

SECTION 7

**CORROSION AND MECHANICAL
WEAR**

ON

**EQUIPMENT USED IN
HANDLING PRODUCED WATER**

BY

BOB KIKER

SPECIAL EMPHASIS ON WELLBORE MANAGEMENT

- THE WELLBORE IS THE PRIMARY ASSET**
- MOST OPERATING COSTS DIRECTLY
RELATED TO LIFTING FLUID**
- REDUCING WELL FAILURES**

REDUCES OPERATING COSTS

**KEEPS MARGINAL WELLS ON
LONGER**

REDUCING DOWNHOLE FAILURES-WELLBORE MANAGEMENT

- CHEMICAL PROGRAMS**

PROTECT TUBULARS-INSIDE CASING

- CATHODIC PROTECTION**

PROTECTS EXTERNAL CASING

SURFACE FACILITY PROTECTION

GENERAL GUIDELINES AND PRACTICES FOR TREATING CORROSION

- **BATCH TREATMENT –WELLS MAKING <600BFPD**
- **CONTINUOUS TREATMENT > 600BFPD**
- **ALWAYS SELECT AN INHIBITOR THAT PASSES BOTH AN EMULSION TENDENCY TEST AND A FILM PERSISTENCY TEST**
- **VOLUME OF CHEMICAL USUALLY BASED ON 100 BFPD**
- **Chemical concentrations vary by operator from 1-4 gals per 100 BFPD**
- **Rule of thumb: 25-50 ppm concentration is adequate.**
- **Excessive volumes can increase oil carryover.**

CHEMICAL INHIBITION GUIDELINES CONTINUED

FLUSH VERY IMPORTANT

- OIL IS BEST
- KEEP OXYGEN OUT
- PREWET CASING-1 BARREL OF FLUSH
- PUMP INHIBITOR
- FLUSH WITH ½ BARREL/1000 FEET-2 BBL MIN.

IF FLUSHING WITH H₂O USE WATER FROM
GAS BLANKETED TANKS OR O₂
SCAVENGER

CHEMICAL GUIDELINES CONTINUED

PRETREATING RODS

- 5 GALS INHIBITOR IN TUBING PRIOR TO RUNNING THE PUMP**
- CIRCULATE ONE TUBING VOL PRIOR TO PUMPING**

UNDER DIFFICULT CIRCUMSTANCES

- DISPLACE TUBING WITH LEASE CRUDE**
- PLUS 10 GALS OF INHIBITOR**
- LUBRICATE SUCKER ROD PINS**

CHEMICAL GUIDELINES AND PRACTICES CONTINUED

PARA PROBES

USED IN LIEU OF SURFACE CORROSION COUPONS

WELLHEAD INSTALLATION

FOR

INSTANTANEOUS CORROSION RATE

EQUIPMENT (DOWNHOLE) OPTIONS-METALLURGY

TUBING-J 55

BEST CHOICE IN CORROSIVE ENVIRONMENT

INTERNAL CORROSION PROTECTED WITH

•COATINGS OR INHIBITOR

**SOME OPERATORS USE TK 99 PLASTIC COATING
NEAR THE BOTTOM HOLE PUMP-OR ENOUGH JOINTS
TO COVER SIDE LOADING OF THE RODS (50-75 JTS)**

SOME USE 316 SS BLAST JOINT

**•ALSO POLYETHYLENE LINERS NOW
VERY POPULAR**

**WHICH ALSO PROTECTS AGAINST
MECHANICAL WEAR FROM RODS**



DOWNHOLE EQUIPMENT CONTINUED

SUCKER RODS

- **KD (Norris Grade 90) MOST POPULAR IN CORROSIVE ENVIRONMENT**
- **OTHERS UPGRADE from Norris grade 54 to 78**
- **SOME FIBERGLASS USED**

HIGH FLUID LEVELS

**OVERLOADED SURFACE AND
DOWNHOLE EQUIPMENT**

DEEP WELLS-LOAD FACTOR

DOWNHOLE EQUIPMENT CONTINUED

PUMPS

BASIC METALLURGY

- **BARREL SURFACE HARDNESS>PLUNGER**

BASIC METALLURGY

- **BARREL: CHROME-PLATED CARBON STEEL, OR BRASS
NICARB**
- **PLUNGER: SPRAYED METAL CARBON STEEL**
- **BALLS: COBALT ALLOY STEEL, TITANIUM CARBIDE**
- **SEATS: TUNGSTEN CARBIDE**

