ISO Standards Introduction Milking Machine Performance Requirements

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Learning Objectives

In this module, we will…

- Learn about the performance requirements for milking machines as presented in the international standard:

  "ISO 5707: Milking Machine Installations – Construction and Performance"

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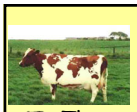

Types of Performance Tests

- There are 3 general categories of performance tests for milking machines:
  1) **Dry tests:** done with only air flowing in the milking machine.
     - ✓ Used to determine the adequacy of the vacuum production and control system.
  2) **Wet tests:** done with an artificial udder using water to simulate milk flow.
     - ✓ Usually done to test the average vacuum drop across milking machine components using a known flow rate of water.
  3) **Milking-time tests:** done during milking when both milk and air are flowing through the milking machine.
     - ✓ These are the most direct tests to determine the performance of the milking machine under its normal use conditions.

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Dry Tests

- Let's start by looking at the dry tests of milking machine performance:
  - These tests are the easiest to perform because the only test equipment you need is an air flow meter and a vacuum recorder.
  - These tests are done to determine the adequacy of the vacuum production and control system and the airline piping.

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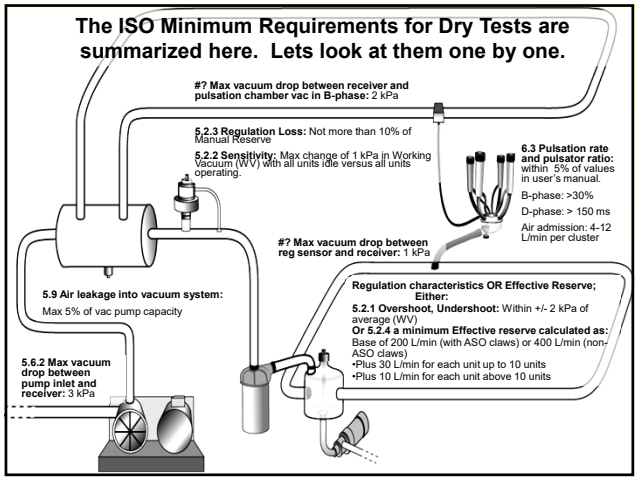
The ISO Minimum Requirements for Dry Tests are summarized here. Lets look at them one by one.



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Vacuum System Dry Tests

Vacuum Regulation

The ultimate goal of vacuum regulation is to maintain vacuum conditions at the teat end within the intended range.

A properly designed, installed, and maintained milking machine should be capable controlling vacuum within certain limits when the operators use the machine with reasonable care.

Let's look at some of the requirements for vacuum control.

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Vacuum System Dry Tests

Vacuum Regulation

5.2.1 Regulation drift:

- The regulation system together with the vacuum pump capacity shall be such that the working vacuum, after a specified start-up period, in or near the receiver, is maintained within +/- 2 kPa of the nominal vacuum when tested in accordance with part 5.2.1 of ISO 6690.
- Drift refers to slow changes in vacuum over a relatively long period of time (10 minutes to several hours) during the time that the machine is in use.

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Vacuum System Dry Tests

Vacuum Regulation

5.2.2 Regulation Sensitivity:

- The regulator shall control the working vacuum such that, when tested in accordance with 5.2.2 of ISO 6690, the regulation sensitivity does not exceed 1 kPa.

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Vacuum System Dry Tests
Vacuum Regulation

5.2.3 Regulation Loss:

- In order to use the installed vacuum pump capacity efficiently the total regulation loss, when tested in accordance with 5.2.3 of ISO 6690, shall not exceed 35 l/min of free air or 10% of the manual reserve, whichever is greater.
- NOTE: Regulation loss and effective reserve depend on the vacuum pump capacity, the regulation characteristic, and the pressure drop between Vm and the regulator sensing point.

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Vacuum System Dry Tests
Vacuum Regulation

5.2.4 Regulation Characteristics and Effective Reserve:

- The regulation characteristic overshoot shall be less than 2 kPa when the fall off test is conducted in accordance with 5.2.4 of ISO 6690.
- Either the regulation characteristics vacuum drop and undershoot shall be less than 2 kPa when the fall off test is conducted in accordance with 5.2.4 of ISO 6690 or at least the minimum effective reserve standard atmospheric pressure given in Table A.1 for cows and buffalo and Annex D.1 for sheep and goats shall be fulfilled.

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Vacuum System Dry Tests
Vacuum Regulation

Regulation Characteristics and Effective Reserve (continued)

- NOTE: regulation loss and effective reserve depend on vacuum pump capacity, the regulation characteristic, and the pressure drop between Vm and the regulator sensing point. The effect of this pressure drop is that the vacuum regulating range for the regulator becomes smaller than 2 kPa.

