

CONFIDENTIAL

**WearSox 30 and WearSox64
Torque Study Report
In Oil Base Mud**

Test Numbers: 20050126 and 20050202
Project Number: 172361

Prepared for:

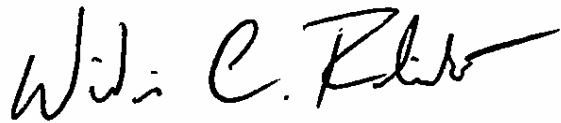
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a division of  **STRESS ENGINEERING SERVICES, INC.**

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Introduction

Specimens of spray-on coatings named WearSox 30 and WearSox 64 were received by Mohr Engineering for evaluation. These specimens were each run to determine torque response in the presence of oil base mud on P110 casing. A smooth tool joint specimen was also run under similar conditions and served as the "control". All specimens were run "as received". Mohr Engineering did not alter the appearance or surface in any way prior to testing.

Objective

Determine torque values by simulating drilling operations with customer supplied tool joint specimens, with ExxonMobil supplied casing specimens and non-aqueous fluids. Physical testing was performed in the Casing Wear Test Machine specifically modified for this test protocol at Mohr Engineering.



Torque Study Test Protocol (after ExxonMobil)

Mohr did:

1. Bathe casing sample with a full chamber of non-aqueous fluids maintained at 150°F.

2. Prepare test apparatus to accept the specimen tool joint supplied by client described in Drawing M-11-00001.
3. Prepare test apparatus to accept casing specimen described in Drawing M-11-00011.
 - a. Exxon sample is 9 5/8" (244.48 mm) OD, 47 lb/ft (69.94 kg/m), P110
4. Perform tests according to agreed protocol.
 - a. Rotating speed of 158 RPM
 - b. Side load to be 3,000 lb_f/foot
 - c. Translation of casing against tool joint
 - d. Test Sequence
 - i. Record torque values for sixty minutes with Escaid 110 Oil Base Mud
5. Provide raw data to client upon request.
6. Produce a graph that describes torque change over time.

Client did:

1. Supply specimen tool joints as described in Drawing M-11-00001.
 - a. Smooth Tool Joint (supplied by Exxon)
 - b. WearSox 30
 - c. WearSox 64

