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Field Testing of Milking Machines by the Veterinarian

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The question of veterinary involvement in milking machine (M M) analysis is controversial. It is the opinion of some that M M matters should be left to the M M serviceman's judgement.[3] The veterinarian should have an advisory role in M M management. With adequate knowledge and proper testing equipment a veterinarian can give an accurate and unbiased evaluation of M M function. The veterinarian should involve himself more in evaluating M M function and less in making recommendations on specific equipment designs.

The requirements[1] for analyzing M M systems are:

1. A knowledge of basic principles of the M M.
2. Testing equipment.
3. Evaluation forms.
4. Interpretation of data.

A fast, reliable and inexpensive analysis is necessary. The procedures explained here are adequate for this purpose.

The objectives of these procedures are to determine the vacuum system's capacity, its activity at the teat end and to appraise the equipment.

Equipment needed for this analysis is a vacuum recording device, (preferably a dual channel recorder) and an air flow meter. A mercury manometer would be helpful to periodically check the accuracy of the vacuum gauges of the recorder and air flow meter.

Figure 1 shows a form which when completed would contain the necessary data for the analysis. If possible the M M serviceman should be present at the evaluation. Step I through IV of the analysis are completed prior to milking. Step V and VI are completed during the milking operation.

Step I. Vacuum Pump Performance

Determine the air flow at the vacuum pump by breaking into the system as close

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† The American Society of Mechanical Engineers Method measures volume of air at sea-level pressure (Free Air).

‡ The New Zealand Method measures volume of air at 15 inches Hg vacuum.

to the pump as possible. Compare the air flow reading with the capacity of the pump as given by the manufacturer. If the pump does not meet these standards it should be checked by the serviceman. The capacity of the pump is then compared with the requirements of the system.

For optimal milking performance the vacuum system must have the capacity to remove sufficient air to maintain 15 inches of vacuum. Generally, air is admitted to the system by the vacuum regulator and through air admission holes in each milking unit.

Guidelines are used in selection of the appropriate sized pump to avoid overloading a pump. Air is measured by c.f.m. (cubic feet per minute). Each milking unit in a bucket system or a pipeline system can admit 2 or 4 c.f.m. free air (ASME Standard†) respectively. However,[4] if the NZ‡ standard is used 4 c.f.m. and 8 c.f.m. per milking unit can be admitted to the vacuum system. To determine the total c.f.m. capacity a pump must possess, multiply the number of units used by the amount of c.f.m. allowed per unit adjusted for the kind of system and method used. Add 50% of this subtotal for reserve. The total c.f.m. should be compared with c.f.m. determined at the pump and the manufacturer's ratings.

Example

4 buckets used *or* 2 pipeline units
12 c.f.m. ASME or 24 c.f.m. NZ—manufacturer's rating of pump
24 c.f.m. at pump determined with airflow meter

ASME Method		*New Zealand Method*	
4 buckets or 2 pipeline units		4 buckets or 2 pipeline units	
2 c.f.m.	4 c.f.m.	4 c.f.m./unit	8 c.f.m.
8 c.f.m.	8 c.f.m.	16 c.f.m.	16 c.f.m.
4 c.f.m.	4 c.f.m. (50% re-	8 c.f.m.	8 c.f.m.
12 c.f.m.	12 c.f.m. serve)	24 c.f.m.	24 c.f.m.

The pump should function adequately if it is maintained properly.

