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# THE ROUGH CHROMATES STEEL XC45 WEAR BEHAVIOR AT DRY FRICTION AND HIGH TEMPERATURE

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***Abstract:*** *In this paper, we have considered the improvement of the OLC 45 steel functional qualities using rough chrome plating, deciding to use some materials with medium mechanical characteristics instead of allied steals. To make it obvious, we have tried the OLC 45 rough chrome-plated material on a pawn-disk tribometer at dry friction at 400 degrees' temperature. The experiment results and the conclusions we draw are shown in the paper.*

**Keywords:** OLC 45 steel, functional qualities.

## INTRODUCTION

Since the traditional materials frequently used in industry cannot offer superior mechanical properties, we use some modern technologies to change them. Chrome plating is a hard coverage and it can be applied to a large range of basic materials, including stainless steel, cast iron, aluminum, titanium, copper, bronze and nickel alloys. The experiment we use is on good carbon steel, which will be used in auto industry at the gear box.
The rough chrome plating operation has the following purposes:

- Obtaining a higher hardness (~ 1000 HV);
- Very good tribological properties: low friction coefficient, wear resistance (approximately 200 times) better than other hardness treatments, especially in dry friction situations;
- High protection level against corrosion;
- Long exploitation time and the product lifetime extension;
- Costs reduction, higher than other technologies.

## MATERIALS WE USE AND THE APPLIED TECHNOLOGY

We used XC45. The samples roughed chrome plated have the geometrical form of a disc having the outer diameter of ϕ 37mm. For the chrome plating process, we used 22 samples: 10 samples for chrome plating at 30 μm thickness and 11 samples for chrome plating at 50 μm thickness. A witness sample was left for each group.
The chrome plating bath has trivalent chrome acid. The piece is linked to the cathode, and the anode is made of plumb (99% purity). The continuous electric power density is 30 A/ $dm^2$, the electric power calculated at the chromed surface has been adjusted at 48 A. The bath temperature is $55^0$C, the tension of 4 V. The chrome plating speed is 25 μm/h.

## THE TESTING CONDITIONS

The used tribometer for tests was made by Adamou [1] in Tribology laboratory of ENI Tarbes (figure 1). The contact configuration is pawn-disc type.

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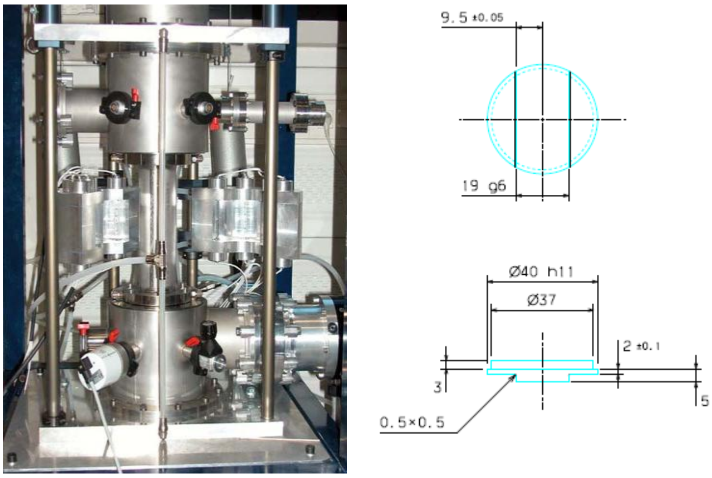


**Figure 1.** The tests device and the samples and pawn dimensions [5]

This tribometer has the following technical specifications:

- The contact configuration is pawn-disc type, fixed plane, rotative disc;
- Vacuum chamber at $10^{-6}$ mbar having the gas introduction possibility;
- The samples temperature is forecasted to vary between $20^0$ and $900^0$ C;
- The normal load is from 1 to 100 N;
- The slipping speed may vary from 0,01 and 1,5 m/s.

The samples are assembled at the two vertical coaxial shafts ends. The cylindrical pawn and the disc have diameters of 6 mm, respectively 37 mm. The contact surfaces are of 28 $mm^2$. The pawn length is of 15 mm. The load is made using gravity (marked masses) at the tribometer upper part, outside the device.

Data storage is ongoing, with some HBM console SPIDER 8 type help, collateral linked to a computer.

The tests took place in the following conditions [5]:

- first test:
- temperature $400^0$ C± $5^0$ C;
- speed: constant of 0,25 m/s;
- loading: cumulated from 2,5 N to 40 N with levels of 2,5 N, 300 s duration;
- total time: 65 min;
- exterior relative humidity: approximately 65 %
- second test:
- temperature: $400^0$ C ± $5^0$ C;
- speed: cumulated from 0,1 m/s, to 1,5 m/s through levels of 300 s;
- loading: constant of 15 N;
- total time: 35 min.;
- exterior relative humidity: approximately 65 %

During the test, the following parameters were checked in using the detective elements:

- the friction coefficient as ratio between the tangent force and the normal force, in ASCII form under EXCEL;
- the samples vertical displacement, represented by the materials wear;
- the friction coefficient evolution comparing with the duration;
- the contact surface temperature.

