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Guidelines for routine periodic inspection and testing of cast iron Yankee and MG dryers

Scope

This Technical Information Paper (TIP) provides guidelines for routine periodic inspection and testing of cylindrical pressure vessels made from gray cast iron (GCI) known as Yankee or MG dryers, used as rotating, steam-heated dryers in paper machines. The purpose of the paper is not to provide detailed inspection procedures but to provide an industry wide “benchmark” on the scope and frequency of recommended inspections and tests giving the mill a better understanding so they can better: plan outages, evaluate contractors and identify & rectify problems.

Safety precautions

Personal safety for inspectors should be ensured by complying with jurisdictional and mill procedures for lockout procedures and safe entry of a confined space. The dryer must be cooled enough for safe entry and adequately ventilated. All personnel shall use the specified personnel protective equipment (PPE).

Definitions

Group definitions

Safety, a failure may cause one or more of: injury or death to personnel, damage to capital equipment, damage to environment.

Reliability, a failure may cause one or more of: unplanned outages, additional maintenance costs.

Process, a failure may cause one or more of: reduced product quality, reduced production, reduced efficiency.

Condition definitions

Run, the machine is in normal operation.

Stop, the Yankee not rotating but it is still hot.

Cool, the Yankee is stopped and has been cooled sufficiently for entry.

Person definitions

Operator, a machine operator who understands the process.

Competent, a person who has sufficient experience and understanding to complete the task.

Responsible, an assigned person at the mill with authority and understanding.

Qualified, a person who is technically qualified to complete the task, this may require documented evidence.

TIP Category: Automatically periodically reviewed (5 years)



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Certified, a person or organization that meet the statutory requirements of the local jurisdiction and is certified to that end.

Introduction

A Yankee (used in the production of tissue) or MG (machine glaze, used to gloss paper or board) dryer is characterized as: a cast iron pressure vessel. It has a flanged shell, two heads, two journals, center stay (journals and stays can be several pieces bolted together or integrally cast), and condensate removal system. It differs from the regular “can dryer” by having a center stay and a pressure roll loaded on the outside. They are also larger in diameter, typically 8 to 23 ft (2.5 to 7 m) in diameter. See Figure 1.