Step II. System Capacity

The vacuum reserve reading is taken at the end of the vacuum line with all units attached to the vacuum line, liners stoppered and all accessories including the vacuum regulator operating. In a double-slope pipeline disconnect one of the pipelines at the receiving jar, plug one end and measure at the other. In a single slope pipeline, measure at the dead end. In a bucket system measure at the dead end or furthest point from the pump. To make this determination measure the air flow necessary to lower the static vacuum ½ inch Hg. There should be a minimum of 2½ to 3 c.f.m. free air per unit or a reserve equal to an additional 50% of the total requirements of the installation.[5]

Step III. Vacuum Supply Lines

Measure the inside diameter of the vacuum line from the pump to the moisture trap and the diameter of the vacuum supply milkline and the pulsation line. The diameters should conform to published minimum standards.[1,7] Generally, all lines should be at least 1¼ inch I.D. for 1–3 units, 1½ inch I.D. for 4–8 units and 2 inches I.D. for 9–12 units. Take note of other factors which would reduce air flow such as numerous pipe fittings, excessively long lines, street L's and leaks.

Step IV. Milking Units

Liners should be designed to fit the teatcup shells. Narrow bore liners should be used (inside diameter less than ¾ inch). Liners should be replaced after 500 to 1,500 individual cow milkings[3]. Check for plugged air bleeder holes on the claws.

Step V. Pulsator Action—Line Vacuum

Measure the line vacuum maintained by the regulator. Generally, this level should be 14 to 15 inches Hg but it may be best to check tables of manufacturer's specifications.[6] Check the pulsation rate. Pulsation rates between 40 and 60 per minute seem to be adequate.[5] Make recordings from each pulsator with the vacuum recorder. Examine the recordings for evidence of sticky or sluggish pulsators. From the recording, determine the pulsator ratio. Pulsator ratios between 2:1 and 1:1 are adequate. A 1:1 ratio is acceptable but a 2:1 ratio will reduce milking time slightly. Pulsator ratios above 2:1 may be irritating, especially when coupled with vacuum above 13" Hg.[5]

Step VI. Teat End Recordings

At milking time set up the dual channel vacuum recorder on a milking unit to record pulsation and teat end vacuum simultaneously. Place the unit on a fast milking cow and have all other units in use at the same time. Take both rapid and slow speed recordings of the entire milking. From this recording determine if the pulsator is functioning correctly under load. It should not be overly snappy, sluggish or sticking. For efficiency and minimal irritation, teat end vacuum should not fluctuate more than 3 inches Hg.[5] Teat end vacuums of over 12 inches Hg may be dangerous especially when used with a wide milk-rest ratio.[7] Calculate the milk-rest ratio from the recording. The ratio is calculated at the point of liner collapse or 3 inches Hg less than maximum teat end vacuum. The milk-rest ratio is influenced by the pulsator ratio but will vary according to the amount of time required to evacuate the air in the pulsator chambers. A 50:50 milk-rest ratio is adequate. Wider ratios should be used with care.

Figure 1

Milking Machine Analysis Form

Step I Vacuum Pump Performance
1. Record air flow at the pump______c.f.m. at 15"Hg (N.Z.std)
2. Pump specifications: Make______ Model______
Engine H.P.______ Pump RPM______

Step II System Capacity
1. Record vacuum reserve ______c.f.m. (take at end of line with all units attached, liners stoppered and all accessories including the vacuum regulator operating. Lower static vacuum ½" Hg and take the air flow reading).

Step III Vacuum Supply Lines
1. Diameter of line from pump to moisture trap ______I.D.
2. Diameter of vacuum supply or milkline ______" I.D.
3. Diameter of pulsator lines ______" I.D.

Step IV Milking Units
1. Type (name)
2. No. of units ______
3. Kind of liners (widemouth or narrow)
a. condition ______
b. how often changed ______
4. Bleeder holes open yes ( ) no ( )

Step V Pulsator Action—Line Vacuum
1. Measure vacuum maintained by regulator ______" Hg
2. Pulsation rate______ ratio______
3. Check each pulsator with the recorder for correct operation.

Step VI Teat End Recordings
1. Set up the dual recorder on a fast milking cow with system under full load.
a. Pulsator action: snappy______ sluggish______ sticking______
b. Teat end: Full load average ______" Hg
Vacuum fluctuation ______" Hg
Maximum vacuum at teat end ______" Hg
c. Milk-rest ration ______

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