The Use of Robotic Slat Cleaners to Clean Slatted Floor Dairy Barns

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Abstract. Robotic slat cleaners are an effective way of keeping slatted floors clean by pushing the manure down through the slats. They cause little disturbance to the cow's normal behaviour. They can be programmed to clean the areas of high manure production, such as at the stall curb frequently. They can also be programmed to clean cross-overs and holding areas. They result in fewer obstructions on the slats compared to automatic alley scrapers.

Most robotic barns make use of slatted floors for better manure removal. Robotic slat cleaners are used extensively in robotic milking barns with slatted floors because they have the ability to scrape the slatted floors without interfering with cow traffic or leaving dead spots as traditional alley scrapers would.

A trial was conducted in a robotic milking barn which used the Lely Discovery robotic slat cleaners. The robotic slat cleaner was shut off for 24 hours and the goal was to measure the build up of manure in the alleys when the scraper was shut off, and more importantly what effect the build-up of manure in the alleys had on the manure that was transferred to the stall beds from the cows hooves.

This paper describes this trial, why robotic slat cleaners are used, and how the cleaners function. Limitations and maintenance requirements are also discussed.

Keywords. dairy, robotic, slatted, manure, floors
Introduction

It is important to keep cow alleys clean and dry to improve foot health and also to keep cow stalls clean as cows will drag manure from dirty alleys onto their free stall bed which can result in poor udder health. This is true whether the floors are solid or slatted.

There was a time when slatted floor barns were designed to use cow traffic to push the manure down through the slats. Alleyways were narrow to concentrate cow traffic to push the manure through. As interest in cow comfort increased, and lying times in stalls lengthened, cow movement in the alleys was reduced and a greater build-up of manure in the alleyways occurred. The most effective way to deal with this manure build-up was to use some form of scraper to push the manure down through the slats. These scrapers varied from scrapers mounted on garden tractors to self propelled units almost like snow blowers with a scraper attachment. The most popular installations were automatic alley scrapers with a cable drive, or shuttle drive. These scrapers did not need to be as rugged as regular alley scrapers as they did not drag great quantities of manure down the barn alley, rather they were designed to push the manure through the slats.

Why Use Robotic Slat Cleaners

Automatic alley scrapers were effective in pushing manure through slats, but they still involved cables, or shuttle arms that needed to be maintained and corner wheels or other drive mechanisms that needed to be installed outside of the cow area so not to be a hazard to cow traffic, adding to the size of the barn. There was still the problem with automatic alley scrapers that they could not remove manure from cross-overs and holding areas, so in a slatted floor barn these areas had to be manually scraped to keep clean.

Robotic slat cleaners address these issues. They do not require cables or drive wheels and they can deal with cross-overs and the large open areas that have become common adjacent to robotic milking units. They can be programmed to scrape the areas in the barn where manure builds up quicker, such as next to the free stall curb, more frequently than other areas of the barn. This keeps the slats and consequently the cows cleaner.

Robotic slat cleaners are not intrusive. They do their job quietly and have little effect on cow behaviour. If they encounter a cow lying in the alley or other obstacle, they will either try to go around it or try several times to push it out of the way. If the cow or obstacle still will not move the robotic cleaner will shut down and wait for the producer to take action.

Application to Robotic Milking Barns

Robotic slat cleaners are a good fit with robotic milking barns. The cows adapt quite readily to their slow steady movement, and actually become quite concerned when a unit stops where it shouldn’t. The cleaners can be programmed to deal with the unique layouts of robotic milking barns, especially the large holding areas in front of the robots.

While robotic slat cleaners work well in robotic milking barns their greatest application is still in slatted floor free stall barns where the cows are milked in parlours. This is mainly due to the fact that there are many more slatted floor barns where the cows are milked in parlours compared to barns where the cows are milked with robots.
Description of Current Units

There are two types of robotic slat cleaners used at present in Ontario the JOZ-tech and the Lely Discovery. A third is presently available in Europe manufactured by Royal De Boer.

**JOZ-tech**

The JOZ-tech (Figure 1) robotic slat cleaner navigates using a series of transponders mounted in the floor. An antenna on the unit picks up the signal from the transponder. A remote control device is used to walk the robotic slat cleaner around the barn to layout its initial route. At each transponder it passes over, the scraper unit is programmed with a command to tell the unit to turn, continue in a straight line, etc. The unit has three wheels - the single front wheel is a drive and steering wheel. It is about 30 cm. (12") in diameter and 20 cm. (8") wide and filled with foam. Besides the transponders, there are sensors in the wings of the scraper blade that keep the unit tracking along the stall curbs and walls. The rear wheels are used to count revolutions to track distance travelled. If the JOZ-tech becomes stopped or disorientated for some reason it can be steered by the remote control to the next transponder, and it can re-adjust its route from that point.

The JOZ-tech uses a deep cycle marine battery and must charge for a continuous six hours each night, plus several 30 minute charges throughout the day as it navigates its route, so it has a total of 16 hours of cleaning time. Some basic parameters for the JOZ-tech are shown in Table 1.

**Lely Discovery**

The Lely Discovery (Figure 2) navigates by a combination of a gyroscope, ultra sound device and by wheel revolutions. The gyroscope is used to maintain orientation; ultra sound is used to determine the distance away from walls and curbs and to keep the unit tracking along stall curbs. The wheel revolution count is used to track distance.

The Discovery is powered by two separate electric motors driving two gel filled wheels. The unit turns by varying the rpm of each wheel.