CONTROLLING MECHANICAL WEAR

TUBING ANCHORS

- **USED FOR WELLS >3000 FEET DEEP**
- **SHOULD BE AS CLOSE TO PUMP AS POSSIBLE**

TUBING ROTATORS-LIMITED USE

- **DEEPER WELLS REQUIRING TUBING ANCHORS RESTRICT ROTATOR**
- **OMEGA-INEXPENSIVE MECHANICAL TUBING ROTATOR**

CONTROLLING MECHANICAL WEAR CONTINUED

ROD GUIDES

- **USED ONLY AS NECESSARY**
- **RESTRICTS INHIBITOR COATING**

ACCEPTED PRACTICE OF ROD GUIDE USE

- **USE 3-4 GUIDES PER ROD-DEPENDENT ON DEVIATION**
- **USE MOLDED ON ROD GUIDES**

SINKER BARS

- **USED TO CONTROL DOWNSTROKE BUCKLING**
- **MOST USE 1 ½ in BARS**

CONTROLLING MECHANICAL WEAR CONTINUED

ROD ROTATORS

- USED ONLY WHEN ROD GUIDES ARE USED**
- BE SURE THE CORRECT ROTATOR IS BEING USED**

**THEY ARE DIFFERENT FOR STEEL AND
FIBERGLASS RODS**

THE DIFFERENCE IS THE TORQUE APPLIED

CONTROLLING MECHANICAL WEAR CONTINUED

POLYETHYLENE TUBING LINERS

VERY POPULAR LAST 2 YEARS

PROTECTS AGAINST:

- CORROSION**
- MECHANICAL WEAR**
- INEXPENSIVE**
- INSTALLED ON USED TUBING**
GREEN BAND-\$1.55/FT
- VARIOUS AMOUNTS USED-BOTTOM 200'TO**
OVER HALF THE STRING

CONTROLLING MECHANICAL WEAR CONTINUED

TABLE 5. TUBING LINERS

Tubing size	ID	Drift	Liner Weight
23/8	1.71 in	1.60in	.40#/ft
27/8	2.16in	2.00in	.47#/ft
31/2	2.67in	2.50in	.64#/ft



CONTROLLING MECHANICAL WEAR CONTINUED

MORE ON POLYETHYLENE LINERS

NEW INSIDE TUBING SCANNER TECHNOLOGY

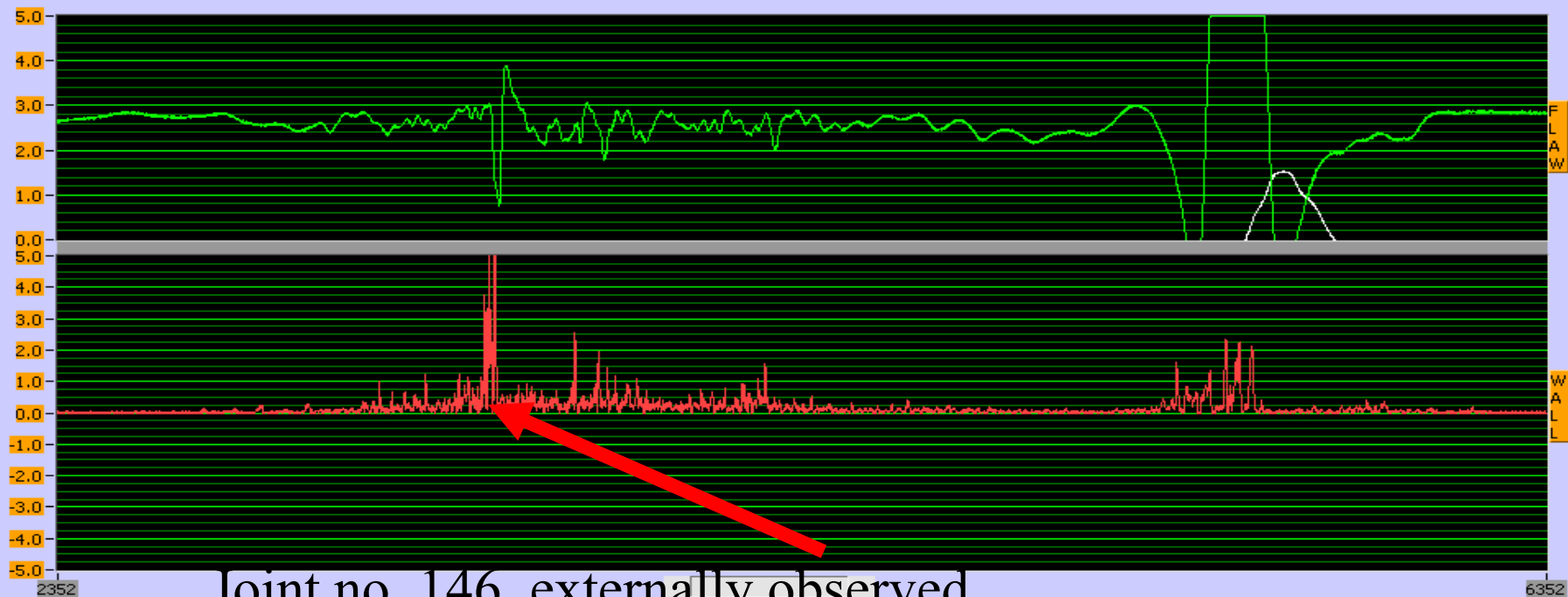
- DEVELOPED BY HERDON OCI, INC**
- COMPUTERIZED RIG-FLOOR PIPE INSPECTION**
- DISPLAYS CONDITION OF INTERNAL TUBING**
- SHOWS PITS AND WEAR**
- RESULTS SHOW PROTECTION OF LINERS**



