EXPERIMENTAL RESEARCH RELATED TO THE BEHAVIOUR OF THE MATERIALS AFFERENT TO THE LINERS AND THE PISTONS FOR PRODUCTION PUMPS UNDER WEAR CONDITIONS

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1 INTRODUCTION

The sucker rod pumps for production are permanently exposed to a complex wear process generated by environments containing abrasive particles under suspension conditions. The operational life of the above-specified pumps depends on the manufacture materials for pistons and liners.
Nowadays, using high-hardness manufacture materials for liners and pistons makes the operational life of the production pumps get longer under abrasive working conditions. The steels being case-hardened, nitrided, carbonitrided and chromium-plated are the best ones for liners and the steels being treated by surface hardening, hard-chromium or metal-carbide plating are the most recommended for pistons.
Taking into account the above-specified circumstances, this paper presents the results of an experimental research activity developed under laboratory conditions, the said research being related to the behaviour shown by the piston and liner couples of the production pumps under wear conditions specific to some abrasive media, when the liners are case-hardened and the pistons are chromium-plated or surface-hardened.
The pistons and the liners having been utilized are manufactured by two important Romanian oilfield-equipment manufacturers: Upetrom S.A. Ploiesti and P.C.C. Sterom S.A. Campina.
The estimation of the behaviour afferent to the said components (liners and pistons) and shown under wear conditions corresponding to:

- certain values of temperature and specific pressure;
- the environment and
- the number of double strokes per minute
- is based on determination of the mass loss per unit of time and surface as shown the couples of liners and pistons having been studied.

2 ABRASIVE WEAR TEST METHODOLOGY MATERIALS FOR PRODUCTION PUMP PISTONS AND LINERS

A specialized testing machine was utilized for the performance of the material test under the following conditions: 20^0 C (the room temperature) and abrasive medium generating wear.
The test requires a relative translation motion to be applied to a couple consisting of a notched ring (the pump liner) and a piston.
See Fig. 1 for the power flow diagram of the abrasive-wear testing machine having been used for gaining the experimental determinations.
The piston-type specimen 2 is screwed on the bottom of the rod 1. Generating diverse contact pressure values requires the liner type on the piston by means of a flexible line piece 4 extended through the weights 5. The specific pressure between the notched ring and the piston can be adjusted due to the modification of the line stress. Studying the wear degree specific to the materials for liners and pistons requires a testing pressure of 21.50 N/mm^2 to be provided.
During the test, the liner is fix and the piston performs an alternate rectilineal motion. The piston stroke is adjustable between 50 and 100 mm. A mechanism 6, namely a crank and connecting-rod assembly receives motion from the electric motor 11 (1,420 rpm, 1 kW) and permits the piston to move from top to bottom.
Working conditions is

- 54 double strokes per minute;
- a 50 N load applied to the end of the line afferent to the notched ring.

The rotational speed and the displacement speed of the piston, respectively, in case of the piston in comparison with the notched liner can be adjusted stage by stage depending on the gear ratio of the

belt 7 and the planetary gear reducer being inside the multiple element 8. Each piston and liner assembly is completely immersed into the abrasive medium being into the tube 9 (10 l capacity). Intensifying the wear process in conjunction with the reduction of the experiment time interval requires an amount of solution consisting of water and 20 percents of abrasive particles. The agitator 10 (perforated plate) attached to the piston rod maintains the abrasive particles under suspension conditions. Each test applied to each couple consisting of a liner and a piston covers 75 minutes.

