Review on Design the Scrapers for the Press Manure Removal

Mati Heinloo and Taavi Leola
Estonian Agricultural University
Mati.Heinloo@eau.ee, ttaavi@eau.ee
Kreutzwaldi 56, 51014 Tartu, Estonia

Abstract. This paper reviews different cinematic schemes of the scrapers for the press manure removal and generate novel ideas of adding the manipulator to this scraper. The results of synthesis the manipulator, taking optimal positions in the working process of the scraper, are also discussed in this paper. The review in this paper can be useful for the designers of scrapers for press manure removals.

Keywords: agriculture, machinery, manure, technology, manipulator, scraper.

1. Introduction

There are exists different manure removal systems, which are intend to remove manure from a cowshed and store it into a dung pit. One of them is the press manure removal that is intended to remove manure from a cowshed and store it by pressing through a manure pipe into a heap of muck. Fig. 1 shows a principal scheme of a manure press removal.

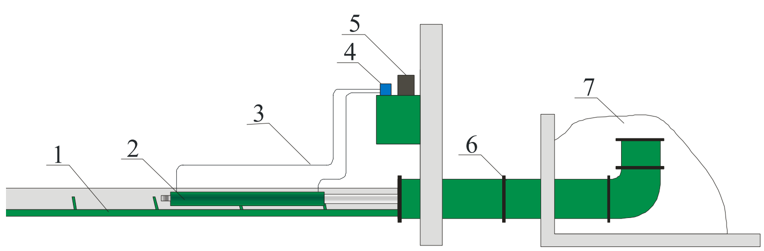
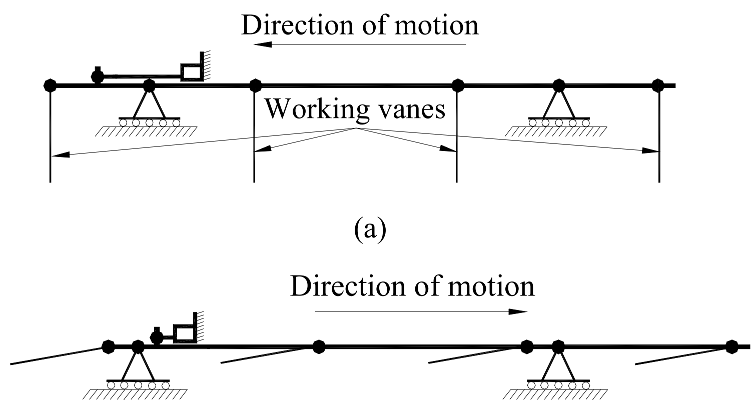


Figure 1. A principal scheme of the press manure removal, 1 – one-sided scraper; 2 – hydraulic cylinder; 3 – oil pipe; 4 – valve; 5 – electric engine; 6 – manure pipe; 7 – heap of muck

The principle of work of the press manure removal in Fig. 1 is the following. The manure scraper, driven by a hydraulic cylinder 2, transports the portions of manure to the manure pipe and presses these by the first manipulator of the manure scraper through the pipe 6 into a heap of muck 7. After the working stroke the valve 4 changes the direction of flow of oil in the oil pipes 3 and the scraper moves back to the initial position. By repeating this working cycle a large heap of muck will be structured. Press manure removal is safe in winter, economical and environmentally sound. A press manure removal might be in use in a small farm with 20 – 50 cows.

The manure scraper in Fig 2 is used as the working tool of the manure press removal in Fig. 1. A principal scheme of a one-sided manure scraper in the working stroke (a) and in the backward stroke (b) is shown in Fig. 2, where the working vanes of the scraper have vertical axes of rotation.



(a)

(b)

Figure 2. The cinematic scheme of a one-sided manure scraper in the working stroke (a) and in the backward stroke (b)

The working vanes of the manure scraper are foursquare and can rotate freely around its vertical (or horizontal) axis under the resistance forces, applied to vane in the manure ply. Scrapers in Fig 2 are, for example, in the structure of press manure removals Paskervilleri 8000 (1997), and Schauer (2001). The disadvantage of the scraper in Fig. 2 is the lugging of manure by the manure scraper on its backward stroke (Fig. 2b).

Merivirta Oy (1998) and Paskervilleri 4000 (1999) have used the forced driven system for rotation of the working vanes of the manure scraper. This system is complicated but guarantees the stable rotation of the working vanes from working position (Fig. 4) to the position of backward stroke (Fig. 5) and opposite.

