Guide for increasing the maximum allowable working pressure of cast iron, ASME constructed paper machine dryers

Scope

The intent of this document is to provide a guide that may be used to increase the maximum allowable working pressure of American Society of Mechanical Engineers certified cast iron paper machine dryers. This process, in which no physical change is made to the dryer, is defined as an “alteration” by the National Board Inspection Code. Machine capacity may be increased by increasing the dryer steam pressure. This benefit may be accompanied by an increase in machine speed. Any increase in machine speed will also need to be considered as dryer rotational velocity additive to the internal pressure stress. This guideline does not address determination of additional stress due to increased machine speed. This guide also provides insight on jurisdictional and insurance provider acceptance, which may be required before any pressure increase is implemented.

This guide does not address a paper machine dryer that was not originally certified to the ASME Boiler & Pressure Vessel Code. A dryer manufactured for use in a jurisdiction or country that does not recognize the ASME Code or follows an alternate set of design and manufacturing standards is not addressed in this guide. Seek guidance elsewhere for dryers that were not certified to ASME Code.

Definitions

VT – Visual testing or inspection
PT – Penetrant testing or examination
MT – Magnetic particle testing or examination
UT – Ultrasonic testing or examination
AE – Acoustic emission examination
MAWP – Maximum allowable working pressure
ASME – American Society of Mechanical Engineers
ASME Code – ASME Boiler & Pressure Vessel Code, Rules for Construction of Pressure Vessels
NB – National Board of Boiler and Pressure Vessel Inspectors
NBIC – National Board Inspection Code
NDE – Nondestructive Examination
AI – Authorized Inspector
Safety precautions

There are no safety precautions associated with the implementation of this guide. The guidance provided involves analysis of information, not how to obtain that information.

MAWP alteration process

Review documentation to determine if dryer is suitable for continued operation. No dryer should be considered that is in a poor operating condition. All related components such as steam and condensate joints, syphons, spoiler bars, gaskets for the inspection openings and head to shell joints, dryer balance weights, bearings, bearing lubrication system, dryer alignment and drive components should be in satisfactory operating condition (1).

The steps in this process are:

1. Obtain Documentation
2. Obtain Authorization for Rerating
3. Perform Required Inspections and Tests
4. Stamping of Dryer with New Operating Pressure
5. Documentation of Rerating

1. Obtain documentation

- DESIGN CALCULATIONS
- ASME DATA REPORT (U-1 OR U-1A) FOR DRYER(S)
- NONDESTRUCTIVE EXAMINATION REPORTS

The following is a detailed explanation of the above documentation requirements:

a. Design calculations:

Calculations verify that the original design of the paper machine dryer can safely operate at a higher steam pressure. By “safely” it is meant that the stresses induced by the higher steam pressure are within the specified allowable stress of the construction code for a given material. Note that an increase in machine speed will also increase stress in the dryer.

ASME Code, Section VIII, Division 1, provides the basic dryer design requirements, with cast iron specific requirements in Part UCI (2). The original dryer manufacturer or a qualified engineering firm can provide calculations to document that the original design, with the higher pressure desired, and meets the design criteria of the ASME Code edition and addenda applicable for the date of original manufacture. Qualified individuals who are knowledgeable in paper machine dryers and paper machine operations should perform these calculations. This evaluation must consider the following imposed loads on the individual dryer components:

- Desired new steam pressure
- Thermal loads resulting from the drying process
- Centrifugal force from rotation of the dryer in the paper machine at new design speed
- Mass of the dryer and its related affects on the shell, journals and fasteners
- External loads such as dryer fabrics
- Condensate load
Calculation methods or documented tests to destruction (per ASME Code rules) under hydrostatic loads can determine the adequacy of the dryer heads. Calculations of dryer head journal strength, due to the imposed loads, may also be required.

**b. ASME Data Reports:**

The ASME Data Report(s) for a pressure vessel are issued by the vessel manufacturer. The original manufacturer may provide the Data Report, or it may be found in engineering files at the mill or central engineering office. If the Data Report cannot be obtained from these sources, the NB may have an original Data Report for the dryer on file. NB Data Reports are generally filed by Manufacture Name and “NB” number as shown on the pressure vessel nameplate.

Most ASME Code dryers are registered with the NB. Many states or other jurisdictional authorities, but not all, require NB registration at the time of manufacture. Dryers that are registered have a “NB” number stamped on the dryer or a separate nameplate attached to the dryer.

