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DEVELOPMENT OF HIGH PERFORMANCE ROLLING OILS WITH A.D.T. TECHNOLOGY: PAST, PRESENT AND FUTURE[1]

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Abstract
Over time, rolling oils have become a crucial element for success in all types of Cold Rolling Mills. The performance of a good rolling lubricant is directly related in rolling the most demanding gauges with high power efficiency, Extended Roll life, excellent strip cleanliness, prolonged corrosion protection and other chemical attacks. The relation between excellent lubricity Vs. strip cleanliness has been the Achilles heel of Cold mills and rolling oil formulators. In this paper, several years of research work is presented referring to make rolling oil dispersions that provide: higher lubricity, excellent anti-wear properties and outstanding cleanliness from where Rolmex's Technology, ADT (Advanced Dispersion Technology) is derived. This technology was developed by Mr. José Guzman and is known as the next step from his SDT (Stabilized Dispersion Technology). This technology gave birth to the introduction of the ONE OIL Cold rolling oil technology. Also, in this work is shown an overview of how we formulate oils using this technology, the technologies of the past and technologies for the near future.
Key words: *Rolling oils.*

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1 INTRODUCTION

The cold rolling process is used to reduce the steel sheet gauge to meet different markets such as electric motors, appliances, automotive, steel cans, construction etc. This reduction in gauge is done without heating the steel, so the big effort of both; elongation and deformation phenomena are very important and they need to be assisted by chemical agents specially designed for each particular application. Historically, lubrication systems for cold rolling mills fell into two main families: Dispersions and Emulsions.

The emulsions are more typically used in products that do not require large reductions (moderated gauges) and require high levels of cleanliness. These features can be given by an emulsion because of its extra small particle size (less than 5 microns) and their high detergency. The problem is the low lubricity which is inherent in this technology. Dispersions by having larger particle sizes are able to leave more oil on the steel sheet, allowing greater lubrication and the possibility of higher reductions; however the problem of leaving the strip with oil is the cleanliness, which is considerably reduced after annealing. These two differences in rolling technologies, have kept both options as valid and many mills had to use both technologies.

Because of the cross contamination between the light gauge and heavy gauge products which caused dirty steel, a single oil to roll all gauges became most desirable.

In the past decade a new technology was developed. SDT (Stabilized Dispersion Technology), which pioneered the search for a single oil that would allow a mill to produce sheet of any gauge with exceptional cleanliness for the automotive industry. The secret was to find a technology that uses the advantages of emulsions and dispersions in a single system.

2 STABILIZED DISPERSION TECHNOLOGY

Stabilized dispersion technology (SDT) seeks to combine the advantages of both emulsion and dispersion technologies. Utilizing a proprietary emulsifier system, a narrow particle size distribution is obtained which remains stable with little or no agitation. Typical particle size distributions generated in the laboratory range from 8 to 12 microns compared to 20 to 30 microns for dispersions and less than 5 microns for emulsions. (These measurements were generated on a small recirculating pump stand; therefore, data taken from a mill will show smaller particle sizes.) This characteristic is also reflected in Emulsion Stability Measurements (ESI). Typically emulsions would show a .95 or greater ESI and dispersions would produce a .20 or lower. Stabilized dispersion technology typically shows a .70 to .80 ESI. Although stabilized dispersions require a specific pH range, it is generally wider than a traditional dispersion. By combining the dispersive effects of dispersions and the tramp oil rejecting ability of emulsions, stabilized dispersions reduce the iron on the strip and reject iron and tramp oils by floating them to the surface. Stabilized Dispersion technology has produced surface cleanliness readings comparable to semi-synthetic and synthetic based rolling oils. This technology also has the dispersive ability to keep mill housings clean. The ability to disperse iron fines and skim tramp oils resulting in an extended solution life. These comparative properties are summarized in Table 1.

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Table 1. Comparison of emulsion and dispersion technologies

Parameter	Emulsion Technology	Traditional Dispersion Technology	Rolmex Advanced Dispersion Technology
Concentration	4-7%	2-5%	1-4%
Operating pH	>7.0	5.8-6.2	5.2-6.8
Typical Particle Size (microns)- Lab	<5.0	20-30	8-12
ESI	0.95	0.20	0.70
Tramp Oil Rejection	Fair to Good	Fair	Excellent
Plateout	Low to Moderate	High	Moderate to High
Irons on Strip	High	Low	Low
Agitation Required	No	Yes	None to moderate

3 ADVANCED DISPERSION TECHNOLOGY (THE ONE OIL TECHNOLOGY)

The ADT technology is known as a step forward of SDT, and is the continuation of the same research work. The main goal was to keep the benefits of both dispersion and emulsions but improving every aspect of the lubricating system performance to permit every rolling mill to work with a single ONE OIL for every job required. This was achieved at the same time improving even more the ability to clean the strip.
In this formulating work, also took into account every new base oil molecules such as synthetic and semi-synthetic esters, and how to get the best performances from them.
The main advantages of this new rolling oil technology are listed below.

