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INFLUENCE OF CYLINDER DESIGN ON POWER CONSUMPTION DURING CORN EAR THRESHING

Harvesting of corn requires specific conditions and the fine-tuning of combine-harvester threshing apparatus. In 2010, the German company CLAAS patented an enclosed threshing cylinder. In general, their cylinder has a solid, continuous cylindrical surface on which rasp bars are mounted for threshing the cereals. The enclosed cylinder is highly impervious to crops so that debris cannot accumulate inside the cylinder during operation.

Fitting the cylinder with filler plates was found to have a positive effect on wheat grain separation through the concave and also to reduce grain damage. Experimental trials on a threshing cylinder with spaces between the cylinder rasp bars covered with filler plates showed a decrease in wheat grain damage from 2.01% to 0.17% [1]. Researchers considered the main reason for the reduction in grain damage to be that when threshing with an enclosed construction cylinder, grain separation increases in the frontal part of the threshing apparatus, i.e. in front of the concave. Moreover, researchers noted that wheat grain separation using an enclosed construction cylinder might be intensified by increasing the cylinder speed. It is considered that the shape of filler plates appropriate for corn ear threshing should be optimized [2].

The aim of this work was to determine the influence of feed rate and threshing cylinder filler plates on power consumption during corn ear threshing process.

Experimental trials were carried out using a stationary tangential single-cylinder threshing unit (Fig. 1).

During the experimental trials, threshing performance was measured by means of the following indicators: max. and average power consumption, and power consumption for one kg s^{-1} corn ears threshing. Threshing cylinder speed was fixed (450 min^{-1}) using a variable frequency drive controller. Investigation was carried out using a threshing apparatus equipped with a concave with surface area of 0.96 m^2, for which the active separation area was equal to 69.19%.

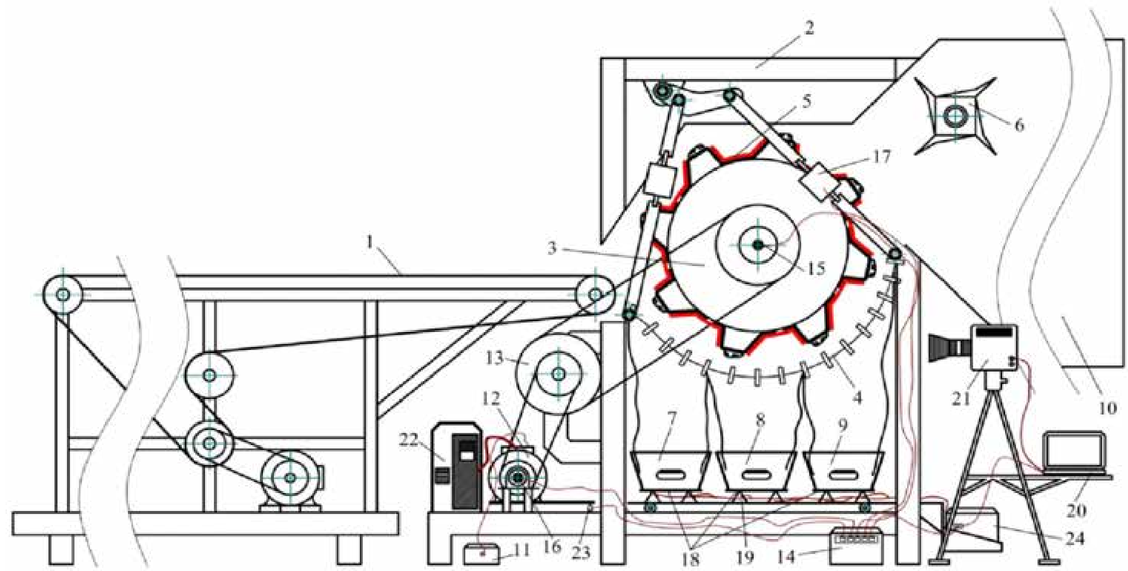
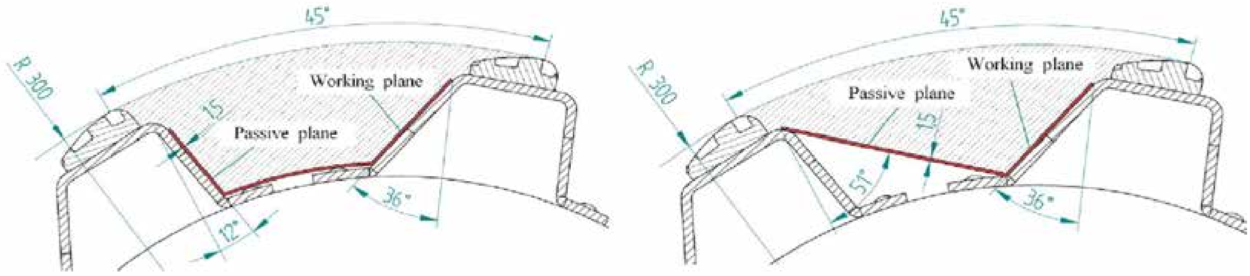


