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OPERATION, MAINTENANCE AND
INSTRUCTION MANUAL
FOR
DEAERATING FEEDWATER HEATER

[redacted]

M.C.I.
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RESUBMITTAL
REC./APRVL STAT

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RECEIVED MCI REVIEW SECTION STAT

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DESIGN SPECIFICATIONS

TYPE:	SPRAY TYPE DEAERATING HEATER
HEATER SIZE:	7'-0" x 13'-6"
STORAGE SIZE:	--
CONSTRUCTION:	ASME CODE CONSTRUCTION
MATERIAL:	A 516 GR 70
DESIGN PRESSURE:	50 PSIG
STORAGE CAPACITY:	3,300 G
OUTLET CAPACITY:	165,000 #/HR
OPERATING PRESSURE:	10 PSI

PMI INDUSTRIES, INC.

DESCRIPTION, INSTALLATION MAINTENANCE AND OPERATION INSTRUCTIONS

PREFACE

The principles of deaeration of water are outlined in these instructions and the physical equipment which accomplishes this deaeration are basically described. It is the intent of these instructions to present in broad terms only and to allow this manual to cover any possible variations of equipment or operating conditions.

Deaerating heaters are flexible and will meet the guarantees of deaeration and heating of water when operated in accordance with these instructions provided that operating conditions load fluctuations are within the design limits and operating personnel understand the principles of deaeration and the equipment.

Any drawings contained within this bulletin are general and for exact details; please refer to the engineering drawings. This applies to both the drawings of PMI equipment and any auxiliary equipment used in conjunction with the deaerator. For a complete list of this equipment refer to the engineering bill of material.

These instructions should be carefully read and fully understood before proceeding with erection and/or operation of the equipment and thereafter referred to as required.

FUNCTION

The function of a deaerating heater is to remove non-condensable gases and to heat boiler feed water. A deaerating heater consists of a pressure vessel in which water and steam are mixed with controlled velocities. When this occurs, water temperature rises, and all non-condensable dissolved gases are liberated and removed and the effluent water may be considered corrosion free from an oxygen or carbon dioxide standpoint.

A deaerating heater is the watch dog of a boiler plant as it protects the feed pumps, piping, boilers and any other piece of equipment that is in the boiler feed and return cycle from the effects of corrosive gases. It accomplishes this by reducing the concentration of non-condensable gases, i.e. oxygen and carbon dioxide, to a level where they are no longer a factor of corrosion.

Principles of Deaeration

There is a physical law which states that the solubility of any gas in a liquid is directly proportional to the partial pressure of the gas above the liquid surface. Another law states, the solubility of a gas in a liquid decreases with an increase in temperature of the liquid. Experience has shown that more rapid and more complete removal of non-condensable gases from a liquid is obtained when the liquid is vigorously boiled or scrubbed by condensable or carrier gas bubbles. Therefore, essentially the deaerating heater must first heat the feedwater to as high a temperature as possible, i.e. to the temperature corresponding to the steam pressure. It must vigorously boil and scrub the heated water with fresh steam which can carry to the liquid surface any traces of oxygen or carbon dioxide. The partial pressure of the oxygen and carbon dioxide in the steam atmosphere must be maintained as low as possible, particularly at the point where the deaerated water separates from the steam. Non-condensable gases must be continually withdrawn from the heater at the rate at which they are being liberated. To avoid waste of steam an efficient vent condenser is required to concentrate non-condensable gas mixture as it leaves the heater.

Operation

A deaerating heater utilizes steam by spraying the incoming water into an atmosphere of steam in the preheater section, it then mixes this water with fresh incoming steam in the deaerator section. In the first state the water is heated to within 2 degrees of steam temperature and virtually all of the oxygen and free carbon dioxide are removed. This is accomplished by spraying the water through self-adjusting spray valves which are designed to produce a uniform spray film under all conditions of load and consequently a constant temperature and uniform gas removal is obtained at this point.

From the first stage section the preheated water containing minute traces of dissolved gases, flows into the second stage or deaerator section. This section consists of either a distributor or several assemblies of trays. Here the water is intimately contacted with an excess of fresh gas free steam. The steam passes into this stage and it is mixed with the preheated water. Deaeration is accomplished at all rates of flow if conditions are maintained in accordance with design criteria. Very little steam is condensed here as incoming water has a high temperature caused by the preheating. The steam rises to the first stage and carries out the small traces of residual gases. This mixture of steam and non-condensable gases pass through first stage compartment to the vent condenser. In the preheater most of the steam is condensed and the remaining gases pass through to the vent condenser where most remaining steam is condensed and the non-condensable gases vent to the atmosphere. A very small amount of steam is passed to the atmosphere which assures that the deaerating heater is adequately vented at all times.

