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INVESTIGATION ON THE PRODUCTION OF PISTON AND RINGS FOR AN INDUSTRIAL FREON COMPRESSOR USING LOCAL MATERIALS.

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ABSTRACT

This paper presents an investigation on the production of piston and rings for an industrial Freon compressor from locally available materials. The scraps of imported LM14 piston were melted in a crucible furnace and cast in a permanent mould constructed for the purpose. The cast piston was subjected to tests such as chemical composition, mechanical properties and heat treatment to improve its properties. Test results showed that the piston and rings produced were for adequate strength, hardness, wear resistance ability and compared favorably with the imported ones.

Keywords: *Piston, rings, reciprocating, Freon, compressor, refrigeration.*

INTRODUCTION

The level of Nigeria backwardness associated with chains of economic, social and political problems in spite of her abundant human and material resources has been a major concern to the people of the nation and the v orld at large, Sunmonu, (2004). The government, private sectors, institutions of higher learning, and rious professional groups haven been brainstorming on the various solutions to these nagging problems. or a nation to be relevant to the committee of nations, its research efforts should be direct towards finding ys to make more efficient use of energy, materials, labour, facilities, and to get more capacity out of the esent facilities. The ultimate challenge is greater productivity and higher quality at lower cost. Muman 9970, advanced that the poor collaborative alliance between the private sector and tertiary institutions ntributed to Nigeria's over dependence on imported technology, thus, an additional hindrance to the onomic growth. He recommended the setting up of central research councils at polytechnics and universities to coordinate researched and more sponsorship for research oriented efforts. Rumah, (2000) dealt with development of metallic mould for automobile piston. His work was a creative process that needed further improvement items of proper designing and heat treatment of the mould to increase its durability. Sunmonu, (1996) worked on local production of spare parts giving detailed composition on how machine parts could be produced locally to meet the required quality standard. Despite environmental limitations. The process of melting metal and pouring it in to the required mould size and shape, known as casting, has wide applications in machine parts production. The combination of casting and machining processes have made it possible to product parts of very irregular and complex shapes such as engine blocks, pump housing, fan blades, and pistons, Mitra and Prasad (1986). Permanent mould casting usually coated with a refractory wash and then lamp black, which reduces the chilling effect on the metal and facilitates the removal of the casting. The mould consisting of two or more parts is used repeatedly for the production of many casting of the same form. The liquid metal enters the mould cavity by gravity.

MATERIALS AND METHODS

Materials

Scraps of LM14 aluminum alloy for the production of pistons were sourced locally from already used and abandoned parts. Austenitic alloy steel used for the production of the piston rings were sourced from local materials and machined to the required dimensions.

Methods

Mould Productions

The mould consists of the dies, the accessories and the sprue. It is made from grey cast iron, the accessories which include the lifting and ejection mechanism were produced from medium carbon steel. The parts were assembled using screws and bolts after machining to the stipulated dimensions.

Core Production

Sand core was used in this research work due to the simplicity of production, cheapness, availability and ease of removal. A wooden core box containing the required cavity that gives the shape of the core was rammed full with silica sand mixed with vegetable oil, bentonite and water. After ramming, the core box was removed from the formed sand core, which was mounted on a support plate for the purpose of drying.

Costing of Piston

The scraps of LM14 aluminum alloy were melted in a blower type coke fired crucible furnance. The mould surface was coated with graphite dust, preheated and the molten aluminum alloy was poured in to the cavity after degassing cleaning. Solidification of the molten metal took an average of 32 seconds. Ejection of the cast piston was done by breaking the sprue from the upper die gently using hammer. The sand core was then removed and the piston machined to the required size and dimensions. The piston was strengthened in boiling water for three hours and aged at room temperature for five days. This procedure is in accordance with Sunmonu (2004) and Dangyara (2002)

Mechanical test

Two tests were conducted on the cast piston namely, tensile and hardness.

Tensile test

The specimen for the tensile test was taken from the cast piston, heat treated along with piston and machined to the standard size. The tensile test was carried out using house field tensometer with loading applied axially on the test specimen. Results obtained are shown in tables 3.2,3.3 and 3.55 respectively.