The scientific group, headed by Professor Emeritus Vambola Veinla, in Estonian Agricultural University has created the manure scraper for press manure removal in which the first working vane was clamped to the forced driven manipulator. Fig. 3 shows this scraper in the working stroke (a), after turning the manipulator (b) and at the backward stroke (c). The disadvantage of this scraper is the necessity to turn the working vane in the manure, compressed in the manure pipe (Fig.1).

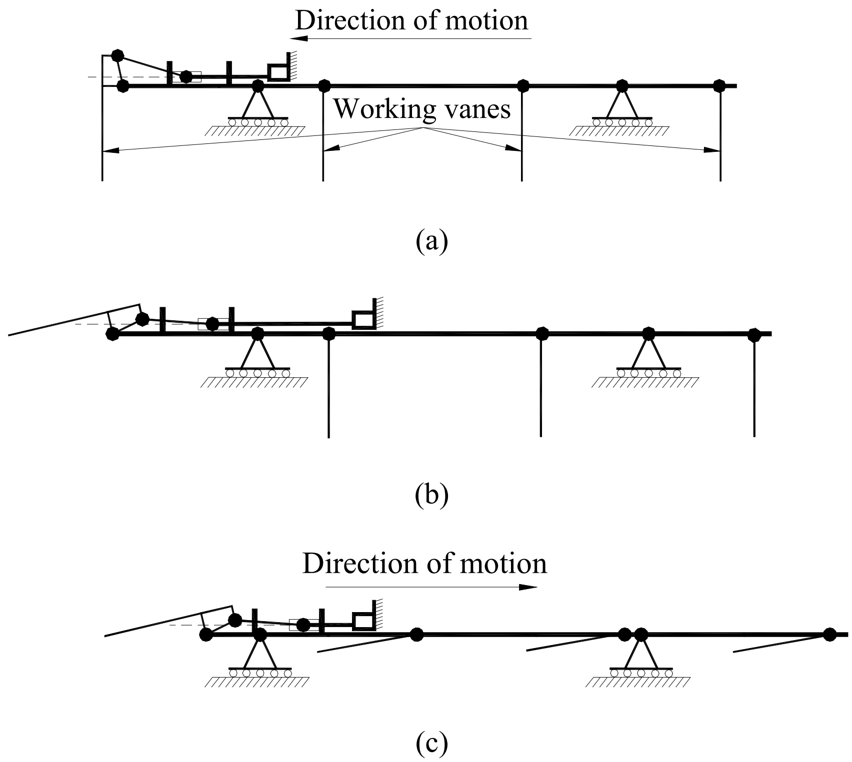


Figure 3. The cinematic scheme of a Manure scraper with the forced driven manipulator

The structure of manipulator in Fig. 3 is shown in Fig. 4.

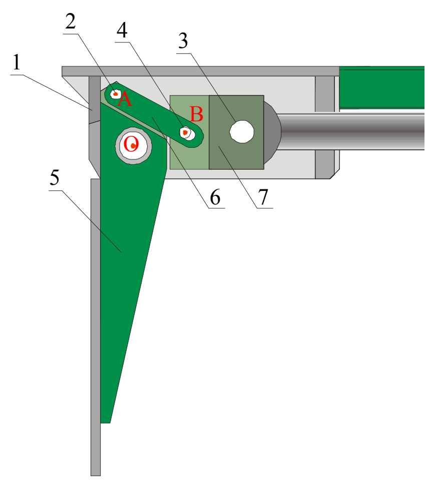


Figure 4. Manipulator, 1 – case; 2, 3 – pivots; 4 – pivot with large tolerance; 5 – rib with a vane, 6 – connecting plate; 7 – slider

Veinla, Leola (2001, 2003) have made experimentally thorough study the press manure removal in Fig.1 with manure scraper in Fig. 3. The purpose of their experimental study of the manure press removal was to measure the

- resistance force, applied to the working vane by manure in the manure pipe,
- pressure, applied to the walls of the manure pipe,
- pressure inside of the heap of muck,

and to study the dependence the height of the heap of muck on the resistance pressure of manure in the manure pipe. Fig. 5 shows the device for study the press manure removal experimentally.

Figure 5. The experimental device of the press manure removal

2. On synthesis the manipulator for the manure scraper

The synthesis of the virtual manipulator in Fig. 6, modelling the manipulator in Fig. 4, can be based on the mathematical model, created by Leola, Veinla, Heinloo, 2004. In Fig. 6 the points C, E, D correspond to the points on the contour of the rib in Fig. 4.

