COMMON MISUNDERSTANDINGS OF SUCKER ROD PUMPING & MISDIAGNOSIS OF WELL PROBLEMS

MARK W. MAHONEY
SENIOR SALES APPLICATIONS ENGINEER
HARBISON-FISCHER
COMMON MISUNDERSTANDINGS OF SUCKER ROD PUMP FUNCTIONS

• HOW THE PUMP FUNCTIONS
• DOES IT PUMP ON THE UPSTROKE OR THE DOWNSTROKE?
• WHAT IS A DOWNSTROKE PUMP?
• WHAT IS AN UPSTROKE PUMP?
VISUALIZING PROBLEMS

• THINK IN PICTURES NOT WORDS
• DRAW IT OUT JUST LIKE WELL BORE DIAGRAMS
ESTABLISH ROOT CAUSE

• START WITH THE SYMPTOMS NOT A DIAGNOSIS
• NOT, I HAVE GAS LOCK!
• NOT, I HAVE A SAND PROBLEMS!

BE SPECIFIC
• I HAVE LOW PUMP EFFICIENCY
• COARSE SAND IS CUTTING THE PLUNGER
• I AM BREAKING PARTS ABOVE THE PLUNGER!
• I HAVE DEFLECTION WEAR ON THE PLUNGER!
PUMP FUNCTION

Operation of Sucker Rod Pump

START OF UP STROKE

START OF DOWN STROKE

PLUNGER FALLS THROUGH FLUID

FLUID LIFTED TOWARD SURFACE

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SURFACE PUMP DISCHARGE

POLISHED ROD

PLUNGER SIZE VS POLISHED ROD SIZE
**SOLID PLUNGER**

"DOWNSTROKE PUMP"

**Bottom Discharge Valve**

### Valve, Bottom Discharge
For Rod Pumps

<table>
<thead>
<tr>
<th>ITEM</th>
<th>PARTS DESCRIPTION</th>
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<tbody>
<tr>
<td>A</td>
<td>BODY, DISCHARGE</td>
</tr>
<tr>
<td>B</td>
<td>CAGE, CLOSED</td>
</tr>
<tr>
<td>C</td>
<td>BALL &amp; SEAT</td>
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<tr>
<td>D</td>
<td>PLUG</td>
</tr>
<tr>
<td>E</td>
<td>COUPLING</td>
</tr>
<tr>
<td>F</td>
<td>CAGE, BLIND</td>
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- **Production Fluid thru**
  - **Pump, upstroke**
  - Fluid Exit to
  - **Tubing, downstroke**

- **Discharge Valve**
- **Standing Valve**

**Production Fluid**
SOLID PLUNGER VS HOLLOW

FLUID ENTERS THROUGH STANDING VALVE
DISCHARGES THROUGH THE TRAVELING
VALVE AND PLUNGER ID

FLUID ENTERS THROUGH STANDING VALVE
DISCHARGERS THROUGH THE BOTTOM
DISCHARGE VALVE
SOLID PLUNGER VS HOLLOW

BOTH PLUNGERS HAVE HYDROSTATIC LOAD ON THE UPSTROKE

THE SOLID PLUNGER WILL HAVE HIGHER FORCES ON THE BOTTOM OF THE PLUNGER ON THE DOWNSTROKE
DESIGN RESTRAINTS OF BOTTOM DISCHARGE VALVES

FOR EACH SIZE OF TUBING THERE IS A DESIGN TRADE-OFF OF STANDING VALVE FLOW AND DISCHARGE VALVE. THE FLOW PASSAGES ALSO ADD TO THE UNCOMPRESSIBLE VOLUME.
BUOYANCY FORCES  
FLUID  
FORCES &  
PUMP FRICTION

• SUBSURFACE PUMPS HAVE MANY FORCES AT WORK DURING THE PUMP CYCLE

• UNDERSTANDING THE BASIC PHYSICS & FORCES HELPS UNDERSTAND WHAT IS PHYSICALLY POSSIBLE AND WHAT IS NOT
BUOYANCY

FORCE ON BOTTOM = BUOYANCY

NO UPWARD FORCE = NO BUOYANCY
BUOYANCY

EXAMPLE:
¾" SUCKER RODS WEIGH 1630 LBS PER 1000' IN AIR BUT ONLY 1,410 LBS PER 1000' BUOYANT

SUCKER ROD COUPLINGS AND THE UPSET AREA = BUOYANCY FORCES
FLUID FORCES ACT IN ALL DIRECTIONS SO SOME UPWARD FORCES CANCEL OUT DOWNWARD FORCES