The water which leaves the second stage falls to the storage tank where it is stored for use. At this time the water is completely deaerated and is heated to the steam temperature corresponding to the pressure with the vessel.

Preparation for Shipment

Usually all deaerating heaters are shipped with main shell completely assembled and with all interior parts in position. Normally the only exception to this would be that for very large tray type heaters, the trays are sometimes shipped loose.

Accessories and piping are usually shipped separately for ease in handling and to avoid damage in transit. When accessories and piping are shipped separately, each item is described completely on the job Bill of Material. It is a simple matter for the purchaser to identify each piece received by referring to the final Bill of Material. At times, where shipping problems are encountered, protruding parts, such as vent condenser, vent pipes may be shipped inside of the heater. Always check the storage tank and deaerator shell for any loose parts. When the deaerating heater is extremely large or where clearances will not permit shipment of a preheater and storage tank as one unit, or when the customer specifically requests disassembled units, the main tanks may be

shipped in two or more pieces. Field joints are always marked and clearly identified on the engineering drawings. Therefore, a deaerating heater can be easily reassembled by the purchaser, as the shells normally are completely assembled and tested before being dismantled and sealed for shipment. Normally, only a field piping connection, either welded or flanged, depending on the installation and bolting between the preheater and storage tank, must be made. Large vessels are either skidded or supported on their own saddles for ease of handling. All nozzles and openings are plugged to avoid entrance of foreign matter. Smaller parts and accessories are normally boxed and tagged. All parts should be checked and if any breakage or shortage occurs, this should be reported immediately to the carrier's representative. If the parts are not to be erected immediately, it is best that the boxes remain closed to avoid their being mislaid or subjected to the elements.

Foundations

Deaerating heater foundations normally do not have to be of the massive design as required for moving machinery.

Foundation should be level and be of adequate strength to support the maximum loads that the deaerating heater can impose upon it. The foundation should be designed to carry the "flooded weight" which is the maximum weight of the deaerating heater vessel when completely installed and flooded for hydrostatic test. In addition to this, there must be an added allowance for piping, platforms, stairs and any other attachment on the deaerating heater. The normal weight which the foundation must carry is that weight shown on the engineering drawing as "operating weight". This is the weight of the installed unit with the water level in the storage tank at the maximum operating or overflow level.

The deaerating heater should be firmly bolted to the supporting steel or reinforced concrete foundation.

Installation

That weight shown on the engineering drawings as "shipping weight", is the approximate weight of the deaerating heater vessel as shipped. Rigging facilities must be available to handle this weight both for unloading and raising the unit to its foundation. Qualified riggers should be used to set the deaerating heater upon the foundation. Slings, blocks and handling rigging must be carefully placed and care must be excercised to avoid damaging nozzles or internal parts of the heater. After the vessel is placed upon the foundation, it may be shimmed if necessary.

Insulation

The deaerating heater, storage tank and all equipment carrying hot water or containing steam should be thoroughly insulated to prevent condensation of steam and loss of heat. Sample connections and thermometer wells should not be covered, and provision should be made to allow for annual inspection through manholes and to inspect control valves, level controllers, etc., without damaging the insulation and covering.

Elevation of Deaerating Heater

Any deaerating heater must be elevated above the boiler feed pump to insure sufficient net positive suction head on the inlet side of the boiler feed pump. The minimum head required on the suction of the pump should be carefully checked with the pump manufacturer, emphasizing the fact that the pump is handling water at a temperature corresponding to the saturated temperature of the steam supplied to the deaerating heater. Flashing and consequent steam binding of the pump may occur if the boiler feed pump is operated with a low or negative suction head. The suction head is considered that distance from the low water line in the deaerating heater or bottom of storage tank to the centerline of the feed pump.

Water Pressure

Sufficient water pressure must be supplied at the inlet of the deaerating heater for all entering water supplies; this pressure must be high enough to overcome any loss of head caused by pipe friction, control valves, vent condenser and spray valves. It must also overcome internal steam pressure. Normally, minimum pressures for condensate not flowing through controllers, vent condensers, etc., must be equal to the steam pressure in the vessel plus approximately 3 psi. at the heater connection where spray valves are used and approximately 7-9 psi. is required where spray pipes are used.