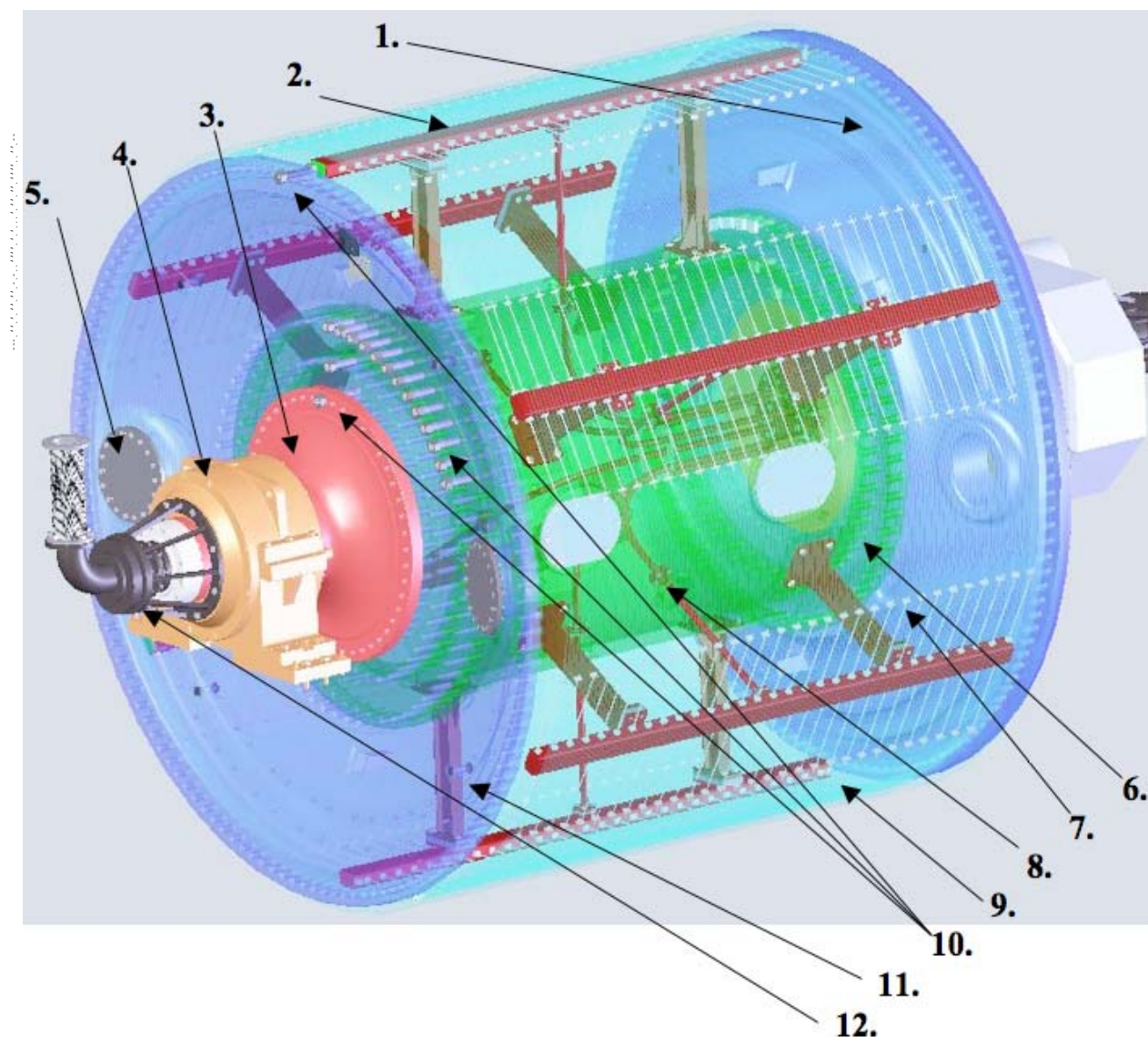


Fig. 1. A typical ribbed Yankee dryer (there are many variations in design). 1 = back head; 2 = header; 3 = front journal; 4 = front bearing housing; 5 = manhole cover; 6 = center stay; 7 = condensate straw; 8 = condensate piping; 9 = shell (transparent); 10 = pressure containing bolts; 11 = front head; 12 = front steam joint.

Routine periodic inspections

Table 1 lists the recommend routine periodic inspection and tests, the group it affects, the condition the vessel needs to be in to complete the inspection or test, the person or organization who should complete the inspection or test, the method of inspection or test and the frequency of the inspection or test. It should be noted that these guidelines are for a vessel in good condition and therefore consideration of the age, design and condition of the vessel should be taken into account.

Table 1. Recommend routine periodic inspection and tests

<i>Inspection</i>	<i>Group</i>	<i>Condition</i>	<i>Person</i>	<i>Method</i>	<i>Frequency (Months)</i>
Spring type safety relief valves (pressure lift)	Safety	Stop	Responsible	Test	12
Lever type safety relief valves (pressure lift)	Safety	Stop	Responsible	Test	6
Pilot operated safety relief valves (pressure lift)	Safety	Stop	Responsible	Test	6
Head Tilt	Safety	All	Competent	Instrument	12
Safety Interlocks	Safety	Stop	Responsible	Test	12
Pressure & nip load instrumentation calibration	Safety	Stop	Responsible	Test	12
Shell thickness	Safety	Stop	Competent	Instrument	24
Cracks, wear, erosion, corrosion & damage of External Iron parts	Safety	Stop	Competent	Visual	24
Cracks, wear, erosion, corrosion & damage of Internal Iron parts	Safety	Cool	Competent	Visual	24
UT bolts / screws (pressure containing)	Safety	Cool	Qualified	Instrument	60
Steam quality	Reliability	Run	Operator	Instrument	0.25
Bearing vibration	Reliability	Run	Qualified	Instrument	0.25
Steam leaks	Reliability	Run	Operator	Visual	1
Shell runout	Reliability	Stop	Competent	Instrument	12
Internal screws, weights and brackets	Reliability	Cool	Competent	Visual	24
Insulating sleeve Condition	Reliability	Cool	Competent	Visual	60
Straw condition	Process	Cool	Competent	Visual	24
Header condition	Process	Cool	Competent	Visual	24
Internal piping condition	Process	Cool	Competent	Visual	24
Internal gaskets	Process	Cool	Competent	Visual	24

Pressure relief devices

A pressure relief device is a safety device designed to protect a pressurized vessel or system during an overpressure event. An overpressure event refers to any condition which would cause pressure in a vessel or system to increase beyond the specified design pressure or maximum allowable working pressure (MAWP). They are precision items set to close tolerances and have accurately machined internal parts. They are susceptible to misalignment and damage if mishandled or incorrectly installed.

