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Moral Obsolescence, Wear, And Corrosion of Grain Harvesting Combines During Storage

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Abstract: This article examines the processes of corrosion, wear, and aging of grain harvesters during storage. The main factors affecting the corrosion of metal components, including humidity, temperature, and aggressive environmental conditions, are analyzed. Based on the study, recommendations are provided to improve the reliability of agricultural machinery, extend its service life, and reduce corrosion effects.

Keywords: Grain harvester, corrosion, storage process, metal degradation, environmental impact, maintenance, reliability, agricultural machinery.

INTRODUCTION:

Corrosion is the spontaneous and irreversible destruction of metal as a result of physicochemical interaction with the environment. The most common type of corrosion affecting the metal surfaces of combine units and components is atmospheric corrosion. The main condition for this process to occur is the contact of the metal with water and oxygen.

Figure 1. Short-term storage.

Figure 2. Long-term storage.

Figures 1–2. Corrosion of grain harvesters and their units during storage.

The corrosion rate of iron–carbon alloys (all grades of steel and cast iron) depends on many factors acting simultaneously or individually, such as air temperature and humidity, the presence of aggressive impurities (industrial gases, solid dust particles, etc.), as well as the amount and duration of atmospheric precipitation. When relative humidity increases from 50% to 100%, the mass loss of steel due to corrosion may increase more than sevenfold per year and can reach up to 800 g. When the temperature rises from 20°C to 25°C under conditions of 100% relative humidity, the corrosion rate almost doubles.

As a result of corrosion, many valuable properties of metals deteriorate; their strength and plasticity decrease and may even be completely lost. The failure of a single unit or component can lead to the failure of the entire arperate or machine.

For example, severe corrosion of the combine header mechanism, fuel system, engine cylinder-piston group, valves, or other mechanisms can disable a grain harvester during the critical harvesting period. Similarly, corrosion of thin sheet metal in the combine body disrupts its tightness, leading to grain losses, changes in geometric dimensions, and a sharp increase in friction in the joints and connections of the combine.

Studies conducted by a number of research institutes (GOSNITI, SNIIMESX) have shown that the wear resistance of steel parts and cast iron components in agricultural machinery decreases by 1.5–4 times under corrosion conditions. For unprotected thin sheet steels (grades 3 and 08), exposure to a corrosive environment combined with cyclic tensile and bending stresses reduces fatigue strength by 45–50%. Corrosion is especially intensive in livestock buildings, where the concentration of corrosive gases such as sulfur dioxide, carbon dioxide, and hydrogen sulfide is high.

These factors lead to the corrosion of grain harvester bodies (Fig. 2.6). Corrosion of the combine body is the process of spontaneous destruction and degradation of the body materials as a result of chemical or electrochemical interaction with the external environment. Such degradation occurs under the influence of oxygen in the air, moist sulfur compounds, nitrogen oxides, and other chemically active substances. Metals corrode much faster in saline water compared to ordinary water. Rust on the surface of steel and cast iron products is the most visible manifestation of corrosion.