Inlet control valves have been selected to operate within the range of pressures. If the pressure is too low, sufficient water will not enter the heater. If water pressure is too high, difficulty may be experienced with the control valve. A high pressure drop across control valves could cause valve shatter, hunting of the unit, and reduce the efficiency of the plant. In such cases, it is necessary to install a water pressure reducing valve and regulator.

Steam Requirements

Steam is required to heat and deaerate the water in a deaerating heater. The amount of steam required does not depend upon the design of a deaerating heater but only upon thermo-dynamic laws; to determine accurately the amount of steam required, it is necessary to make a heat balance.

The amount of steam consumed by any deaerating heater is that amount determined by the heat balance required to heat all of the incoming water to the saturated steam temperature within the heater, plus a minute amount that is vented with the gases less any flashed steam from hot condensate or trap returns. This calculation should be taken with the incoming water at its lowest temperatures. If there is insufficient exhaust or bleed steam, then makeup steam should be applied at reduced pressure.

The following procedures may be used, the first two methods "a" and "b" are approximations, the third "c" is an exact method. A complete heat balance can be made of the entire heat cycle, in accordance with any established procedures.

a) If the operating steam pressure is between 1 and 5 psi., and if the maximum inlet water temperature is below 100° F, the required amount of steam will be one seventh of the outlet flow.

(1) $\frac{Q \quad \text{(outlet)}}{7} = \text{Steam required}$

Example: 60,000 #/hr. outlet capacity entering at 60° F. heater operating at 2 psi.: $\frac{60{,}000}{7} = 8570$ #/hr. steam required.

b) If the operating pressure is between 1 and 5 psi., and if the inlet water temperature is between 100° F and 150° F, the required amount of steam will be one tenth of the outlet flow:

(2) $\frac{Q \quad \text{(outlet)}}{10} = \text{Steam required}$

Example: 60,000 #/hr. outlet entering at 140° F, heater operating at 2 psi.: $\frac{60{,}000}{10} = 6{,}000$ #/hr. steam required.

c) *Exact Method*

Q	=	Total deaerated outlet capacity (#/hr.)
Qm	=	Inlet Water (under consideration) (#/hr.)
P	=	Steam pressure (psi)
T_1	=	Steam temperature (saturated temperature at inlet pressure) (° F)
T_2	=	Water Temperature (° F)
H_{f_g}	=	Latent heat of steam pressure, see any steam table) (BTU/#)

Makeup

(3) $\frac{Qm\ (T_1 - T_2)}{H_{f_g}} = \#/hr.$ steam required

Condensate (Not Flashing)

(4) Same as (3) using applicable temperatures.

Condensate (Flashing)

(5) $\%\ Flash = \left(\frac{H_f\ (higher) - H_f\ (lower)}{H_{f_g}\ (lower)}\right) 100$

$\frac{\%\ Flash\ X\ Qm}{100} = \#/hr.$ steam flashed.

Then sum all of the flows of required steam for inlet water heating, deduct any steam flashed from hot condensates. This sum will be the maximum steam volume required by the deaerating heater for the loads in question. This procedure may be reversed and solved for any amount of makeup required.

Good deaerating can only be obtained if a sufficient steam supply is available to maintain a continuous positive pressure of at least 1/2 lb. gauge on the deaerating heater shell, unless there has been special provision for vacuum operation.

The only cause for a deaerator to operate at lower temperature than saturated steam temperature is the lack of steam caused by having too small a steam makeup valve, an insufficient supply of steam or improper venting.

Vibrating and hammering can be caused by too low a steam pressure supply or some blockage within the passages for steam within the deaerating heater.

Deaerating heaters can be made to intentionally operate at temperatures below steam temperature by starving the steam supply either with a temperature or a pressure control valve on the steam inlet. However, if the pressure in the heater drops under atmospheric pressure, a vacuum system is required to withdraw the vented gases.

Accessories

The job Bill of Material will always list all accessories purchased with the heater. This could include any of the following control valves and level controllers, gauge glasses, water thermometers, steam theremometers, steam pressure gauges, oil separators, oxygen test equipment, level or pressure recorders and relief valves, piping, etc. We furnish only that material which has been listed on the engineering job Bill of Material. No other equipment is supplied with this order. For operating any of the accessories or auxuiliary equipment connected with this heater, refer to separate instructions which follow.