The set pressure and capacity of the safety valve must be in accordance with the local regulations.

Valves should be transported upright if possible and they should never be carried or lifted by the easing lever. In addition, the protective plugs and flange protectors should not be removed until actual installation. Care should also be taken during movement of the valve to avoid subjecting it to excessive shock as this can result in considerable internal damage or misalignment.

Types of valves which can be found protecting a Yankee dryer (depending on jurisdictional authority requirements): a pilot operated type valve, a spring operated valve, and a lever operated relief valve (see Figs. 2-4).



Fig. 2. Spring type valve



Fig. 3. Pilot operated valve



Fig. 4. Lever valvetype.

Pilot operated valves (PORV)

The essential parts of a PORV are a pilot valve (or control pilot), a main valve, a pilot tube, the dome, a disc or piston, and a seat. The volume above the piston is called the dome.

A pilot-operated pressure safety valve consists of the main valve, which normally encloses a floating unbalanced piston assembly, and an external pilot. The piston is designed to have a larger area on the top than on the bottom. Up to the set pressure, the top and bottom areas are exposed to the same inlet operating pressure. Because of the larger area on the top of the piston, the net force holds the piston tightly against the main valve nozzle. As the operating pressure increases, the net seating force increases and tends to make the valve tighter. This feature allows most pilot-operated valves to be used where the maximum expected operating pressure is higher than 90% of MAWP.

The pilot type has a sensing line and its function is transmitting the built-up pressure that may exist in the pressurized system to the pilot valve. As the pressure in the pressurized system is increasing and reaching the set pressure, the pilot valve will actuate the PSV spring inside the main valve to pop up the PSV. Due to the actuator has no direct contact with the venting system the valve will not relatively be affected by backpressure. Moreover, this type of PSV has a wide range of spring settings. See Fig. 5.

Safety relief valve (SRV)

The significant elements of all spring-loaded pressure relief designs are the springs and the seats.

The springs must provide the desired compression rate and a reasonable range of adjustment. They must also fit into the valve bonnet and stay within the design perimeters.

The seats may be flat or angled, metal or soft. As the seat area usually defines the load transmitted to and from the spring, very high precision is essential to ensure proper valve operation. See Fig. 6

Lever relief valve (LRV)

The significant elements of all lever type pressure relief designs are the lever and weight and the seats. The weight lever must provide the desired compression rate and a reasonable range of adjustment. These valves are allowed in some countries but are not an acceptable valve according to the ASME. If allowed by the Jurisdictional Authority it is extremely important that these valves are calibrated every six (6) months to ensure proper operation. This type of

valve can be easily abused and therefore not recommended by the TAPPI Yankee Dryer Safety & Reliability Subcommittee. See Fig. 7.

