CENTER FOR PRECISION FORMING
DEEP DRAW RESEARCH STUDY SUMMARY

"Control of Galling During Advanced High Strength Steel Forming Operations"

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and
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www.cpforming.org / www.ercnsm.org

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STUDY BACKGROUND

Funding: International Lead Zinc Research Organization (ILZRO)

Start Date: July 2006

Study Participation: ILZRO member companies, die makers, lubricant suppliers and automotive metal stamping companies for selecting sheet/tool materials, coatings and lubricants, and conducting tribotests under relevant production conditions.

Advanced tool materials and coatings providers:

BÖHLER UDDEHOLM

INTERNATIONAL MOLD STEEL, INC.

DAYTON PROGRESS CORPORATION

Advanced and Ultra High Strength Steel provider:

USS UNITED STATES STEEL CORPORATION

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STUDY OBJECTIVES

Develop a model to investigate the effect of interface temperature, pressure and relative sliding speed on galling during forming AHSS/UHSS.

Determine critical temperature and pressure for initiation of galling at the tool-workpiece interface for selected sheet/tool characteristics (material properties, surface finish and coating) and lubricants.

Develop guidelines to select best / practical interface conditions of tool, sheet and lubricant that reduce or eliminate galling in forming AHSS/UHSS.

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LUBRICANT CHEMISTRY STUDIED

10 commonly used automotive forming Lubricants from 6 leading companies:

2 Thin Film Polymers (A & B IRMCO)
1 Chlorinated soluble oil
2 Dry Films
1 Pre-coat
2 Straight oils
2 Soluble oils

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EVALUATION CRITERIA

- Lower force = better lubricant
- Higher BHF without fracture = better lubricant
- Shorter cup flange = better lubricant
- Less wall thinning = better lubricant

BHF (Blank Holder Force)

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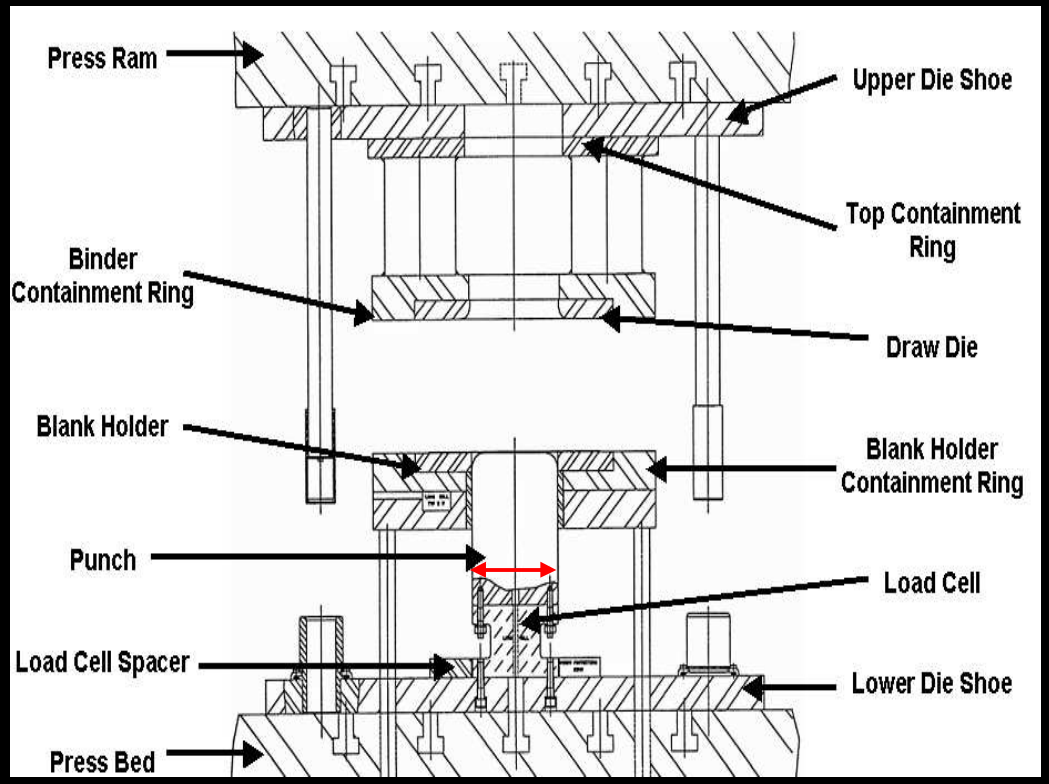
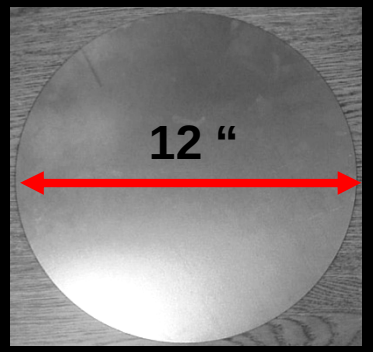
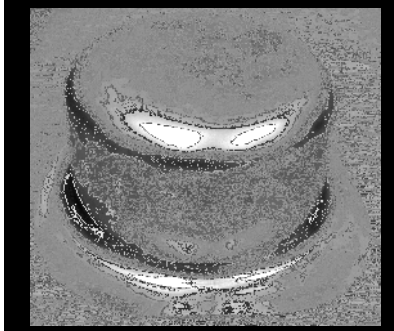
OSU DEEP DRAW TEST



