To remove the seals, first remove the retaining ring (17) with a snap ring pliers. Remove seals (20) using a small hooked tool.

CAUTION

The spring side of the seals must face toward the pressurized cavity properly.

2. Coat the lip and outer surface of seals with light grease and insert them into the body carefully to avoid damage. Make sure they are seated properly. The seals will not seal properly unless the bore surfaces inside the head are perfectly smooth. Replace the retaining ring (17).

CAUTION

When replacing the packing, the steam stem must be clean and free of nicks, burrs, and scratches. A 16-20 Ra finish is required. If the steam stem is pitted, coat lightly with Chesterton Nickel Anti-Seize, or equivalent.

3. Remove the packing gland (24), and then remove the packing (10,11).

CAUTION
Make sure neither pieces of packing nor any foreign material remain in the counterbore in the head.

4. The packing consists of five rings, one rope type fiber graphite ring on each end, and three die formed graphite tape packing rings in the middle. Install the rings one at a time with their joints staggered 90° apart. Seat each ring individually using a tamping tool, a hollow cylinder, or the packing follower. Each ring must be individually seated so the packing follower will be able to tighten the entire set of five. Replace the packing gland (24).

CAUTION
Never mix different ring segments or half rings (rings installed as two halves).

6.3.5 Install Steam Stem

Install the steam stem (5) (coat lightly with light grease) in the head (2), being very careful not to damage or score the seals (20). Thread on the steam stem nut and locknut (not illustrated) until they are in the same location they were removed from (same distance from the end of the stem).

6.3.6 Remove Nozzle

1. Remove the nozzle retaining ring (18) using a snap ring pliers. The retaining ring fits fairly tight in its groove and may take some prying to remove.

2. Use a small hooked tool to pull the nozzle (4) from the body (1). Because the nozzle and body are machined for a close fit, the nozzle may not come out easily, particularly if cocked. If the nozzle resists removal, use the combining tube (3) to push it out using a soft metal rod through the discharge connection.

6.3.7 Remove Combining Tube

1. Remove the combining tube stud nut (26) and the flat washer (21).

NOTE
If the operating position of the combining tube was not match-marked as stated in step 2.a above, match-mark it now.

2. Loosen both the yoke locknuts (16), and remove the sliding block (6), along with the yoke locknuts, the washers (7), and the stud o-ring (15). Lift off the sliding block o-ring (14).

3. Unscrew the stud (8) from the combining tube using a wrench on the flats of the stud.

NOTE
If the Hydroheater has been removed from the system, it can be tapped gently against wood until the combining tube is dislodged. If this is not effective, the combining tube must be pushed out.

4. If the Hydroheater has not been removed from the system, disconnect the discharge pipe so a blunt push rod can be used to push the combining tube out of the head end of the body. The combining tube may be difficult to dislodge because of the close fit between it and the body, and the two o-rings (13). Also, depending upon what type of liquid (such as a slurry) has been pumped, the combining tube could be "frozen" in position.

CAUTION
Care must be taken not to damage any parts while pressing or hammering to free the combining tube. If a push rod is used, it should be either hardwood or soft brass.

6.3.8 Install Combining Tube

CAUTION
Examine o-rings (13, 14, and 15) for cuts, nicks, and elasticity before installing them. Replace if damaged or hardened.

1. Install the combining tube o-ring (13) on the combining tube (3). They should be coated liberally with light grease.

2. Coat outside of entire combining tube liberally with light grease and slide it into the body with the non-tapered (squared-off) end of the tube facing the discharge connection. Be very careful to align the combining tube properly with the body. The fit is snug because of the close tolerances. The first O-Ring will also cause additional drag as the combining tube is inserted into the body. Be sure that the threaded hole in the combining is facing "up" toward the slotted hole in the body.

CAUTION
Care must be taken not to damage any parts while inserting the combining tube. If a push rod is used, it should be either hardwood or soft brass.

3. Slide the combining tube into the body until the threaded hole in the combining tube appears in the slotted hole in the body.

4. Line up the combining tube carefully with the slot in the body, and using a wrench on the flats of the combining tube stud. (8), threaded it into the combining tube until tight.

5. Place the sliding block o-ring (14) in the groove in the body.

6. Install sliding block (6) onto the stud (8) with the stamped letters and the counterbore facing up. There must be one yoke locknut and washer on either side of the slotted boss on the body.

7. Install the stud o-ring (15) over the stud (8) and into the counterbore in the sliding block (6).

8. Install the flat washer (21) and the nut (26). Tighten the nut "finger-tight" only.

6.3.9 Adjusting Position of Combining Tube

1. Align the match marks added during disassembly on the sliding block (6) and the body (1) as follows: (See section 6.2.6 for more detailed information)

   a. Tighten yoke locknut (16) closest to the discharge connection against the slotted boss to move the combining tube TOWARD the discharge end. This moves the combining tube toward the fully open position.
   b. Tighten yoke locknut (also 16) closest to the steam connection against the slotted boss to move the combining tube AWAY FROM the discharge connection. This moves the combining tube toward the fully closed position.

2. Tighten the combining tube stud nut (26) and yoke locknuts (16) to lock the combining tube in the match-marked position it was in prior to its removal.

