NEW ERA NEWS

R&M ENERGY SYSTEMS
A Unit of Robbins & Myers, Inc.

TECHNICAL BULLETIN NO. 12

*SUMMARY*

* Hydraulic resistance can be a significant factor as production volumes and fluid viscosity increase.

* Anything added to sucker rods, including couplings and rod guides, increases drag.

* A low-drag rod guide, such as R&M Energy Systems NETB, will add less drag than a standard rod coupling.

* A roller guide will add 3-4 times more drag than a NETB.

* Field installed guides can add as much as 6-10 times more drag than a NETB.

* Rod guides with the highest drag introduce the greatest amount of turbulence.

* Depending on pumping speed, sinker bars can generate large drag forces.

# Hydraulic Drag Forces on Sucker Rod Strings

Analytical procedures and techniques used to predict downhole forces for beam pumped wells are constantly evolving. With this in mind, R&M Energy Systems conducted a series of tests to measure the drag of various rod guide designs. Research was eventually extended to measure the drag generated by rod bodies and couplings, including the upsets and wrenching squares. This project culminated in the development of a new series of rod guides, the R&M Energy Systems NETB, which significantly improved fluid dynamic properties.

In analyzing the problem of hydraulic drag force, R&M Energy Systems recognized that total resistance on the downstroke was caused by a combination of forces: (1) Mechanical friction resulting from contact between the rod string and tubing; (2) Hydraulic friction or drag resulting from fluid flowing around the rod guides, sucker rods and couplings; (3) Buoyancy caused by the displacement of fluid by the rod string. This Technical Bulletin addresses only hydraulic drag.

# Production System Efficiency

The need to pump at higher rates is frequently associated with increasing water-oil ratios. As a result, the lubricating quality of the production fluid declines. Poor lubrication, coupled with greater rod string velocities, increases wear on rods and tubing which results in greater maintenance and repair cost.

As the speed and stroke length of conventional pumping units are increased, the forces resisting the downward motion of the rod strings can become the limiting factor in the amount of fluid that can be pumped. As the limit is approached, the minimum and maximum carrier bar loads diverge at an increasingly greater rate, making it difficult - if not impossible - to effectively counterbalance the pumping unit. As a result, the overall efficiency of the production system declines.

# Study Objectives

The objective of R&M Energy Systems study was to quantify the hydraulic resistance acting on reciprocating rod strings, particularly of rod guides, which are an important component of rod string designs. This resistance, or drag force, which occurs as the string falls through production fluid, increases exponentially with pumping speeds. R&M Energy Systems determined these drag forces can be a significant factor in proper rod string design.

Maximum hydraulic resistance occurs midway through the downstroke. In extreme cases, the effects of the fluid dynamics can become so great that rod strings will stack out or float off the carrier bar.

# Test Program

A series of tests were conducted to measure the drag of various rod guide designs. The rod guide to be tested was mounted in tubing and held stationary. Water was pumped through the tubing to simulate a rod string s downward travel through the tubing. Flow rates were varied to cover a wide range of rod string velocities in 2", 2-1/2" and 3" tubing. However, only tests conducted in 2-1/2" tubing are included in this technical bulletin.

The resulting forces were measured with a scale mounted on top of the test stand. Prior to each test, the test rod and rod guide were weighed at zero flow to compensate for buoyancy.

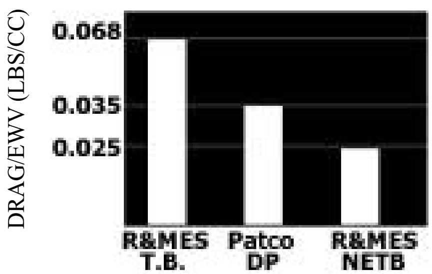
# Design Criteria

The primary function of a rod guide is to prevent metal-to-metal contact between sucker rods and tubing. Design criteria for a rod guide are:

1. Maximum erodible wear volume (EWV)
2. Minimum total volume to EWV ratio
3. Minimum drag to EWV ratio
4. Minimum rate of wear
5. Minimum abrasion to metal
6. Maximum structural and impact strength
7. Maximum chemical and temperature resistance
8. Maximum bond to the sucker rod

Criteria #3 is important because it indicates a rod guide s hydraulic efficiency relative to its ability to prevent metal-to-metal contact on the rod and tubing. Drag-to-EWV ratios for selected shop installed guides are shown in Figure 3.