Schematic of ERC/NSM Draw Tooling



Initial blank



Drawn cup

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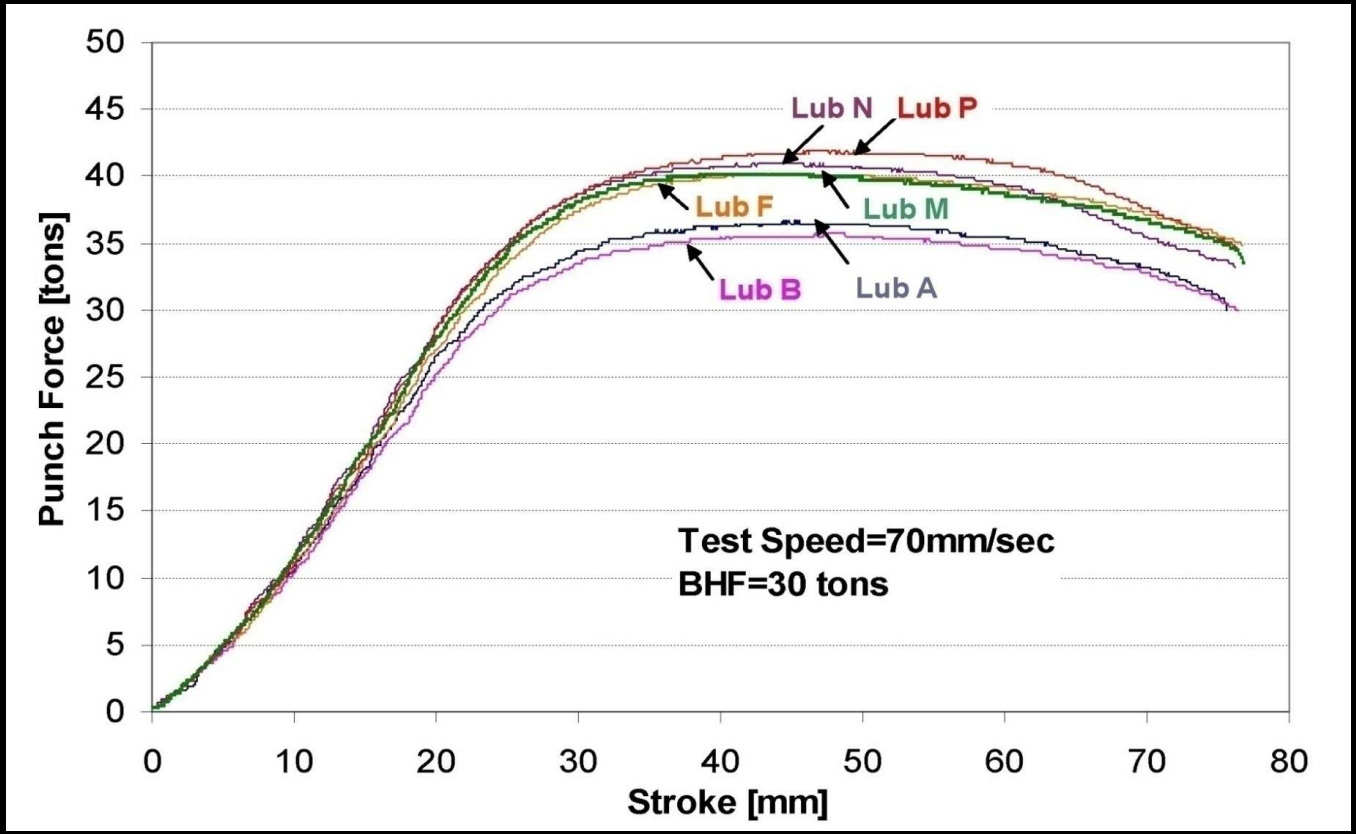
RESULTS