The plane friction surface pawn is made from steel „Stub" X22CrNi17, 247 $HV_{30}$ durity.

The samples heating is made using the collar internal surface radiation. Samples temperature raising is very fast (7 minutes from 20 to $900^0$ C). The temperature is homogenous on all disc's surfaces.

The used marked devices are the optical microscope (binocular LEICA), the electronic microscope having the analyzer joined with the one for the energy dispersion X (MEB Philips SEM 515) and the optical profilometer (VEECO NT 1100) [laboratory ENI Tarbes].

## RESULTS - THE FRICTION COEFFICIENT EVOLUTION

For the friction couple steel (pawn)/ chromed steel, the friction coefficient is of 0,3 for the first load of 2,5 N. From 5 N to 40 N this has an oscillatory variation between 0,6 and 0,7 (fig.2) [4, 5[.

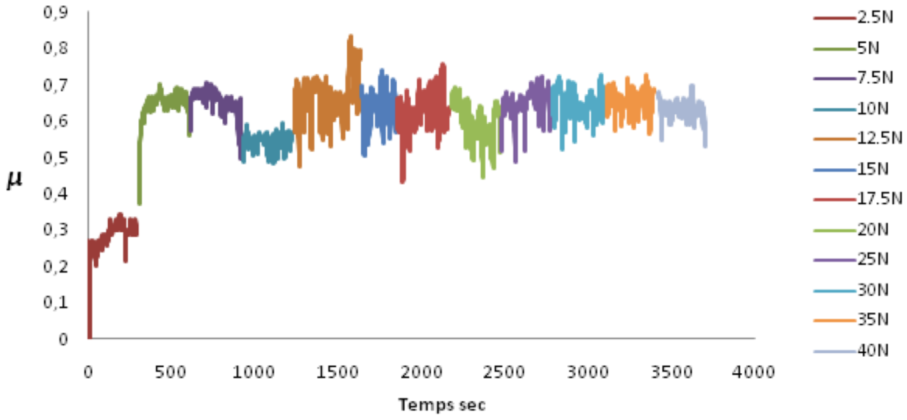


**Figure 2.** The friction coefficient evolution at the chromed steel in time, for a constant speed of 0,25 m/s and a cumulated load at $400^0$ C.[5]

Figure 3 listed below shows the friction coefficient variation at the second test:

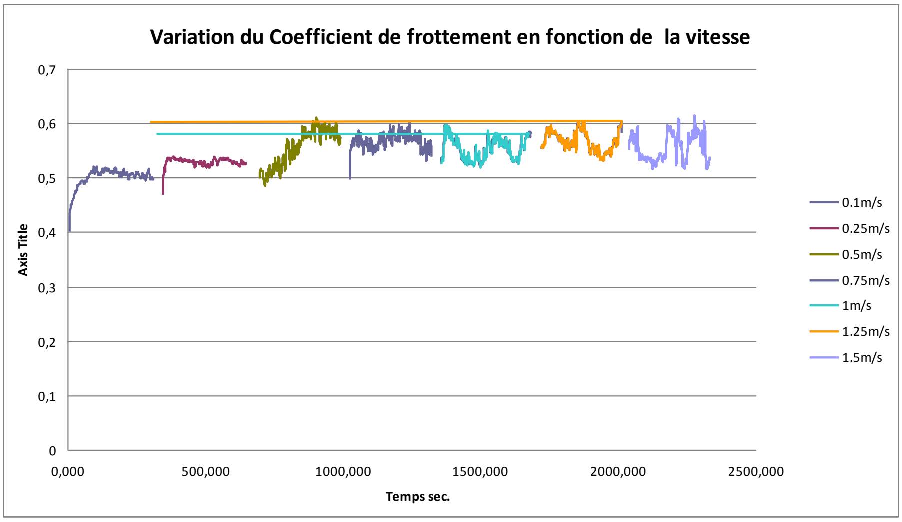


**Figure 3.** Friction coefficient evolution at constant load (15N) and cumulated speed [5]

The global medium value obtained is μ = 0,65.

## CONCLUSIONS

This study has permitted the tribological behavior analyze at $400^0$ C temperature, for the XC45 rough chrome plated material. It was shown that it has a lower friction coefficient than an alloyed steel [4] and a lower wear.
From the chrome plating treatment point of view, we draw the following conclusion, according with the advantages mentioned in the introduction: it assures a better resistance and it is a future oriented process, combined with an advanced environmental technology.

The authors use this opportunity to thank their students for the commitment and hard-work during the tests.

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