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ROZPRAWA DOKTORSKA

WPŁYW ZWIĄZKÓW KRZEMU NA FORMOWANIE DEPOZYTÓW MINERALNYCH ORAZ DEGRADACJĘ OLEJU SMAROWEGO W SILNIKACH ZASILANYCH BIOGAZEM W RZECZYWISTYCH WARUNKACH EKSPLOATACJI

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Abstract

Landfill gas used to power generators in cogeneration units contains various types of harmful chemicals for energy equipment and lubricants. It shows a relatively high variability of the composition with respect to time the emission even within the same landfill. This is influenced by various factors, ranging from the morphology of the waste by their density, weather conditions during storage and storage time. This gas, in addition to the basic components (methane, carbon dioxide) also contains various substances including damaging effects on engine components. In addition to the hydrogen sulfide which is present in relatively large amounts of biogas, there are hundreds of other compounds in trace quantities, among them halogenated and organosilicon. They can cause the destruction of installations and equipment for the energy use of biogas, raising operating costs and investment for its treatment. A special role is played by anthropogenic organosilicon compounds - siloxanes. The presence of volatile methylsiloxanes greatly reduces the efficiency of energy recovery from biogas. During the combustion of the biogas containing siloxanes, silicon can combine with oxygen or various other elements present in the flue gas. Then there are formed in the engine deposits comprising silicon compounds (eg., silica, silicates), and other elements. They manifest themselves as a sludge with a smooth or rough texture in different shades of gray. They may form a layer having a thickness of several millimeters, being very difficult to remove. These substances can lead to abrasion of the moving parts of the engine or the deposition of layers blocking the conduction of heat or significantly reducing lubrication. In practice, this can lead to equipment failure - very serious and expensive. Under normal operating conditions, a thin film of oil is formed on the surface of the cylinder liner of the engine to separate it from the piston ring. On the other hand, when using aggressive silicon-containing gases, the mineral structures formed during combustion can to absorb the lubricant, reducing its amount to ensure efficient lubrication. This results in an insufficient amount of oil to produce the film and thus safeguard the correct level of lubrication. Engine oil, which is an essential element of a gas engine, changes its quality parameters during operation, which is a natural and unavoidable process. However, the lack of proper thickness of the lubrication layer due to excessive silicon content can lead to increased friction between the cooperating surfaces. This may result in intensified change the oil, leading to the accelerated degradation, which in turn can lead to excessive wear of the engine. This may result in intensified of changes the oil, leading to the accelerated degradation, which in turn can

lead to excessive wear of the engine. Taking into consideration the above, an important aspect of the impact on the engine-oil system appears to be the mineralogical and chemical structure of deposits on which research was concentrated. Also highlight of there are relation correlations between selected parameters used of engine oils based on monitoring research results. Attention has also been paid to the engine operating time intervals, respecting the operating times of the engine and the oil change intervals in the machine. It has been illustrated the correlations of concentration of silicon in relation to the results of monitoring tests determining oil condition and in relation to the selected chemical elements introduced by the motor during operation. Among the parameters defining the state of the oil included kinematic viscosity, nitration, oxidation, total acid number and total base number. In the case of oils working with gases aggressive included additionally: initial concentration of hydrogen ions (initial pH - I-pH) that can pass from the gas even before it is burned as well as chlorine and PQ index indicating the content of ferromagnetic products in the oil. In the analysis were also taken into account included elements that have been introduced by the engine: aluminum, chromium, copper, iron, lead and tin. In this treatise focuse has been on examining the deposit structures formed on the surfaces of the piston and engine head and determining whether and eventually what effect does the silicon compounds exert on the condition of the engine oil. The correlations between selected qualitative parameters in engine oil are determined with particular emphasis on concentration of silicon which occurs in the compounds. The intent of the study was to determine the effect of silicon compounds on the formation of deposits and their impact on engine construction components as well as engine oil degradation