Wear of Impact Socket: A Review

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Abstract— Wear have been identified as some of the major problem associated with failure of impact sockets. Impact sockets are rotated by impact wrenches. These wrenches are designed to deliver high torque output with minimum exertion by the user. Wear and tear of impact socket takes place because of various reasons. This paper presents an overview of wear failure problem in impact socket and looks at some recent technique of wear prevention and discusses the future development of wear resistant impact socket.

Key words: Wear, Impact socket

I. Introduction

Wear may be defined as the unintentional deterioration resulting from use or environment. It may be considered essentially a surface phenomenon. Wear is one of the most destructive influences to which metal are exposed, and the importance of wear resistance needs no amplification. The displacement and detachment of metallic particles from a metallic surface may be caused by contact with (1) another metal (adhesive or metallic wear), (2) a metallic or a nonmetallic abrasive (abrasion), or (3) moving liquids or gases (erosion). The above three types of wears may be subdivided into wear under rolling friction or sliding friction and, further, according to whether lubrication can or can't be used. Impact socket is a tool designed to exert a torque on a fastener to achieve proper tightening or loosening of a connection. A hydraulic torque wrenches are applied to the nut or Allen bolt either directly or in conjunction with an impact socket. Hydraulic torque wrenches apply control amount of torque to a properly lubricated fastener through impact socket. The purpose of impact sockets is to withstand the force the applied by impact tools, which cause the standard sockets to failure. In their service periods, impact socket undergo heavy working stresses. As a result wearing and tearing take place in the body parts. The quality of the impact socket depends on the condition of their surfaces and on surface deterioration due to use. Surface deterioration is also important in engineering practice; it is often the major factor limiting the life and performance of machine components.

II. Literature survey

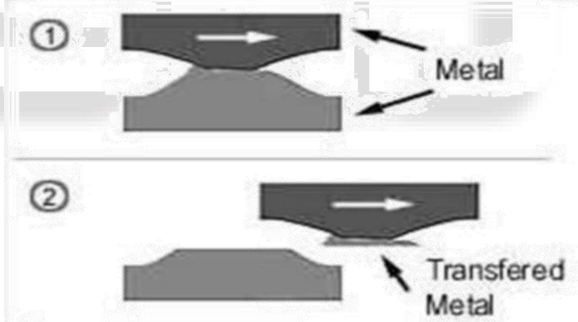
A. Wear

Wear is erosion or sideways displacement of material from its "derivative" and original position on a solid surface performed by the action of another surface. Wear is related to interactions between surfaces and more specifically the removal and deformation of material on a surface as a result of mechanical action of the opposite surface. The need for relative motion between two surfaces and initial mechanical contact between asperities is an important distinction between mechanical wear compared to other processes with similar outcomes. The definition of wear may include loss of dimension from plastic deformation if it is originated at the interface between two sliding surfaces [2].

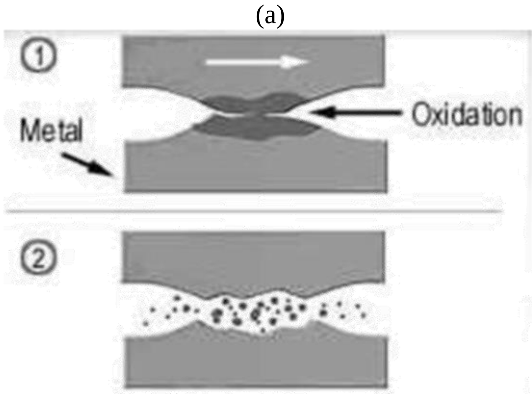
B. Different types of wear

1) Adhesive wear

This type of wear occurs due to sliding of two metallic components against each other under an applied load where no abrasives are present (Fig. 1.1(a)). A strong metallic bond forms between surface asperities of the contacting materials and hence the name 'adhesive' [10]. In case of stainless steel, there is a thin oxide layer on the surface, which prevents the formation of metallic bonding in between the asperities on the sliding surfaces. Hence, wear rates are low at low load. This type of adhesive wear is known as mild wear or oxidative wear (Fig. 1.1(b)). When the load applied on the surface is high, metallic bond forms between the surface asperities and the resulting wear rates are high. This kind of wear is more prevalent where a lubricant cannot be used e.g. chain-link conveyer belts, fasteners and sliding components in a valve. For stainless steel, hardness affects adhesive wear resistance. For martensitic alloys, a minimum hardness of 53 HRC is required for excellent wear resistance. In austenitic stainless steel, the work hardened hardness is critical due to the presence of the alloying additions that increase the stability of oxide film. These factors increase the transition load required for severe corrosion to occur.