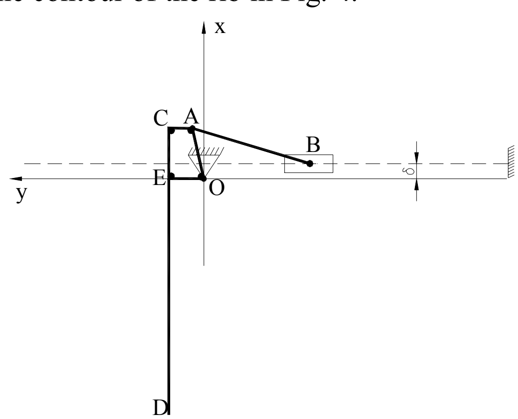


Figure 6. Virtual model of the scraper's manipulator in Fig 4,
O, A, B – the pivots; OACED – rigid link

The virtual manipulator, which initial position is imagined in Figs. 6 and 3a, has as result of synthesis by Heinloo, Leola, Veinla (2005) the following properties:

- After turning the link OACED anticlockwise the point D is settle exactly on the y-axis (Figs. 3b, 6) and stay there during backward stroke of the scraper (Figs. 3c, 6).
- At the end of the backward stroke of the scraper the link OACED turns clockwise exactly to the position in Fig 6 for working stroke (Fig. 3a) of the scraper.
- The scraper returns in the working stroke the link OACED exactly to the initial position (Figs 3a, 6).

3. Novel ideas

There was possible to generate novel scrapers for the press manure removals. The scrapers in Figs 7 – 9 are free from necessity to turn vane, connected to manipulator, in the compressed manure.

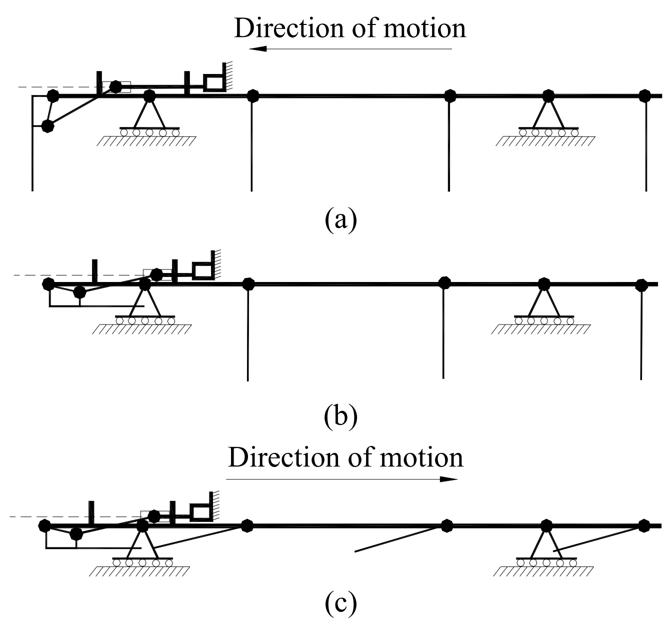


Figure 7. The cinematic scheme of a manure scraper with novel forced driven manipulator

Fig. 7 shows the positions of the working vanes at the working stroke (Fig. 7a), after turning the manipulator clockwise by 90 degree (Fig. 7b), away from the compressed manure in the manure pipe (Fig. 1) and in the position of backward stroke (Fig 7c).

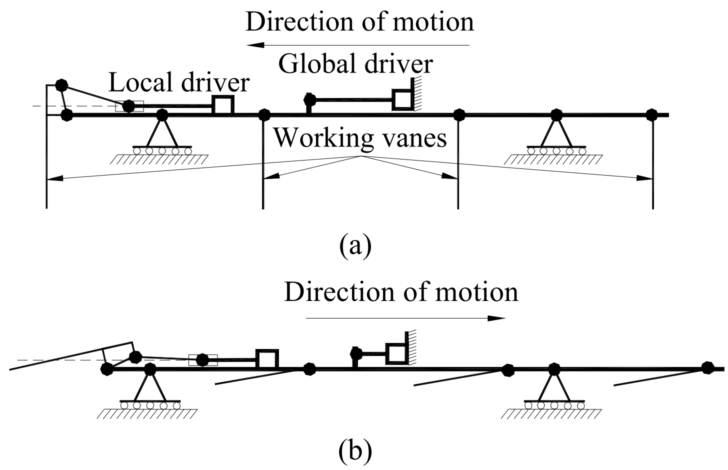


Figure 8. The cinematic scheme of a manure scraper with two drivers

Another possibility to avoid the turning of the vane, connected to the manipulator, in the compressed manure is to use two drivers. Fig. 8 shows this case in the working (a) and backward strokes (b).

