UDK 631.3

NUMERICAL SIMULATION OF MECHANIC-TECHNOLOGICAL PROCESSES OF LIVESTOCK

Aliiev E. B., Ph.D., Dudin V. Yr., Ph.D., Gavrilchenko A. S., Ph.D.
(Dnipro State Agrarian and Economic University)

Modern theoretical researches of the mechanical and technological processes of livestock can be summarized to analytical methods, that leads to the compilation of complex systems of differential equations with boundary and initial conditions. These systems practically cannot be solved by traditional methods, so there is a necessity in their numerical solution via computer modeling.

The purpose of this research is to perform the numerical modeling for some mechanical and technological processes of livestock in the Star CCM+ computer software.

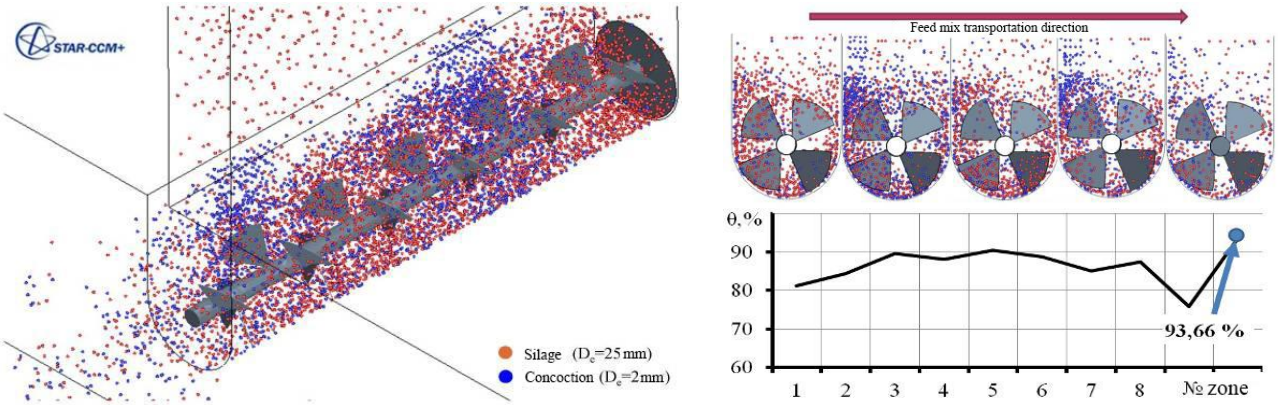
During the finite elements method modeling process in the Star CCM+ software the initial locations and velocities of the particles and substance stream must be pre-determined. Then, basing on these initial data for the contact interaction physical laws, the forces, that act on each particle in each time interval, are being calculated. For each particle, the resultant force is being calculated and the Cauchy problem is solved for a given time interval. The results of these iteration are the initial data for the next step. The following models were selected as physical models for the numerical modeling: k-ε-model of the separated stream turbulence, field of the gravity force, Van-der-Waals real gas model or the non-pressed fluid model, the discrete elements model, the multiphase interaction model. The discrete elements method is based on the momentum conservation law for the Lagrange multiphase stream models.

In order to demonstrate the results of the numerical modeling in the Star CCM+ software, let's consider some mechanical and technological processes of livestock.

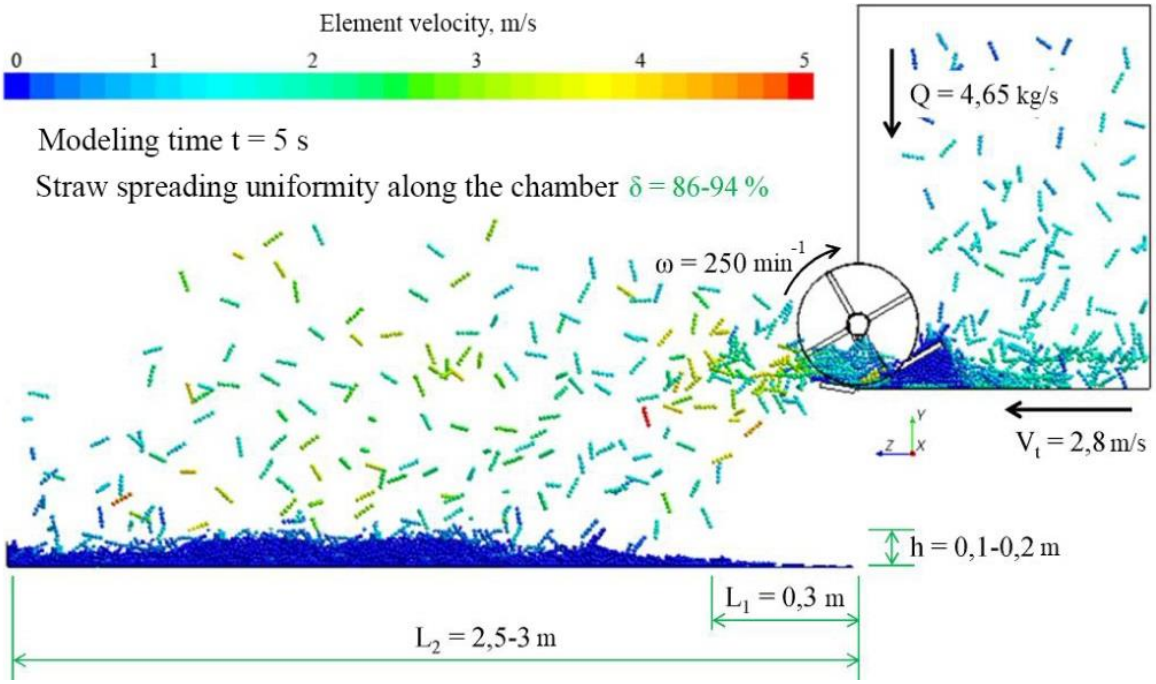
1. The process of the stream-type mixer-feeder operation has been theoretically researched and the mathematical models of the constructive, technological and regime parameters impact on the quality indexes of its operation have been developed [1-2]. The physical mathematical models of the streaming feed mixing process, which is used as a base for the mobile mixer-feeder, has been built within the Star CCM+ software (pic. 1). This physical mathematical model of the streaming feed mixing allows to define the constructive and technological parameters for the mobile mixer-feeder depending on the ration and physical mechanical properties of the feeding mix components with optimal quality, quantity and energy indexes of the mixing process.