A remote control device is used to walk the unit around the barn to layout its initial route. A series of “bump” points are programmed into the route to tell the unit to change direction. In this way the robotic slat cleaner can be programmed to do alleys multiple times.
along the curb and to return to the charging station as needed. The unit can function 40% of the time and needs to charge for 60% of the time.

If a Discovery loses it position in a barn it needs to be directed by the remote control to a “bump” point to continue its route. Some basic parameters for the Lely Discovery are shown in Table 1.

Table 1. Robotic Slat Scraper Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>JOZ-tech</th>
<th>Lely Discovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>1300 mm (51 in)</td>
<td>1270 mm (50 in)</td>
</tr>
<tr>
<td>Width</td>
<td>720 mm (28.3 in)</td>
<td>880 mm (34.7 in)</td>
</tr>
<tr>
<td>Height</td>
<td>600 mm (23.6 in)</td>
<td>545 mm (21.5 in)</td>
</tr>
<tr>
<td>Scraper width</td>
<td>Variable</td>
<td>880 mm (34.7 in)</td>
</tr>
<tr>
<td>Weight</td>
<td>410 kg (900 lb)</td>
<td>272 kg (600 lb)</td>
</tr>
<tr>
<td>Driving speed</td>
<td>4 m/min (13 fpm)</td>
<td>11 to 18 m/min (35 to 60 fpm)</td>
</tr>
<tr>
<td>Tank capacity</td>
<td>80 l (21 USG)</td>
<td>30 l (8 USG)</td>
</tr>
</tbody>
</table>

**Challenges**

Dry manure on slats can be a challenge for robotic slat cleaners. This can be an issue in hot dry weather and especially in barns with summer cooling fans which can dry out the manure on the slats. In these conditions it can be more difficult to push manure down through the slats, and the tires may spin on the dry manure causing the robotic slat cleaner to lose its position as the revolution count on the wheels is not accurate.

This challenge has been addressed in both units by adding a water spray system. Water tanks are refilled during or after charging, and water spray can be applied to the floor to soften dry manure. The JOZ system has both front and rear spray nozzles, and the Lely system has nozzles spraying just in front of the scraper blade.

**Materials and Methods**

A trial was conducted in a robotic milking barn which used the Lely Discovery robotic slat cleaners near Innerkip, Ontario in January of 2010. The barn consisted of six rows of 356 free stalls total with perimeter feeding. The barn was divided in half across the width with six robotic milkers in a center room. Three units were used to milk one half of the herd and three the other. Each half of the barn used one robotic slat cleaner. The robotic slat cleaner in one half of the barn was shut off for 24 hours and the goal was to measure the build up of manure in the alleys when the scraper was shut off, and more importantly what effect the build-up of manure in the alleys had on the manure that was transferred to the stall beds from the cows hooves. Conditions were not compared between the halves of the barn, as one end of the barn housed more cows.

A method of determining the amount of manure on the stall bed was used similar to Gaworski et al., 2003. A 1m x 1m (39 in x 39 in) square divided into a 10 x 10 grid was placed on top of the stall bed, centered under a stall partition and the squares containing any signs of manure were totalled. A second 1m x 1m (39 in x 39 in) grid was placed on the slatted floor next to the free stall curb, also centered on a partition. The manure within the square was collected and weighed. Data from four locations in one of the four interior rows was collected and averaged at each collection time.

Time lapse video photography was used to monitor cow behaviour before the Discovery was shut off; during the period when it was shut off; and following the period when it was shut off.
**Results**

The data collection started at 7:30 on January 12th and ended at 18:30 on the following day. Results from the data collection are shown in Figure 1.

![Figure 1](image_url)

**Observations and Discussion**

Although trends could be observed in the barn during the data collection, there were insufficient samples to establish these trends statistically. The one exception was the evening sampling with the robotic slat cleaner off and then the next day after the robotic slat cleaner was operating again. The squares containing manure with the cleaner off were double what they were with the cleaner on (69 cw. 35), seeming to indicate that the cows were indeed dragging more manure into their stall bed.

Stalls were maintained twice a day, early in the morning at about 7:00, and late in the evening at about 21:00. This explains why the accumulation in manure on the stall surface did not continue to increase after the 18:30 sampling, and as the cows were quieter over night the stall surface was still cleaner in the morning at 6:30 even though the amount of manure in the alley had increased significantly.

The manure build-up in the alleys was quite noticeable after 24 hours (Figure 4), and this build-up would only continue to increase. However with only four samples this didn’t always show on the data. After cleaning the difference was visually evident (Figure 5).
The time lapse video photography showed that the cows paid little attention to the robotic slat cleaner, unless it stopped for some reason. It then seemed to become a matter of great concern. When the robotic slat cleaner was turned on it did an excellent job of keeping the slats clean.

**Conclusion**

Manure builds up on alleys especially next to the free stall curb when it is not pushed through by a scraper. Eventually a build-up of manure on the slatted floor will lead to increased contamination of the stall beds from cows dragging manure into the stalls with their feet and with their tails.

Robotic slat cleaners are an effective way of keeping slatted floors clean by pushing the manure down through the slats. They cause little disturbance to the cows normal behaviour. They can be programmed to clean the areas of high manure production, such as at the stall curb frequently. They can also be programmed to clean cross-overs and holding areas. They result in fewer obstructions on the slats compared to automatic alley scrapers.

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**References**


Personal Communications with JOZ Canada.

Personal Communications with Lely Canada.
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