(a)

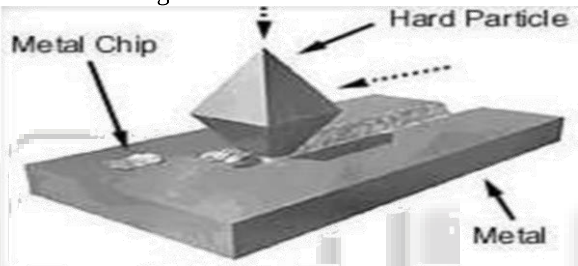


(b)

Fig 1.1 Schematic representation of (a) adhesive wear, (b) oxidative wear

2) Abrasive wear

It involves ploughing of localized surface contacts through a softer mated material [6]. Nonmetallic particles usually cause abrasion but metallic particles can also cause abrasion. A material is seriously abraded or scratched if the particle is harder than itself. Abrasive wear can be divided into three different types: low stress (Fig. 1.2(a)), high stress (Fig. 1.2(b)) and gouging (Fig. 1.3(c)). Low-stress abrasion or scratching can be defined as wear that involves a relatively light rubbing contact of abrasive particles with the metal. The subsurface deformation is minimal and shows scratches, hence the surface does not work harden. High stress abrasion involves wear under stress, high enough to crush the abrasive and hence more strain hardening occurs. Examples are abrasion by rolling-contact bearings, gears, cams and pivots. Gouging abrasion is the high-stress abrasion that results in sizable grooves or gouges on the worn surface. In this type of wear, strain hardening and deformation are the dominant factors. This form of wear occurs on parts of crusher liners, impact hammers in pulverizers, etc. Factors affecting abrasion resistance are: microstructure, hardness, and carbon content (for steel), e.g. for low stress abrasion, hard martensitic structure is preferable. Martensitic stainless steel is used for its high hardness where high-stress abrasion occurs.



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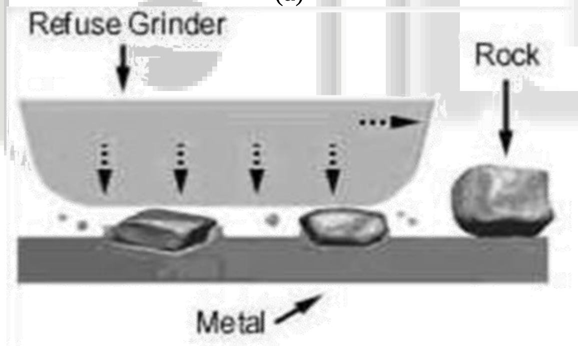

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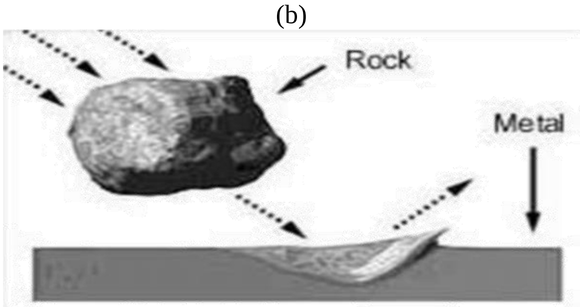

(c)

Fig 1.2 (a) Low stress abrasive wear, (b) high stress abrasive wear, (c) gouging.

3) Fretting wear

The process involves wear caused by the small amplitude vibrations (Fig. 1.3) at mechanical connections e.g. at riveted joints [6].This is caused by the combined effects of oxidation and abrasive wear. Two oscillating metallic surfaces produce tiny metallic fragments that oxidize and become abrasive. Subsequently, wear progresses by mild adhesive wear in combination with abrasive wear. Factors that influence fretting wear are contact conditions, environmental conditions and material properties. Fretting is influenced by parameters such as load frequency, amplitude of fretting motion, numbers of fretting cycles, relative humidity and temperature [9].