Fig. 1. Schematic of the stationary unit used for threshing corn ears [2]

The clearance between the cylinder rasp bars and the concave crossbars was set to 34 mm in the front, 26 mm in the middle and 22 mm at the end of concave. The ears were at physiological maturity and had a grain moisture content of 30.49±0.60%. For the trials, steel filler plates (FP) of two different shapes were used (Fig. 2).



a) *b)*

Fig. 2. Parts of the threshing cylinder with spaces between rasp bars covered by FP-1 and FP-2

Power consumption for threshing of corn ears was measured by increase in feed rate from 4 kg s^{-1} to 12 kg s^{-1}. Power requirement increases respectively from 8.08±0.08 kW to 14.4±0.14 kW when using cylinder with covered spaces between rasp bars FP-1, and from 7.95±0.08 kW to 14.16±0.1 kW when using cylinder fitted with FP-2. At peaks this increase is more pronounced: i.e. from 8.5 kW to 16.41 kW (FP-1) and from 8.4 kW to 15.9 kW (FP-2). It's worth noting that power required for rotation of non-loaded (empty) threshing cylinder amounts for 5.1±0.3 kW.

Power required for threshing one kg of corn ears per second following increase in feed rate from 4 kg s^{-1} to 12 kg s^{-1} has decreased on average from 2.0 kW to 1.2 kW, whereas at peaks this decrease was from 2.35 kW to 1.35 kW, when using FP-1. After replacing them with FP-2, these values have decreased on average from 1.90 kW to 1.18 kW, whereas at peaks – from 2.3 kW to 1.3 kW (Fig. 3).

