Extending the service life of oil pumps by detonation coating

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ABSTRACT

Long life of the equipments for oil extraction has big importance in the national economy. This equipment breaks down due to wear and tear. The method of detonation precipitation has an important place among different methods of thermal spraying which allow to get high density gas coating and high strength of tenacity with basic metal. For precipitate the coating we use standard powder of Al_2O_3 have grains size 20-36 μm and mechanical mixture of:
Al_2O_3 +3% Cr_2O_3 and Al_2O_3 + 3% TiO_2. Analyze of Tested samples , shows that on the active surface of detonation coating which consist of big single grains , which have low porosity , there is no cavitation breakdown in the first hour of experiment. Whereas explosion bubbles don't cause cracks, extractions, and holes. With passing of time a micro deformations is appeared on the coating surface in the holes and micro curves and explosion bubbles places. And this micro deformations with continues of current flow, causes micro cracks, which increases and cause breakdown of coating between molecules and grains and extract grains from the coating and moved it away of cavitation area.

Introduction

Improve and increase reliability of oil extract equipment consider one of the most economic and technology issues in field of building machines which enables to economize fundamental materials, efforts and energy. Oil extract equipment usually break-down due to the wear of active surfaces and to mechanical loads on it and the effective chemical gas milieu or the liquid one and high pressure, temperature and velocity.

In conclusion ,the reasons of break-down of surfaces are: friction, abrasion, cavitations, chemical and elect-chemical corrosion which can be classified according to basic phenomenon , which determine its effective as a mechanical corrosion (which happens due to plucking out molecules or injuring or breakdown surface layers) and the mechanical - molecular corrosion (molecular coupling is happened on separated places of coupling surfaces and form a contact) as well as a mechanical rust (the products of friction surface react with effective milieu and exclusion products from area). For example of exposed equipment to corrosion we mention operating elements in oil's extract pump (clutter, rings, sealers valves .etc.). Protect the operating surface of elements with resisting corrosion coating and restoration this elements after wear is considered the optimal solution.

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Thermal spray coating is the active method of precipitation methods, and it is used widely, and this allows saving phys-mechanical and element shape thus improve the thermal spray coating precipitation and use it in preparing and restoring machines element will be interested for all industrial developing countries. Moreover detonation coating method is considered the most important method because it produces a coating with high quality for that it has been chosen for this research.

The materials:

For precipitate the coating we use standard powder of Al_2O_3 have grains size (20-36 μm) and mechanical mixture of Al_2O_3 +3% Cr_2O_3 and Al_2O_3 + 3% TiO_2.

The Technical Specification of Coating in Traibology Friction Conditions:

We have determined the resistance of detonation coating against wear and abrasion, in traibology friction conditions in air and industrial lubricant I -20, by diagram column-bearing. the column is made of quenched –steel CT-45 and the coating was precipitated on bearing surface which is made of steel CT-45 .the tests was performed by the laboratory machines of friction. The coating without lubricant consist of the following materials have been tested in traibology friction conditions: Al_2O_3+TiO_2 , Al_2O_3 according to variable of bearing force within range (0.5-4 Mpa) in constant rolling speed (1 m/sec) for distance (1 km). During the test the friction strength, linear and weight wear, and temperature in the friction area have been determined. Figure (1) shows that if bearing strength increase the wear increase too. The strength of oxide layer on friction surfaces depend on portion of fundamental metal hardness and its oxide. If the oxide layer has a high hardness and the fundamental metal is, tender the layer will be breakdown rapidly. Such as what happen to aluminium oxide when the fundamental is pure aluminium then the hardness portion of aluminium oxide and aluminium is (22000:2Mpa) and this effects on layer strength and will be the reason for increases the wear of machine parts, which are made of aluminium alloy.

During friction of precipitated oxide coating on steel parts, which have hardness more than aluminium, crush of oxide layer will be done and break down will be noticed just under the effect of over loading. Second stage of experiment was done in friction traibology conditions without lubricant when temperature of surface layers increase to (100-200 C^o) and in the contact points of micro prominences on the surfaces, the temperature may increase whereas in this conditions plastic deformations are happened for thin layers coating and smoothing of grains is happened, and this grains are effected by air and new crystal structure have been created on friction surfaces. If the Al_2O_3 hardness is (2100-2300kg\mm^2) in the normal temperature it will become (600kg\mm^2) in the temperature 900 C^o.