Access

Provisions should be made for platforms or ladders so that various valves, controls and instruments are accessible to the operator. Manholes should be accessible for internal inspection of the heater.

Piping Connections

Previous to connecting the deaerating heater to the piping, the heater and storage tank should be bolted firmly to the foundation and the interior should be inspected to ascertain that all interior parts are in position and working order.

When connecting steam and water lines to the heater, care should be exercised in the piping arrangement. Include expansion joints if necessary to avoid imposing excess piping strain upon the shell. Isolating gate valves in these lines are desirable, as they allow for complete isolation for cleaning or repairing, and are bypassed around inlet control valves or steam pressure reducing valves.

Piping should be supported independently to avoid strains from being exerted upon the heater or storage shell or any nozzles.

The pump suction line should be as large as practical and the use of sharp angle bends should be avoided. The line should be as direct to the boiler feed pump suction as practical. Vent condenser vent piping should be installed with care to avoid any traps or pockets. Normally, a vertical line short as possible, is best. A gate valve should be installed in this line. Normally a 1/8" hole is drilled through the disc of the valve to prevent the valve from being closed completely. An alternative to this would be a gate valve with no holes drilled in the seat and with a pipe cap mounted above the valve. This pipe cap should be drilled with an orifice that will allow sufficient venting. This method is most feasible for a system that would have a fairly uniform amount of non-condensable gases venting from it. Care must also be taken to avoid closing the gate valve at any time except for maintenance or change of the orifice.

The drain line should be piped to waste and all of the connections made in accordance with the layout drawings using usual pipe practice.

Sampling lines should be installed using extreme care to avoid leakage of air into this line. For a full description of the installation of sampling lines, refer to section under Oxygen Testing.

Thermometers

Thermometers are supplied only when ordered and then they are usually of the indicating type. They are installed to indicate the steam temperature within the deaerating heater and the water temperature within the storage tank. The thermometer wells are usually of the separable socket type with extension neck and with union connections. It is possible to remove thermometer for calibration without reducing the pressure in the deaerating heater. For special installations, indicating, remote, or recording instruments can be supplied. Temperatures external to the heater often supply useful information. This would be temperature of any water stream coming to the heater, temperature of steam to the heater, temperature of the water at the boiler feed pump.

Pressure Gauges

Pressure gauges are normally supplied when ordered and are usually of the bourdon tube type which are used to indicate the steam pressure. A siphon should be installed between the vessel and the gauge to insure accurate reading of the gauge. The gauge is usually installed to indicate steam pressure in the preheating section of the deaerating heater. On special installations or where specifically required for remote control, indicating or recording pressure gauges can be supplied

It is often useful to have pressure at sources external to the heater should information ever be required, such as pressure upstream of the inlet control valves, steam heater piping, feed pump suction.

ACCESSORY EQUIPMENT

Relief Valves

Relief valves, when furnished, are not designed to prevent excess pressure in the steam line. They are designed to relieve excess pressure which might occur in the deaerating heater when steam is flashed from high temperature waters returned to the heater in the form of trapped discharges, condensate returns, etc. These relief valves are sentinel type valves.

Main steam lines should be protected external to the deaerating heater to avoid pressurizing for any cause. They must be sized to completely remove any steam formed from pressure reducing stations, or other control devices, which may be installed between the deaerating heater and point of supply. They must also be capable of relieving the complete volume of steam flowing to the deaerating heater.

Normally, the relief valves supplied have hand release, and it is recommended that occasionally this relief be manipulated to check free movement and to avoid freezing of the valve seat. This can also be opened when starting the deaerating heater to relieve displaced air when filling the unit.

Vacuum Breakers

Vacuum breakers are occasionally supplied to protect shells from external pressure where they have not been designed to withstand this force. When a vacuum breaker is observed to be opened, there is a definite malfunction within the deaerating heater, as normally this vacuum breaker should never be used. It will only open when there is an insufficient supply of steam. Water going to service during these times could conceivably contain dissolved oxygen.

Vacuum breakers which are supplied are steam tight, suitable for the design pressure of the vessel and are set to open at the slightest vacuum. These should be checked periodically to insure that the seats have not frozen or allowed to become excessively dirty.

Other Equipment

For a description of the other equipment sometimes furnished in deaerating heaters, as inlet valves and controllers, overflow valves and controllers, oil separators, vent condensers, tray banks, spray valves, etc., refer to those sections outlining installation and operating procedures to be used.