FORCE VS. STROKE @ BHF 30 TONS



Lubricants A and B performed 18% better then next competitors

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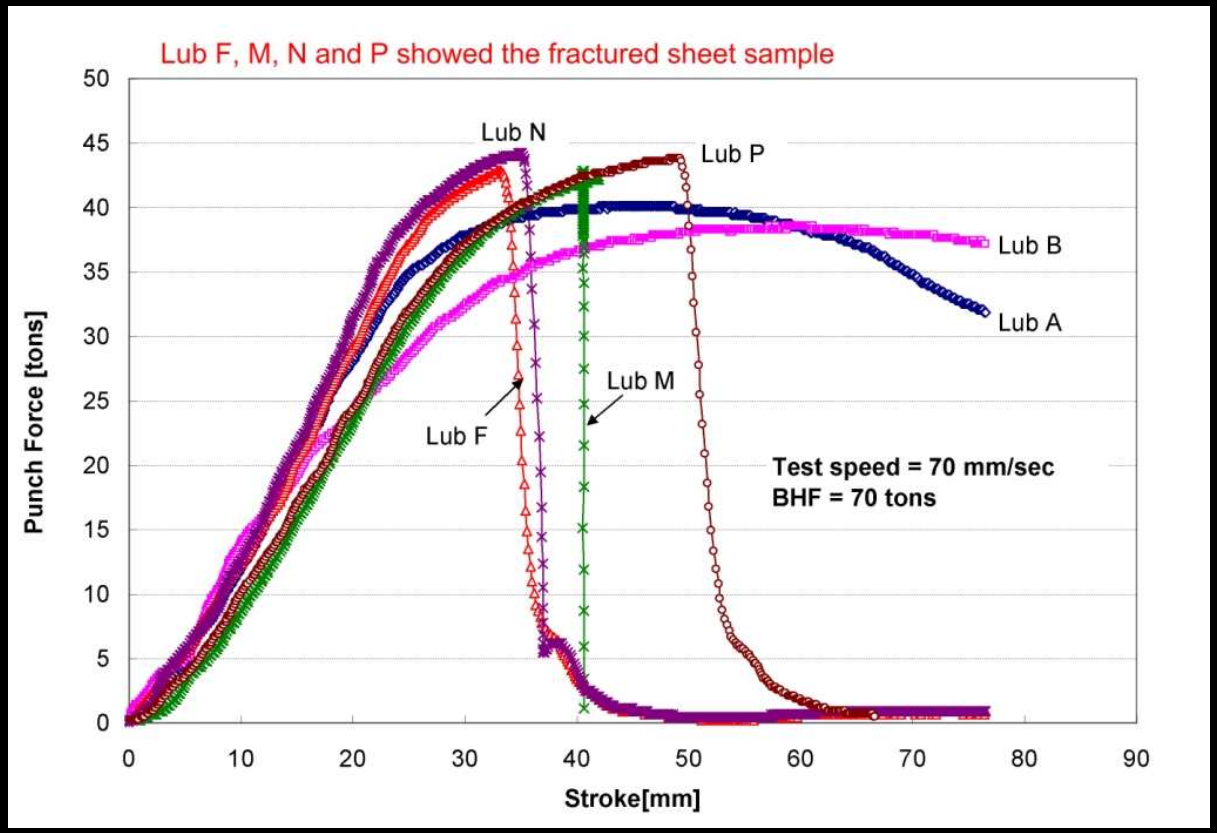
RESULTS