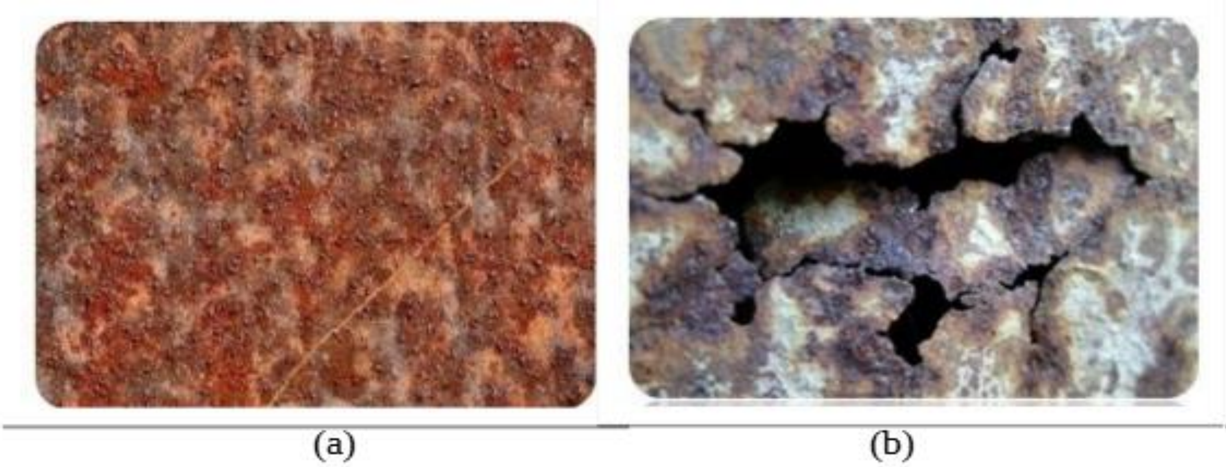

Figure 3. Corrosion of grain harvester bodies

The agricultural economy of every country suffers significant losses due to corrosion (about 5–10% of national income). When calculating the damage caused by corrosion, not only the costs of replacing worn-out agricultural machinery parts are considered, but also losses due to equipment failure, accidents, repair and replacement of components and equipment, as well as the increased consumption of metal resulting from corrosion.

Experimental studies and observations show that the costs of preventing or reducing corrosion are several times lower than the costs of compensating for damage caused by material degradation. Corrosion affects not only metals and their alloys but also detachable parts of agricultural machinery stored for long periods in machine yards.

After this process, the metal becomes unsuitable for further use. Nevertheless, approximately two-thirds of ferrous metal scrap and waste are remelted in open-hearth furnaces and converters and returned to industry. In engineering practice, the corrosion rate is measured by the mass of metal lost (in grams) per hour per unit surface area. If this value does not exceed a certain limit, the metal is considered corrosion-resistant; if it exceeds this threshold, the corrosion resistance is low; and if more than 10 g of metal is lost per hour from the surface, the metal is considered non-resistant to corrosion.

Depending on its characteristics, corrosion is classified according to several criteria:

-By mechanism: chemical and electrochemical corrosion;

-By conditions of occurrence: atmospheric, gas, electrolyte, soil (ground), structural (due to non-uniform metal structure), electrocorrosion, cavitation, and others;

-By the nature of damage:

o uniform (general) corrosion, occurring over the entire surface of the metal;

o localized corrosion, occurring only in specific areas of the surface.

The most common type of chemical corrosion is gas corrosion. It occurs at high temperatures as a result of chemical interaction between metals and surrounding gases, for example, oxidation of steel pipes in heating furnaces, in internal combustion engines, gas turbines, ammonia synthesis equipment, and other cases.

In many cases, gas corrosion leads to the formation of a film (layer) on the metal surface, with a thickness ranging from 10−710^{-7}10−7 mm to 10−310^{-3}10−3 mm. In some cases, the formation of this film can slow down or even stop the corrosion process. For this to occur, two conditions must be met: the film must completely cover the surface of the component, and it must be sufficiently dense to prevent the penetration of chemical agents (such as oxygen) to the metal surface.

Figure 4a. Chemical corrosion

Figure 4b. Electrochemical corrosion

The prevention of gas corrosion should be carried out in the following three directions:

1. The use of corrosion-resistant metals and alloys;
2. Coating the surface of metal products with protective layers;
3. The application of a protective gas atmosphere is recommended.

In the manufacture of components operating in aggressive environments, metals containing alloying elements and alloys with increased corrosion resistance are used. In many cases, alloying elements are applied to improve heat resistance and high-temperature strength of alloys (Table 12). For example, a copper alloy containing 70% copper and 30% zinc (brass) can be considered heat-resistant. Also, copper alloys containing up to 10% of certain elements and up to 2.5% of other metals are used as heat-resistant and fire-resistant materials.

Protective metal coatings are widely used in cladding bimetallic sheets, strips, rubberized products, wires, steel containers, and autoclaves. Such coatings are produced by rolling, hot pressing, or heating two metals under pressure. As a rule, the coating thickness should be about 10–20% of the base metal thickness. The use of composite coatings allows saving alloyed steel.

According to the results of this study, one of the main problems arising during the storage of grain harvesters is corrosion, wear, and deterioration of the technical condition of metal components. The acceleration of corrosion processes is mainly influenced by environmental factors such as high humidity, temperature fluctuations, aggressive gases, and atmospheric precipitation. As a result, the strength, reliability, and service life of the machinery are significantly reduced.

The analysis showed that improper or insufficiently protected storage conditions lead to rapid deterioration of combine units and components, which in turn causes technical failures and economic losses during the harvesting season. Therefore, the implementation of measures to prevent and reduce corrosion is of great importance.

As a final result, the application of modern protection methods during storage—such as coating metal surfaces with special protective layers, creating optimal storage conditions, and performing regular maintenance—can significantly increase the reliability and service life of the machinery. Measures aimed at combating corrosion are economically efficient and contribute to improving the overall efficiency of agricultural machinery utilization.

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