MAINTENANCE AND INSPECTION

Normally, deaerating equipment requires little maintenance. The operation should be completely automatic. For normal operation, little or no maintenance is required, except for the usual attention required for instrumentation and controls.
Complete annual inspection should be made of this equipment. In plants where duty is unusually severe, or abnormal water supplies are used, inspection may be required semi-annually, or more frequently.

These inspections should include the following:

1. Internal inspection for evidence of corrosion or scaling.

2a. Spray Valve: Valve must seat firmly. Check under plug for debris. Valve nuts should be tight with no evidence of leakage under gasket. If disc appears to hang down spray valve can easily be adjusted by removing from tank, loosening top lock nut and hand tighten spring retainer until valve disc just seats then turn one-quarter turn more. Tighten lock nut firmly and re-install.

2b. Spray Nozzle: Should likewise be checked for foreign matter and see that all holes are clean and clear.

3. Check packing of controllers and valves, replace if necessary.

4. Check manhole gasket, replace if there is evidence of leaks.

5. Check operations of all controllers; they should move freely and not have excessive play. Make any necessary adjustments, paying particular attention to the overflow valve and controller as this is not used frequently and may have a tendency to corrode and freeze in position.

6. Open and close all gate valves that have not been used since last inspection. Lubricate when necessary.

7. Recalibrate thermometers, pressure gauges and any other instruments.

8. Inspect all piping connections for evidence of corrosion.

9. Inspect insulation.

10. After unit is returned to service, oxygen testing should be performed with more frequency to ascertain that the vent setting is correct.

OPERATION OF EQUIPMENT

The following procedures should be followed when commencing operation of a deaerating heater, after the unit has been completely installed, and all equipment has been tested and checked.

1. The startup period should be carefully planned so that wastage of water and steam to the drain do not unduly overload existing facilities such as pumps, engines, heaters, etc.

2. Flush out all lines and tanks with water until there is no apparent indication of foreign matter or rust. Spray valves and nozzles should be freed of all large pieces of mill scale, etc.

3. Manipulate manually all controls; see that each is working freely and that shipping stops have been removed.

4. Check all instruments to ascertain that they are operating and indicating correctly.

5. Open vent valve from vent condenser to atmosphere. Do not depend on 1/8" orifice in gate. Refer to venting instructions.

6. Close outlet valve from heater to feed pumps.

7. Start flow of inlet water and slowly increase from 50% to 60% of design rate.

8. Open valve, admitting steam into tank slowly. Possibly some rumbling may occur but this may be disregarded with the cold tank. Check steam gauge in heater and make absolutely certain that positive steam pressure is maintained in heater; if steam supply is insufficient, utilize other source such as makeup steam with reducing valve or any other auxiliary steam supply. Provide suitable relief provisions if these other supplies are not protected for the low pressure condition.

9. Filling the tank with water will purge most of the air from the vessel. As the water approaches operating level, increase the steam flow. Caution: Filling the tank with steam and then flooding with cold water subjects the tank to undue stresses caused by vacuum created by rapid condensation; normally the open vent may relieve this condition but caution is urged.

10. As the water reaches the operating level, check the operation of inlet controllers. Make adjustments at all controllers. Manually continue the flow of water until high level controls operate. Check operating level of controllers and alarms, if any.

11. When a considerable volume of steam is issuing from the vent valve, start throttling back on the vent valve until only a plume of vapor can be seen issuing from it. The water temperature should rise to within 3° of saturation temperature of steam at heater pressure. A lower water temperature indicates that pockets of air have not been completely purged. If this occurs, open steam valve wide, then open vent valve fairly wide for a few seconds, then throttle back to force pockets to the vent.

12. Open steam valve wide.

13. Keep checking water temperature until the unit comes within 2° F of steam temperature; when it does, the unit is now ready for service and the outlet valve may be opened and vent valve throttled back in accordance with instruction shown under vent condenser description. When the unit is operating, the storage water temperature should be at the saturated temperature of the steam at the heater pressure.

14. For any special equipment that has been supplied with this heater, check the descriptive literature and operating instructions for that equipment.

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OPERATING INSTRUCTIONS

INTERNAL VENT CONDENSER

THEORY OF OPERATION

Efficient removal of the non-condensable gases from the deaerating heater requires that the vent valve be opened sufficiently to allow complete discharge of the gases passed to the vent condenser outlet pipe. The maximum concentration of the non-condensable gases such as oxygen, carbon dioxide passing out the vent depends on the degree of condensation produced by the steam and gas mixture passing through and around the spray created by the special spray valve. The optimum condition is when the unit is venting all non-condensable gases with the minimum steam loss. This point can only be found through trial and error.