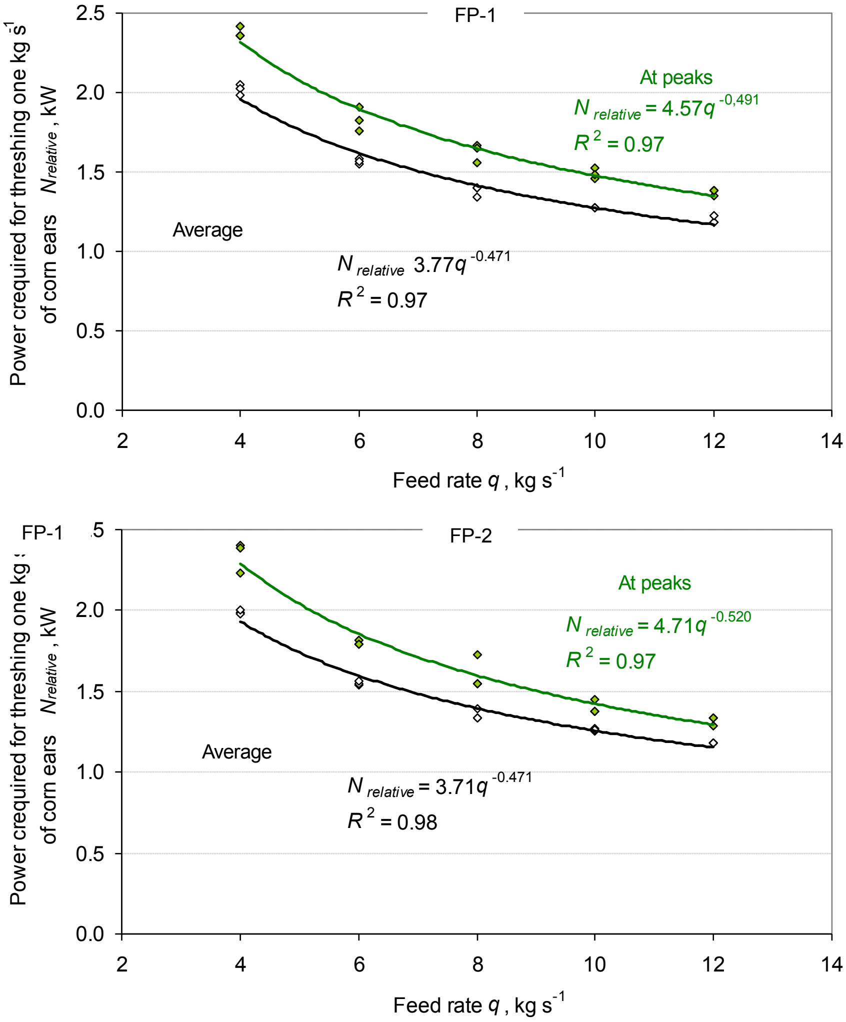


Fig. 3. Power required for threshing one kg s^{-1} of corn ears when using threshing cylinder fitted with FP-1 and FP-2

Out of the entire power required for cylinder rotation only part of it is used for accomplishment of the very process of threshing. The average power consumed by threshing unit for threshing at corn ear feed rate of 4 kg s^{-1} amounts for 36.9%, whereas at feed rate of 12 kg s^{-1} it rises to 64.6%. In result of replacing covered spaces between rasp bars with FP-2, this percentage has jumped from 35.9% to 64.0%.

Conclusions. Power required for threshing one kg of corn ears per second following increase in feed rate from 4 kg s^{-1} to 12 kg s^{-1} has decreased on average by one kilowatt. The average power consumed by threshing unit for threshing at corn ear feed rate of 4 kg s^{-1} amounts for 36%, whereas at feed rate of 12 kg s^{-1} – approx. 64%. In summary of investigation findings, higher corn ear feed rate leads to more efficient use of threshing unit, i.e. relatively lower losses of power consumed are suffered. The shape of filler plates can be considered to have no significant effect on this parameter.

References

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УНІВЕРСАЛЬНИЙ ДЕРЕВОПАЛИВНИЙ ДВОКОНТУРНИЙ ВОДОГРІЙНИЙ КОТЕЛ З КЕРОВАНИМ ТЕПЛОВИМ ПОТОКОМ ТА АВТОМАТИЧНОЮ ПОДАЧЕЮ ДРОВ У КАМЕРУ ЗГОРЯННЯ

Для підвищення енергоефективності в Україні є стимулювання розвитку енергетики на невикопних видах палива, виробництво теплової та електричної енергії на основі використання поновлюваних джерел енергії [1].

Серед різних видів біопалива особливе місце займає деревина, оскільки вона за своїми енергетичними показниками рівноцінна бурому вугіллю [2]. Крім цього при спалюванні деревини утворюється така кількість CO_2, яка була вилучена в ході фотосинтезу. Отже, деревина є екологічно чистим енергоносієм. Теплота згоряння деревини залежить від її густини (залежно від породи) та вмісту в ній вологи. При спалюванні одного складометра бука (з вмістом вологи 15 %) теплота згоряння складає 2325 кВт·год, а ялиці лише 1490 кВт·год [2]. Калорійність (кВт·год) одного кубічного метра деревини (з вмістом вологи 20 %) зростає від тополі до акації. Теплота згоряння свіжозрізаної деревини, що містить до 60 % вологи, становить 2 кВт·год/кг, після зберігання деревини протягом певного періоду часу вміст вологи в ній зменшується до 25 % і нижче, а теплота згоряння зростає до 4 кВт·год/кг.

З метою підвищення ефективності передачі виробленого тепла теплоносію для обігріву приміщень та можливості його раціонального використання для температурного приготування їжі та нагріву води для побутових потреб на рис.1 показано конструкцію універсального деревопаливного двоконтурного водогрійного котла з керованим тепловим потоком та автоматичною подачею дров в камеру згоряння [3].