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Vacuum System Dry Tests
Vacuum Regulator

5.4.1 Regulator Leakage

- The regulator leakage, when tested in accordance with 5.4.1 of ISO 6690, shall not exceed 35 l/min of free air or 5% of the manual reserve, whichever is greater.

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Vacuum System Dry Tests
Airlines

5.6.2 Internal Diameter and Air Flow

- The vacuum drop between Vr, the regulator sensing point, and Vm should not exceed 1 kPa, and the vacuum drop between Vr and Vp should not exceed 3 kPa when tested with an air inlet of the minimum effective reserve according to 5.2.5.
- NOTE: As a design guideline, the vacuum drop in the airline between the receiver and the regulator sensing point should not exceed 1 kPa and between the receiver and vacuum pump should not exceed 3 kPa at the effective reserve installed. The vacuum drop between Vm and Vr reduces the control range of the regulator and the vacuum drop between Vm and Vp increases power consumption.

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Vacuum System Dry Tests
Leakage into the Vacuum System

5.9 When determined in accordance with 5.9 of ISO 6690, leakage into the vacuum system shall not exceed 5% of the pump capacity.

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Pulsation System Dry Tests
Pulsator Airline

6.2 The vacuum drop between the working vacuum at the measuring point Vm and the maximum pulsation chamber vacuum shall not be more than 2 kPa when pulsation is tested in accordance with 6.3 of ISO 6690.

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Pulsation System Dry Tests
Pulsator Airline

6.3 Pulsation Rate, Pulsator Ratio, and Pulsation Chamber Vacuum Phases

- The pulsation rate should not deviate more than +/- 5% from the values given in the user's handbook.
- NOTE: Pulsation rate are typically between 50 and 65 cycles/min for cows and water buffalo, 60 to 120 cycles/min for goats, and 90 to 180 cycles/min for sheep.
- NOTE: In case of alternate pulsation in combination with claw a ratio of near 50% should be avoided due to pumping between teatcups. For cows and water buffalo, phase b should not be less than 30% of a pulsation cycle and phase d should not be less that 150 ms. Vacuum drop during phase b shall not be more than 4 kPa below maximum pulsation chamber vacuum, and the vacuum during phase d shall not be more than 4 kPa.

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Milk System Dry Tests
Air Leakage

7.3 The air leakage into the milking system, when tested in accordance with 7.2 of ISO 6690, in a pipeline, recorder, and automatic milking installation shall not exceed 10 l/min, plus:

- For movable milking units, 1 l/min per each milk inlet valve.
- For each fixed milking unit, 2 l/min.

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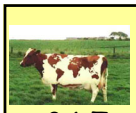

Milking Unit Dry Tests
Air Vent and Leakage

8.6 To allow effective milk transport from the claw and to limit excessive agitation of the milk and total air admission per cluster shall be at least 4 l/min and shall not exceed 12 l/min for cows and water buffalo, and 8 l/min for sheep and goats at the nominal working vacuum. The air vents shall be in a rigid material.

- For quarter milking, clusters with deliberate cyclic air admission or other specific design where the above quantitative requirements do not apply, the total air admission per cluster or teat cup shall be stated in the user's handbook.

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Milking Unit Dry Tests
Air Vent and Leakage

- Air vents necessary for proper operation of milk meters, automatic teatcup valves, or other devices may add air admission. The air use and location of such air vents shall be stated in the user's handbook.
- Leakage into each cluster assembly with the liners plugged and the vacuum shut-off valve opened shall not exceed 2 l/min. The air admission and air leakage shall be measured and calculated in accordance with 8.5 of ISO 6690.
- NOTE: All air vents should be positioned to avoid unnecessary turbulence in milk to limit free fatty acid development.

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Wet Tests

- Wet tests are done using an artificial udder using water to simulate milk flow.
- Artificial udders are suitable for measuring the average vacuum drop across milking machine components using a known flow rate of water.
- The measurements of the average vacuum at different locations should be done with a vacuum recorder, using a 5 second averaging interval.
- The vacuum recorder must have sufficient sample rate and response rate for the intended measurement.
  - See instrument requirements topic for details.
- Some of these wet tests are intended to be performed in a 'laboratory' by the manufacturer to develop recommendations for their equipment.
  - Some of these tests can also be performed on installed milking machines to verify compliance.