3.1 Self Cleaning System

ADT technology is also characterized to be a “self cleaning” system due to the high performance behavior in terms of dispersion characteristics. The unique balance of emulsifiers let the dispersion to have moderate detergency. This is important to identify every contaminant or rolling debris not desirable in the system and to split that matter away by flotation very quickly. That contamination is easily removed by an oil skimmer. This is also known as an auto-maintenance characteristic because bottom draining is practically eliminated increasing the productivity.
Actual case from a high speed five stand tandem mill:

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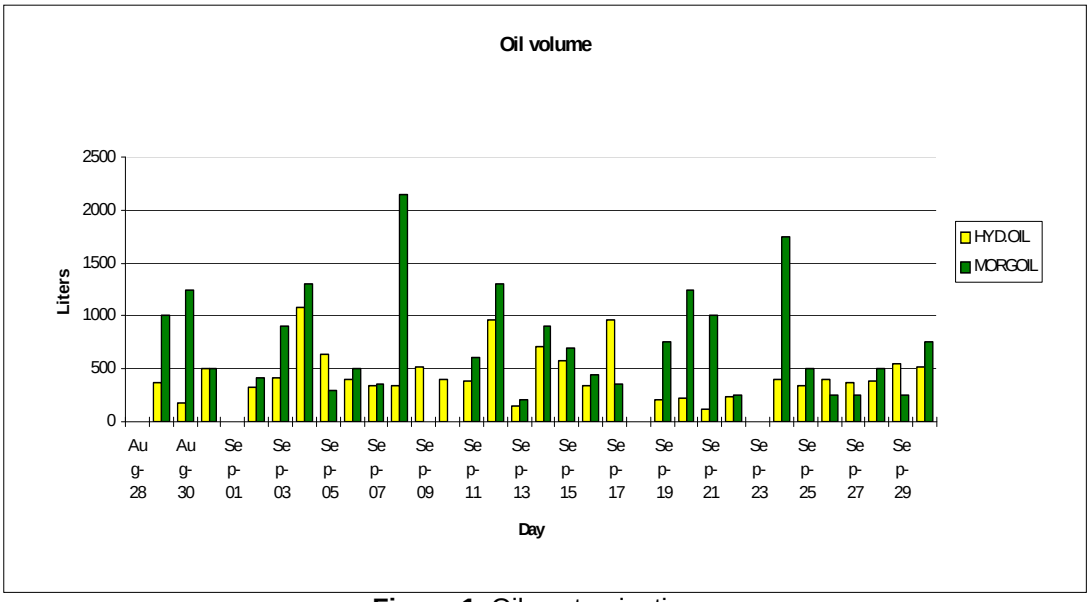

Figure 1. Oil contaminations.

In Figure 1 is shown the hydraulic and morgoil leakages in the rolling dispersion of the mill, and in Figure 2; the same mill but can be seen the productivity and the oil consumption. Is notorious that the production schedule neither the rolling oil consumption were affected by the all those leaks.

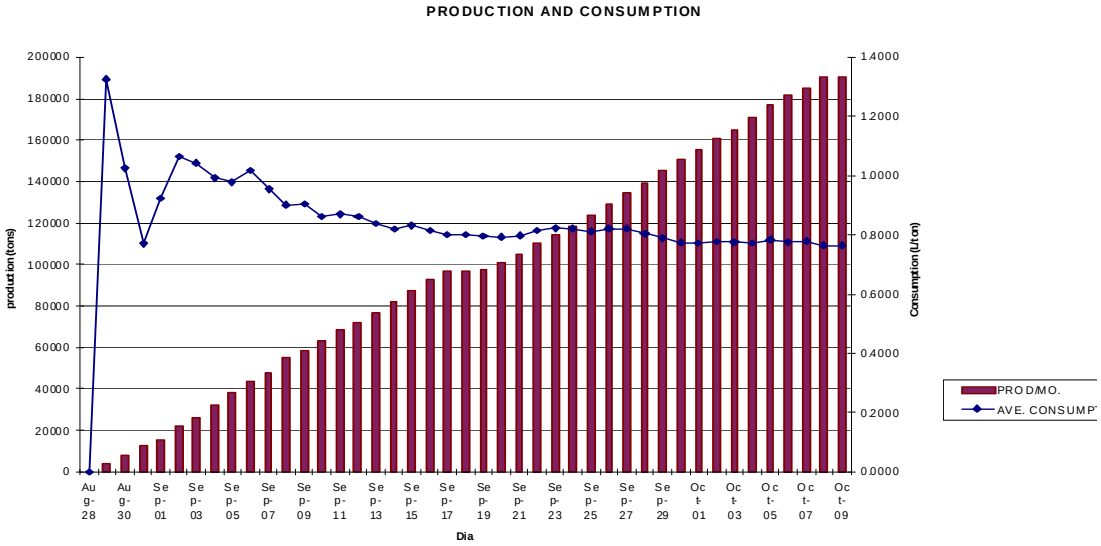

Figure 2 Production vs. consumption.

