44th Leeds-Lyon Symposium on Tribology - September 4-6, 2017, Lyon, France

Tribology of Surfaces: A Study in Cartilaginous Tissue from Synovial Joints

Fausto A. Moreira I. [a*], A. Jabbarzadeh [b]
fmor7046@uni.sydney.edu.au
[a] The University of Sydney
Quito, Ecuador

[b] The University of Sydney
Sydney, Australia

KEYWORDS

Biotribology; friction coefficient; cartilage; synovial joint.

ABSTRACT

Tribology applied to biology, or bio-tribology, studies the interaction of surfaces in these different biological systems. One of the main fields in biomedical industry nowadays, is orthopaedics; replacement of worn, damaged or destructed joints is, perhaps, one of the most important advances in medicine from last century. Natural surface interactions in joints occur between layers of cartilage that cover the portion of bone which participate in motion structures. Tribology in biological systems (or bio-tribology) embraces concepts in physics, chemistry, biology and material science [1]. Bio-tribology applications in biomedical engineering are from different nature; examples of this are: total joint replacements, footwear tribology, skin tribology, ocular and oral tribology, among others [2].

One of the main fields in biomedical industry nowadays, is orthopaedics. Replacement of worn, damaged or destructed joints is, perhaps, one of the most important advances in medicine from last century. Total joint replacement, principally total knee replacements and total hip replacements, was reported to have, only in 2010 in the U.S., over one million cases [3]. One of the main reasons for these surgeries to occur is osteoarthritis, which happens when cartilage from bone ends wears away [4].

This research work, aims to expand the knowledge on how surfaces, as part of human joints, behave. The main factor to be analysed in the experiments embraced on this work is friction coefficient. Friction coefficient becomes vital as it changes along an individual's life; it is directly connected to tear and wear of cartilage tissue due to aging but severely affected by diseases. In order to analyse friction coefficient in human joints, experiments were performed in samples obtained from animal models.

Friction, defined as the force exerted by a surface when an object moves across it [6] becomes vital as it changes along an individual's life; it is directly connected to tear and wear of cartilage tissue due to aging but severely affected by diseases.

The experiment consisted in the measurement of the friction coefficient of the samples harvested from plateau and condyle portions of bones from synovial joints. Measurement of the friction coefficient in the samples using a tribometer equipped with a Peltier hood for precise temperature control; controlled temperature was set to be 24ºC as the usual environmental temperature, and also, 37ºC as the average body temperature. Setup used in the test was a ball-on-three-plates. Comparison between two different lubrication means was also performed: one, distilled water and, a second one, a salty solution replicating human body's interstitial fluid. These experiments were partially reproduced from the techniques and experiments carried out in [45, 46]. Two lubrication configurations were set for the experiments: a salty solution replicating human body's interstitial fluid and artificial synovial fluid.

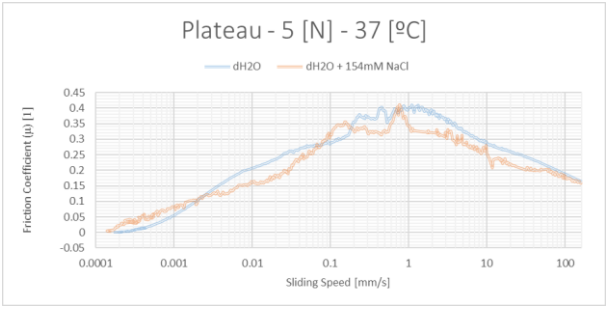

Figure 1. Compiled result for different lubricants interacting with Plateau samples with a 5 [N] normal force.

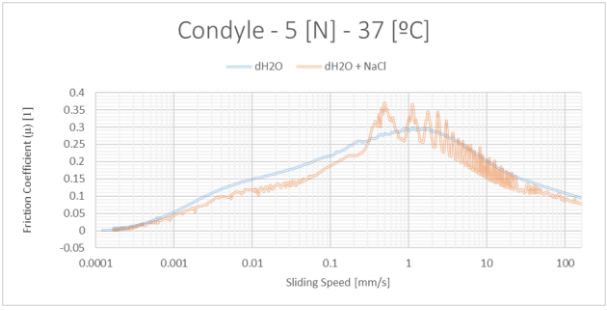

Figure 2. Compiled result for different lubricants interacting with Condyle samples with a 10 [N] normal force.

REFERENCES

[1] Centers for Disease Control and Prevention, "FastStats," US. Department of Healt and Human Services, 2010. [Online]. Available: http://www.cdc.gov/nchs/fastats/inpatient-surgery.htm. [Accessed 29 August 2015].

[2] Arthirtis Foundation, "What is Arthritis?," Arthritis Foundation, 2015. [Online]. Available: www.arthritis.org. [Accessed 30 August 2015].

[3] I. C. Gebeshuber, "Biotribology inspires new technologies.," *Nano Today,* vol. 2, no. 5, pp. 30-37, 2007.

[4] D. Dowson, "Bio-tribology," *The Royal Society of Chemistry,* vol. 1, no. 156, pp. 9-30, 2012.

[5] The Engineering Toolbox, "Friction and Coefficients of Friction," The Engineering ToolBox, 2015. [Online]. Available: http://www.engineeringtoolbox.com/friction-coefficients-d_778.html. [Accessed 9 October 2015].

[6] Anton Paar, "Application Report: Biotribological Investigation of Cartilage.," Anton Paar GmbH, Graz, AUSTRIA, 2015.

[7] Anton Paar, "Application Report: Advanced Tribological Charactrerization of Limiting Friction of Greases," Anton Paar GmbH, Graz, AUSTRIA, 2015.