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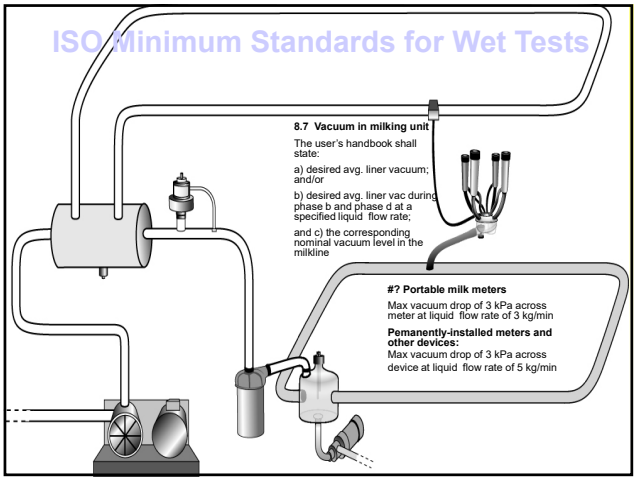
ISO Minimum Standards for Wet Tests



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Milking Unit Wet Tests

Vacuum in Milking Unit

8.7 The user's handbook for the milking unit shall state, for specified milk flows (where at least one shall be chosen from Table 1):

- The desired average liner vacuum and/or the average liner vacuum during phase b and phase d of the pulsation chamber vacuum.
- The corresponding nominal level in the milkline. This nominal vacuum shall be based on the average vacuum drop measured in accordance with Annex A of ISO 6690.
- NOTE: Both research and field experience indicate that a mean liner vacuum, within the range 32-42 kPa during the peak flow period of milking for cows ensures that most cows will be milking quickly, gently, and completely. Similarly, a mean liner working vacuum, within the range of 28-38 kPa during the peak flow period of milking for sheep and goats will ensure that most animals will be milked quickly, gently, and completely.

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Milking Unit Wet Tests

Vacuum in Milking Unit

Table 1— Reference flow Rates for different species

Spices Commercially Milked		Reference Liquid Flow for Testing kg/min
Cows	Low Producing	3
	High Producing	5
Water Buffalo	Low Producing	1, 5
	High Producing	2, 5
Sheep	Low Producing	0, 8
	High Producing	1, 5
Goats	Low Producing	1, 0
	High Producing	2, 0

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Milking-Time Tests

- Milking-time tests are performed during milking (of cows) when both milk and air are flowing through the milking machine.
- These are the most direct tests to determine the performance of the milking machine under its normal use conditions.
- The test equipment required is a vacuum recorder with appropriate sample rate, response rate and fittings for the intended test (see instrument requirements topic for more detail).

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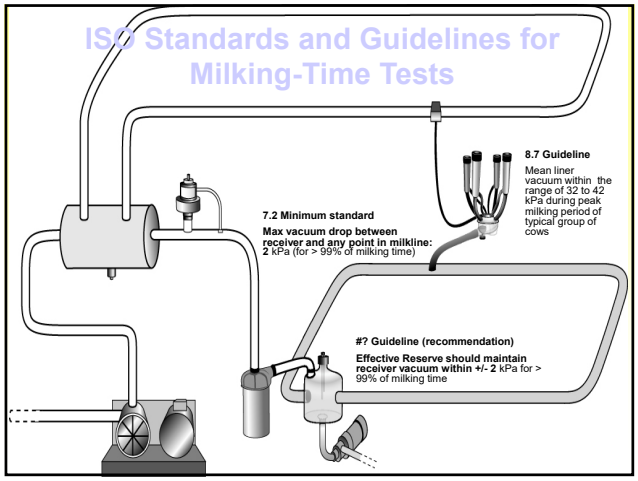

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Milk System Milking-Time Tests

Design of Milklines

7.2 The internal diameter and slope of the milkline shall be such that the vacuum drop between the receiver and any point in the milkline does not exceed 2kPa with all units operating at the designed milk and air flow rates.

- If the milkline is installed to form a loop, then each end of the loop shall have a separate full-bore connection to the receiver vessel. If several loops are used, two ends may be grouped together directly in front of the receiver to form a single line which has adequate cross sectional area for the combined milk and air flow rates.

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Milk System Milking Time Tests

Design of Milklines

- Milklines shall have a continuous fall towards the receiver for drainage measured in accordance with 7.1 of ISO 6690. Equipment that can cause obstruction or reduction in vacuum, milk flow, or drainage such as enlargements, restrictions, or filters, shall not be used.
- Branches in the milkline shall be swept in the direction of milk flow. The minimum centerline radius for bends shall be 1.5 times the diameter.

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Milking Unit Milking Time Tests

Vacuum in Milking Unit

8.7 The user's handbook for the milking unit shall state, for specified milk flows (where at least one shall be chosen from Table 1):

- The desired average liner vacuum and/or the average liner vacuum during phase b and phase d of the pulsation chamber vacuum.
- The corresponding nominal level in the milkline. This nominal vacuum shall be based on the average vacuum drop measured in accordance with Annex A of ISO 6690.
- NOTE: Both research and field experience indicate that a mean liner vacuum, within the range 32–42 kPa during the peak flow period of milking for cows ensures that most cows will be milking quickly, gently, and completely. Similarly, a mean liner working vacuum, within the range of 28–38 kPa during the peak flow period of milking for sheep and goats will ensure that most animals will be milked quickly, gently, and completely.

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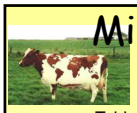

Milking Unit Milking Time Tests

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