FORCE VS. STROKE @ BHF 70 TONS



Formed sample

Fractured sample

Lubricants A and B performed 40% better then next competitor

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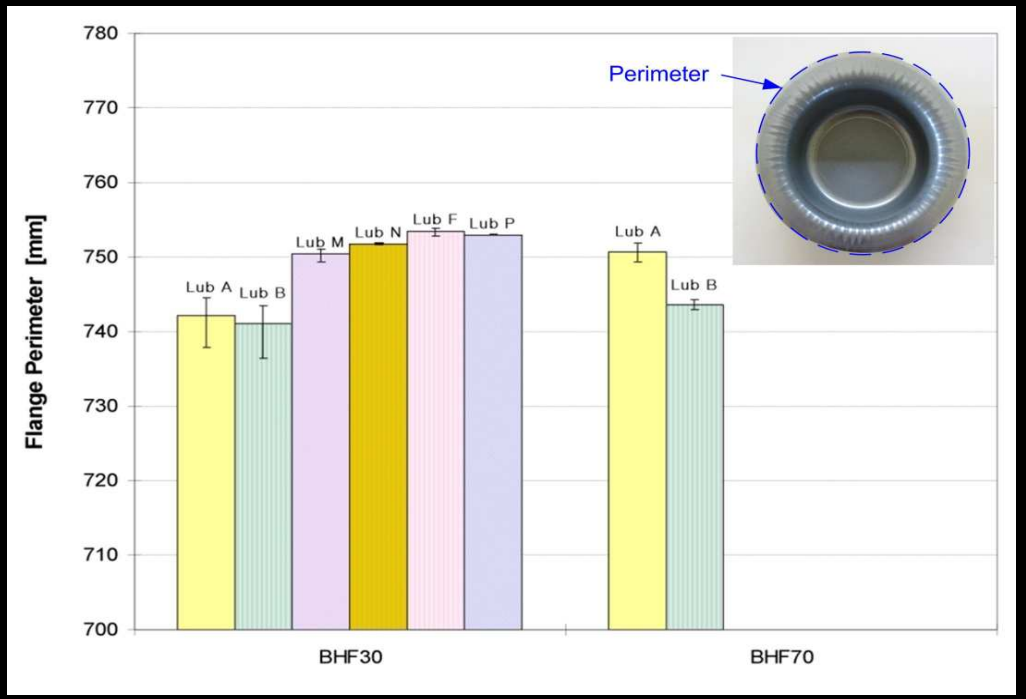
RESULTS

COMPARISON OF FLANGE PERIMETER



Shorter perimeter

Better lubricant

The deep drawing test was able to distinguish the performance of lubricants under different BHFs. No visible galling or powdering was observed in the tests, regardless of lubricants and BHFs. In BHF 30 tons, Lub A and B showed better effectiveness compared to other lubes. The other lubes (F, M, N and P) showed almost equivalent performances. In BHF 70 tons, most lubes, except Lubes A and B, lead to fracture of cup sample. Lubes A and B may be good lubricants for most severe deep drawing conditions, however, the other lubes are relatively effective for use in moderate deep drawing conditions. The performance of lubricants was found to change with the contact pressure at the sheet-die interface. Therefore, it is critical to evaluate lubricants under process-relevant test conditions. All the evaluation criteria used in the test gave consistent results in the ranking of lubricants tested (in ranking of performance: 1st group = Lubes B & A. 2nd group = Lubes M and N, 3rd group = Lubes F and P)