6.3.10 Install Nozzle

1. Insert the nozzle into the body. Press or tap nozzle until it is seated firmly in body. The fit between the nozzle and the body will be very snug because of the close tolerances.

CAUTION
Care must be taken not to damage any parts while pressing or tapping the nozzle to seat it firmly. If a push rod is used, it should be either hardwood or soft brass.

2. Install the nozzle retaining ring (18) using a snap ring pliers.

6.3.11 Install Head Assembly

CAUTION
Examine head o-ring (12) for cuts, nicks, and loss of elasticity. Replace if damaged or hardened.

Install the o-ring in the groove in the head (2). If the heater is mounted vertically, it may be necessary to apply a viscous non-petroleum based material to the o-ring to hold it in the groove during assembly. Glycerin or silicone based grease is acceptable. Install the head (with the steam stem installed) over the studs (22). Replace the nuts (25) and tighten them. Push against the threaded end of the steam stem to be sure the plug end is up against the nozzle (4) in a fully closed position.

Note: Hydroheaters are sometimes equipped with special o-ring elastomers for corrosion or high temperature resistance. Material properties such as hardness, stretch, etc. may vary. Always replace o-rings with the identical o-ring number to insure proper sealing characteristics.

CAUTION
Do not mar or score the steam stem while handling the assembly of the head and the stem.

6.3.12 Install Actuator

Attach the actuator (27) (if it was removed for seals and/or steam stem replacement) to the head (2) by screwing the actuator locknut (9) onto the threaded end of the head; leave the locknut about 1/4 turn loose. Install the packing gland nut (23) after the locknut is installed; tighten the packing gland nut snugly. Place the travel indicator over the end of the steam stem and up against the stem nut. Attach the actuator stem clamp (not illustrated) to the actuator stem and the steam stem (5). Attach the positioner linkage (if unit is so equipped) and snug up the stem clamp bolts. Tighten the stem nut tight against the travel indicator; continue turning (the entire stem will turn) until resistance is felt indicating that the steam stem is firmly seated against the nozzle (4). Tighten the stem locknut. Tighten the actuator locknut (9) the last 1/4 turn. Tighten the actuator stem clamp bolts (not illustrated)

6.3.13 Check Actuator Operation (for 3-15 psi Temperature Controller Signal)

Apply air pressure to the actuator. If the actuator stem moves with less than 3 psi applied air pressure, see the actuator instructions for calibration procedures.

6.3.14 Tighten Packing

After start-up tighten the packing gland nut (23) in 60° increments until acceptable controlled leakage is obtained.

6.3.15 Remove and Install Packing (When Steam Stem IS NOT Removed)

Packing (10,11) can be replaced, if necessary due to steam leakage, without disassembling the Hydroheater and without removing the air actuator (27). Proceed as follows:

1. Unscrew the packing gland nut (23), withdraw the packing gland (24), and carefully slide them up the steam stem. If the Hydroheater is mounted upright, use a twist tie to prevent the packing follower from sliding down the steam stem.

2. Use a small hooked tool to remove the packing (10,11). Make sure no pieces of packing nor any foreign material remain in the counterbore in the head.

CAUTION!
When replacing the packing, the steam stem must be clean and free of nicks, burrs, and scratches. A 16-20 Ra finish or better is required. If the steam stem is pitted, coat it lightly with Chesterton Nickel Anti-Seize, or equivalent.

3. The packing consists of five rings, one rope type fiber graphite ring on each end and three die formed graphite tape packing rings in the middle. Install the rings one at a time with their joints staggered 90° apart. Rope type fiber graphite rings can be wrapped around the stem; die formed graphite tape rings must be installed by twisting them open and placing them over the stem (see Figure 8). Seat each ring individually using either a tamping tool, a split hollow cylinder, or the packing follower. Each ring must be individually seated so the packing follower will be able to tighten the entire set of five.

CAUTION!
Never mix different ring segments or half rings (rings installed as two halves).

4. Replace the packing gland (24) and the packing gland nut (23) snugly; after start-up, tighten the nut 60° in increments until acceptable controlled leakage is obtained.

6.4 Disassembly and Re-Assembly of Series K413, K414, K415, K416, and K417 Hydroheaters (See Figure 12)

6.4.1 Remove Head Assembly

NOTE
If your Hydroheater installation includes an actuator mounting bracket (38), remove the four screws (42) which attach it to the body of the Hydroheater so that the actuator and head assembly can be removed from the body.

Remove the hex nuts (25) which attach the head (2) to the body (1). Remove the head with the actuator attached, thereby eliminating the necessity of re-calibrating the actuator (unless the actuator must be removed for replacement of the BAL SEALs and/or the steam stem). The steam stem (5) will also remain in the head and attached to the actuator as the head and actuator assembly are removed. The head o-ring (12) should remain with the head.

CAUTION!
Do not mar or score the steam stem while handling the assembly of the head, actuator, and stem.

6.4.2 Remove Actuator (If required for seals and/or Steam Stem Replacement)

If the Hydroheater is equipped with a pneumatic positioner and filter/regulator, they are attached to the actuator body and connected to the steam stem clamp (not illustrated). To remove the actuator, proceed as follows:

1. Disconnect the positioner linkage from the steam stem clamp. Remove the two cap screws which hold the two steam stem clamp halves together and remove the clamp. Remove the travel indicator from the steam stem.