3.2 Cleanliness

ADT technology can also let the mill to produce a very clean strip even better than when using a simple emulsion with high detergency. This is obtained because of three specific reasons. Oil droplets are electrically charged; that issue permits the formation of a very thin oil film on the roll bite inducing good lubrication with low plate out. Oil droplets are given a specific interfacial tension and those oil droplets can move freely out of the aqueous phase for a uniform plate out.

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In Figure 3 is shown two reversing mills with normal reflectivity values of 60s and 70s with a conventional dispersion system that moved to 80s and 90s with an ADT system.

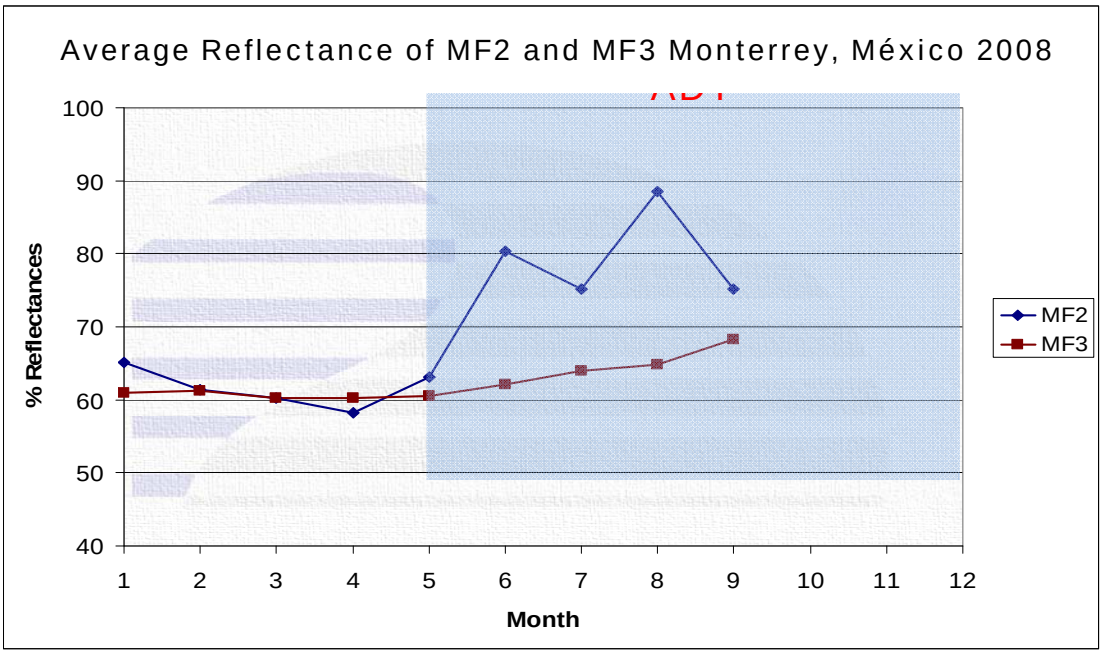

Figure 3. Average reflectance of MF2 and MF3 Monterrey, México 2008.

Rolmex ADT technology, counts with a designed dispersion system in which oil droplets distribute uniformly in the roll bite to have a consistent film and superior lubrication. The high uniformity of the oil film provides an excellent distribution of the roll forces. That issue prevents mill vibrations and bad form of the strip. The film high consistency also prevents roll wear.

Is important to note that the lubrication properties of this technology; are not dependent on the extreme pressure additives or anti-wear molecules. High reactive oils can provide several finish problems to the strip (stains), so the ADT rolling oil contains minimum amounts of reactive additives. High lubricity is provided only by the controlled behavior of the oil droplets oriented by the electrical charge property.

Figures 4 and 5 are from a five stand tandem mill producing gauges up to 0.0083 in (0.21 mm). The first graph shows the dispersion flow the pumps provided to the roll bite before and after the ADT technology and in the second graph, is shown the electric current used in the same mill and the same period of time. The result was substantially less flow (less oil provided) and the lowest electric consumption obtained in that mill.

