Automatic cluster removers (ACRs)

1. Introduction

Fully and semi-automatic cluster removers (ACRs) are designed to remove a cluster from an individual cow at, or soon after, the time when her milk flow rate falls below a pre-set threshold. Most ACRs use a piston and air cylinder, powered either by compressed air or vacuum, to withdraw the cluster from the udder via a cord, chain or arm support connected to the claw-piece. The removal sequence is initiated either by a milk flow rate sensor or by a lever mechanism. Lever types can be operated manually or by a pre-set timer in non-rotary dairies. In rotary dairies, they can be actuated by the rotation of the platform from one or more fixed positions.

2. Interpretation and relevance to Australian conditions

Milking times per cow could be shortened significantly in most Australian dairy herds by investing in ACRs and by improved routine maintenance of ACRs in many existing installations.

Extensive research around the world indicates that cows giving 10 L per milking (not per day) can be milked in about 5 min, while cows giving 15 L per milking should have an average milking time of about 6 min/cow. When these estimates are compared with typical rotation times of 12 minutes for many rotary parlors (with some cows going around twice), it is clear that Australian cows are very slow milking, or they are being subjected to prolonged over-milking, or both. In fact, Australian cows appear to be relatively slow milking mainly because the teatcups are attached too soon, before milk letdown occurs, and because they are over-milked routinely.

Over-milking defines the period when teatcups remain attached to teats after the milk flow rate from an individual cow has fallen below an arbitrary end-point (traditionally 200ml/min). Although some over-milking is inevitable because the separate quarters of an udder milk out at different times, it seems as if many Australian farmers have 'lost the plot'. As a result, over-milking of 2-5 min per cow is common in many herds particularly in swing-over dairies and rotary dairies.

3. Relationship to CowTime goals

Traditionally, ACRs have been promoted mainly to save labor and prevent over-milking. Recent research results highlight other benefits including faster milking, better teat condition, and more tranquil cows that result from optimising ACR settings. This improves cow flow into the dairy and reduces operator stress. Perhaps ACRs should be standard equipment for milking, especially in high-producing herds (averaging more than about 7000 L of milk per cow).

4. Features of ACRs

ACRs increase the average milk flow rate per cow and shorten milking times by reducing overmilking. Up until the mid-1980s, the commonly-accepted view was that over-milking was not particularly harmful in low-producing Australian herds even though there seemed to be little point in leaving cups on cows that had finished milking. This story started to change in 1986, however. An interesting experiment at the old Milking Research Centre at Werribee showed a nine-fold increase in new mastitis infections in quarters that were over-milked for 5 minutes per milking in conjunction with pulsation failure.

In the intervening years, the results of new research from Denmark, The Netherlands and the USA have identified other issues associated with overmilking. In summary, the new results show that:

- teat condition usually deteriorates as milk yield per cow is raised;
- there is a progressively greater risk of mastitis as average yield per cow is increased;
- the total time per day when teatcups are attached, but the milk flow rate is less than about 1 kg/min, appears to have a major effect on teat-end condition; and
- both teat condition and cow behaviour can be improved, and milking times per cow reduced, by use of better milking procedures, installing some type of reliable ACRs, and adjusting the ACR take-off settings to optimise milking efficiency.

Potential cost savings

If the current average 'cups-on' time per cow can be reduced substantially, there is scope for reducing the number of milking units in new milking facilities in Australia. Most cows have finished milking by 2/3rds of the way around the platform in typical Australian rotary dairies, even at the peak of their lactation. If so, it seems difficult to justify investment in rotary dairies with any more than about 50 units. The potential savings in reduced building costs,

basic equipment costs and maintenance costs could be used to invest in appropriate automation equipment like ACRs.

5. Potential challenges with implementation

Learning to use ACRs effectively

ACRs rely on a predictable milk flow pattern coming from each cow. They work best when the cups are attached to cows that have already let-down their milk. Poorly prepared cows have variable milk flow rates which may result in incomplete milking and poor ACR performance. Many farms find they must change their milking routine to successfully use ACRs.

Vacuum drop across 'attachments in the long milk tube'

Some early float-operated types of ACR sensors caused a substantial vacuum drop due to flow restrictions in milk tubes and fittings. To avoid the consequent problems of slow milking and cluster falling, the new ISO International Standard specifies a limit of 5 kPa vacuum drop across attachments, including ACR sensors, at a milking rate of 5 L/min. Newer types of electronic flow sensors (such as conductivity sensors) easily meet this ISO limit.

Testing the operating sequence

The typical sequence for the common cord-type ACR is:

- vacuum or air pressure is applied to the air cylinder, causing the piston to move;
- the initial movement tensions the cord and, by closing a valve in the claw or long milk tube, shuts off the milking vacuum from the cluster;
- when vacuum in the cluster has declined sufficiently for the teatcups to start sliding down the teats, the increasing tension on the cord pulls the cluster away from the udder and swings it clear (Akam & Spencer, 1992).

Most types of ACR allow some adjustment of the air or vacuum supply to the cylinder so the rate of retraction of the cord can be matched to the time when the cluster starts to slide down the teats. If the cord moves too fast, the cluster may be pulled off the teats while still under vacuum, thereby increasing the risk of mastitis. If it moves too slowly, the cluster may fall onto the floor, thereby increasing the likelihood of dirt getting into the system or damaging the cluster. The simplest way to check the timing is to disconnect the cord from the claw-piece and attach a weight to the free end of the cord to simulate the weight of the cluster (about 2.5 kg). Then, note the time-difference between the instant when the cluster falls clear of the udder and the instant when the cord is pulled up.

Other variables

- More sophisticated ACRs include options for:
- setting or adjusting an "initial delay period" after the start of milking to avoid pre-mature removal, especially in herds where clusters are applied before all cows have had a proper milk letdown (for example, an initial delay setting of 3 min).
- setting the preferred flow rate threshold (based on overseas research, threshold settings are being increased from 200 up to 400 or 500 mL/min or even higher in herds with excellent milking management.
- setting the "final delay time" which is a pre-determined period of 1-30 sec, after a cow's milking rate has fallen below the flow rate threshold, before the cluster removal device is activated.
- setting a maximum time for milking (for example, clusters will be detached from all cows that have not activated the ACR by 7 min after the start of their milking).

6. Robustness of this information

Both the Danish and American results have been obtained in herds with good pre-milking teat preparation, calm consistent milking routines, the use of narrow-bore liners, and milking units that are positioned carefully on the udder by the operator(s) at the start of milking. In addition, most of the field data have been obtained in high-producing US herds milked three times per day.

The application of these overseas research results is currently being evaluated under Australian conditions by the National Milk Harvesting Centre at Ellinbank. Initial results from small groups of slow-milking cows showed a 35% improvement in "milking efficiency" when ACRs were activated by a simple timer after a pre-set period of milking. The time allowed for milking was based on the cows' average yield. Increasing ACR thresholds to 500 mL/min had little effect on reducing milking times of these slow milking cows.

7. References and further reading

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CowTime Guidelines for milk harvesting - Chapter 5, edited by Klindworth, D. et al (2003). Available on the CowTime website www.cowtime.com.au

Quick Note 3.2: Checklist for making changes to milk harvesting infrastructure