2. For series K413, K414, and K415 Hydroheaters, unscrew the actuator locknut (9) from the head (2); for series K416 and K417 Hydroheaters, remove the eight hex head cap screws (41) and lock washers (42) from the head (2).

3. Remove the actuator (27) from the head; the positioner and filter regulator will come off as part of the actuator assembly.

6.4.3 Remove Steam Stem (If Replacement is Required and/or Seals are Being Replaced)

Measure and record the position of the steam stem nut and locknut (not illustrated) from the end of the stem this dimension will be used during reassembly . Remove the stem nut and locknut. Remove the steam stem, (5) carefully from the head (2) to avoid damaging the seals (20).

6.4.4 Remove and Install Seals and Packing (When Steam Stem IS Removed)

Replace seals and packing as follows:

1. To remove the seals, first remove the retaining ring (17) with a snap ring pliers. Remove the seals (20) using a small hooked tool

CAUTION!
The spring sides of the seals must face toward the pressurized cavity to seal properly.

2. Coat lip and outer surface of seals with light grease and insert them into the body carefully to avoid damage; make sure they are seated properly. The seals will not seal properly unless the bore surfaces inside the head are perfectly smooth. Replace the retaining ring (17).

CAUTION!
When replacing the packing, the steam stem must be clean and free of nicks, burrs, and scratches. A 16-20 Ra finish is required. If the steam stem is pitted, coat it lightly with Chesterton Nickel Anti-Seize, or equivalent.

3. Remove the two cap screws (35) and lock washers (36), and the packing follower (37); then use a small hooked tool to remove the packing (11,12). Make sure no pieces of packing nor any foreign material remain in the counterbore in the head.

4. The packing consists of five rings, one rope type fiber graphite ring on each end, and three die formed graphite tape packing rings in the middle. Install the rings one at a time with their joints staggered 90° apart. Seat each ring individually using a tamping tool, a hollow cylinder, or the packing follower. Each ring must be individually seated so the packing follower will be able to tighten the entire set of five. Replace the packing follower (37) and install the two cap screws (35) and lock washers (36) finger tight. The packing follower will be tightened to prevent steam leakage after replacement of the steam stem and the head and the actuator.

CAUTION
Never mix different ring segments or half rings (rings installed as two halves).

6.4.5 Install Steam Stem

Install the steam stem (5) (coat lightly with light grease) in the head (2), being very careful not to damage or score the seals. Thread on the steam stem nut and locknut (not illustrated) until they are in the same location they were removed from (same distance from the end of the stem).

6.4.6 Remove Nozzle

1. Remove the nozzle spiral retaining ring (18) by using a screwdriver or similar prying tool. The ring has a removal notch (see Figure 9) which is used to free its end from its groove. When the end is free, use a punch, or similar thin tool, to unwind the rest of the ring from its groove by working it under the ring in a clockwise rotation.

2. Use a small hooked tool to remove the nozzle (4) from the body (1). Because the nozzle and the body are machined for a close fit, the nozzle may not come out easily, particularly if cocked. If the nozzle resists removal, use the combining tube (3) to push it out as follows:

a. Match mark the sliding block (6) and the body (1) to allow reassembly with the combining tube in the same operating position.

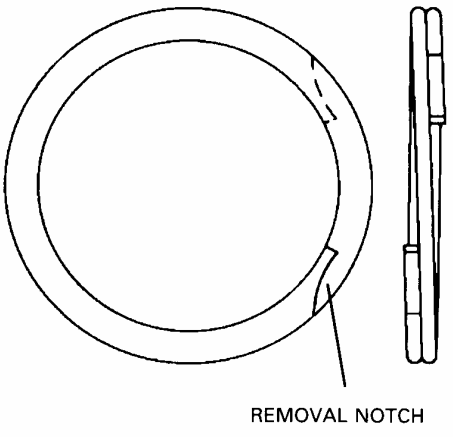


Figure 9 Spiral Retaining ring notch

NOTE
Series K413 Hydroheaters have their sliding block adjusting stud facing away from the discharge connection, rather than toward it as other series Hydroheaters do (see Figure 12). However, the combining tube adjusting procedure is the same for series K413 Hydroheaters as for the other models.

b. Loosen the yoke locknut (16) closest to the discharge connection.

c. Tighten the other yoke locknut, also (16), against the slotted boss, which is part of the body casting. Tightening this locknut against the boss, which now acts as a stop-block, will force the sliding block (6) and the stud (8) to move away from the discharge connection. Since the stud is threaded into the combining tube (3), the combining tube will also move away from the discharge connection toward the nozzle.

d. Continue alternately loosening and tightening the two yoke locknuts until the combining tube dislodges the nozzle from the body.

6.4.7 Remove Combining Tube

1. Remove the combining tube stud nut (19) and the packing bushing washer (18).

NOTE
If the operating position of the combining tube was not match-marked as stated in step 2.a above, match-mark it now.

2. Loosen both yoke locknuts (16), and remove the sliding block (6), along with the yoke locknuts, the washers (21), the packing gland (33), and the stud packing (32). Remove the gasket (31).