2. The constructive and technological schemes of the working parts of the rotor straw underlay spreader for the non-leash cow maintenance has been theoretically substantiated [3]. The presence and absence of the sealing or directional plate have been used as research objects. The straw particles flight distance and the coefficient of the variation of their even distribution through the box length have been picked as

the evaluation criteria. The results of numerical modeling are described on picture 2.



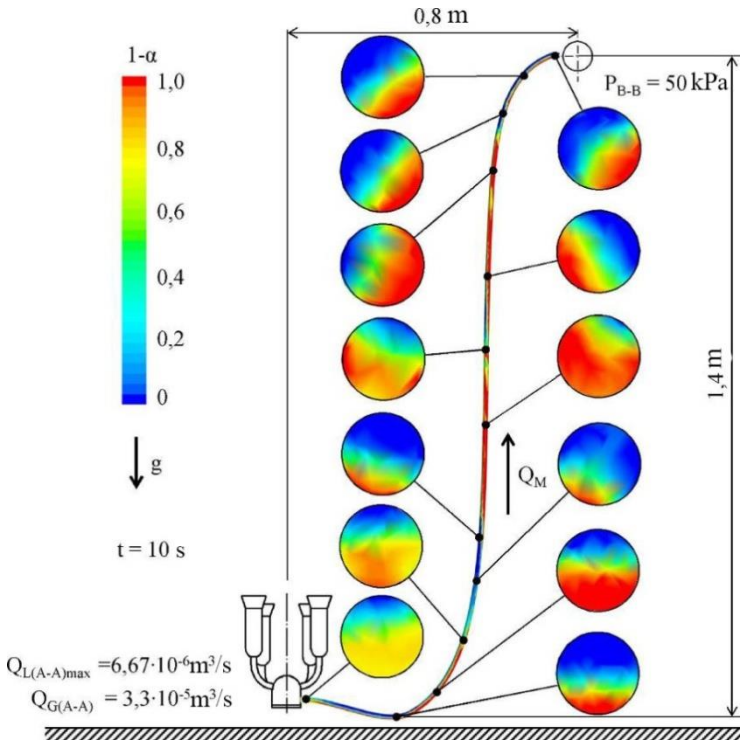
Pict. 1 – Visualization of the mobile mixer-feeder streaming feed mixing process and the dynamic of its homogeneity changing



Pict. 2 – Process visualization of the rotor straw underlay spreading with condensing and guiding plates

3. Numerical modeling of the process of the milk-air mix movement in the milking machine has allowed us to determine a relation between the vacuum pressure fluctuation value and the milk withdrawal velocity, pulsation frequency and the working vacuum pressure value [4-5]. Picture 3 describes the spreading of the 1-α liquid content along the milking machine milk hose by the upper milk pipe.

There are given the results of the numerical modeling within the Star CCM+ computer software for some mechanical and technological processes of livestock, as the mixing of components in a stream-type mixer-feeder, distribution of the straw underlay by the rotor spreader for the non-leash cow maintenance, process of the milk-air mix movement in the milking machine. These results point about the wide area of implementation of the numerical modeling for theoretical researches of mechanical and technological processes of livestock.



Pict. 3 – Spreading of the 1-α liquid content along the milking machine milk hose by the upper milk pipe

References

1. Шевченко І.А. Моделювання процесу потокового змішування кормосумішей з використанням методу дискретних елементів / І.А. Шевченко, Е.Б. Алієв, С.О. Доруда // Механізація та електрифікація сільського господарства – Глеваха, 2013. – Вип. 97. Том 1. – С. 536-544.

2. Шевченко І.А. Моделювання процесу потокового змішування кормосумішей з використанням методу дискретних елементів / І.А. Шевченко, Е.Б. Алієв, С.О. Доруда // Механізація та електрифікація сільського господарства – Глеваха, 2013. – Вип. 97. Том 1. – С. 536-544.

3. Луц С.М. Обоснование конструктивно-технологической схемы универсальной машины для внесения соломенной подстилки на основе численного моделирования / С.М. Луц, Э.Б. Алиев // Научно-технический прогресс в сельскохозяйственном производстве: материалы Междунар. науч.-техн. конф.: в 3 т. / РУП «НПЦ НАН Беларуси по механизации сельского хозяйства». – Минск, 2014. – Т.3. – С. 137-141.

4. Линник Ю.А. Математическая модель движения молочно-воздушной смеси по молокопроводной линии доильной установки / Ю.А. Линник, Э.Б. Алиев, С И. Павленко // Научно-технический прогресс в сельскохозяйственном производстве: материалы Междунар. науч.-техн. конф.: в 3 т. / РУП «НПЦ НАН Беларуси по механизации сельского хозяйства». – Минск, 2014. – Т.3. – С. 181-185.

5. Павленко С И. Результаты численного моделирования процесса перемещения молочно-воздушной смеси в доильном аппарате / С И. Павленко, Э.Б. Алиев, Ю.А. Линник // Вестник ВНИИМЖ. Серия: Механизация, автоматизация и машинные технологии в животноводстве – М., 2014. – №4(16). – С. 77-81.