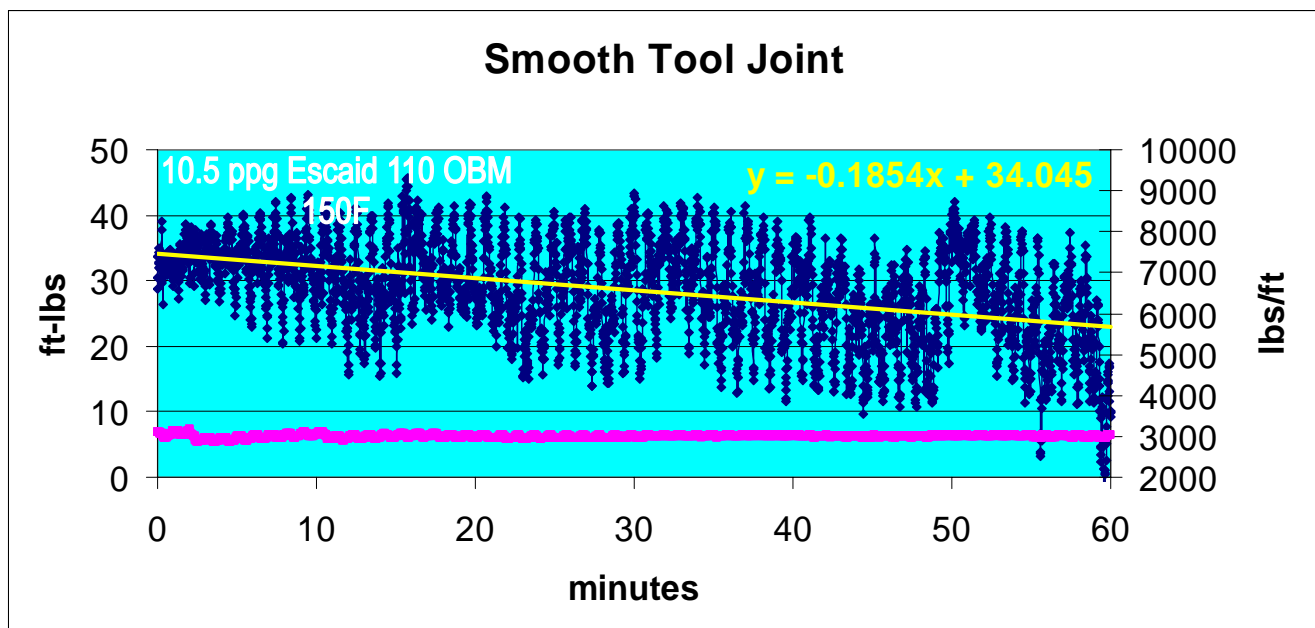
		
Smooth Tool Joint	WearSox 30	WearSox 64

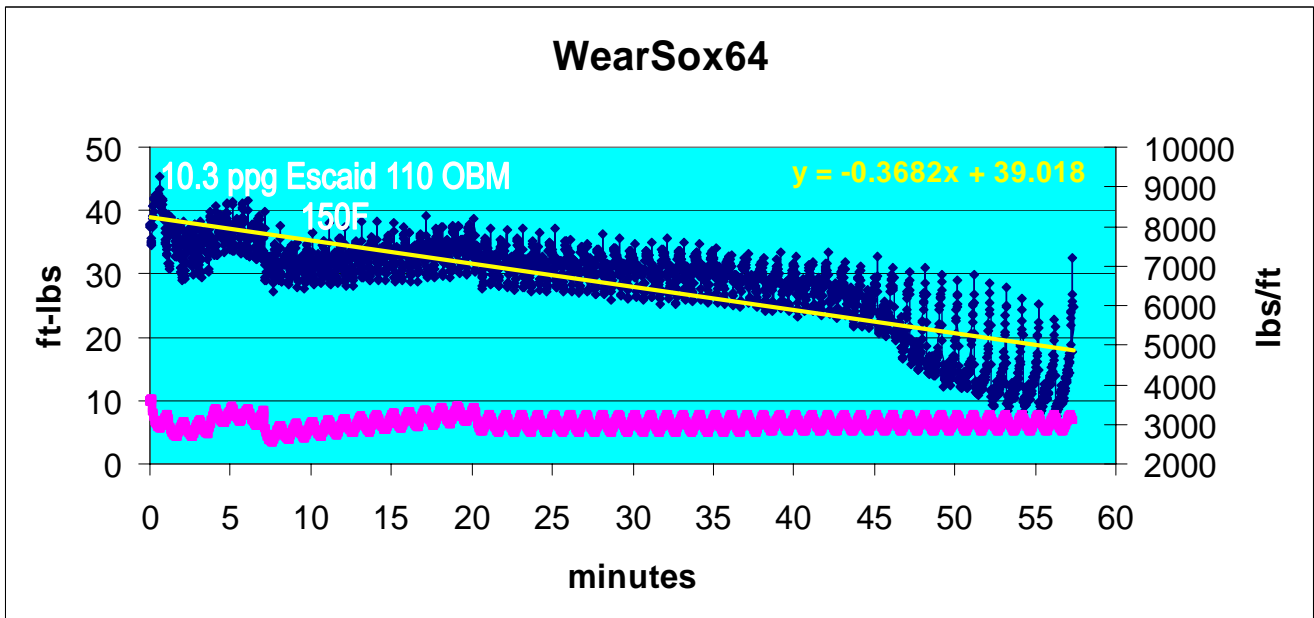
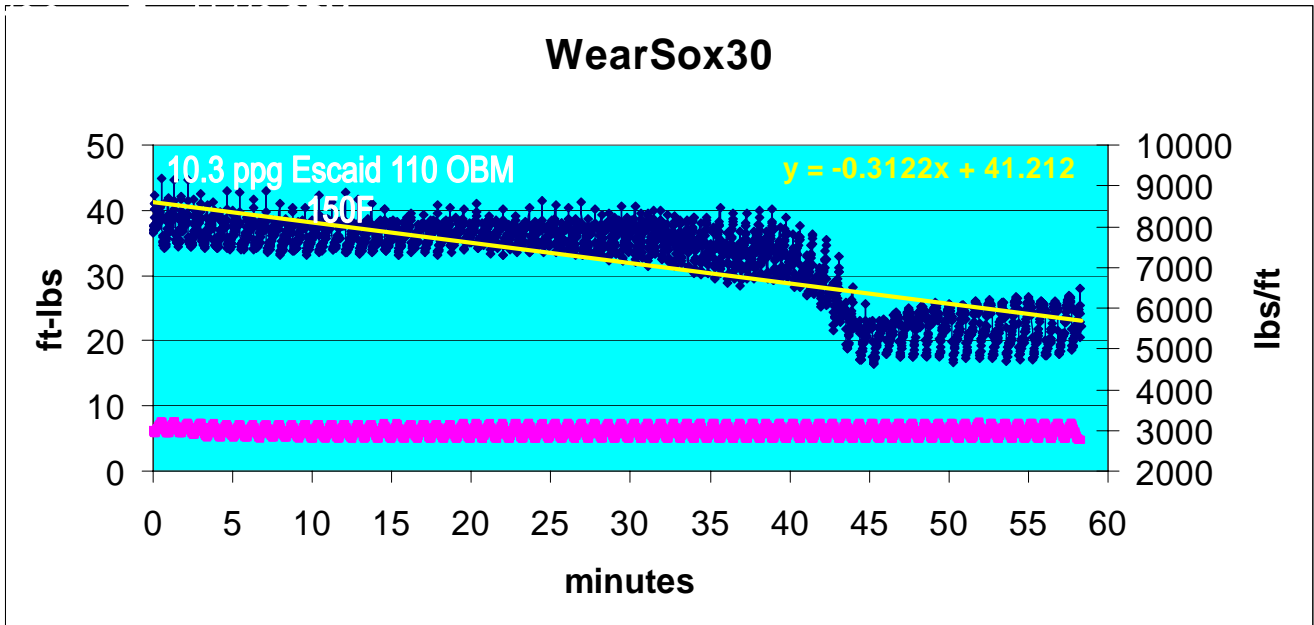
Results

