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#### **COMBINE HARVESTER PROCESS MODULES AND SENSORS**

The combine harvester consists of three crop processing modules, the threshing, separation and cleaning processes. The threshing process is done using a transverse (conventional) or longitudinal rotor with threshing elements to separate the grain kernels from the heads, stems or pods of the given crop. The purpose of the separation system is to segregate the threshed grain kernels through the crop mat from the threshing system prior to leaving the machine as residue material in the field.

The conventional separation system is constructed using straw walkers relying on gravity for kernel segregation or as a longitudinal rotor using the rotational force to increase the kernel segregation. The threshing and separation systems are constructed as one coherent system in modern combine harvesters. The conventional walker machines uses a transverse threshing rotor and a straw walker for separation, the an axial machines uses one or two parallel rotors with threshing elements in front and separation in the rear end, and the hybrid machines a transverse threshing rotor and a longitudinal separation rotor. The project was conducted in parallel with the development of combine harvester series using a single or dual axial rotor threshing and separation system depending on combine class grading. It is possible to adjust rotor speed ( $\omega_r$ ) and concave clearance ( $d_p$ ) in the threshing section to vary how hard the crop is threshed as well as the separation rate, see Figure 1. The concave facilitates an individual adjustment of the inside and outside clearances [14], however these were set identical for all tests, thus the clearance is denoted with one variable ( $d_p$ ). The threshing and separation system is equipped with impact sensors longitudinally along the rotor to measure the separation curve and one transverse in the rear end to measure the separation loss. The total throughput ( $m_f$ ) can be measured using two different relative sensor readings, i.e. a mechanical sensor measuring the crop height in the feederhouse and a measurement of the hydraulic oil pressure of the belt variator in the rotor drive train. The grain damage is measured with a grain quality sensor (GQS) located in the top of the clean grain elevator.

The threshing and separation system additionally separates a considerable amount of chaff and straw pieces, generally characterised as material other than grain (MOG). The separated material flow of grain ( $m_{p;g}$ ) and MOG ( $m_{p;c}$ ) is collected using the front and rear return pans transporting the material in the forward direction. Both return pans deliver the material on the stratification pan which transport the material in the rearward direction where it enters the cleaning shoe ( $m_{c;g}$  and  $m_{c;c}$ ). The purpose of the cleaning system is to clean the grain ( $m_{c;g}$ ) from the MOG ( $m_{c;c}$ ) in the delivered material throughput from the threshing and separation system. All modern combine use a system with an adjustable fan ( $\omega_f$ ) and two sieves with adjustable

openings ( $d_c$  and  $d_s$ ). The purpose of the upper sieve is to separate the grain kernels before leaving the cleaning system as residue ( $m_{c;l}$  and  $m_{c;r}$ ), and for the lower sieve to avoid separation of MOG particles into the clean grain throughput ( $m_{y;g}$  and  $m_{y;c}$ ) to the grain bin.

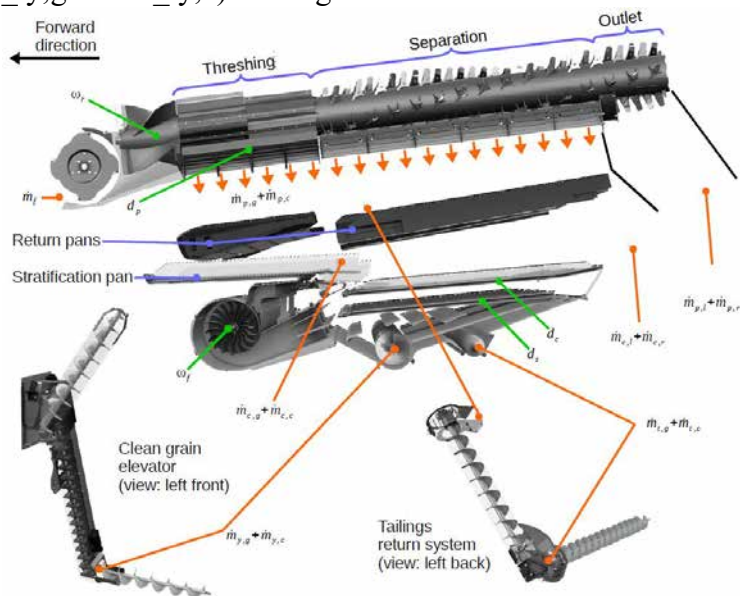


Fig. 1. Threshing, separation and cleaning system material flows.

The material being segregated through the upper sieve but not the lower sieve is denoted tailings ( $m_{t;g}$  and  $m_{t;c}$ ) and is returned into the cleaning system on the rear return as marked on Figure 1.2. The tailings return location depends on the overall design of the combine. The purpose on the cleaning fan is to maintain the MOG airborne where the grain can be segregated throughout the sieves. The cleaning system is equipped with longitudinal impact sensors under the upper sieve and transverse sensors for grain loss detection over the full width behind the upper sieve. Additionally a transverse impact sensor is used to measure the tailings grain throughput and a proximity sensor used to measure the volumetric tailings throughput. The amount of MOG in the clean grain throughput is measured with the GQS and the clean grain throughput is measured with the yield sensor in the top of the clean grain elevator. The  $m_{\text{material}}$  flow sub-script notation refers the module before the comma and material type after the comma. Before the comma p notate threshing and separation system, c cleaning shoe, t tailings and y clean grain material flows, where after the comma g and c refers to grain and MOG that remains in the combine where l and r refers to grain (loss) and MOG (residue) leaving the combine.

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**МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ**  
**ЖИТОМИРСЬКИЙ АГРОТЕХНІЧНИЙ ФАХОВИЙ КОЛЕДЖ**



# **ЗБІРНИК ТЕЗ**

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В збірнику представлені тези доповідей науково-педагогічних працівників, наукових співробітників, аспірантів та студентів Житомирського агротехнічного фахового коледжу, провідних вітчизняних і закордонних закладів вищої освіти та наукових установ, в яких розглядаються завершені етапи розробок.

The collection presents abstracts of reports by scientific and pedagogical workers, researchers, postgraduates and students of the Zhytomyr Agrotechnical Professional College, leading domestic and foreign higher educational institutions and scientific institutions, which consider the completed stages of development.

*Передрук або інше відтворення в будь-якій формі в цілому або частково матеріалів, опублікованих у цьому віданні, дозволено лише за посиланням на джерело і дотриманням вимог законодавства*