**c. Nondestructive examination methods:**

TAPPI TIP 0402-16 (3) provides a baseline for NDE to be completed on all dryers. Per the NBIC, NDE “may be conducted when contamination of the pressure-retaining item by liquids is possible or when pressure testing is not practicable. Concurrence of the owner shall be obtained in addition to the Inspector and Jurisdiction where required.”

VT: A visual internal inspection can be important in evaluating a dryer. Internal grooving due to a siphon pickup, loose balance weights or spoiler bars can be identified at this point. External grooving may also be present due to doctor blade wear.

MT: Test for cracks in the dryer heads and shell.

UT: Test of the dryer shell, and heads for thickness and test of the head attachment fasteners for cracks.

AE: Test results of dryer assembly for cracks may be substituted for water pressure testing (4).

All NDE reports must show that no relevant indications have been found that might affect the safe operation of the dryer. The results confirming the dryer shell thickness are usually the most important in the MAWP alteration process as actual shell thickness must equal or be greater than the thickness required for the desired operating steam pressure.

2. **Obtain authorization for rerating**

The Authorized Repair Agency is the entity that holds a NB issued certificate of authorization to apply the R stamp (NB-415) and is required to oversee all aspects of the alteration. An Authorized Inspection Agency and their designated AI function as a third-party entity to provide oversight of work performed by the Repair Agency. The responsible party in the jurisdiction must authorize alterations. This may be a city, state or provincial authority. In many jurisdictions the insurance provider representative serves as the AI and is a representative of the jurisdiction.

It is best to first discuss the dryer alteration with the insurance provider. The insurance provider will be knowledgeable in the procedures and official documentation that must be completed and signed. Review the supporting documentation with the AI to determine the procedures that will fulfill the requirements of the local jurisdiction.

If the documentation supports a higher MAWP, the AI and the jurisdiction may give acceptance and detail any additional inspection and tests required to complete this alteration.

3. **Perform any additional inspections and tests**

Alterations require some form of NDE or testing. Exclusive use of visual inspection is not acceptable per the NBIC (5). The NBIC (5) permits examination techniques other than water pressure testing to be employed, such as acoustic emission testing, when acceptable to the jurisdiction. AE has been successfully used in lieu of hydrostatic testing in a number of states. If applied, the minimum pressure test information is stated in the NBIC (5). Two certified test gages should be used for the test. The pressure should be held for a minimum of ten minutes prior to examination for leaks. The AI must pre-approve the test procedure(s) including duration of pressure hold, and witness pressure or other tests procedures.

Pressure (hydrostatic) testing is not desirable or recommended because the weight of a water filled dryer will significantly increase the dryer load on the bearings, machine frame and foundations. An engineering review should
be done when water pressure tests are considered for dryers installed in the paper machine. Temporary supports may be needed to support the dryer. If pressure testing is required for a dryer that is to be operated, the dryer should be examined for damage from the water pressure test before placing the dryer in service.

If pressure testing is required, the dryer can be filled with water by use of the steam or condensate joint connection on the dryer journal. The suitability of the actual steam or condensate joint to be free of leaks at the test pressure application must be considered. Ensure all air has been removed from the dryer prior to pressurization.

A pressure test may reveal leaks, which should be corrected before the dryer is returned to service. If steam leaks occur later, they can damage the dryer head, shell or bolts and may require the dryer being shut off from steam until corrective action is completed.

4. **Stamping of dryer with altered MAWP**

The dryer must be stamped with the altered MAWP. A new nameplate or stamping is typically required by the jurisdiction and may be applied adjacent to the original nameplate. The appropriate stamping information is stated in the NBIC (5).

5. **Documentation of alteration**

As stated previously, increasing the MAWP of a paper machine dryer, as originally stamped, is an alteration per the NBIC. NBIC Form R-2 is completed by the authorized repair agency performing the MAWP alteration evaluation. The AI(s) that reviewed the design change and witnessed all the tests will be responsible for signing the appropriate section(s) of the completed Form R-2. The authorized repair agency will appropriately distribute the Form R-2. The paper mill should keep copies of the Form R-2 with the other documentation on their paper machine dryers.

**Keywords**

Paper machines, Dryers, Cast iron, Steam, Pressure

**Additional information**

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**Literature cited**

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