A vent condenser is not functioning properly when there is entrainment of water in the plume discharging to the atmosphere or where a steam plume cannot be observed, or the plume appears to be puffing. These malfunctions can be caused by any of a number of reasons such as insufficient vent opening, erratic spray valve action or incorrect vent piping.

Installation

All the spray valves should be checked to ascertain if they are tightly bolted in place. Silver plated stainless steel "elastic stop" nuts are normally used on each stud for fastening purposes. A Teflon gasket is located between the valve and water box. Spray valves should not require field adjustment as they are pre-set in the factory for zero spring compression. That is, the plugs should just set in the seats with no looseness or apparent spring force. The disc should move freely. The gasket should be firmly seated.

The area immediately above the spray valve should be inspected after all piping is in place. It may be necessary to remove one valve, or cover plate or inspection hole to check for pipe scale, pieces of welding rod, rocks, bottles, or other foreign matter that may have washed in through the piping during the testing of the plant or the installation of the water piping which could possibly lodge in the spray valve and cause difficulty with the operation of the unit.

VENT PIPING

The vent piping should be installed with no sharp vent bends or traps that could obstruct the flow of gases. The ideal vent pipe rises vertically from the heater to the valve located above the junction of the vessel in a short length of pipe above the valve. This is normally satisfactory where a slight amount of steam vapor can be tolerated in the area of the deaerating heater. Where this is not possible, and it becomes necessary to pipe the vent line to the outside atmosphere, precautions must be taken to avoid consistently long lines with a great number of turns. Horizontal runs should be avoided wherever possible. Trapped pockets in pipe lines must be eliminated if the heater is to operate successfully. The vent plume should be visible to the operator to enable him to periodically check the plume, therefore avoid piping the vent to stacks, risers or other closed systems unless provision is made to allow for this periodic inspection.

VENTING

Normally the vent valve has a 1/8" hole drilled in the seat to prevent this valve from being tightly closed during operation. For very light loads or plants where there is a small amount of non-condensables in the feed water, this vent orifice is sometimes large enough to act as the throttling orifice, but this is the unusual situation. The vent valve should not be operated in a closed position unless adequate venting is indicated by temperature checks and thorough oxygen tests. Normally the valve should be open one or more turns to allow for complete removal of the gases. To determine the correct amount of opening required, the vent valve should be opened approximately one or two turns and the effect on the operating temperature noted. If no appreciable effect on the temperature is noted after a period of one hour, oxygen tests should be then made to determine the effectiveness of venting; satisfactory reduction of oxygen is obtained when tested by a recognized sampling and testing procedure. The vent setting of the valve can be further decreased by tightening the vent valve. Normally, the plume of steam would indicate sufficient venting if it appears firm and rises approximately 18 inches to three feet above the termination of the pipe. If after reducing the vent valve openings, a drop in operating temperature is observed or a difference between outlet temperature of the water in comparison with the saturated temperature of the steam as shown in a thermodynamic table the indication is that venting is not adequate and the vent valve or orifice must be opened further.

ORIFICE TYPE VENT

Where loads are very small or where uniform operation (flow rates and pressures) can be expected for long periods of time a fixed orifice may be employed. This would usually consist of a drilled pipe cap. mounted above the vent valve. (When an orifice vent cap. is employed the vent valve should not be drilled). The vent valve should always be full open, and precautions noted above should be observed. The optimum size of the hole in the orifice cap can best be found by drilling a small hole (1/8" to 1/4") and checking the dissolved oxygen in the effluent, also observe the water temperature to see that it is at saturation temperature of the steam within the heater. If the oxygen reading is high or the temperature is low increase the hole size in the orifice and recheck. Repeat until oxygen is below the guaranteed level and the temperature rises to steam saturation temperature.

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SPRAY TRAY TYPE DEAERATING HEATER

DESCRIPTION

Each Spray Tray type deaerating heater has been specifically tailored to fit the power plant cycle and operating conditions of the individual plant in which it is to be installed. This assures the most efficient use of steam and pressure and energy level in the feed water cycle and the lowest operating cost.

SHELL

The shell structure is of fabricated steel. The design pressure is shown on the job bill of material or, if an ASME Code vessel has been ordered, the pressure is stamped on the vessel.