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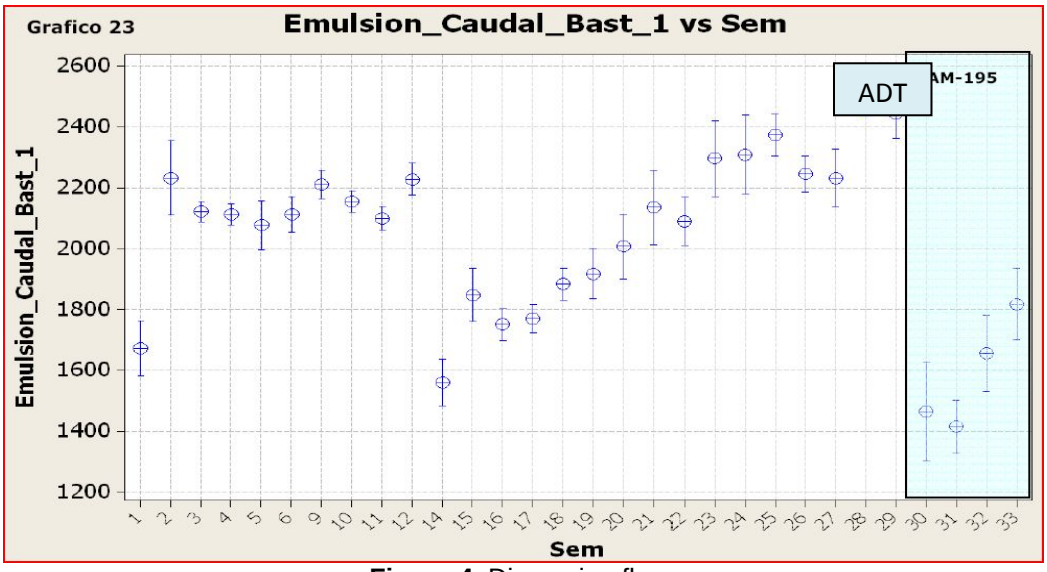

Figure 4. Dispersion flow.

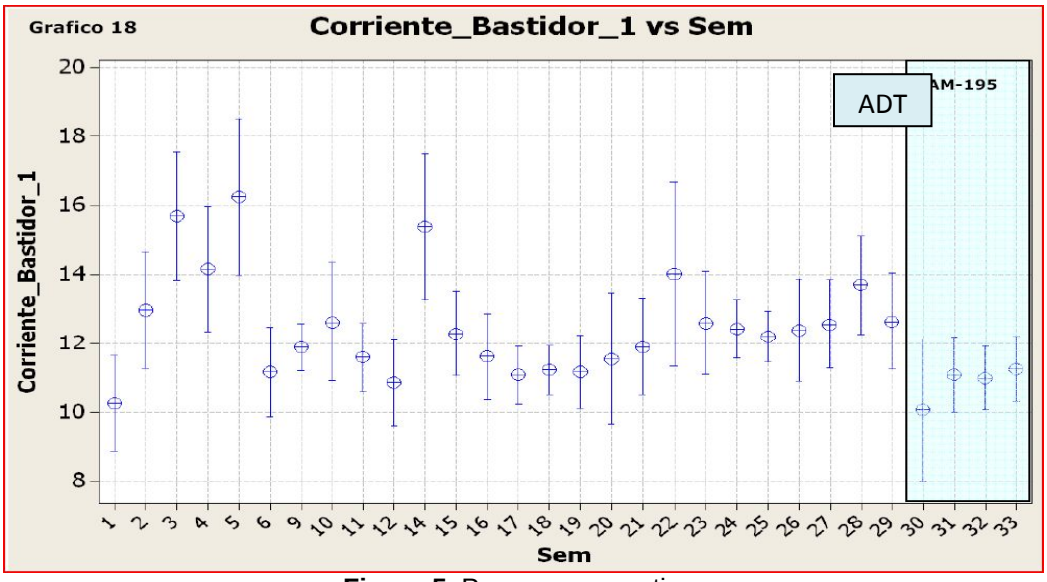

Figure 5. Power consumption.

4 A QUICK OVERVIEW OF ROLLING OILS IN THE FUTURE

To date, rolling oils have been developed with many new features designed to improve the cold rolling operation; however there's always things that can be done and improved and formulators will be challenged to keep working on improving current cold mill rolling oil technology.

Besides making better rolling oils to improve performance on the mill, formulators are now looking for new ways to lower costs for mill operators. With ADT technology we are arduously working towards these goals. With this technology it is possible to work even the most demanding gauges such as tin gauges with very low concentrations. This fact together with the self cleaning mechanism inherent in the technology provides the mill operators to avoid the extensive maintainance and draining necessary with the older technologies. Another objective now is to develop new nobel base oil molecules. The newest base oil technologies for rolling are synthetic esters. The problem with them is that prices are getting higher and their

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improvements are not very clear, so we think that in the near future, new chemical family molecules should be investigated.
Another objective for the future is to increase dispersion life further and reduce even more the maintenance required by the lubrication system. That could make the system more efficient and will reduce substantially the rolling problems and the most important: the cost of the operation.