

High-pressure piston with variable profile for balancing wear surface.

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Abstract .

The present paper describes the methodology that started the improvement of the hydraulic equipment of drilling mud pumps 2PN 1600 and 3PN 1600 type, used in drilling of oil wells on rigs in the Black Sea, methodology that is the object of S.C. CAMIRO ENGINEERING S.R.L. application for STATE OFFICE FOR INVENTIONS AND TRADEMARKS (OSIM) nr.A 2005- 00734.

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1. Introduction.

As researches that are made at world scale regarding the friction and wear behavior of high performance polyimide (PI) and its composites reinforced with glass fiber add-ons, short cut carbon fiber and solid lubricants such as graphite, MoS₂ and polytetrafluoroethylene (PTFE) have evolved in two directions: under dry sliding and under water lubrication with open circuit, aiming at selecting matching materials for the pumps of pure water power transmission. The wear mechanism in the two directions regarding to compound friction and friction conditions has been comparatively analysed on scanning electron microscopic examination of the worn composite and steel counterpart surfaces.

Research revealed as the results, the incorporation of solid lubricants and carbon fiber in PI contributed to improve the friction and wear behavior considerably. PI-based composites sliding against stainless steel register higher friction coefficients and wear rates under water-lubricated condition than under dry sliding. The difference in the wear rates of the composites becomes margined under water lubrication, owing to the boundary lubrication effect of the water absorption layer, though the transfer of PI and its composites was considerably hindered in this case. PI and its composites are characterized by plastic deformation, micro cracking, and spalling under both dry- and water-lubricated sliding. Such plastic deformation, micro cracking, and spalling is significantly abated under water-lubricated condition. This accounted for the better friction and wear behavior of the composites under water-lubricated condition. [1], [2].

2. Experimental.

Tribological study regarding the behaviour of materials used in prior manufacturing of hydraulic-operated power cylinder and drilling pump piston as building block revealed the following aspects:

- hydraulic-operated power cylinder and drilling pump piston building block is subject to an alternate stroke wear – active process due to tough working conditions: $P_{nom.} = 120-500$ bars; $Rug_{surf.} = 0,6-0,4\mu m$; $T = 60-90^{\circ}C$, the drill fluid is contaminated with silica microparticles.
- The piston wear determined a metal on metal friction and an accelerated wear progressing and the reduction of the using time of both the piston as well as of the pressure cylinder to 8-100 hr.
- The design, the choice of materials, form and dimensions do not insure the technological role of drilling pump piston.
- The quality control in piston set-up as well as the working conditions of the piston-cylinder as building block are not insure in any way.

The answer was choosing the right tribomaterials, that could insure the gaskets working order of piston at 500 bars, in endurance conditions, that can insure a higher working durability than the drilling time of oil well.

According to EMS GRILAMID data polyamid PA6; PA6.6 is a light hygroscopic water-sensitive polyamid, Fig. 1, [3].

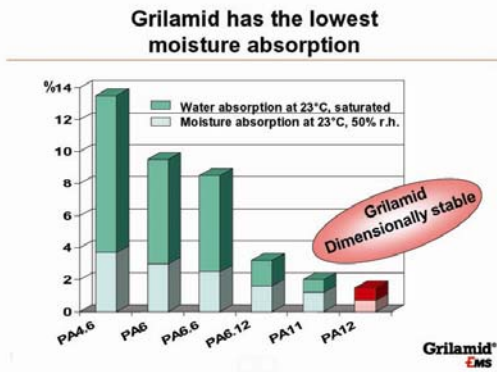


Fig. 1, [3].

Thus a building block formed of two profile V gasket of polyurethane and a specially gasket conceived from PA6 polyamid.

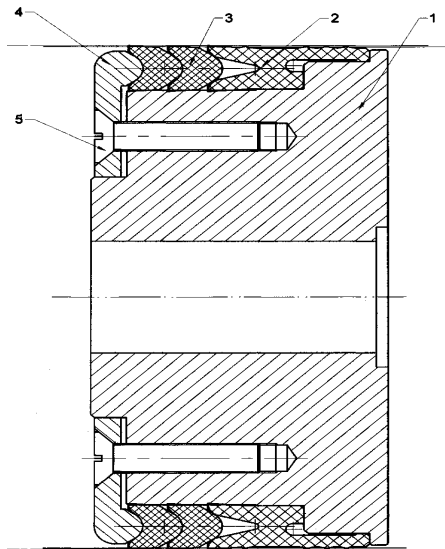


Fig. 2 - CAMIRO High-pressure piston design with variable profile for balancing wear surface for drilling pump 3PN 1600.

High-pressure piston with variable profile for balancing wear surface is the result of a metallic support **1**, special gasket with variable profile **2**, made from PA6 polyamid with shift capabilities in normal pressure and temperature conditions in water lubrication mounted on a metallic support, two profile “V” gasket of polyurethane **3**, a special flange **4**, all mounted through some screws **5**.

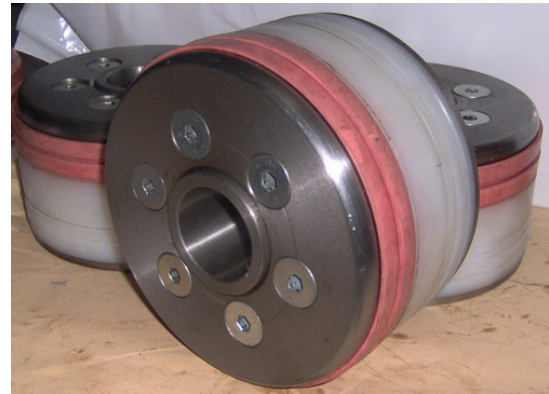


Fig. 3 – The new CAMIRO High-pressure piston with variable profile for balancing wear surface for drilling pump 3PN 1600.

