

TIP 0404-02

OLD NUMBER 014-11
ISSUED - 1972
REVISED - 1984
REVISED - 1989
REAFFIRMED - 1994
REVISED - 2001
REAFFIRMED - 2005
©2005 TAPPI

The information and data contained in this document were prepared by a technical committee of the Association. The committee and the Association assume no liability or responsibility in connection with the use of such information or data, including but not limited to any liability under patent, copyright, or trade secret laws. The user is responsible for determining that this document is the most recent edition published.

Measurement of dryer condensing rates (batch method)

Scope

This Technical Information Paper outlines a method to measure condensing rates and blowthrough steam flows from a single dryer cylinder. Separate methods are provided for dryers operating above atmospheric pressure and those under low pressure or vacuum. The methods require that discharge from the dryer be temporarily diverted and collected in a drum of water.

Safety precautions

This method for measuring the rate of steam condensation places the technician near steam (hot water vapor) and condensate (hot liquid water) under pressure. Care must be taken to ensure that all equipment is properly and securely connected. Extreme care should be taken to avoid contact with hot pipes, valves, and other equipment. Use hand and eye protection when setting up and operating the equipment.

Content

Test instructions

Dryers operating under pressure (Fig. 1)

1. Measure tare weight of drum.
2. Fill drum approximately 2/3 full with cold water.
3. Measure weight of drum and cold water.
4. Measure temperature of cold water in drum.
5. Measure steam supply temperature.
6. Measure steam supply pressure.
7. Open valve V_1 and measure dryer discharge pressure.
8. Shut valve V_3 ; open and regulate valve V_2 so that the dryer discharge pressure does not change.
9. Let steam and condensate flow stabilize in hose, then plunge into drum of cold water. Start stop watch.
10. When water temperature in the drum approaches 60°C (140°F), remove hose and simultaneously stop the stop watch.
11. Measure weight of drum and hot water.

Symbols, formulae, calculations, and results

Tables 1 and 2 show symbols used in calculations, along with units (SI and English) and an example of typical results.

Table 1. Test information and design data.

Symbol	Definition	SI		English	
		Units	Sample	Units	Sample
W_1	Weight of empty drum	kg	20.4	lb	45
W_2	Weight of drum and cold water	kg	144	lb	318
W_3	Weight of drum and hot water	kg	167	lb	368
t_c	Temperature of cold water	°C	30	°F	86
t_n	Temperature of hot water	°C	58	°F	137
t_s	Supply steam temperature	°C	149	°F	300
P_s	Supply steam pressure	kPa	262	psig	38
P^s	Dryer discharge pressure or vacuum	kPa	193	psig	28
T^c	Elapsed time	min	1.95	min	1.95
C	Specific heat of drum	kcal/kg/°C	0.12	Btu/lb/°F	0.12
A_s	Dryer surface area (dryer circumference x paper width)	m ²	19.5	ft ²	210

Table 2. Steam table values.

Symbol	Definition	SI		English	
		Units	Sample	Units	Sample
h_{gs}	Total heat in supply steam	J/kg	2.754×10^6	Btu/lb	1183.8
h_{gc}	Total heat in blow-through steam	J/kg	2.723×10^6	Btu/lb	1170.6
h_{fgc}	Latent heat in blow-through steam	J/kg	2.167×10^6	Btu/lb	931.6
h_{fc}	Heat in dryer discharge condensate	J/kg	5.56×10^5	Btu/lb	239.0

The unknowns to be found are:

W_c = weight of dryer discharge condensate, kg/h (lb/h)

W_d = weight of total dryer discharge, kg/h (lb/h)

W_s = weight of blow-through steam, kg/h (lb/h)

H_c = total heat in dryer discharge, J (Btu).