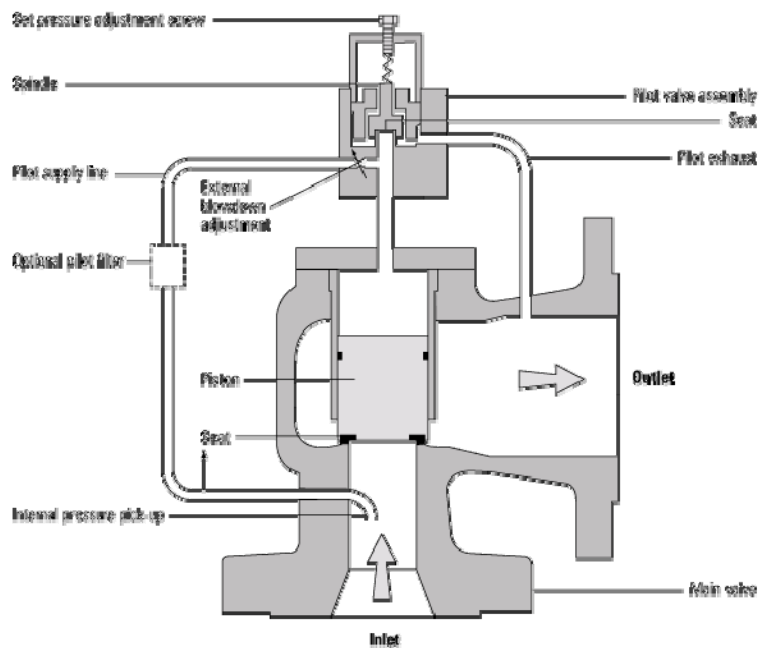


Fig. 5. Pilot operated valve

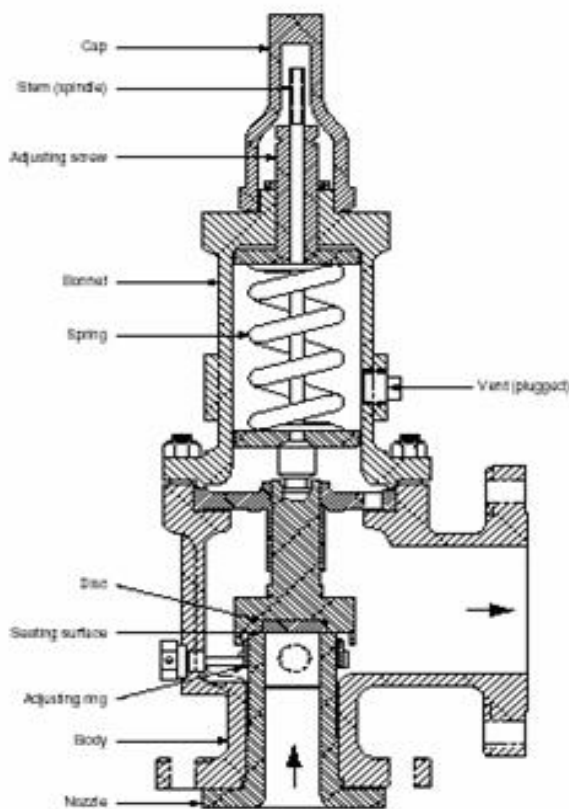


Fig. 6. Safety relief valve.

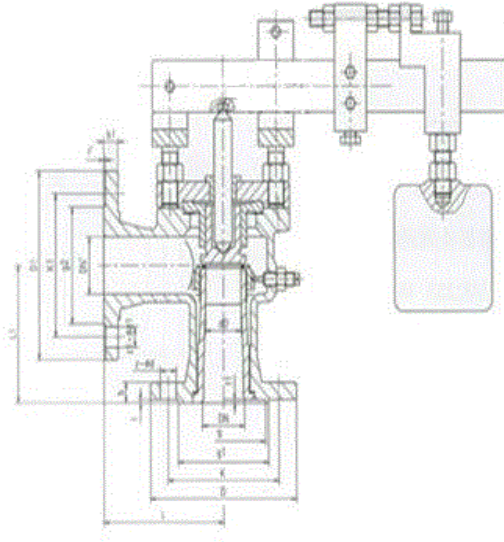


Fig. 7. Lever relief valve.

Testing and maintenance

Pressure relief valve testing is one of the most important elements of an effective maintenance program.

Spring type pressure relief valves on Yankee dryers should be pressure tested every 12 months from the date of the last test and removed every 60 months for servicing. Pilot operated value and lever operated valves should be pressure tested every 6 months and removed every 12 months for servicing.

There are many techniques available for conducting pressure relief valve tests. The most desirable type of test is one that subjects the pressure relief valves to the full operating conditions that it is expected to endure. Such a test has the advantage of assuring that all of the operating characteristics of the valve, set pressure, lift and blowdown are acceptable.

An alternative is the bench test. There are many contract services that provide pressure relief valve testing capabilities. It is important to review and qualify these service contractors in the same manner that valve suppliers are reviewed. The best choice is the manufacturer directly. If this option is impractical, then the manufacturer's authorized service center would be recommended. This alternative has the disadvantage of having to remove the valve.