HYDROSTATIC LOAD

PUMP INTAKE PRESSURE
FLUID FORCES

FLUID FORCES ACT IN ALL DIRECTIONS

HYDROSTATIC LOAD

NET FORCES

PUMP INTAKE PRESSURE
Slippage Past Plunger

Downstroke

High Pressure Fluid

Upstroke

Slippage

Low Pressure

Production Fluid Flow

IN

Production Fluid Flow
PUMP FRICTION

- FRICTION FROM FLUID BETWEEN BARREL & PLUNGER
- FLUID FRICTION THROUGH VALVE & PLUNGER
- BUOYANCY
FLUID LOAD ($F_o$) =
NET FORCE OF HYDROSTATIC LOAD
MINUS PUMP CHAMBER PRESSURE

- HYDROSTATIC LOAD
- PUMP INTAKE PRESSURE MINUS FRICTIONAL FORCES THROUGH THE STANDING VALVE = PUMP CHAMBER PRESSURE
- UPSTROKE
Typical Pumping Problems

1. Gas or Vacuum
   - Gas or Vacuum
   - Fluid
   - Fluid Pound

2. Gas
   - Gas
   - Fluid
   - Gas Pound

3. Gas Locking
   - Gas
   - Fluid
   - Gas Locking

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Compression Ratio

\[ CR = \frac{\text{Swept Vol.} + \text{Unswept Vol.}}{\text{Unswept Vol.}} \]

Example:
1-1/4” plunger
134” downhole stroke length
9.5 cubic inches unswept volume
\[
(164.4 + 9.5) / 9.5 = 18.3
\]

Discharge Pressure =
(Intake Press) times (CR)
Example:
400 psi Intake Pressure
18.3 compression ratio, CR
400 times 18.3 = 7,320 psi

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**DECOMPRESSION**

Ideal gas law
\[
\frac{V_1}{V_2} = \frac{P_2}{P_1}
\]

VOLUME AND PRESSURE ARE INVERSELY PROPORTIONAL

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WHAT IS GAS LOCK?

• USUAL ANSWER IS GAS FILLED PUMP CHAMBER AND PRESSURE DOES NOT BUILD HIGH ENOUGH TO OPEN TRAVELING VALVE AND THE PUMP CHAMBER PRESSURE DOES NOT DROP ENOUGH TO OPEN THE STANDING VALVE
WHAT IS GAS LOCK?

• BETTER ANSWER IS PUMP HAS PUMPED DOWN TO PUMP CHAMBER DECOMPRESSION LIMIT
## DECOMPRESSION

Ideal gas law:

\[
\frac{V_1}{V_2} = \frac{P_2}{P_1}
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Two Stage “Gas Chaser” Pump

Production Fluid Flow

Full Positive Seal

Upstroke

Downstroke

IN

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Sliding Top Valve

Fluid Ports

Sliding Sleeve
WHAT IS GAS LOCK?

• GAS LOCK IS NOT JUST A PUMP MECHANICAL PROBLEM BUT ALSO A STROKE LENGTH PROBLEM.

• PUMP MECHANICS CAN BE CHANGED BUT FOR THE CHANGES TO BE THE MOST EFFECTIVE THE LONGEST POSSIBLE STROKE ALSO NEEDS TO BE USED
PUMP EFFICIENCY

- SLIPPAGE NEED AT LEAST 2-3% FOR LUBRICATION AND COOLING
- TO MINIMIZE ROD STRETCH LOSS. USE A STIFF STRING SLOW TO MINIMIZE OR ELASTIC STRING FAST TO GAIN OVERTRAVEL
- DO NOT POUND FLUID: SIZED TO FIT, TIME CLOCK, OR USE PUMP CONTROLLER OR VSP PUMP
- GOR THROUGH THE PUMP OR STOCK TANK SHRINKAGE WILL REDUCE PRODUCTION
PUMP EFFICIENCY

• WHAT IS MORE IMPORTANT; ELECTRICITY COST OR CYCLES BEFORE FAILURE?

• GAS POUND, IF WE CANNOT SEPARATE THE GAS USE A LARGER PUMP TO GET PRODUCTION & DESIGN TO HANDLE THE GAS COMPRESSION EFFECTS
PUMP EFFICIENCY

• DO NOT ALLOW PUMP EFFICIENCY TO AFFECT NEW DESIGN TO HANDLE STICKING PROBLEMS, PUMP FRICTION PROBLEMS AND IMPROVE CYCLE LIFE.