NOTE
If the Hydroheater has not been removed from the system, disconnect the discharge pipe so a blunt push rod can be used to push the combining tube out the head end of the body.

3. Unscrew the stud (8) from the combining tube using a wrench on the flats of the stud.

4. Press the combining tube (3) out of the body. The combining tube may be difficult to dislodge because of the close fit between it and the body. Also, depending upon what type of liquid (such as a slurry) has been pumped, the combining tube could be "frozen" in position.

CAUTION
Care must be taken not to damage any parts while pressing or hammering to free the combining tube. If a push rod is used, it should be either hardwood or soft brass.

6.4.8 Install Combining Tube

1. Coat outside of entire combining tube liberally with light grease and slide it into the body with the non-tapered (squared-off) end of the tube facing the discharge connection. Be very careful to align the combining tube properly with the body. The fit is snug because of the close tolerances. Be sure that the threaded hole in the combining tube is facing "up" toward the slotted hole in the body.

2. Slide the combining tube into the body until the threaded hole in the combining tube appears in the slotted hole in the body.

3. Line up the combining tube carefully with the slot in the body, and using a wrench on the flats of the combining tube stud (8), thread it into the combining tube until tight.

4. Place the sliding block gasket (31) in position on the body.

5. Install the sliding block (6) onto the stud (8) with the stamped letters and the counterbore facing up. There must be one yoke locknut and washer on either side of the slotted boss on the body.

6. Install stud packing (32) onto the stud (8) and into the counter-bore in the sliding block (6).

7. Install the packing gland (33), packing bushing washer (21), and nut (26). Tighten the nut "fingertight" only.

6.4.9 Adjust Position of Combining Tube (See Figure 4)

1. Align the match mark added during disassembly on the sliding block (6) and the body (1) as follows:

NOTE
Series K413 Hydroheater have their sliding block adjusting stud facing away from the discharge connection, rather than toward it as other series Hydroheaters do. However, the combining tube adjusting procedure is the same for series K413 Hydroheaters as for the other models.

a. Tighten yoke locknut (16) closest to the discharge connection against the slotted boss to move the combining tube TOWARD the discharge end; this moves the combining tube toward the fully open position.

b. Tighten yoke locknut, also (16), closest to the steam connection against the slotted boss to move the combining tube AWAY FROM the discharge connection; this moves the combining tube toward the fully closed position.

2. Tighten the combining tube stud nut (19) and yoke locknuts (20) to lock the combining tube in the match-marked position it was in prior to its removal.

6.4.10 Install Nozzle

CAUTION
Care must be taken not to damage any parts while pressing or tapping the nozzle to seat it firmly. If a push rod is used, it should be either hardwood or soft brass.

1. Insert the nozzle (4) into the body (1). Press or tap the nozzle until it is seated firmly in the body. The fit between the nozzle and the body will be very snug because of the close tolerance.

2. Install the nozzle spiral retaining ring (18) by inserting one end into its groove and winding the rest of it in clockwise until it is completely seated (see Figure 9).

6.4.11 Install Head Assembly

CAUTION
Examine head o-ring (12) for cuts, nicks, and loss of elasticity. Replace if damaged or hardened.

Install the o-ring in the groove in the head (2). Install the head (with the steam stem installed) over the studs (22), being careful not to damage the steam stem as it is inserted into the body (1). Replace the nuts (25) and tighten them. Push against the threaded end of the steam stem to be sure the plug end is up against the nozzle (4) in fully closed position.

6.4.12 Install Actuator (If it was Removed for Seals and/or Steam Stem Replacement)

For series K413, K414, and K415 Hydroheaters, attach the actuator (27) to the head (2) by screwing the actuator locknut (9) onto the threaded end of the head; leave the locknut about 1/4 turn loose. For series K416 and K417 Hydroheaters, attach the actuator to the head with eight hex head cap screws (41) and lock washers (42); leave the screws about 1/4 turn loose. Place the travel indicator over the end of the steam stem and up against the stem nut. Attach stem clamp (not illustrated) to the actuator stem and the steam stem (5). Attach the positioner linkage (if unit is so equipped) and snug up the stem clamp bolt. Tighten the stem nut tight against the travel indicator; continue turning (the entire stem will turn) until resistance is felt indicating that the steam stem is firmly seated against the nozzle (4). Tighten the stem locknut. For series K413, K414, and K415 Hydroheaters, tighten the cap screws (41) the last 1/4 turn. Tighten the actuator stem clamp bolts (not illustrated).

6.4.13 Check Actuator Operation (for 3-15 psi Temperature Controller Signal)

Apply air pressure to the actuator. If the actuator stem moves with less than 3 psi applied air pressure, see the Instructions for calibration.

6.4.14 Tighten Packing

After start-up, alternately tighten the follower screws (3) 60° until acceptable controlled leakage is obtained.

6.4.15 Remove and Install Packing (When Steam Stem IS NOT Removed)

Packing (10,11) can be replaced, if necessary due to steam leakage, without disassembling the Hydroheater and without removing the air actuator (27). Proceed as follows:

NOTE
The seals (20) function as wipers and do not have to be replaced when the packing is replaced (without disassembling the Hydroheater) due to steam leakage.