During the friction of oxide coating with quenched steel, an oxide layer has been created on surface of foundation iron due to this a react between aluminium oxides and iron oxides is happened. Iron oxides are appeared on the active surface of coating oxide, but with pressure and temperature effect a complex union of spinel was formed on the micro surface prominences. In friction conditions with lubricant the wear strength and friction factor less more than friction without lubricant for all kinds of coating. Elctrocrond coating have the maximum value of friction factor and Al_2O_3 coating have the minimum one which equals (0.05), but other kinds of coating equal (0.09-0.095). It is noticed that maximum wear in friction group of Al_2O_3 coating is (5.5 μm/km) under loading (1 Mpa) and rolling speed (1 m/sec). In this case the temperature in friction area is taken in (1mm) of coating surface and it is reached to (40C^o) . This temperature don't effect on friction operation and in this case the oxidation on active surfaces happens slowly but lubricant in friction area cause formations of secondary crystal structure which decreases friction factor and wear.

Table 1: friction of oxide coating with quenched steel

Coating type	**Friction factor**	**Wear of coating (μm/km)**	**Temperature (C^o)**
γ - Al_2O_3	0.05	5.5	40
Al_2O_3+TiO_2	0.09	2.18	55
Eletrocrond	0.095	2.25	60

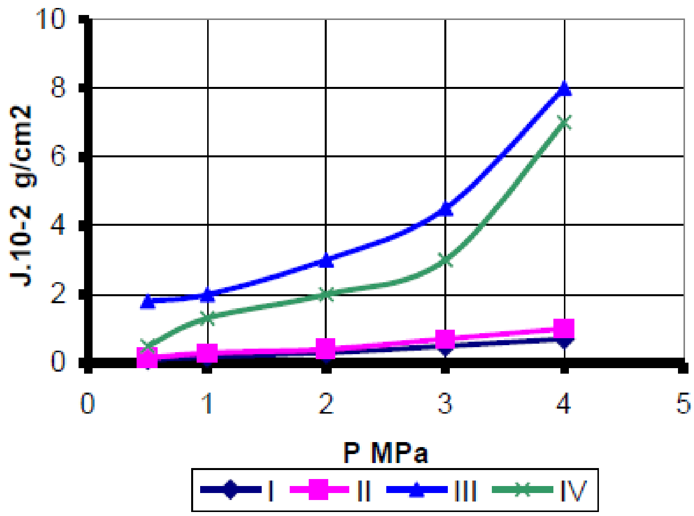

Fig.1: Relation between wear (J. 10-2 g/cm²) and loading during friction: I. Coating of Al_2O_3 with quenched steel, II. Coating Al_2O_3+3%TiO_2, III. Wear of quenched steel with Al_2O_3, IV. Wear of quenched steel with Al_2O_3+TiO_2

Coating Resistance against Wear of Cavitation:

Recently different kinds of machines , are used for study the wear occurred by cavitation , some of these machines are magnetic vibrator , ultra sound waves machines , jet current machines which forms bubbles have high dynamics in liquids . The machines which have various nozzles (one of them is Venture pipe), consider more development and provide high rate of formation bubbles. Various diffusion nozzle is used and the samples like rings with thickness 3mm were fixed vertically on path of flow current in order to increase wear strength and decrease time of experiments. Bubbles formation and diffusion them is regulated by changing the pressure between input and output of the liquid which is hydraulic oil AMG-10 the pressure in the input is constant: (Pin = 15Mpa) and the difference between input and output is (Δp = 0,93Mpa), Velocity of liquid (180m/sec), Pump pressure (Pp=0.5Pa). For comparison and in addition to coating experiment, we tested high resistaning materials, and low one for this phenomenon and some of this materials , are cast iron H1-50,bronze, quenched steel 45,chemical treatment steel CT-45 with boron . First stage of wear take important place in studying and this stage provide exact determination of breakdown mechanism for later stage. Use tender and plastic aluminum alloy allow to determine the kinetic of breakdown with the effect of cavitation from exploration of bubbles to strong occurrence of cavitation. Figure (2) shows experiment results of some materials in cavitation phenomenon. It is noticed from the figure that the precipitate of detonation coating have high resistance in comparison with other materials except Nickel-Crom steel which a little bit better .