As another alternative an external hydraulic lifting device, Electronic valve testing (EVT) commonly referred to as a Trevitest or Hydrosset, by a contracted, certified technician. Trevitest is widely accepted by safety authorities and industrial insurance companies in all the key areas of operation including ASME and National Board in the USA, the HSE and Lloyds Industrial Services in the UK and the TUV in Germany.

As an alternative to a pressure test, the valve may be checked by the owner for freedom of operation by activating the test or "try" lever (manual check). When doing this test, it should be performed only at a pressure greater than 75% of the stamped set pressure of the valve or the lifting device may be damaged. This test will only indicate that the valve is free to operate and does not provide any information on the actual set pressure. All manual checks should be performed with some pressure under the valve in order to flush out debris from the seat that could cause leakage.

Pressure relief valves are mechanical devices which require periodic preventive maintenance even though external inspection and test results indicate acceptable performance. There may be wear on internal parts, galling between sliding surfaces or internal corrosion and fouling which will not be evident from an external inspection or test.

Periodic re-establishment of seating surfaces and the replacement of soft goods such as o-rings and diaphragms are also well advised preventative maintenance activities which can prevent future problems. If the valve is serviced, a complete disassembly, internal inspection and repair as necessary, such that the valves condition and performance are restored to a like new condition, should be done by an organization meeting the requirements of the jurisdictional authority.

Head tilt

The sole purpose of head tilt measurement is to monitor head to shell corrosion. Head to shell corrosion, or crevice corrosion, is probably the most serious problem that can occur with a Yankee. If undetected, it gradually becomes worse until a catastrophic failure occurs. See Fig. 8

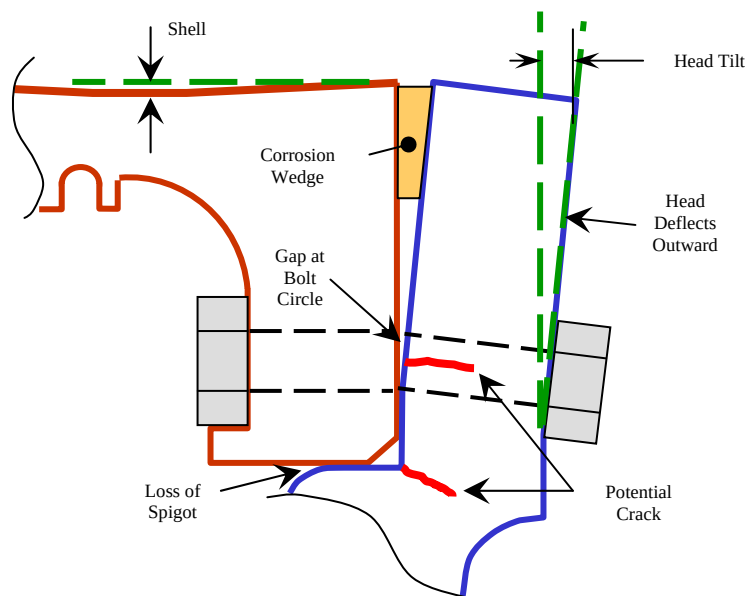


Fig. 8. Head tilt.

The problem was first identified in 1985, and since then several studies have been undertaken to understand the problem and formulate solutions. The problem can be stopped before failure occurs, if the problem is identified early.

Crevice corrosion requires two elements: a crevice and corrosive elements. On some dryers at the head to shell joint a crevice occurs when the relatively cold paper shrinks the shell and causes it to pull away from the head. The corrosive elements come from the wet end and get into the crevice. Iron oxide, or rust, is typically three times the volume of the iron it came from; therefore, the crevice soon fills up and starts “jacking” the joint open. Jacking increases the stresses in the bolts and head, and it will eventually result in the failure of the head. The stresses significantly increase when the Yankee is in a grind situation with no cold sheet on the dryer, and the crevice tries to close; this is when most failures occur. See Fig. 9.

There are several methods of measuring head tilt; all are acceptable providing the method is kept consistent. The results will have little meaning if the method, state of the dryer (cold, hot, under pressure), or competency of user are not consistent between measurements:

1. *Mechanical tilt gauge* – this is a custom made device that gives a micrometer reading of tilt. The span can be adjusted for different design dryers; the span must be consistent for meaningful results. It is recommended that the person using the gauge is competent and experienced in its use. See Fig. 10.