1. Remove the two cap screws (35) and lock washers (36) and carefully slide the packing follower (37) up the steam stem (away from the head). If the Hydroheater is mounted upright, use a twist tie to prevent the packing follower from sliding down.

2. Use a small hooked tool to remove the packing (10,11). Make sure no pieces of packing nor any foreign material remain in the counterbore in the head.

CAUTION

When replacing the packing, the steam stem must be clean and free of nicks, burrs, and scratches. A 16-20 Ra finish is required. If the steam stem is pitted, coat it lightly with Chesterton Nickel Anti-Seize, or equivalent.

3. The packing consists of five rings, one rope-type fiber graphite ring on each end and three die-formed graphite tape packing rings in the middle. Install the rings one at a time with their joints staggered 90° apart. Rope-type fiber graphite rings can be wrapped around the stem; die-formed graphite tape rings must be installed by twisting them open and placing them over the stem (see Figure 8). Seat each ring individually using either a tamping tool, a split hollow cylinder, or the packing follower. Each ring must be individually seated so the packing follower will be able to tighten the entire set of five.

CAUTION

Never mix different ring segments or half rings (rings installed as two halves.)

4. Replace the packing follower (37) in the head (2) and install the two cap screws (35) and lock washers (36) snugly; after start-up, alternately tighten the follower screws 60° until acceptable controlled leakage is obtained.

7 Illustrated Parts List

NOTE
When ordering replacement parts, be sure to include the series designation and the serial number from the plate affixed to the side of the Hydroheater body. Order by part description and item number. Part numbers are not included in this parts list because of numerous variations; however, the Equipment Specification sheet included in the manual lists the part numbers for the combining tube, steam nozzle, and steam stem.

