



Steam



Motors



Compressed Air

Additional Benefits

Deaerators provide the water storage capacity and the net positive suction head necessary at the boiler feed pump inlet. Returned condensate is mixed with makeup water within the deaerator. Operating temperatures range from 215 to over 350°F, which reduces the thermal shock on downstream preheating equipment and the boiler.

Insulation

The deaerator section and storage tank and all piping conveying hot water or steam should be adequately insulated to prevent the condensation of steam and loss of heat.

Function Clarification

The deaerator is designed to remove oxygen that is dissolved in the entering water, not entrained air. Sources of “free air” include loose piping connections on the suction side of pumps and improper pump packing.

Pressure Fluctuations

Sudden increases in free or “flash” steam can cause a spike in deaerator vessel pressure, resulting in re-oxygenation of the feedwater. A dedicated pressure-regulating valve should be provided to maintain the deaerator at a constant pressure.

Steam Tip Sheet information has been reviewed by the DOE BestPractices Steam Technical Subcommittee. For additional information on industrial energy efficiency measures, contact the Information Clearinghouse at (800) 862-2086.



Deaerators in Industrial Steam Systems

Deaerators are mechanical devices that remove dissolved gases from boiler feedwater. Deaeration protects the steam system from the effects of corrosive gases. It accomplishes this by reducing the concentration of dissolved oxygen and carbon dioxide to a level where corrosion is minimized. A dissolved oxygen level of 5 parts per billion (ppb) or lower is needed to prevent corrosion in most high pressure (>200 psig) boilers. While oxygen concentrations of up to 43 ppb may be tolerated in low pressure boilers, equipment life is extended at little or no cost by limiting the oxygen concentration to 5 ppb. Dissolved carbon dioxide is essentially completely removed by the deaerator.

How They Work

The design of an effective deaeration system depends upon the amount of gases to be removed and the final gas (O₂) concentration desired. This in turn depends upon the ratio of boiler feedwater makeup to returned condensate and the operating pressure of the deaerator.

Deaerators use steam to heat the water to the full saturation temperature corresponding to the steam pressure in the deaerator and to scrub out and carry away dissolved gases. Steam flow may be parallel, cross, or counter to the water flow. The deaerator consists of a deaeration section, a storage tank, and a vent. In the deaeration section, steam bubbles through the water, both heating and agitating it. Steam is cooled by incoming water and condensed at the vent condenser. Non-condensable gases and some steam are released through the vent.

Steam provided to the deaerator provides physical stripping action and heats the mixture of returned condensate and boiler feedwater makeup to saturation temperature. Most of the steam will condense, but a small fraction (usually 5 to 14%) must be vented to accommodate the stripping requirements. Normal design practice is to calculate the steam required for heating, and then make sure that the flow is sufficient for stripping as well. If the condensate return rate is high (>80%) and the condensate pressure is high compared to the deaerator pressure, then very little steam is needed for heating, and provisions may be made for condensing the surplus flash steam.

Deaerator Steam Consumption

The deaerator steam consumption is equal to the steam required to heat incoming water to its saturation temperature, plus the amount vented with the non-condensable gases, less any flashed steam from hot condensate or steam losses through failed traps. The heat balance calculation is made with the incoming water at its lowest expected temperature. The vent rate is a function of deaerator type, size (rated feedwater capacity), and the amount of makeup water. The operating vent rate is at its maximum with the introduction of cold, oxygen-rich makeup water.

Suggested Actions

- Deaerator steam requirements should be re-examined following the retrofit of steam distribution system, condensate return, or heat recovery energy conservation measures.
- Install continuous dissolved oxygen monitoring devices to aid in identifying operating practices that result in poor oxygen removal.

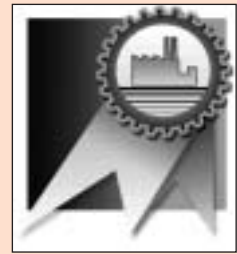
About DOE's Office of Industrial Technologies

The Office of Industrial Technologies (OIT), through partnerships with industry, government, and non-governmental organizations, develops and delivers advanced energy efficiency, renewable energy, and pollution prevention technologies for industrial applications. OIT is part of the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy.

OIT encourages industry-wide efforts to boost resource productivity through a strategy called Industries of the Future (IOF). IOF focuses on the following nine energy- and resource-intensive industries:

- Agriculture
- Aluminum
- Chemicals
- Forest Products
- Glass
- Metal Casting
- Mining
- Petroleum
- Steel

OIT and its BestPractices program offer a wide variety of resources to industrial partners that cover motor, steam, compressed air, and process heating systems. For example, BestPractices software can help you decide whether to replace or rewind motors (MotorMaster+), assess the efficiency of pumping systems (PSAT), compressed air systems (AirMaster+), steam systems (Steam Scoping Tool), or determine optimal insulation thickness for pipes and pressure vessels (3E Plus). Training is available to help you or your staff learn how to use these software programs and learn more about industrial systems. Workshops are held around the country on topics such as "Capturing the Value of Steam Efficiency," "Fundamentals and Advanced Management of Compressed Air Systems," and "Motor System Management." Available technical publications range from case studies and tip sheets to sourcebooks and market assessments. The *Energy Matters* newsletter, for example, provides timely articles and information on comprehensive energy systems for industry. You can access these resources and more by visiting the BestPractices Web site at www.oit.doe.gov/bestpractices or by contacting the OIT Clearinghouse at 800-862-2086 or via email at clearinghouse@ee.doe.gov.



BestPractices is part of the Office of Industrial Technologies' (OIT's) Industries of the Future strategy, which helps the country's most energy-intensive industries improve their competitiveness. BestPractices brings together the best-available and emerging technologies and practices to help companies begin improving energy efficiency, environmental performance, and productivity right now.

BestPractices focuses on plant systems, where significant efficiency improvements and savings can be achieved. Industry gains easy access to near-term and long-term solutions for improving the performance of motor, steam, compressed air, and process heating systems. In addition, the Industrial Assessment Centers provide comprehensive industrial energy evaluations to small and medium-size manufacturers.

FOR ADDITIONAL INFORMATION, PLEASE CONTACT:

Peter Salmon-Cox
Office of Industrial Technologies
Phone: (202) 586-2380
Fax: (202) 586-6507
Peter.Salmon-Cox@hq.doe.gov
www.oit.doe.gov/bestpractices

OIT Clearinghouse
Phone: (800) 862-2086
Fax: (360) 586-8303
clearinghouse@ee.doe.gov

Please send any comments, questions, or suggestions to webmaster.oit@ee.doe.gov

Visit our home page at www.oit.doe.gov

Office of Industrial Technologies
Energy Efficiency
and Renewable Energy
U.S. Department of Energy
Washington, D.C. 20585



DOE/GO-102000-1118
December 2000
Steam Tip Sheet #18