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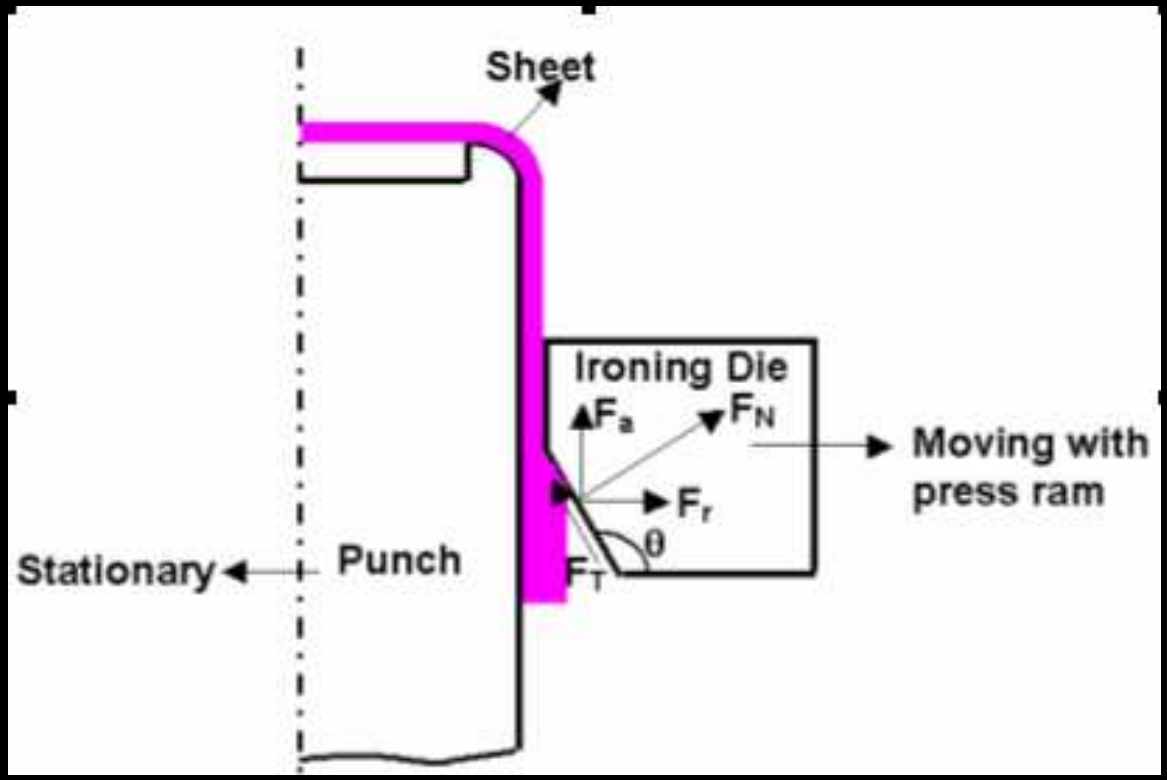
RESULTS
IRONING TEST



Ironing Test developed at ERC/NSM successfully reproduces production conditions (contact pressure up to 650 MPa (= 94.2 ksi) and temperature up to 150 ℃ (=302 ℉) in a laboratory setup .

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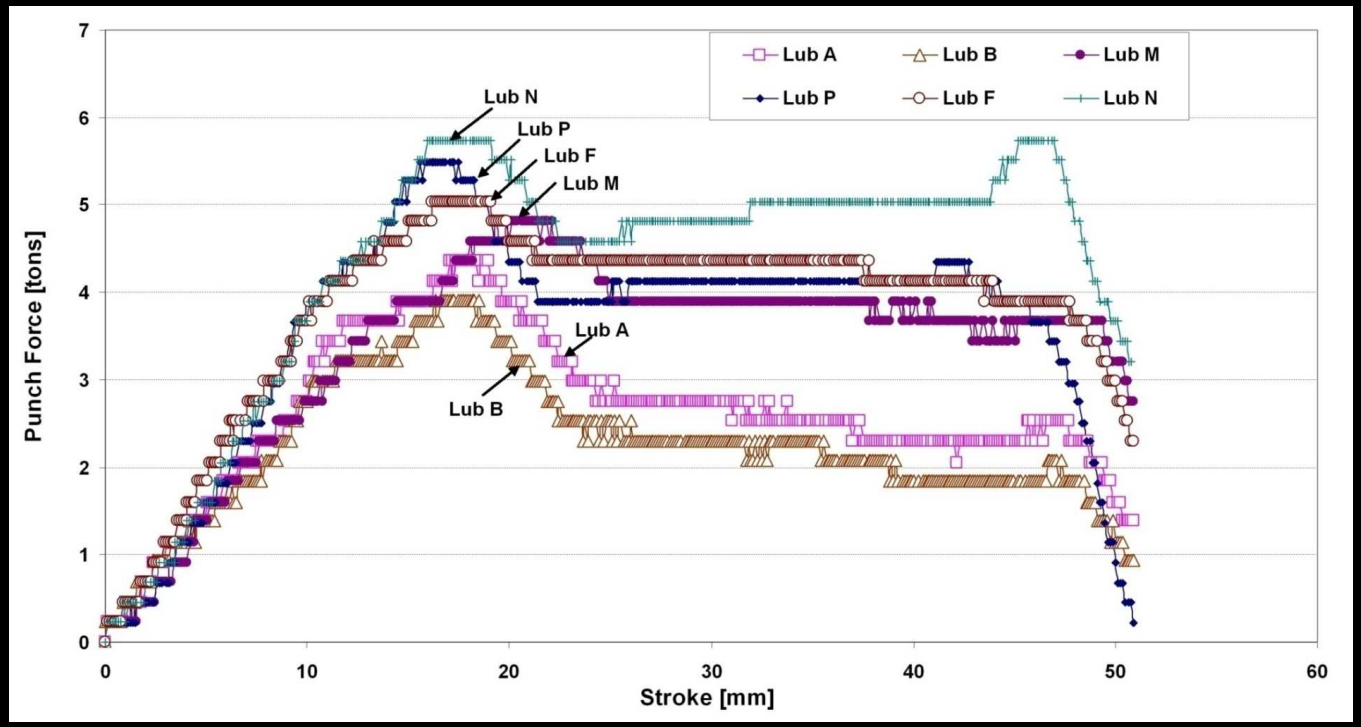
RESULTS