7.1 "M" Series Hydroheaters

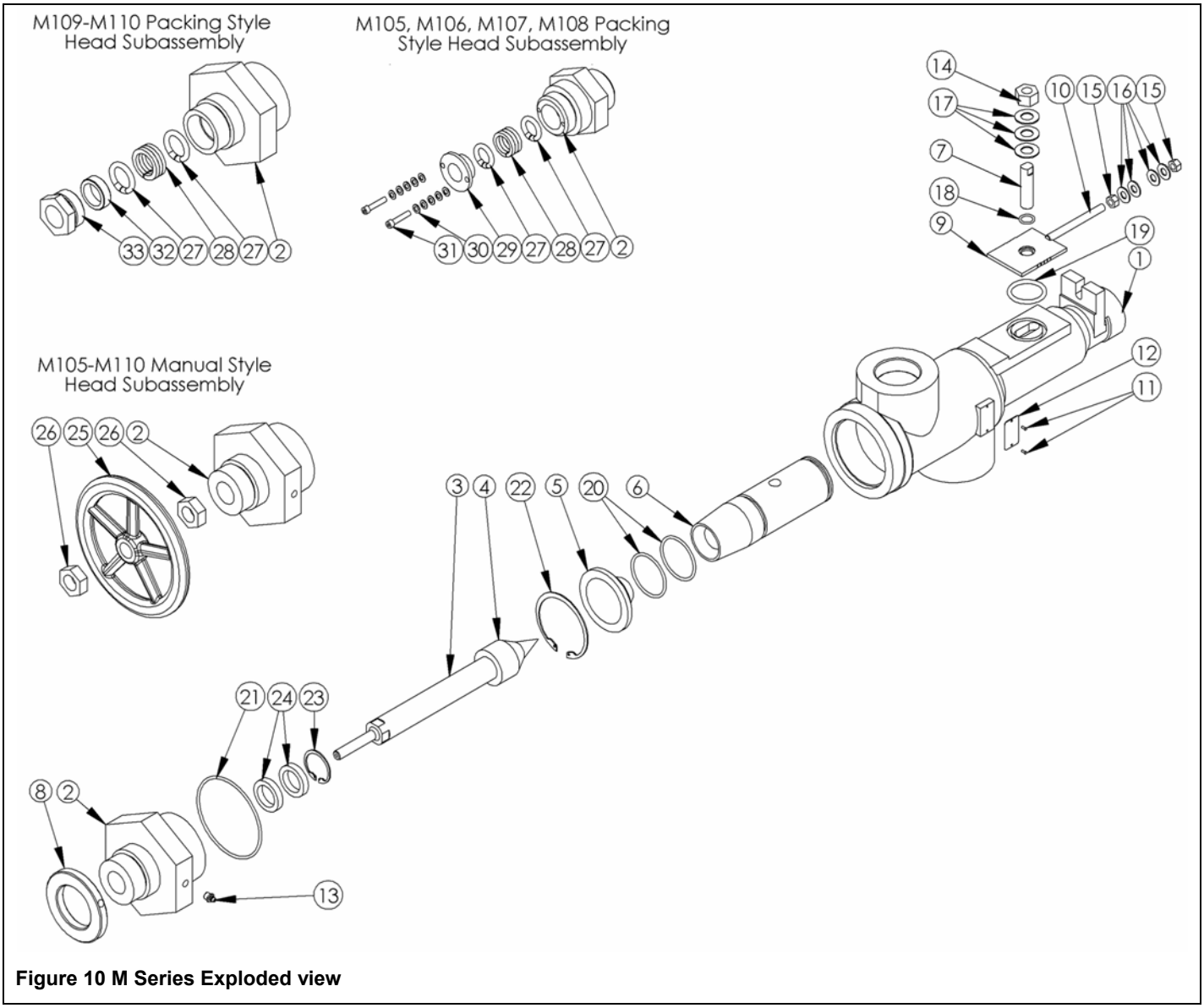


Figure 10 M Series Exploded view

7.1.1 M series Parts listing

Item Number	Quantity	Description
1	1	Body
2	1	Head
3	1	Stem
4	1	Plug
5	1	Nozzle
6	1	Combining Tube
7	1	Combining Tube Stud
8	1	Actuator Locknut
9	1	Sliding Block
10	1	Sliding Block Rod
11	2	Screw
12	1	Nameplate
13	1	Grease Fitting
14	1	Nut
15	2	Nut
16	4	Washer
17	3	Washer
18	1	O-Ring
19	1	O-Ring
20	2	O-Ring
21	1	O-Ring
22	1	Retaining Ring
23	1	Retaining Ring
24	2	Seal
25	1	Handwheel
26	1	Handwheel Locknut
27	2	Rope
28	3	Ring
29	1	Packing Follower
30	10	Washer
31	2	Cap Screw
32	1	Packing Gland
33	1	Packing Gland Nut

7.2 "K" Series Automatic Hydroheaters (Models K410 through K412)

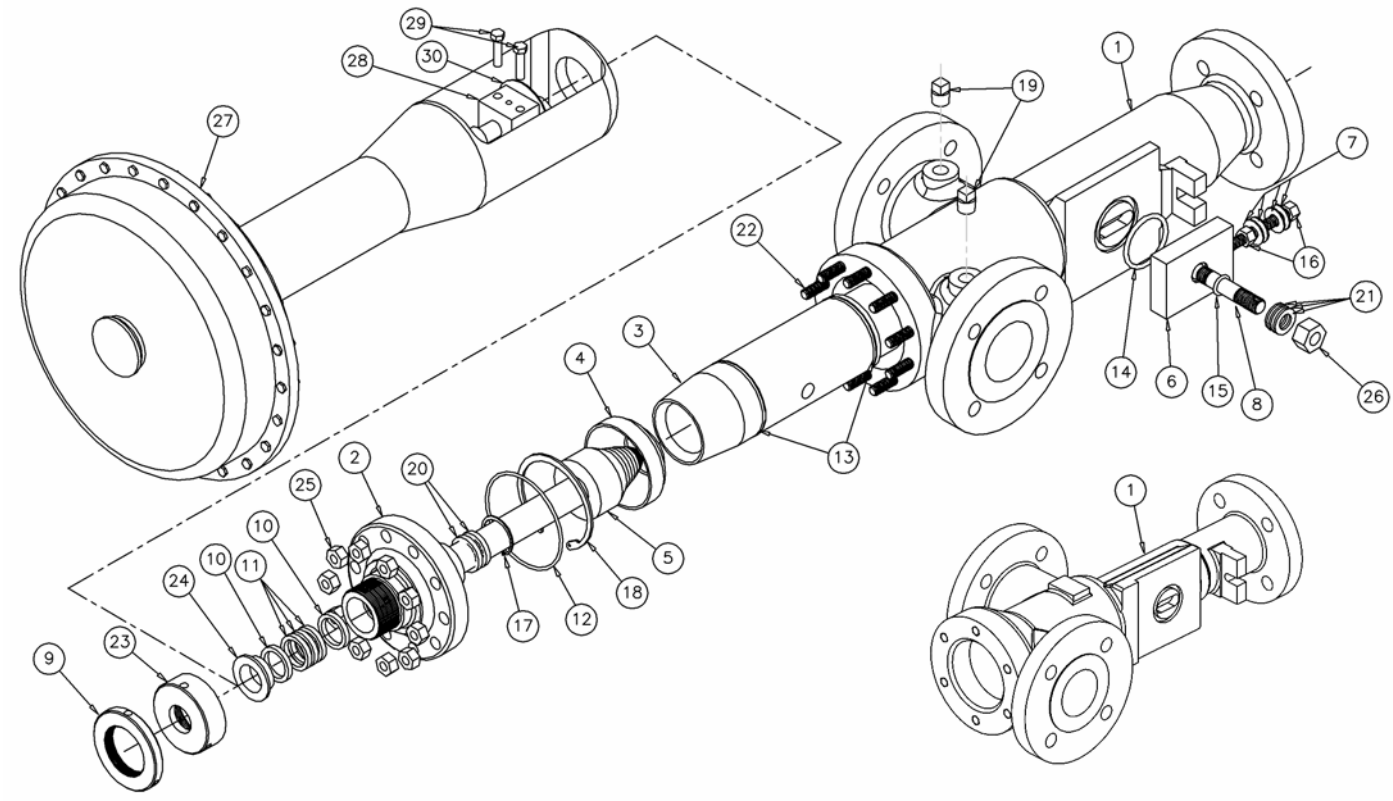


Figure 11 K410 - K412 Hydroheater

7.2.1 K410 - K412 Parts listing

Item Number	Quantity	Description
1	1	Body
2	1	Head
3	1	Combining Tube
4	1	Nozzle
5	1	Stem
6	1	Sliding Block Assembly
7	4	Washer
8	1	Stud
9	1	Actuator Locknut
10	2	Rope
11	3	Ring
12	1	O-Ring
13	2	O-Ring
14	1	O-Ring
15	1	O-Ring
16	2	Nut
17	1	Retaining Ring
18	1	Retaining Ring
19	2	Plug
20	2	Seal
21	3	Washer
22	10	Head Stud
23	1	Gland Nut
24	1	Gland
25	10	Nut
26	1	Nut
27	1	Actuator
28	1	Coupling Block
29	2	Cap Screw
30	1	Actuator Travel Indicator