SHAPE

In general, the deaerating heater will be of the following shapes:

1. Fully vertical deaerator with a self-contained storage tank.
2. A vertical deaerating heater mounted on a horizontal storage tank either directly welded (tank car) or connected by nozzles and structural attachments (Double Shell).
3. A horizontal deaerating heater mounted on a horizontal storage tank.

OPERATION

Regardless of the arrangement of the shell, whether the deaerator and storage are joined together in a common tank or separated in different tanks, the operation is identical. Basically, the first stage spray section sprays the water through spray valves which discharge the water in thin films or sheets into the steam which fills the first stage compartment. In this steam space the water is heated to within 2-4° of the steam temperature, and virtually all of the dissolved oxygen and free CO^2 are removed. The self-adjusting, non-clogging spray valves are designed to produce uniform spray action under all conditions of load. Consequently, a constant temperature and uniform gas removal is obtained at this point. The spray valves are arranged so that the preheated water is sprayed downwardly, and does not strike the bottom surface or the sides of the preheated chamber until most of the gases have been removed. Water saturated with oxygen and other non-condensable gases at normal atmospheric temperature will have more than 95% of these gases removed in this first stage preheater.

The water, containing traces of non-condensable gas then enters the tray section where it is intimately mixed with a large excess of steam. The fresh gas-free steam passes into the second stage rising through a tray stack. Within the second stage section, very little steam is condensed because of the high temperature of the preheated water. Therefore, most of the steam remains in a vapor to carry the small traces of residual dissolved gases through to the first stage steam space where the steam is condensed in preheating the water. The residual steam then passes to the vent condenser where it is condensed and the non-condensable gases pass to the atmosphere. The water passes counter-current to the steam through stainless steel tray assemblies. These assemblies are grouped to form a tray stack. The degree of deaeration is determined by the number of water reversals or changes in direction that occur in passing through the stack. Each reversal exposes another surface of the water to the up-flowing steam. This contact physically loosens the dissolved gas molecules and separates them from solution. The rising steam sweeps the gas into the upper section where it is eliminated. The scrubbing action of the steam assures final deaeration as guaranteed. The second stage of every heater is tailor-made for the particular operating conditions prevailing at the plant, and the deaerator has been designed for these specific conditions.

Installation

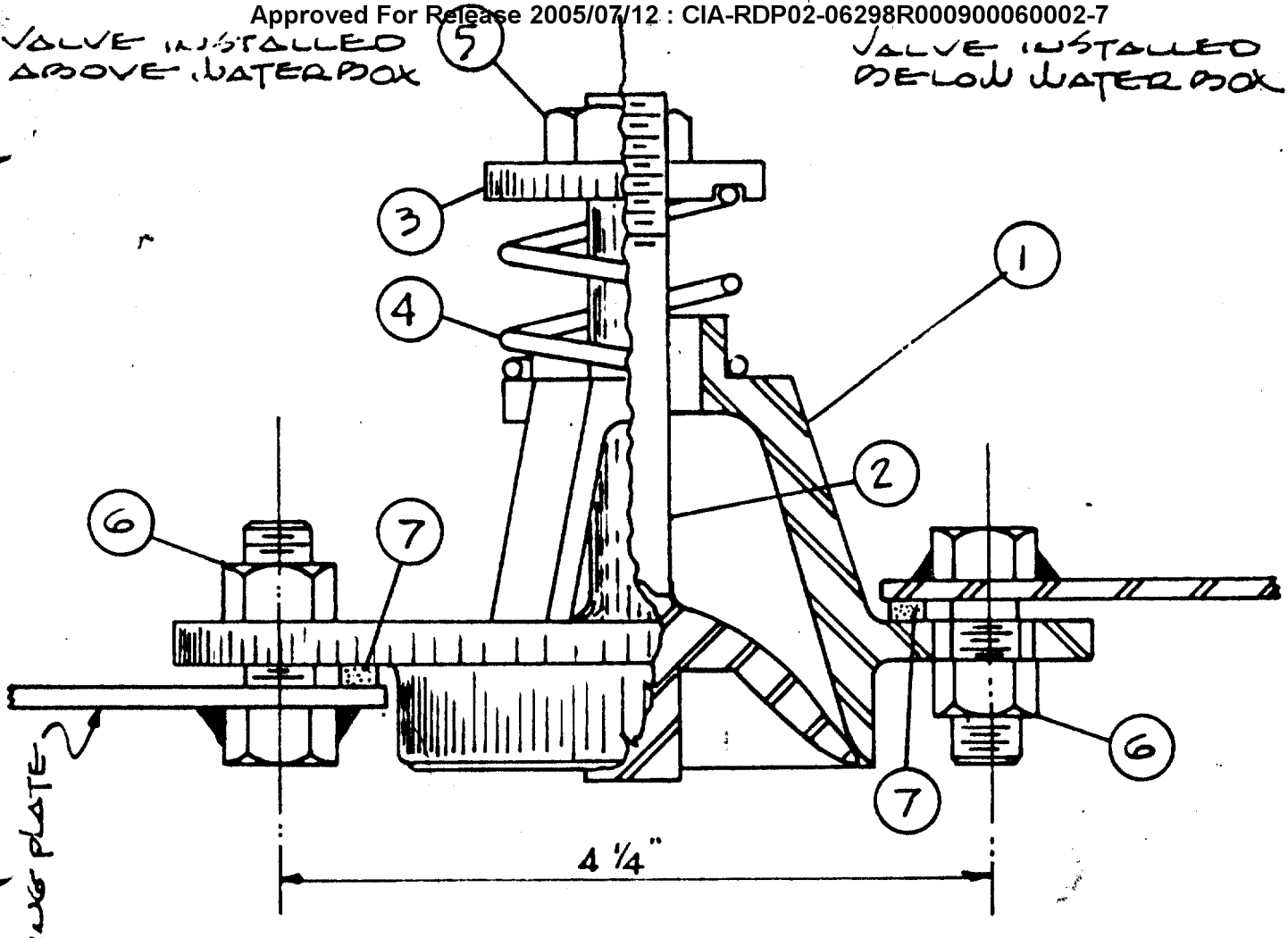
Inspection should occur before start up. Every deaerating heater has been designed to meet specific operating conditions. Fabricating and inspection procedures are the best known. The material selected for each of the components has been proven over many years of service to be the best for the service within economic considerations. However, before the unit is installed and operated it is strongly suggested that the deaerating heater be re-checked to insure that no damage has occurred to the heater since its inspection.