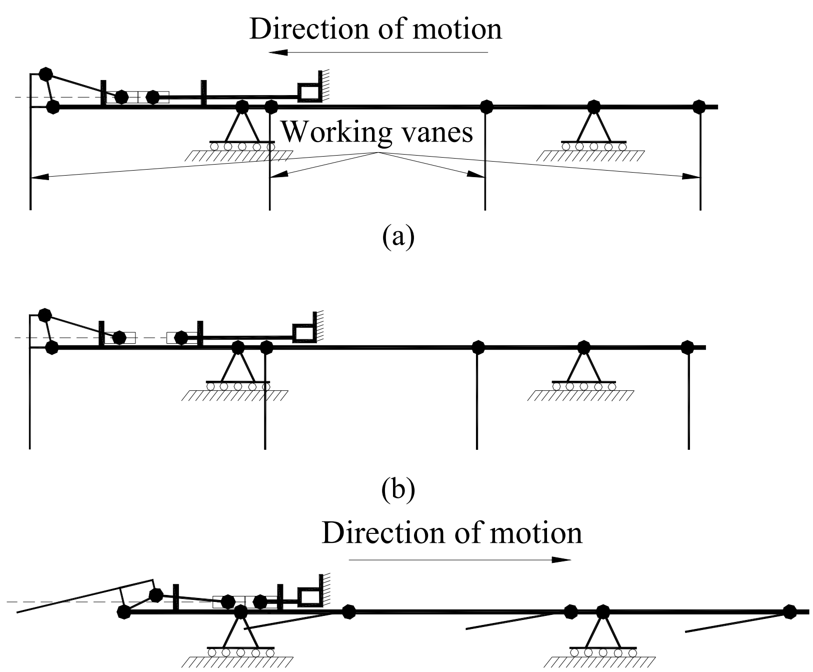


Figure 9. The cinematic scheme of a manure scraper with manipulator of one sided restriction

Finally, let us consider in Fig. 9 the scraper with the forced driven manipulator of one sided restriction. This manipulator drives two sliders.

One of them is connected to the connecting rod of the manipulator and another to the shank of a hydraulic drive. In the working stroke of the scraper two sliders are in contact Fig. 9a. At the beginning of the backward stroke of the scraper the sliders are disconnecting and until reaching the right besieger the right slider do not moves the scraper (Fig. 9b). In the backward stroke (Fig. 9c) of the scraper all vanes are turning anticlockwise under applied forces in the manure and the left slider goes again to contact with the right slider.

4. On simulation of the working process of a virtual manipulator

The technique of simulation of the working process of a virtual manipulator has been created by Heinloo, Leola, Veinla (2005). Fig. 10 shows several video frames from the video clip, which illustrates the working process of the manipulator in Figs. 3 and 6 and the reaching on time the optimal positions.

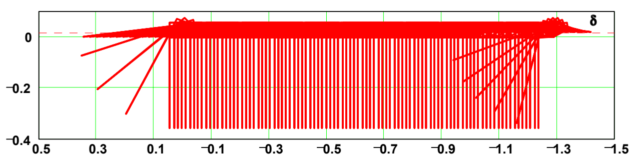
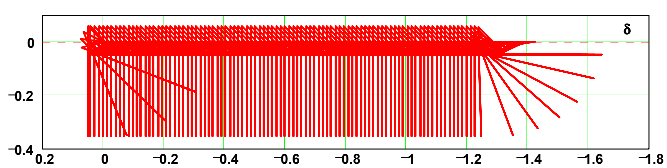
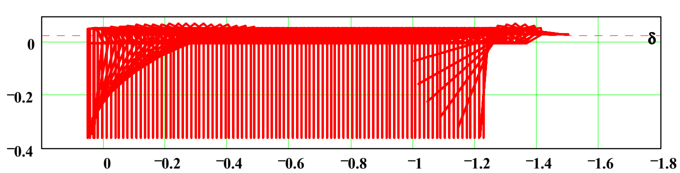


Figure 10. Video frames in the global co-ordinate system from the composed video clip that simulates the working process the virtual manipulator in Fig. 5.

Figs. 11 show analogous video frames for manipulators of the scrapers in Fig. 7 and Fig. 8 accordingly



(a)



(b)

Figure 11. Video frames in the global co-ordinate system from the composed video clip that simulates the working process the virtual manipulator in Fig. 7 (a) and in Fig 8 (b)

5. Conclusion

This paper shows that there are exists several ideas for creation cinematically possible manipulators, which can be used to make better the manure scraper for press manure removals.

World experience shows that the synthesized by computer virtual models based creation of novel machine elements is more effective and precise than the creation of machine element only by experimentation. If possible, then it is reasonable to begin the creation a novel machine element after synthesis its virtual model.

6. References

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