7.3 "K" Series Automatic Hydroheaters (Models K413 through K417)

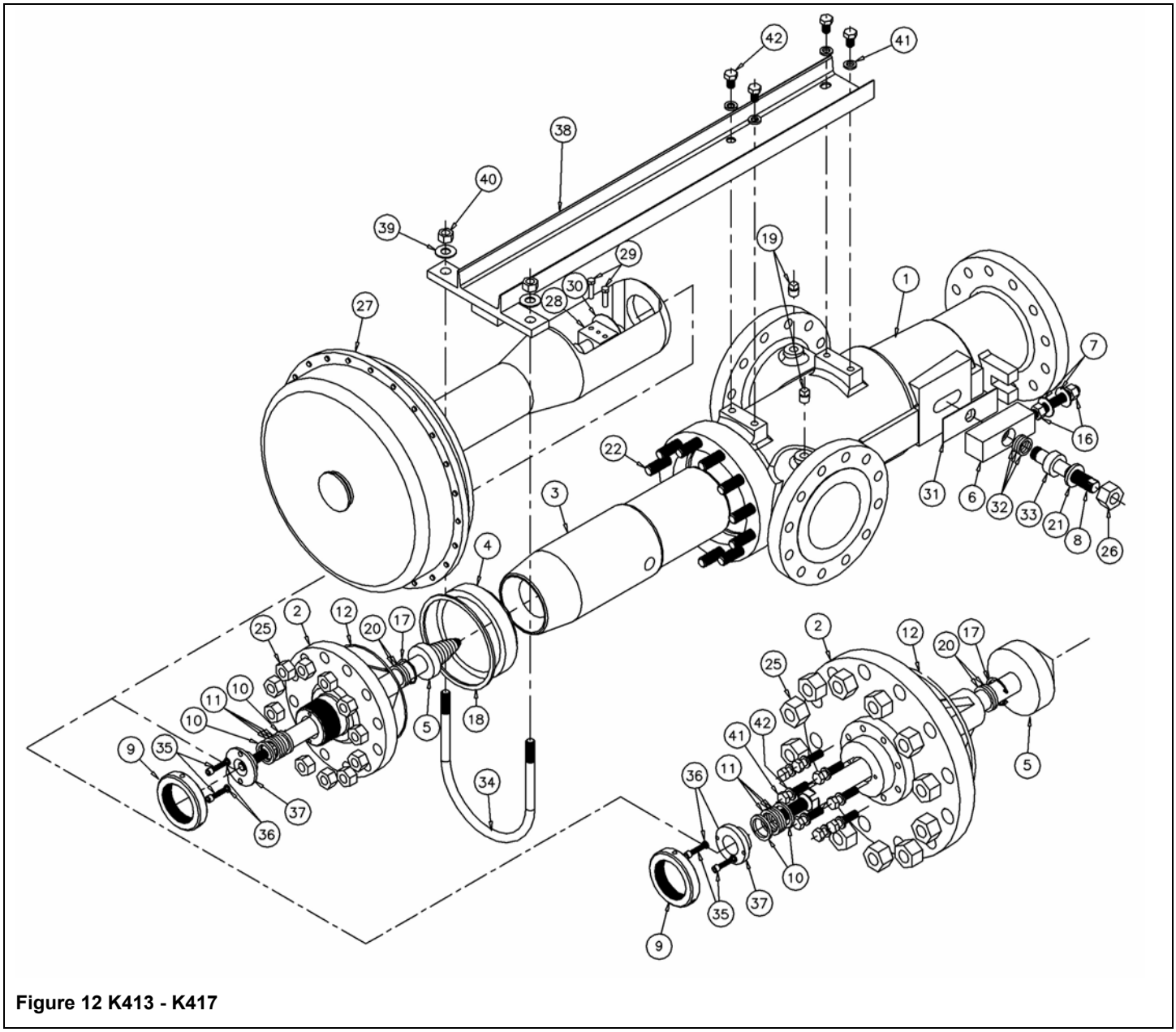
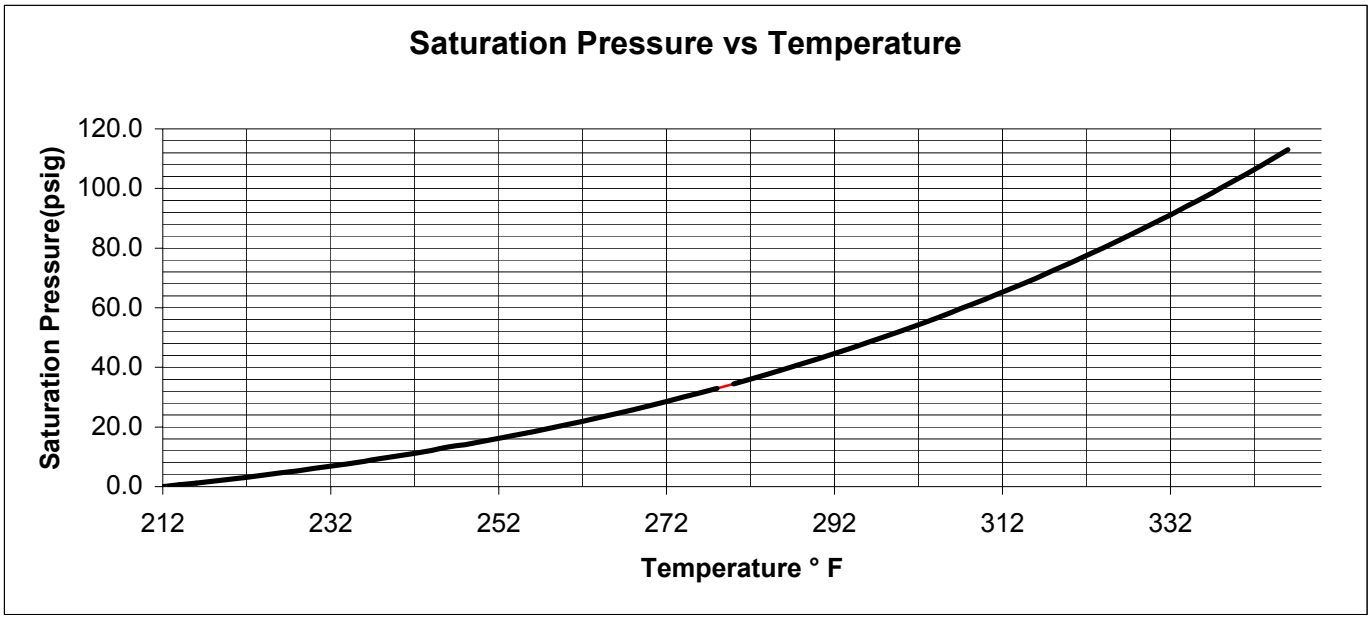