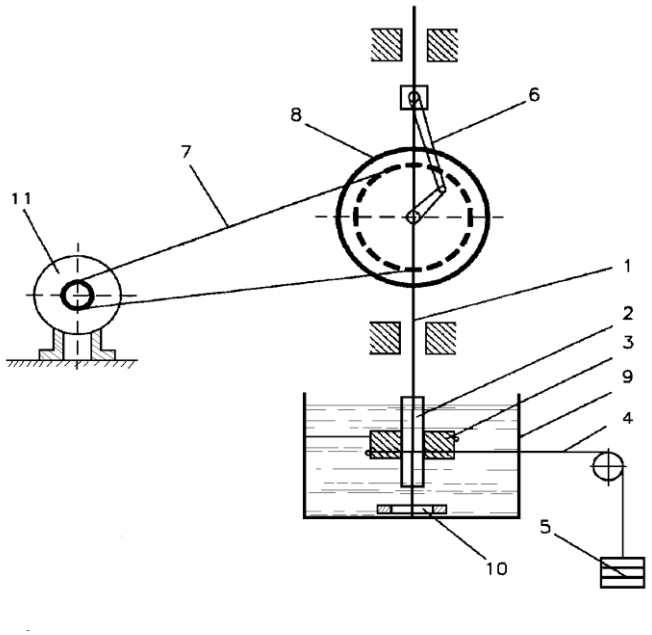
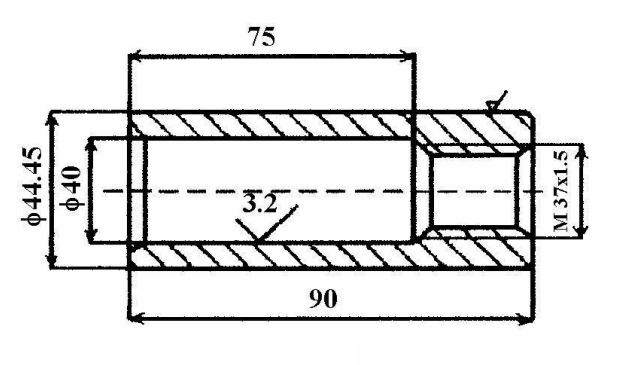
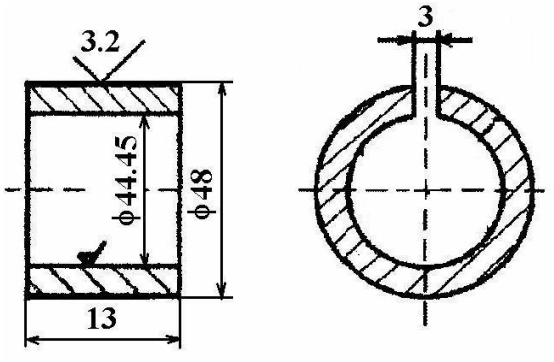


Fig. 1 - The power flow diagram of the abrasive wear testing machine

Establishing the degree of wear is gravimetrically performed, the specimens having been degresed with methyl-ethyl ketone being weighed by means of an analytic balance of 0.1 mg precision. The piston and liner dimensions were modified (limited) by cutting, so that the weight of a couple did not exceed 200 g; that modification was required by the necessity of weighing each liner and piston couple through the above-specified analytic balance.
See Fig. 2 for the dimensions of the liner-type and piston-type specimens used in case of the wear test.



a



b

Fig. 2 - The dimensions and the specimens utilized for the performance of the wear test applied to the manufacture materials afferent to the pistons and the liners of the production pumps: a – piston-type specimen; b – liner-type specimen (ring)

3 RESULTS OF THE EXPERIMENTAL RESEARCH ACTIVITY RELATED TO THE BEHAVIOUR OF THE MATERIALS AFFERENT TO THE PISTONS AND THE LINERS FOR PRODUCTION PUMPS UNDER WEAR CONDITIONS

The experimental research having been developed involves wear tests applied to six specimens, as follows: four case-hardened liner-type and surface-hardened piston-type specimens and two case-hardened liner-type and chromium-plated piston-type specimens, respectively (see Table 1).
The liners and the pistons having been used are fabricated by Upetrom S.A. Ploiesti and P.C.C. Sterom S.A. Campina (oilfield equipment manufacturers);
The estimation regarding the behaviour of the piston and the liner couples under wear conditions relies upon the determination of the mass loss per unit of time and active surface (total wear of the piston and liner assembly):

$$U_t = \frac{C}{A} + \frac{h}{L} \cdot \frac{P}{A}, \text{ mg/h·mm}^2, \qquad (3.1)$$

where C represents liner mass loss per unit of time, mg/h;
P – piston mass loss per unit of time, mg/h;
h – liner length, mm;
L – piston stroke, mm;
A – active surface, mm^2.

