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Original Research

Improvement of the Abrasive Wear Resistance of Pump Shaft (AISI 316L stainless steel) by Salt Bath Nitriding

Ghelloudj Elhadj[1*], Hannachi Mohamed Tahar[2], Djebaili Hamid[1], Hafsaoui Sifeddine[1]

[1] *Department of Mechanical Engineering, University Abbes Laghrour, Khenchela 40000, Algeria*

[2] *Department of Mechanical Engineering, University sheik Larbi Tébessi, Tébessa 12000, Algeria*

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Abstract

Centrifugal pumps are prevalent for many different applications in the industrial or other sectors. The paper reviews the literature available on the improvement of efficiency of centrifugal pump through improvement in performance of pump shaft (AISI 316L stainless steel). The paper discusses the available material of performance improvement through amelioration of tribological characteristics of pump shaft and mainly focuses on the abrasive wear resistance of AISI 316L stainless steel. In order to improve the abrasive wear resistance of stainless steel components, carbide-hardened surfaces were produced on AISI 316L austenitic stainless steel by salt bath nitriding. Nitriding of AISI 316L austenitic stainless steel was carried out at high temperature (580°C) for 10 h. The microstructures, abrasive wear resistance, as well as its surface hardness, were investigated using optical microscopy, tribometer tester and microhardness tester. The results confirmed that salt bath nitriding was effective in improving the abrasive wear resistance.

Keywords: Centrifugal pumps; pump shaft; AISI 316L stainless steel; Abrasive wear resistance; Salt bath nitriding.

1. Introduction

A pump is a machinery or device for raising, compressing or transferring fluid [1–4]. A fluid can be gasses or any liquid [5,6]. Pumps are used in a wide range of industrial and residential applications [7,8]. Over time, the application of pumps in the agricultural domain has expanded to cover other domains as well. The following are a few main domains that use pumps extensively: Water supply, drainage, sewage, irrigation, chemical industry, petroleum industry, pharmaceutical, medical field, steel mills, construction and mining [9–11]. Pumps are also used for diverse applications like in transfer of potatoes, to peel the skin of hazelnuts in chocolate manufacture, and to cut metal sheets in areas that are too hazardous to allow cutting by a gas flame torch. The artificial heart is also a mechanical pump [9]. Pumping equipment is extremely diverse, varying in type, size, and materials of construction. Due to this there is a wide range of different pumps available [12]. Pumps based on their principle of operation are primarily classified into: Positive displacement pumps (reciprocating, rotary pumps) and Roto-dynamic pumps (centrifugal pumps [13–15]).

A Centrifugal pump is one of the rotating machines that are widely used in various industries such as petrochemical, water treatment, power generation, agriculture, fertilizers, oil and gas [16–18], because the pump is robust, effective and inexpensive to produce. Centrifugal pumps are more economical to own, operate and maintain than other types of pumps. Pumps operate via many energy sources, including manual operation, electricity, engines, or wind power, come in many sizes, from microscopic for use in medical applications to large industrial pumps. Mechanical pumps serve in a wide range of applications such as pumping water from wells, aquarium filtering, pond filtering and aeration, in the car industry for water-cooling and fuel injection etc [19,20].

With regard to the principle of work of Centrifugal Pumps, is the conversion of rotational kinetic energy to the hydrodynamic energy of the fluid flow. The rotational energy generally comes from an electric motor, steam turbine, or an

* Corresponding author. Tel.: +213661602387; fax: +21332338885.
E-mail address: hadjhadj105@gmail.com ***(E. Ghelloudj)***.