To obtain an active variable profile of the specially-designed gasket, the right track is to adopt the PA6 polyamid water lubricated, that can insure the permanent seal and centering of the piston with abutting joint. Also, PA6 based composites sliding against stainless steel register higher friction coefficients and wear rates over water-lubricated condition than under dry sliding.[3]. The friction coefficient increases insignificant because a 20% Lubresim A water solution was used as a lubricant. The 20% Lubresim A water solution is an environment-friendly monomer with exceptional lubrication properties. It also has the capability of preserving the metallic surfaces of pressure-cylinders. The adoption of this innovative solution lead to water lubrication as active variable profile of polyamid gasket in the limit of 3% moisture absorbtion the linear swelling at 23°C is 1,1%.

Fig. 4, [3].

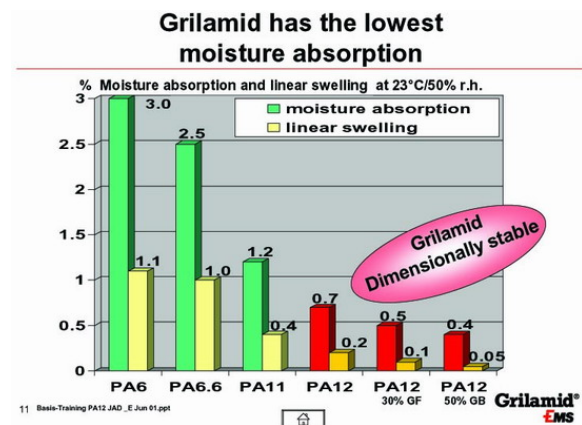


Fig. 4 [3]

Also the polyamid gasket with active variable profile in the limit of 9,5% water absorbtion the linear swelling at 23°C is 3,2%. Fig. 5, [3].

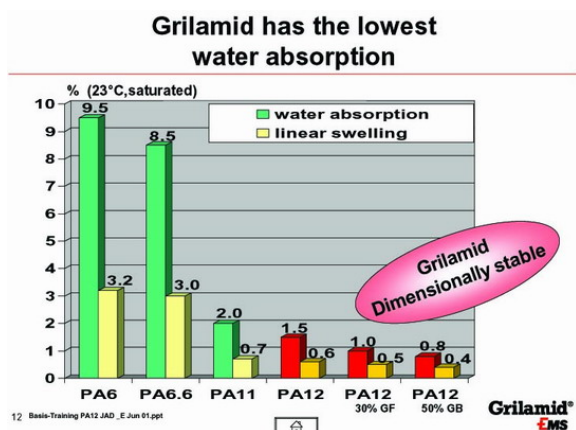


Fig. 5 [3]

3. Results and Discussions

The determination of the volume of lost material through gaskets wear, sustains the innovative solution according to Fig. 4 si 5, through which the volume-raise of the special gasket with variable profile is bigger than the actual raise of special gasket.

In using the piston a circular uniform wear of the special gasket with variable profile 2 was detected, which emphasises the fact the film of lubricant was constant and the seal was obtained on a circular band of given width - Fig. 6. This seal width is marked by two zones with thick walls. The experimental model also emphasized the fact that PA6 parts with thin walls swelled more than in thick-wall zones and also faster.

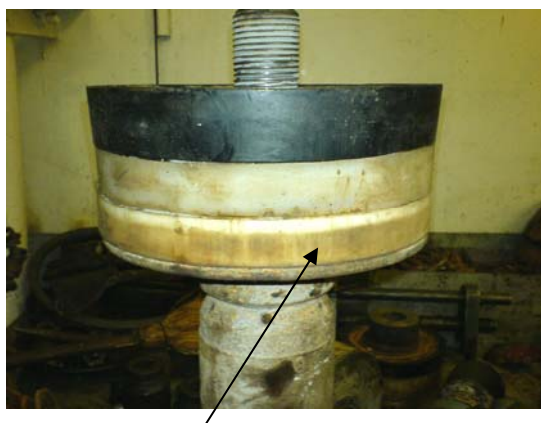


Fig. 6. The circular uniform wear of the special gasket with variable profile.

The results were obvious in the drilling well GALATA EAST FINDER WELL – A, on the SATURN oil rig, on the continental plateau of Turkey, when only 6 cylinders of 6 3/4" were used and 6 pistons of 6 3/4" with active variable profile were used.

No technological stop due to the hydraulic equipment was registered on the entire time of the drill.

4. Conclusions

CAMIRO high-pressure, high endurance with variable profile for balancing wear surface insure under given conditions:

Water lubrication in open circuit of working surfaces of the hydraulic equipment and wear protection of pressure-cylinder metallic surfaces;

On over 500 bars working pressure of the hydraulic equipment;

Pressure-cylinders are wear protected by the elements that insure the variable profile and determine the increase in their using time, drastic reduction of technological stop time, of cost in spare parts and maintenance;

Productivity is high due to increased endurance of piston-pressure cylinder building block resulting in a controlled high-pressure seal;

The piston maintenance service is safe, quick and ergonomic;

Climatic and protection conditions of CAMIRO pistons have to be under strict control due to the properties of the used materials. Thus, the pistons have to be stored in low atmospheric humidity under 2%. In case of higher atmospheric humidity other protective measures are in order: - the gasket have to be protected by a thin layer of grease after their fabrication;

After building-up the pistons have to be protected with grease and plastic bags.

6. References

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