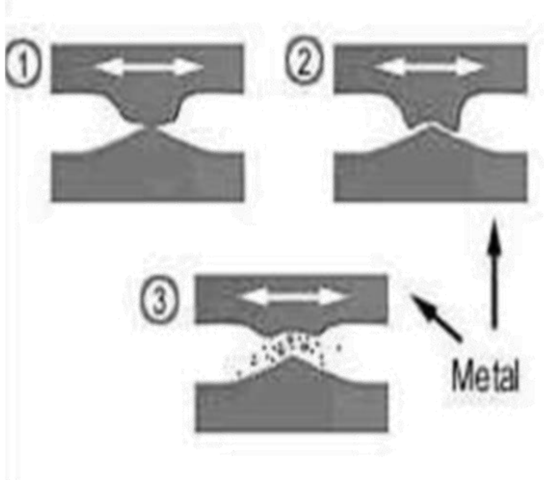

Fig 1.3 : Schematic representation of fretting wear.

4) Corrosive wear

It involves wear under the influence of corrosive reagent [6]. Corrosion is the process of electrochemical removal of material from surface by dissolution whereas wear involves the removal of material due to physical interaction between the two surfaces. These two processes affect synergistically to accelerate the materials removal from its surface and termed as corrosive wear. This type of wear involves the disruption and removal of the oxide film, leading to exposure of active metal surface to the environment, dissolution or re-passivation of the exposed metal surface, elastic field interaction at asperities in contact with the environment and the interaction between the plastically deformed areas and its environment. In mining industries, abrasive wear is aggravated by a wet corrosive environment. Carbon steel readily forms iron oxide, which is removed by sliding and bumping of moving coal/ore causing continuous loss of metal thickness. Stainless steel for its resistance to removal of oxide layer on its surface is desirable for the application in corrosive wear environment.

5) Fatigue wear or contact fatigue

It occurs when a surface is stressed in a cyclic manner (Fig. 1.5). This type of wear can be found in parts subjected to rolling contact, such as ball bearings and gears. Surface conditions, such as finish, residual stress, hardness and microstructure play a role in determining the extent of fatigue wear. Surface treatments e.g. nitriding, carburizing and shot peening which increase surface hardness and improve residual stress distribution in turn could enhance resistance to fatigue wear [6].

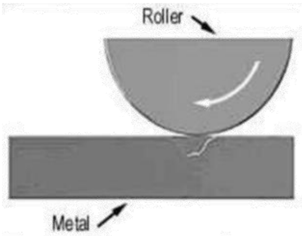

Fig 1.4 : Schematic representation of contact fatigue.

C. *Means of reducing wear*

Improved design; in which relative movements between surfaces are prevented. Surface treatment; in which the surface is made rougher. Coatings; in which a hard coating is applied. caution is to be observed since the coatings, if brittle, may crack under plastic deformations of the bulk material and act as an abrasive. Inserts; which will separate the two surfaces. Lubricants; which will smoothen the contact. However, it is often difficult to maintain the lubricants in the area of contact [8]. High hardness is a desired property (if fatigue is not to be expected). However, hard metal sliding should be avoided in lubricated systems due to the risk of scuffing. Lubrication will reduce wear. Lubrication can be applied by providing a corrosive atmosphere, which will produce surface films. Stainless steel for its resistance to removal of oxide layer on its surface is desirable for the application in corrosive wear environment. Surface treatments e.g. Nitriding, carburizing and shot peening which increase surface hardness and improve residual stress distribution in turn could enhance resistance to fatigue wear [8].

III. IMPACT SOCKET

An impact socket of hex bit type have male hexagonal bit structure at one end and square grove at another end (Fig 2.1). Impact sockets are well known in the art. Impact sockets are rotated by impact wrenches, impact guns or guns. These guns are designed to deliver high torque output with minimum exertion by the user, by storing energy in rotating mass such as a hammer, and the sudden delivery of the energy to the output shaft. Guns use compressed air, hydraulics or electrical energy. Guns are used for precise output torque. Impact sockets can be used for every standard socket, Wrench drive size, from small one quarter inch sizes to over three and one half inch sizes [6].