Piston ring production

The production of the rings was carried out through maçhining of the alloy steel material on lathe machine after initial turning, boring, and parting off. The rings were ground on magnetic vice surface grinding machine. Grinding of the rings were ground on magnetic vice surface grinding machine. Grinding of the rings was done to obtain high surface finish and flatness. The final operation on the rings was cutting of the ring gap with hacksaw and filing with files and sand paper. Dimensional accuracy and surface finish were checked, and the ring was inserted in to the cylinder bore to assess ring gap. Finally, the ring was fitted on the piston and coupled in to Freon compressor for test running. It performed efficiently

X-ray fluorescence test.

This is a computerized method of detecting the presence of alloying elements and their percentage composition by weight. The method depends on the use of auxiliary optical
Magnification to obtain information on the chemical composition of the test piece. The procedure adopted involved surface polishing of the test piece and feeding it in to the machine. As soon as the machine was switched on, the compositions of the various elements were displayed on the screen and recorded. The results obtained are indicated in tables 3.1 and 3.4.

Results and Discussion

Table 3.1 shows the chemical composition obtained through x-ray fluorescence (spectrometry). The presence of chromium and higher content of Zinc, titanium and iron might have taken care of strengthening effect of using lower magnesium content. This result agrees with that of Polmear, (1995) and compares favourably with LM12 in table 3.4 LM14 cast alloy is noted for tremendous strength at elevated temperature, which make them suitable for piston production in heavy duty diesel engine and sir cooled cylinder head.
Table 3.2 indicates that the mechanical properties of the cast piston compare favourably with that of LM14 in table 3.5. Except for the ultimate tensile strength and Brinell hardness values that were lower, the yield strength and elongation values agree with that of LM14. The results of the heat-treated test pieces agree more favourably with that of LM14 as Shown in table 3.3. Although, the mechanical tests were conducted two to three days in which some natural ageing might have occurred, the properties could still be improved upon through solution treatment and artificial ageing. The results further validate the existing knowledge on the effects of heat treatment and work hardening on cast aluminum alloy. It confirms the properties of each treatable aluminum casting alloy could be improved by heat treatment and work hardening, Sunmonu (2004).

CONCLUSION

Product development and perfection most often involved several years of research input, combination of efforts and good finding. An attempt has been made in this research work to produce piston and rings for reciprocating Freon compressors used in Nigerian industries for refrigerating purposes as substitute for imported ones. The mechanical tests conducted on the finished heat-treated piston, indicated that the piston has adequate strength, hardness and resistance to corrosion. The functionality test conducted on the piston and ring by coupling them in to a compressor and running the compressor firstly as an air compressor for compression testing up to 30MN/m2 and secondly mounting the compressor in the refrigerating system, indicate good product functionality and there was no overheating of compressor.

Table 3.1 Chemical composition of cast piston

Alloying Elements	Al	Si	Cu	Fe	Mn	Cr	Ni	Zn	Ti	Sn
Percentage Composition(%)	90.753	0.646	3.930	0.960	0.343	0.244	2.195	0.304	0.343	0.04

Table 3.2 Mechanical properties of cast piston

Properties Tested	Ultimate tensile Strength (N/mms	Yield Strength(N/mm2	Elongation (%)	Reduction In area (%)	Hardness HB
Values Obtained	260.90	230.0	1.15	1.59	75.0

Table 3.3. Mechanical properties of heat-treated cast piston

Properties tested	Ultimate tensile Strength (N/mm2)	Yield Strength(N/mm2)	Elongation (%)	Reduction in area(%)	Hardness HB
Values obtained	275.0	260.0	1.0	1.40	90.0

Table 3.4 Chemical composition of LM14 aluminium pistion

Alloying Elements	Al	Si	Cu	Fe	Mn	Mg	Cr	Ni	Zn	Ti	Sn
Percentage composition	90.8	0.65	3.95	0.80	0.35	0.25	0.24	0.24	0.32	0.35	0.04

Table 3.5 Mechanical properties of LM14 aluminium piston

Properties tested	Ultimate tensile Strength (N/mm2)	Yield Strength(N/mm2)	Elongation (%)	Reduction in Area (%)	Hardness HB
Values obtained	280	230-260	1.20	-	90-120

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