Figure 12 K413 - K417

7.3.1 K413-K417 Parts listing

Item No.	Quantity	Description
1	1	Body
2	1	Head
3	1	Combining Tube
4	1	Nozzle
5	1	Stem
6	1	Sliding Block Assembly
7	2	Washer
8	1	Stud
9	1	Actuator Locknut
10	2	Rope
11	3	Ring
12	1	O-Ring
16	2	Nut
17	1	Retaining Ring
18	1	Retaining Ring
19	2	Plug
20	2	Seal
21	1	Washer
22	10	Stud
25	10	Nut
26	1	Nut
27	1	Actuator
28	1	Coupling Block
29	2	Cap Screw
30	1	Actuator Travel Indicator
31	1	Gasket
32	3	Ring
33	1	Gland
34	1	Actuator U-Bolt
35	2	Cap Screw
36	2	Lock Washer
37	1	Packing Follower
38	1	Actuator Bracket
39	2	Washer
40	2	Nut
41	4	Lock Washer
42	4	Bolt



Temperature (°F)	Flash Pressure (psig)	Recommended Pressure (psig)	Temperature (°F)	Flash Pressure (psig)	Recommended Pressure (psig)
212	0.0	5.0	280	34.5	39.5
214	0.6	5.6	282	36.1	41.1
216	1.2	6.2	284	37.7	42.7
218	1.8	6.8	286	39.4	44.4
220	2.5	7.5	288	41.1	46.1
222	3.1	8.1	290	42.8	47.8
224	3.9	8.9	292	44.6	49.6
226	4.6	9.6	294	46.5	51.5
228	5.3	10.3	296	48.4	53.4
230	6.1	11.1	298	50.3	55.3
232	6.9	11.9	300	52.3	57.3
234	7.6	12.6	302	54.3	59.3
236	8.5	13.5	304	56.4	61.4
238	9.4	14.4	306	58.5	63.5
240	10.3	15.3	308	60.7	65.7
242	11.2	16.2	310	62.9	67.9
244	12.1	17.1	312	65.3	70.3
246	13.3	18.3	314	67.6	72.6
248	14.1	19.1	316	69.9	74.9
250	15.1	20.1	318	72.4	77.4
252	16.2	21.2	320	74.9	79.9
254	17.3	22.3	322	77.5	82.5
256	18.4	23.4	324	80.1	85.1
258	19.5	24.5	326	82.8	87.8
260	20.7	25.7	328	85.5	90.5
262	21.9	26.9	330	88.3	93.3
264	23.2	28.2	332	91.2	96.2
266	24.5	29.5	334	94.1	99.1
268	25.8	30.8	336	97.1	102.1
270	27.2	32.2	338	100.1	105.1
272	28.5	33.5	340	103.2	108.2
274	30.0	35.0	342	106.4	111.4
276	31.4	36.4	344	109.7	114.7
278	32.9	37.9	346	113.0	118.0