

Safe Yankee grinding practices

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ABSTRACT: *Yankee dryer grinding is a routine maintenance practice, undertaken to restore dryer contour, surface finish, and total indicator runout. It is necessary that human, asset, and environmental considerations be made when developing a safe grinding procedure. Safe grinding practices include appropriate use of interlocks, personal protective equipment, guards, procedures, and dust collection equipment. Adherence to local and federal guidelines and regulations is also addressed.*

KEYWORDS: *Comminution, drum driers (dryers), equipment, grinding, maintenance, procedures, safety, Yankee driers (dryers).*

On-site machining to restore critical surface conditions of Yankee dryers is a necessary routine maintenance practice. The machining procedures used have evolved through the years from flat tooling and superfinishing to hard-wheel grinding, high-speed tooling, and modern belt-grinding techniques.

Because of the infrequent and specialized nature of the grinding process, and personnel training required for this critical operation, mills must ensure that safe grinding practices are followed. Whether a mill controls the grinding process or sub-contracts the work, it is incumbent upon the paper manufacturer to understand the essential elements of grinding safety.

Safety, as related to the grinding practices, is an often neglected but critical issue when working on pres-

sure vessels. Safety issues concerned are:

- Yankee dryer operational safety
- Grinding process and equipment
- Grinding personnel safety.

Grinding of Yankee dryers

There is a variety of grinding techniques used for Yankee maintenance. The techniques range from tooling and superfinishing, form-roll grinding and tube grinding to belt grinding. Belt grinding is the most prevalent form of Yankee surface maintenance in use today and is the focus of this paper. Safety considerations, however, are basically generic and can be applied to all grinding practices.

Operational safety

Prior to commencing a grind, all pertinent information on the dryer should be compiled and reviewed by the project engineer and grind leader.

At a minimum, the following information should be reviewed by them:

- Dryer diameter and shell width
- Manufacturer's data
- Design and operating pressure
- Steam pressure and pressure-roll derate curves
- Current allowable pressure and safety relief valve setting
- Centerline diameter and current wall thickness (actual and original)
- Surface type: cast iron (class) or thermal spray coating (type)
- Proposed crown
- Plug and defect reports
- Anomalies
- Current surface condition including TIR (total indicator runout) and current dryer contour (crown)
- Previous grind reports.

If some of the dryer information is not available, the original equipment manufacturer (OEM) and grinding contractors can be a valuable source for obtaining the information. TAPPI publications on safe

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I. Overview of measured work area concentrations (mg/m³)

	MAK and TRK Values ^b					
	Specification			Measured		
	Ni	Cr ^a	Dust	Ni	Cr ^a	Dust
Rough grinding cast iron	0.5	0.5	6	0.03	0.01	2.2
Finish grinding moly/chrome	0.5	0.5	6	0.43	0.06	2.1

^a Molybdenum/chrome material concentration 0.87 g/kg, of which Chromium VI is 0.0012 g/kg
^b MAK = Maximale Arbeitsplatzkonzentration
 MAK = PEL = permissible exposure limit
 TRK = Technische Richtkonzentration
 TRK = TLV = Threshold limit value

operation¹ and condition assessment² are useful references for anyone involved with the operation and maintenance of Yankee dryers.

If operating conditions have changed or if shell thickness has been reduced by 6 mm, the dryer's crown should be recalculated by qualified personnel using finite element analysis, not empirical methods.

Maximum allowable working pressure curves must be calculated according to American Society of Mechanical Engineers (ASME), Technische Ueberwachungs Verein, or local statutory authorities based on shell thickness and material. Actual shell thickness, combined with OEM or equivalently calculated pressure and pressure-roll derate curves (**Fig. 1**), is the basis for the determination of ASME Section 8, Division I safe operating conditions. Methods used for shell thickness determination include: Pi tape, calipers, ultrasonic, and optical metrology.

¹Corboy, W. G., Guidelines for the Safe Operation of Yankee Dryers, Yankee Dryer Safety Subcommittee, TAPPI PRESS, Atlanta, Item no. 0101R122 for reprints.

²Corboy, W. G., Yankee Dryer: Guidelines for Safety and Condition Assessment, Yankee Dryer Safety Subcommittee, TAPPI PRESS, Atlanta, Item no. 0101R202.

Grinding process and equipment safety

Machine preparation

The machine should be stripped of all components that might interfere with the safe installation and operation of the grinding equipment. Simultaneous work should not be scheduled overhead of the grinding operation. Machine cleaning is vital to a safe Yankee grinding project. The entire machine area, including the floors, beams, and hoods, should be thoroughly cleaned of pulp, paper, dust, and grease, which might pose a serious fire hazard. Poor housekeeping also contributes to slipping and other dangers.