Analyze of Tested samples, shows that on the active surface of detonation coating which consist of big single grains , which have low porosity, there is no cavitation breakdown in the first hour of experiment. Whereas explosion bubbles don't cause cracks, extractions, and holes. With passing of time a micro deformations is appeared on the coating surface in the holes and micro curves and explosion bubbles places. And this micro deformations with continues of current flow, causes micro cracks , which increases and cause breakdown of coating between molecules and grains and extract grains from the coating and moved it away of cavitation area . Relation between loss in coating weight and time has curve line shape, but aluminium and bronze alloy has straight line shape because a plastic deformation is happened for this materials.

Time rang of deformation for experiment materials has extended to become (5 to 120 minutes), but for detonation coating it was (75 minutes). According to that the Nickel-Crom steel has time range better than the coating one. In accordance with experiment results the detonation coating on

CT-45 steel has effected on resistance against cavitation and there are no signs of plastic deformation extraction or breakdown of surface layer. This explain that the detonation coating have big single grains which have low porosity no more than 0.5 % and has high cohesion with foundational metal and high resistance against abrasion and corrosion.

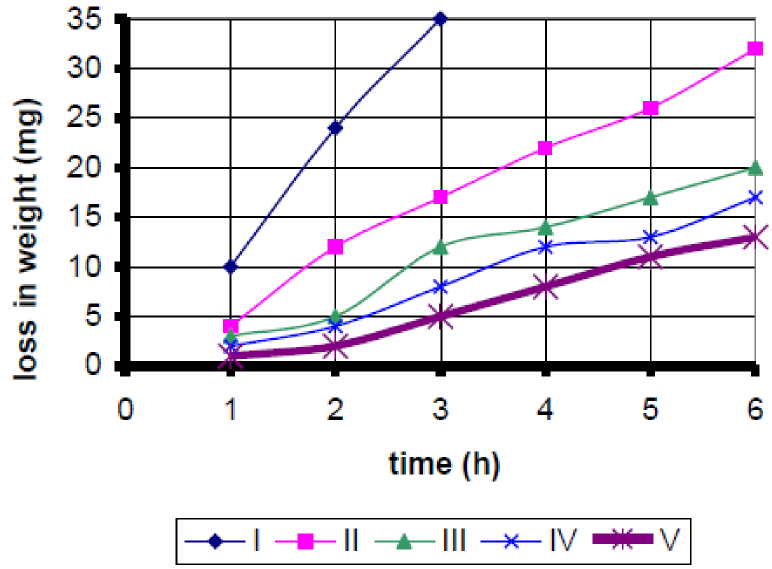

Fig. 2: The relation between loss in weight and time in cavitation conditions High strength cast: I. Iron, II. Bronze, III. Ct-45 quenched steel, IV. Ct-45 steel treatment with boron, V. Steel coated by precipitation with detonation.

Materials and abrasing molecules in the liquids increase wear by cavitation. This case is so sophisticated, and the wear strength in cavitation with abrasion is more than normal cavitation. This explain that in wear by cavitation and with abrasing materials the breakdown doesn't happened due to just bubbles explosion and micro impacts but also from impacts which happened due to abrasing molecules with velocity more than current liquid velocity which causes the cavitation. In addition to that the impacts in cavitation cause thermal, electrical and chemical operations. Then extract of metal molecules and increasing in wear by abrasion are happened simply. According to that, we can specify requirements, which increase, resistance against wear of coating in cavitation phenomenon and abrasive phenomenon.

We should choose work system, which provide us a coating with low porosity when we precipitate detonation coating. If there are abrasing particles, the coating should have a high resistance against wear by abrasion.

The Results:

In abrasion conditions it is noticed that the reason of resistance of coating against wear is its hardness and if it increase the resistance against wear will increase too. Maximum resistance is for (α - Al_2O_3) coating which is 4.22 times more than quenched steel.

The operations on coating surface have been considered during tribology friction. We conclude that in this conditions, oxidation operations on fricting surface have been done. In case of loading 3mpa without lubricant accompanying operation of abrasion, on the coating surface is happened in addition to oxidation. In this conditions the maximum resistance against wear is for quenched steel with Al_2O_3 coating.

In conditions of wear by cavitation surrounding with AMG-10 aircrafts engine lubricant it is noticed that there is no strong wear and with over looking that the oxides are fragile, the high resistance against wear and corrosion and low porosity (not more 2,5%) and high cohesion with foundation provide high resistance against wear by bubbles. the coating resistance against wear by bubbles is more than cast iron ,bronze, quenched steel but Nickel Chrom steel is little bit more than coating.

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