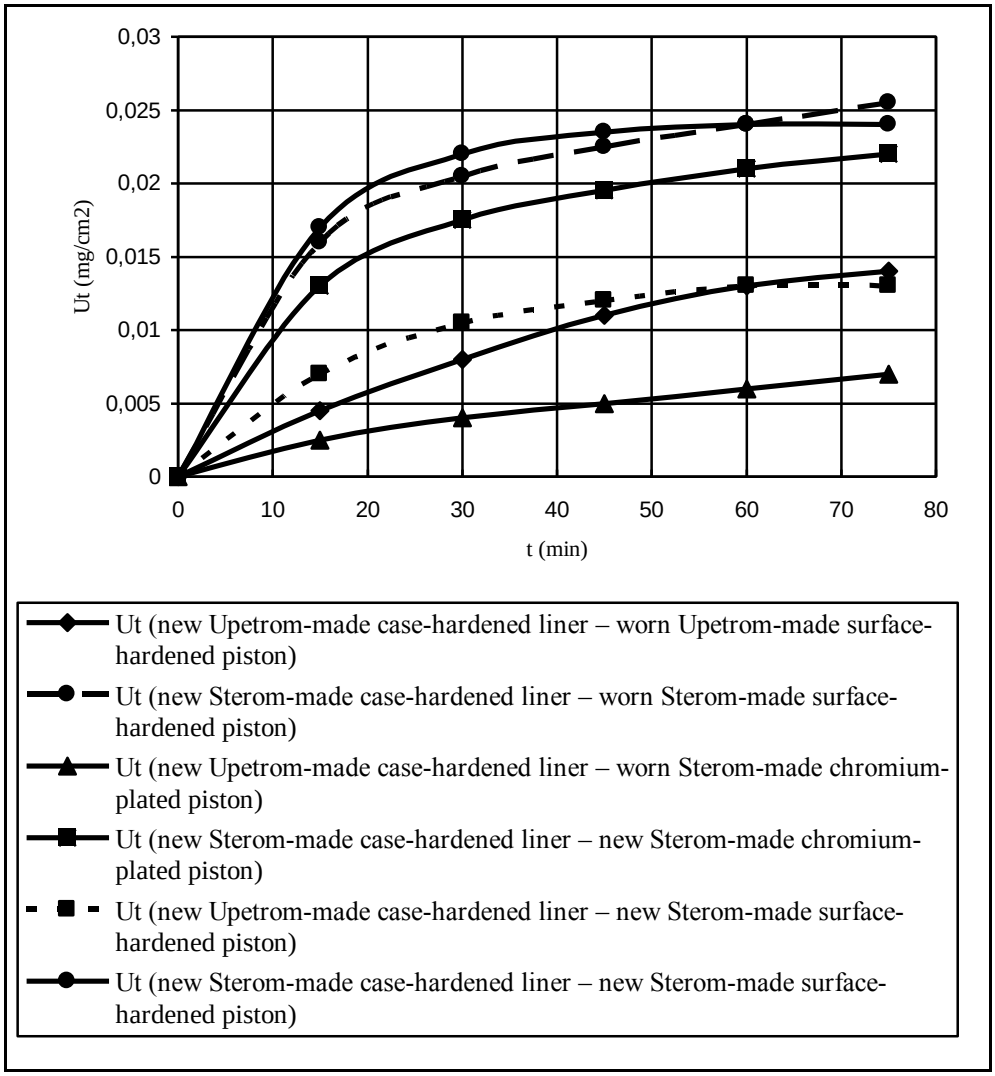


Fig. 3 - The behaviour of the materials for liners and pistons afferent to the production pumps under wear conditions

See Fig. 3 for the wear variation curves for each material afferent to the manufacture of liners and the pistons belonging to the production pumps;
In case of new piston use, the highest degree of durability is proved by the couple consisting of:
In case of worn piston use, the highest degree of durability belongs to the couple consisting of a new Upetrom-made case-hardened liner and a worn Upetrom-made surface-hardened piston, their degree of durability being greater then that of the new couples (case-hardened liner and surface-hardened piston);

Table 1 - Specimens (liners and the pistons for production pumps) utilized or experimental determinations

It.	Specimen Components					
	Liner			Piston		
	Type	Manufacturer	New / Worn liner	Type	Manufacturer	New / Worn Piston
1.	Case Hardening	Upetrom	New Liner	Surface Hardening	Sterom	New Piston
2.		Sterom				
3.		Upetrom		Chromium Plating		
4.		Sterom		Chromium Plating		
5.		Upetrom		Surface Hardening	Upetrom	Worn Piston
6.		Sterom			Sterom	

4 CONCLUSIONS

This paper describes the results of a prodigious research activity developed under laboratory conditions, as follows: temperature: 20^0 C; pressure: 21.50 N/mm^2; number of double strokes per minute: 54; load: 50 N; use of six specimens.

The author studied the behaviour of the materials afferent to the manufacture of the liners and the pistons for production pumps under abrasive wear conditions; the following option was taken into consideration: case-hardened liner – surface-hardened or chromium-plated piston.

The quality of the surface layer covering the liners and the pistons determines the degree of durability afferent to the liner and piston assemblies essentially.

Taking into account all above-specified information, the author recommends the use of the assembly consisting of the new Upetrom-made case-hardened liner and the new Sterom-made chromium-plated piston due to its highest degree of durability in comparison with other options having been studied.

The couples consisting of a new Upetrom-made case-hardened liner and a worn Upetrom-made surface-hardened piston are also recommended due to their very good results related to their degree of durability.

SUMMARY

This paper shows the results of a serious study developed by the author under laboratory conditions and related to the behaviour of the materials for liners and pistons as components of the production pumps. Their behaviour was studied under abrasive wear conditions when the couple including the liner and the piston accommodates a translation motion.

The liners and the pistons were offered by Upetrom S.A. Ploiesti and P.C.C. Sterom S.A. Campina, two important Romanian oilfield-equipment manufacturers.

The estimation of the behaviour afferent to the said components (liners and pistons) and shown under wear conditions corresponding to certain values of temperature and specific pressure, the environment and the number of double strokes per minute is based on the determination of the mass loss per unit of time and surface as shown by the couples of liners and pistons having been studied.

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