The grinding platform should be of sound construction with adequate length, width, back rails, and steps. Platforms should be designed to accommodate a minimum of four times the load for which they are intended, and span lengths should not exceed the load and lumber specifications. Detailed information on the safe construction of temporary work platforms can be found under OSHA Regulation 1910.28 or DIN 4420. The grinding area should be well lighted across the entire width of the cylinder.

Interlocks

The use of hard-nip contact wheels on high-powered belt grinders induces aggressive cutting powers and energy densities (10 MW/m²). It is therefore essential that the rotation of the Yankee cylinder be monitored by fail-safe sensors which will interrupt the grinding process upon rotation failure. A method that monitors head bolt rotation and shuts down the grinder if the preset speed varies by more than $\pm 20\%$ has proven to be the most effective.

An interlock that shuts down the grinder if the grinder housing access door is removed during operation is a worthy consideration for the protection of the grinding crews and is standard on some modern grinders.

Guards

The rotating parts (contact wheel, drive wheel, grinding belt) should be completely housed with only an access door for belt and contact wheel changes. Belt changes should be performed with the contact wheel backed away at least 25 mm. Contact wheel changes should only be performed with the Yankee cylinder at a standstill. Contact wheels should be dressed on a regular basis to keep the wheel true and grinding uniform. This will avoid localized heat build-up in the contact wheel, which can lead to failures.

Stops should be installed to ensure that the grinding head does not traverse off the end of the grinding beam.

Measurements

Pi taping. The cylinder should be stopped while a string on the tape is attached to the head bolt. The dryer should then be rotated slowly and stopped to allow safe removal of the string after one revolution. The string should then be used as a tool to pull the tape around the dryer. The taping of the dryer is done with the dryer stopped and at full grinding pressure. It is important to carry

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out these measurements as efficiently as possible to minimize the time the pressurized dryer is not rotating. Begin rotation as soon as the measurements are complete and the tape safely removed. Because the dryer remains under pressure, safe operating practices dictate that Pi tape measurements must generally be completed within 30 minutes. At this time, the dryer must be restarted and rotated for 10 minutes before shutting down again.

TIR. These measurements are taken with the cylinder rotating and should be documented prior to and at the end of the grind. Stopping the dryer for Pi tape measurements can affect the TIR by as much as 0.2 mm. Therefore, readings should be taken only after the dryer has rotated for 10 minutes or when TIR has stabilized. Particular attention should be given to pregrind measurements on the secondary crown, which are important for historical reasons of wear and safety, as well as the documentation of any local high or low spots.

Surface finish. These measurements are done with the dryer stationary. If spot checks to determine grinding progress are necessary, the cylinder can remain pressurized but only for a maximum of 30 minutes. If detailed final measurements are required, the dryer should not be under pressure.

Head tilt. For historical reasons these measurements should be taken, at a minimum, during each grind. During the life of the dryer, head tilt variation can indicate the potential of head-shell interface crevice corrosion.²

Repairs

Dryer porosity is often exposed during the grinding process. Any surface repairs required (plugging or local spot repair) should only be performed on a pressureless cylinder by qualified technicians. Plugging a dryer should be done in accordance with ASME Code UCI-78 and TAPPI guidelines.¹ Local spot re-

II. Overview of emissions

	Emissions, mg/m ³					
	TA-Luft ^b			Measure values		
	Ni	Cr ^a	Dust	Ni	Cr ^a	Dust
Cast iron (wet collector)	1	5	50	0.095	0.02	1.9
Cast iron (dry collector)	1	5	50	0.051	0.01	1.1
Moly/NiCr (wet collector)	1	5	50	0.23	0.031	1.8
Moly/NiCr (dry collector)	1	5	50	0.2	0.03	1.8

^a TA-Luft for Chromium VI = 1 mg/m³
^b TA-Luft = Technical Specification Air Emissions
 TA-Luft ≈ EPA values

pairs are sometimes performed with plastic-metal resin fillers but more commonly with thermal sprayed metals. In the case of the latter technique, application should be made only by technicians certified in this type of repair.

Maintenance

Grinders require routine maintenance to continue to operate safely. Visual inspection of the contact wheels should be made each time the wheel requires truing. Visual inspection of all grinding equipment should be conducted prior to every grind to check for possible damage which may have occurred during storage or transport. A more detailed preventive maintenance inspection should take place after every sixth grind to check for worn parts which may pose a safety hazard under operating conditions. All parts that are worn beyond acceptable design tolerances should be replaced but only with parts that meet or exceed the original design specifications of the grinding equipment.

