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APPLICATION OF NOVEL COMPOSITE ALLOY FOR IMPROVING RELIABILITY, DURABILITY AND FUNCTIONAL PROPERTIES OF COMBUSTION ENGINE

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ABSTRACT

A target of the paper is a novel composite alloy based on aluminum-silicon AK12 and AK18 alloys, in which a composite addition was silicon carbide (SiC) and ferric sulphide (FeS). The composite material with additive of silicon carbide has a very high resistance to seising and a very low coefficient of friction. Moreover, additive of ferric sulphide has low coefficient of friction and high resistance on seizing. Novel composite alloy has also a low hysteresis of thermal coefficient of linear expansion and better strength parameters, which in effect allows increasing reliability, durability, and improving the functional properties of an internal combustion engine. The test results of strength parameters and functional properties, including hysteresis of coefficient of thermal expansion are presented in the paper.

Keywords: composite alloy, reliability, durability, functional properties.

INTRODUCTION

Material on the pistons has a fundamental meaning for the value of the clearances between the cylinder and the piston Too small clearness between the piston and cylinder on the cold engine cannot be applying, because during the work of an engine, it would be able to occur its seizing (Jankowska Sieminska, 2011). High piston-cylinder clearance is a cause of increase in exhaust gases emission level and noise, primarily as a result of side movements of the piston (Tinaut et al., 2004). On the clearance of the piston in the cylinder a decisive impact has the coefficient of thermal expansion α and its hysteresis (Sieminska, Slawinski, 2012). The strength parameters of materials at high temperature (350°C), the α coefficient, friction coefficient and resistance to seising are better for the composite material. Hardness is important for abrasive wear. Within the ring grooves, the temperature can be 230°C. Under these conditions, the hardness of standard materials decrease, where through high abrasive wear occurs. The composite material has a smaller difference in thermal expansion during heating and cooling than the standard material. It increases the fatigue damage resistance and thermal shocks. In addition it is allows the use of solutions with small clearances and constant dimensions, improving functional parameters from point of view of engine fuel and oil consumption, emission of harmful exhaust gases, the crankcase blow through to the crank case and noise level (Kuroishi at al., 2006).

RESULTS AND CONCLUSIONS

Fig.1. shows the test results of tensile strength in the function of temperature for standard (bottom line) and composite alloy. Fig. 2. shows the test results of linear coefficient of

thermal expansion α in the function of temperature (T) during heating and cooling for the composite alloy with the coefficient α during cooling equal to the coefficient α during heating.

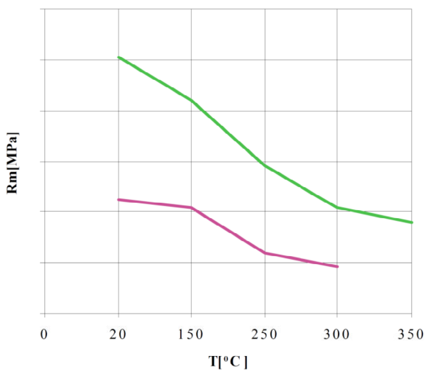

Fig. 1 - Tensile strength in the function of temperature for standard (bottom line) and composite alloy

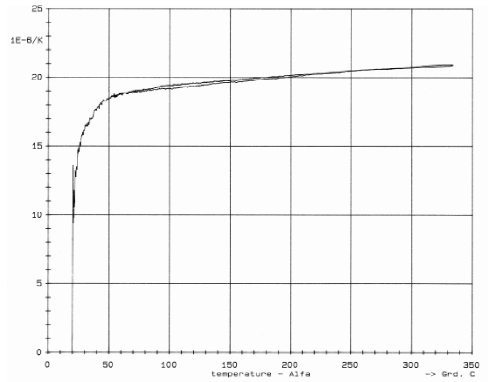

Fig. 2 - The linear coefficient of thermal expansion α during heating and cooling for composite alloy

Application of composite alloy reduced the piston-cylinder clearance. It could reduce oil consumption and noise, reduce emissions of hydrocarbons in the exhaust gases, and reduce blow-to the crankcase. In addition, resistance to seising was increased. As a result, with increased durability and reliability of the engine, functional parameters of the engine properties were significantly elevated.

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REFERENCES

[1]-Jankowska Sieminska B, Some Problems Pistons Made from Composite Materials with Small Hysteresis to Combustion Engines, Journal of KONES, Vol. 18, No. 3, 2011, p. 123-128.

[2]-Kuroishi M, Kawaguchi A, Inagaki M, Torii H, Computational Method of Piston Structure and Lubrication Using Flexible Multibody Dynamics Technique, FISITA2006 Proc., F2006P359, Yokohama, Japan, 2006.

[3]-Tinaut F, Melgar A, Fernandez, L, Illarramendi I, Landa J, A Study of Piston Slap by Analysing Cylinder Wall Acceleration, FISITA Proc., F2004F428, Barcelona, Spain 2004.

[4]-Sieminska B, Slawinski Z, Researches Novel Materials on the Pistons with Low Hysteresis to Combustion Engines, Journal of KONES, Vol. 19, No. 4, 2012, p. 549-554.