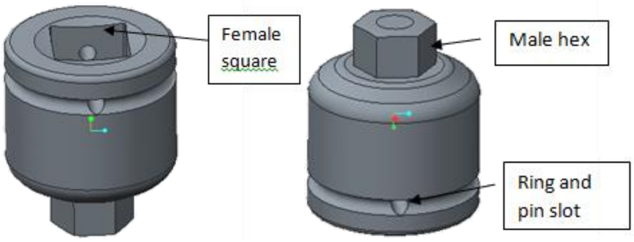

Fig 2.1 : Schematic representation of Impact socket.

IV. MECHANISM OF WEAR IN IMPACT SOCKET

A. *Effect of tolerance*

When male hex of impact socket is inserted into the corresponding opening in the screw head of bolt, all the working surfaces do not act simultaneously on the corresponding opening surfaces in the screw head of the bolt. The tolerances in the tool and the opening in the screw head of bolt is one of the reasons for this. If a torque is now exerted, then, in case of a hard work end, only a punctiform load is exerted on individual engagement surfaces, which would have result that the surfaces are easily overstressed and then break or fail [1]. As the clearance in the joint of hex bit and opening in screw head of bolt is increase then the working end of sockets slips out of the screw head and then continues spinning causes the wear of corner of hex bit of socket in case torque is too high [1,3]. To reduce the slipping of contact surfaces the tolerance of meeting surfaces should be close enough. The clearance exist between the meeting contact surface should be very less so that maximum surface area come in contact and reduced sliding of contact [3].

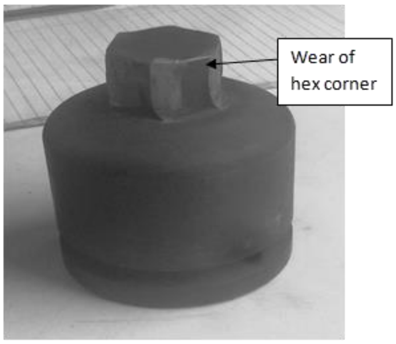

Fig. 2.2 Schematic representation of failure of Impact socket

B. *Effect of material*

An Allen bolt is a threaded fastener used to secure machine parts by engaging corresponding threads on a nut (or the machine part). The bolt typically has a hexagonal socket groove in head portion (the bolt head) with 120° corners. Often, when trying to loosen an over torque hexagonal bolt with an impact socket, the 120°corners of the socket hex bit become rounded (marred) such that the hex bit of the socket wrench (also a hexagon having 120° corners) will no longer engage with the bolt head. The primary cause of the ‘socket hex bit rounding’ is that the metal composition of the impact socket is softer (or weaker) than the metal composition of the bolt head [4]. When loosening or tightening a screw with a screwdriver, the screwdriver will ‘slip off’ of the screw head (the work material) and mar (or gouge) the proximal work material. A common source of the screwdriver slipping off or breaking loose from the screw head is the incompatibility of the metal composition of the screw driver tip relative to that of the screw head i.e., the Work material, and as such, the screwdriver tip often times strips the screw head mating surface [3, 4]. The material strength can be increased by heat treatment processes; generally the softer material undergoes plastic deformation under loading conditions. To shear strength of material is directly depend on the hardness of material. For reducing the wear, hardness of material should be increased [8]. Increasing the hardness of material reduces its strength and for increasing the strength of material various surface treatments is used. In some screwdrivers and impact socket non-marring polymer coating, wherein the polymer coating reduces or prevents marring or damage of the work material and/or a proximal work material [2, 4].

V. CONCLUSION

In impact socket there is a common problem of wear failure of hex bit drive end due to the action of high torque and shear stresses on these parts. The failure of the impact socket causes reduction in efficiency and even breakdowns of bolting process. There are various reasons of wear and tear of impact socket such as slipping of contact in meeting parts, weaker material strength, larger clearances and tolerances of meeting parts due to which impact socket wear takes place. For reducing or preventing impact socket wear clearance of meeting part should be very less so that maximum surface area come in contact and reduce slipping of contact. Material hardness and strength of material increased by various surface treatments. Nitriding, carburizing, shot peening and polymer coatings can be used to increase wear resistance characteristics of impact socket.

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