FORCE VS. STROKE



Punch force = friction force + plastic-deformation induced force

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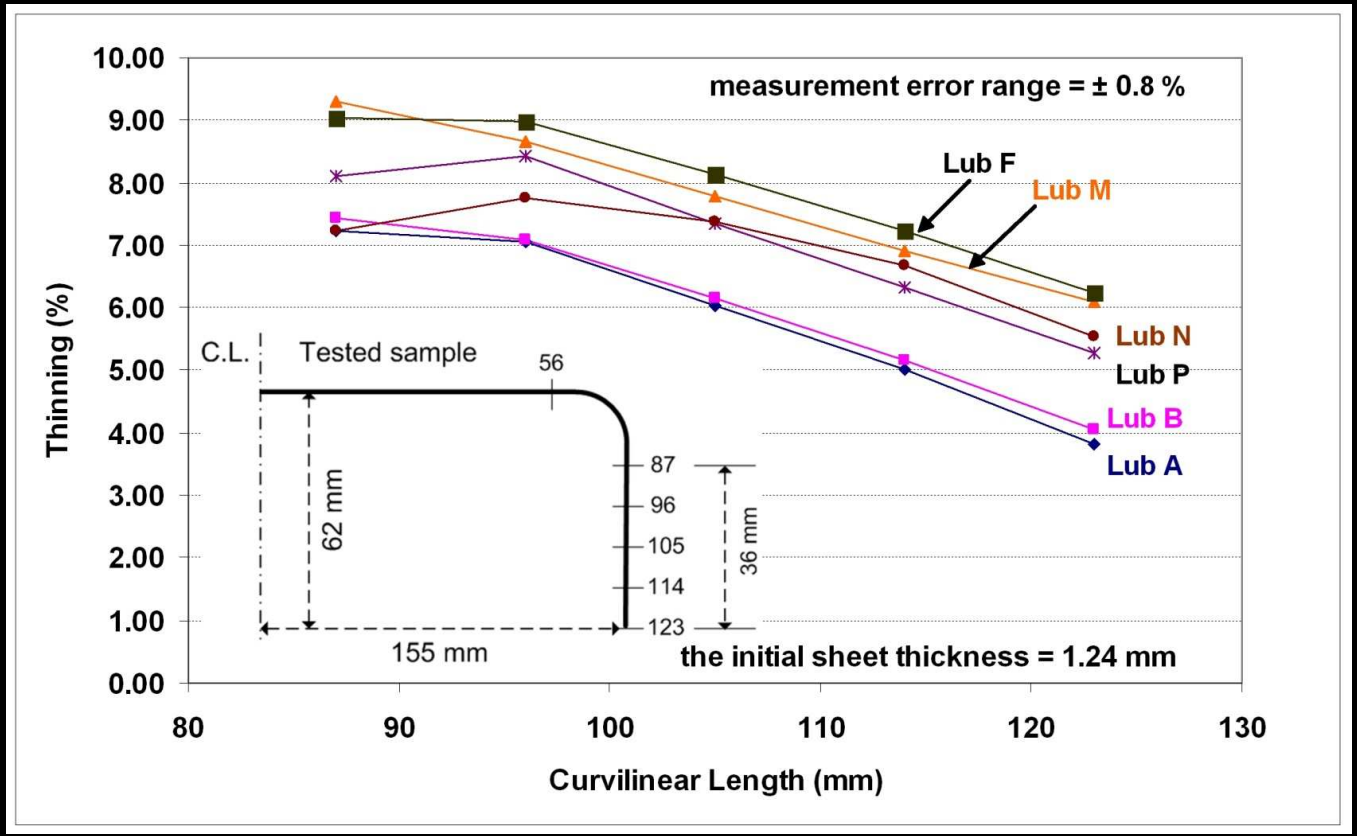
RESULTS
SIDEWALL THINNING



Lubricants A and B performed 20-30% better then next competitors.

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