After one hour the wear pattern was:



The test results are summarized in the graphs below.





Statistical Evaluation

Material	Torque (ft-lbs)					Load/foot (lbs/ft)		
	Starting	Mean ± SD	Median	Mode		Mean ± SD	Median	Mode
Smooth	34.045	28.50±7.45	29.22	31.08		2993.78±37.95	2994.21	3001.46
WSx30	41.212	32.11±6.48	34.79	37.74		2964.60±113.05	2959.40	2794.85
WSx64	39.018	28.46±7.40	30.55	37.49		3008.07±168.92	2998.38	2947.95

Definitions

Mean	Arithmetic average of all the data values
Median	When the values are placed in order, middle value of the data set
Mode	Most commonly occurring value
Standard Deviation	Measure of the spread of values

Wear Evaluation

Material	Wear Groove	
	Average Width (in)	Average Depth (in)
Smooth	0.709	0.016
WSx30	2.070	0.018
WSx64	2.038	0.031

Discussion

The drilling fluid was 10.3 – 10.5 ppg of Escaid 110 oil base mud maintained at a temperature of 150°F. Under a side load of 3000 lbs/ft, both WearSox 30 and WearSox 64 performed well. There was no evidence of spalling or cracking of the materials.

The comparative higher initial torque for each, WearSox 30 and WearSox 64, was likely due to the unmachined texture of the sprayed-on material and its metal chemistry. The initial texture of the material was similar to an automotive brake pad. In both cases, the torque decreased over time, demonstrated by negative slopes -0.3122 and -0.3682, respectively. More pronounced reductions in torque were seen in both specimens after a break-in period of about 45 minutes. Compared to WearSox 30, the WearSox 64 material demonstrated a lower initial torque value and a larger reduction in torque over time.

Within an oil base mud medium, these short-term tests demonstrate that both WearSox30 and WearSox 64 show promise as possible torque reducing materials when applied to the drill string.

This test was not performed under the same protocol as a standard casing wear test. In many cases, the most significant wear occurs in the first hour or two of testing, and then becomes flat. There is not enough data to make any type of conclusion regarding the effective wear caused by the WearSox 30 and WearSox 64 material on this specific P110 casing sample.

We appreciate your continued confidence in our work on your project and look forward helping you in the future. Please contact me if you have any questions regarding this report or any other testing needs where we might be of help.

Thank you for your patience and the opportunity for the Mohr Engineering Division of Stress Engineering Services (SES/Mohr) to provide testing services for your project.