**RATIO OF DRAG TO EWV**
(Figure 3)

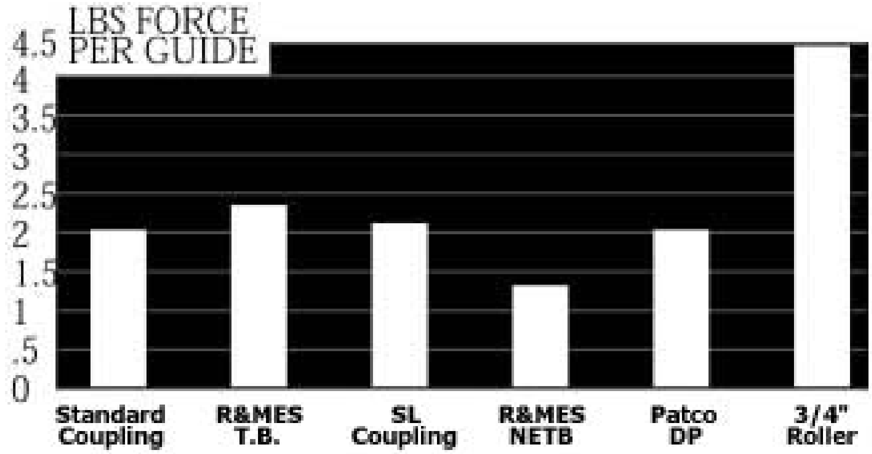



Drag forces in 70$^{o}$F fresh water at 100 gpm.

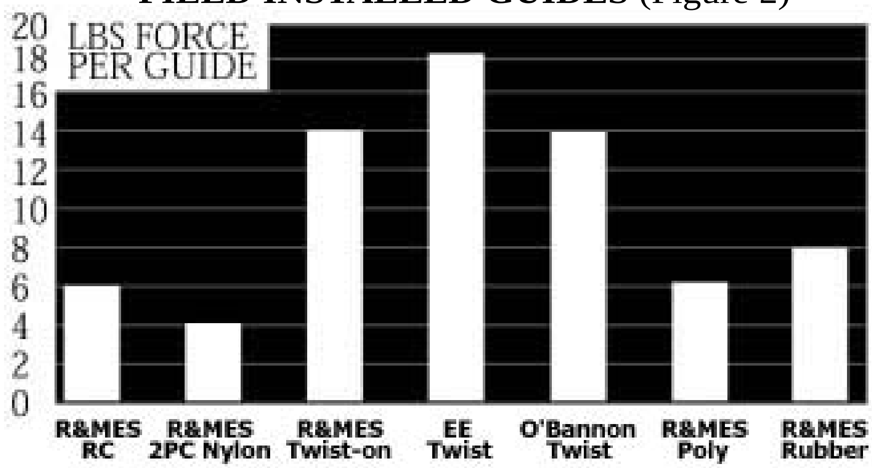
## Summary of Test Results

The results of the test program are summarized in Figures 1 & 2. These graphs compare the drag forces on various shop and field installed rod guides in 70¡F fresh water at a flow rate of 100 gpm.

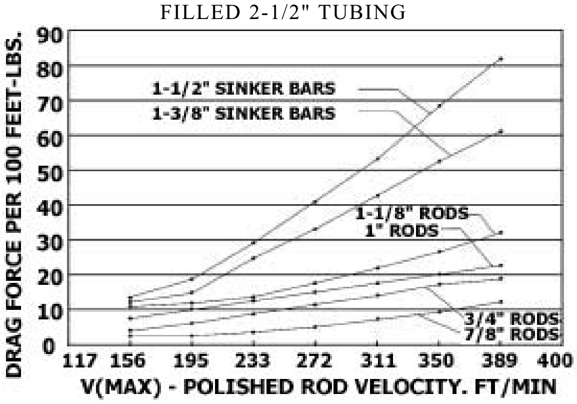
**SHOP INSTALLED GUIDES** (Figure 1)



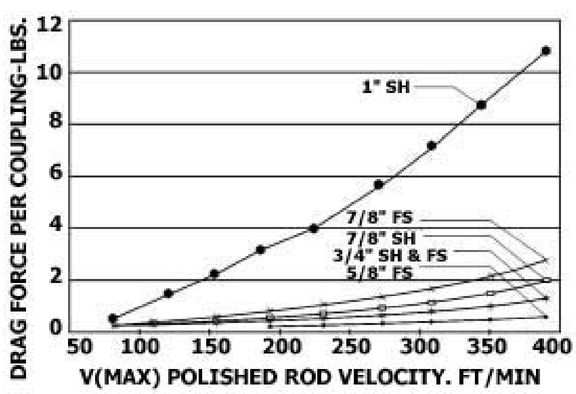

**FIELD INSTALLED GUIDES** (Figure 2)




HYDRAULIC DRAG FORCES FOR SUCKER ROD AND SINKER BAR BODIES IN WATER FILLED 2-1/2" TUBING




HYDRAULIC DRAG FORCES FOR ROD COUPLINGS IN WATER FILLED 2-1/2" TUBING

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