Grinding personnel safety

Grinding environment

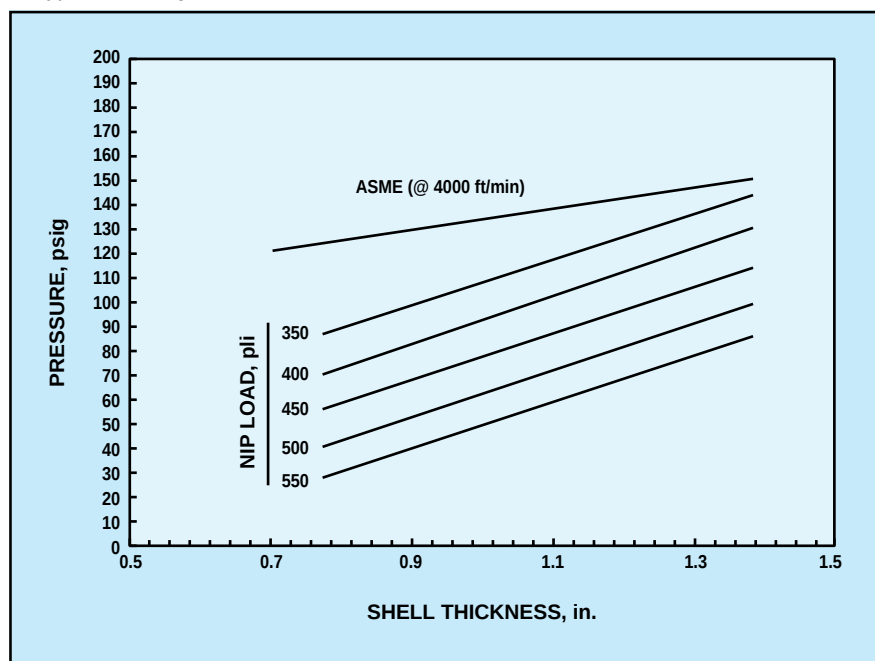
Dry-belt grinding of Yankee dryers generates vast amounts of relatively fine dust. Cast iron grinding can reach 750 g/min stock removal rates. It is important that this material be adequately contained to minimize human exposure to the metal and oxide dust.

In the past decade, molybdenum/nickel chrome coatings have been widely applied to Yankee dryers throughout the industry. Grinding these dryers requires even more stringent precautions because of hazards regarding nickel and chromium dust exposure.

A dust control system should contain the following design considerations:

- During the grind, dust should be adequately caught directly at the source using exhaust nozzles.
- Dust should be transported using metal-lined flex exhaust ducts.

1. Typical derating curve



- Dust collector should possess sufficient capacity and filtering capability.
- Dust collector should, when possible, be positioned outside in the open.
- Dust from the collector should be handled and disposed of in adherence to federal regulation Title 40 CFR, Part 261, Subpart C and local guidelines and regulations.
- Yankee dryer exhaust fans should be running during the grind.
- Adequate fire extinguishing equipment should be present at all times.

During the summer of 1993, working area and emission measurements were carried out during the grinding of a Yankee dryer.

The program was undertaken to determine what type of exhaust equipment is necessary to obtain exposure levels below legal standards.

Equipment tested included:

- Wet collector

Manufacturer:	Handte & Co.
Type:	STWV-5
Capacity:	2000 m ³ /h 6.0 kW
- Cyclone dry collector

Manufacturer:	Rehfus
Type:	VWM 16 Z FFS
Capacity:	1800 m ³ /h 5.5 kW

Tables I and II demonstrate that with the proper cleaning and filtering equipment legal limits can be easily obtained.

For baseline purposes, a measurement was taken without any exhaust equipment. Proper measurements could not be obtained due to block-

ing of the test filters as a result of the vast amounts of dust.

Personal protective equipment

It is important that the grinding personnel be protected against the hazards of the grinding environment.

Eye protection. The grinding process has the potential to cause serious eye injury both from the normal grinding operation and rare catastrophic events. Therefore, eyewear which meets or exceeds ANSI Code Z87.1 is mandatory for any personnel on the grinding platform.

Hearing protection. The consistent noise levels associated with Yankee grinding require ear protection with a minimum noise reduction rating of 22 dB.

Clothing. Because grinding involves rotating elements and nip points, clothing should be durable, in good condition, and not loose fitting. Safety shoes should be worn at all times while in a paper mill environment. Shoulder length or longer hair should be safely contained.

Dust respirator. In the cases where an adequate removal system is not available, precautions against inhalation of grinding dust must be taken. Dust masks must fit well and meet or exceed ANSI Code Z88.2-1969 to minimize possible overexposure of personnel.

Conclusions

Yankee dryers can be ground in a safe and reliable manner by utilizing specially designed machinery equipped with the appropriate safety devices and well-trained grinding specialists. ■

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