The spray valves should be checked to insure that they are installed correctly. That is, with the spring on the water side of the water chamber, special silverplated, stainless steel elastic stop nuts are used to fasten the valve to the vessel. These nuts will not loosen under any load. The nuts should be tight and the gasket should be firmly seated. Inspection should be made to make sure that all internal inspection plates are in place, tightly bolted, and that all debris has been removed from the tank. This is especially true after all piping connections are made and the unit is flushed out. It is recommended that the water side of the water box be checked if the pipe lines have been hydraulically flushed, as often debris will wash in and will lodge in this compartment and eventually work through the deaerating heater to the boiler feed pump. Baffles should be inspected to insure that no damage occurred during shipping or installation, such as cracks of welds or other points that could be subject to damage.

Trays are shipped either separately boxed or are sometimes installed within the heater; refer to your job Bill of Material under "tray assembly" to determine how these are shipped. If shipped within the heater, inspection should be made to ascertain that no damage accrued during shipping or rigging. The trays should be level and nested together with no gaps or spaces between. To inspect or install trays it is necessary to open the access door and the inner tray door or holding braces. The trays should be installed as indicated on the internal assembly drawing. Some trays have serrated edges; install these with the edges (saw teeth) pointing down. For trays with channel shaped sections, install with the channel flanges pointing up.

VALVE INSTALLED ABOVE WATERBOX

VALVE INSTALLED BELOW WATERBOX



SPRAY VALVE MOUNTING PLATE

PARTS LIST

MARK	NO REQD	PART NO	DESCRIPTION	MATERIAL
1	1	B-100	BODY	316. STAIN.S.
2	1	A-100	DISC & STEM	316. STAIN.S
3	1	A-102	RETAINER	303. STAIN.S
4	1	A-103	SPRING	17/7 STAIN.S
5	1	A-104	RETAINER NUT	303 STAIN.S
6	2	A-104	LOCKNUT	316 STAIN.S
7	1	A-105	GASKET	TEFLON.

VALVE ASSEMBLY FURNISHED COMPLETE WITH GASKET & MOUNTING LOCKNUTS.

pmi

P.M.I. INDUSTRIES INC.
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SPRAY VALVE INSTALLATION & ASSEMBLY

DWN [illegible] DATE DEC 1976

CHK [illegible] SCALE FULL

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