Herndon OCI, Inc.

Odessa-Midland, Texas

WellTech II Computerized Rig-Floor Pipe Inspection System



Joint no. 146, externally observed
hole. Rod cut I.D.

Chart BG Color



Copywrite, 2000
New Tech Systems USA
Software Version: [25801]



CONTROLLING MECHANICAL WEAR CONTINUED

SUCKER ROD TORQUE MAKEUP

- IMPROPER TORQUE ALLOTS TO AT LEAST 40% ROD FAILURES**
- SUPPORTED BY PUBLISHED LITERATURE AND LAB DATA**

NEW TECHNOLOGY –UNITRAK SYSTEM- TRIPLE N-MIDLAND, TEXAS

**COMPUTERIZED ROD TONGS AND REMOTE SERVICE
RIG TRACKING SYSTEM**

CONTROLLING MECHANICAL WEAR CONTINUED

VARIABLES LEADING TO SUCKER ROD PIN AND COUPLING FAILURES

- OVER AND UNDER TORQUE
- WRENCH MARKS
- IMPROPER LUBRICATION
- THREAD WEAR AND CROSS THREADING
- IMPROPER HANDLING

BAD PICK UP PRACTICES-DRAGGING RODS THRU DIRT
HAMMERING /KNOCKING OFF THREAD PROTECTORS

EVERY OPERATOR SHOULD INSIST THAT THE PULLING UNIT
RUNNING THEIR RODS ARE PROPERLY TRAINED IN SUCKER
ROD HANDLING AND MAKE UP

CONTROLLING MECHANICAL WEAR CONTINUED

PUMP OFF CONTROLLERS

- USED FOR A LONG TIME TO PREVENT POUNDING FLUID
- REDUCE ROD,TUBING, PUMP, GEAR BOX, PUMPING UNIT BEARING AND STRUCTURE FAILURES

SEVERAL BRANDS-SOME MEASURE ACTUAL LOADS ON THE SUCKER ROD STRING-BAKER, LUFKIN, NABLA , ETC. OTHERS (LESS EXPENSIVE) UTILIZE MOTOR LOADS TO DETERMINE PUMP-OFF CONDITIONS (D-JAX)

POPULAR FOR MARGINAL WELLS-LESS \$

CONTROLLING MECHANICAL WEAR CONTINUED

TIMERS

- **MOST ACCEPTABLE IS THE 15 MINUTE TIMER**
- **CAN BE USED INSTEAD OF A POC WHEN PUMP FILL-UP IS A PROBLEM**

WELLBORE MANAGEMENT-PREFERRED OPERATING PRACTICES AND PHILOSOPHIES

REDUCE WELL FAILURES

- REDUCE OPERATING COSTS**
- MINIMIZES PRODUCTION LOSS**
- HELPS MARGINAL WELLS STAY ON**

SUCCESSFUL PROGRAMS –ALL HAVE IN COMMON

- MANAGEMENT-COMMITMENT**
- VENDORS SUPPORT AND COMMITMENT**
- INFRASTRUCTURE**
- PERSONNEL ACCOUNTABILITY**

WELLBORE MANAGEMENT

SUCCESSFUL PROGRAMS

- AMERADA HESS
- HENRY PETROLEUM
- CONOCO
- SCHLUMBERGER IPM (Contract Operator)
- OXY USA
- CHEVRON TEXACO, BAKER PETROLITE, WILSON PUMPS, CROWN QUEST, ICO, NORRIS RODS, AND POOL –JOINT “ROOT CAUSE FAILURE ANALYSIS AND SOLUTIONS”
- PIONEER NATURAL RESOURCES, INC

THESE COMPANIES OPERATE A LOT OF WELLS-BUT- THE APPROACH CAN BE USED BY THE SMALLEST OF OPERATORS



WELLBORE MANAGEMENT-PREFERRED OPERATING PRACTICES CONTINUED

WELL FAILURE FREQUENCY AVERAGES

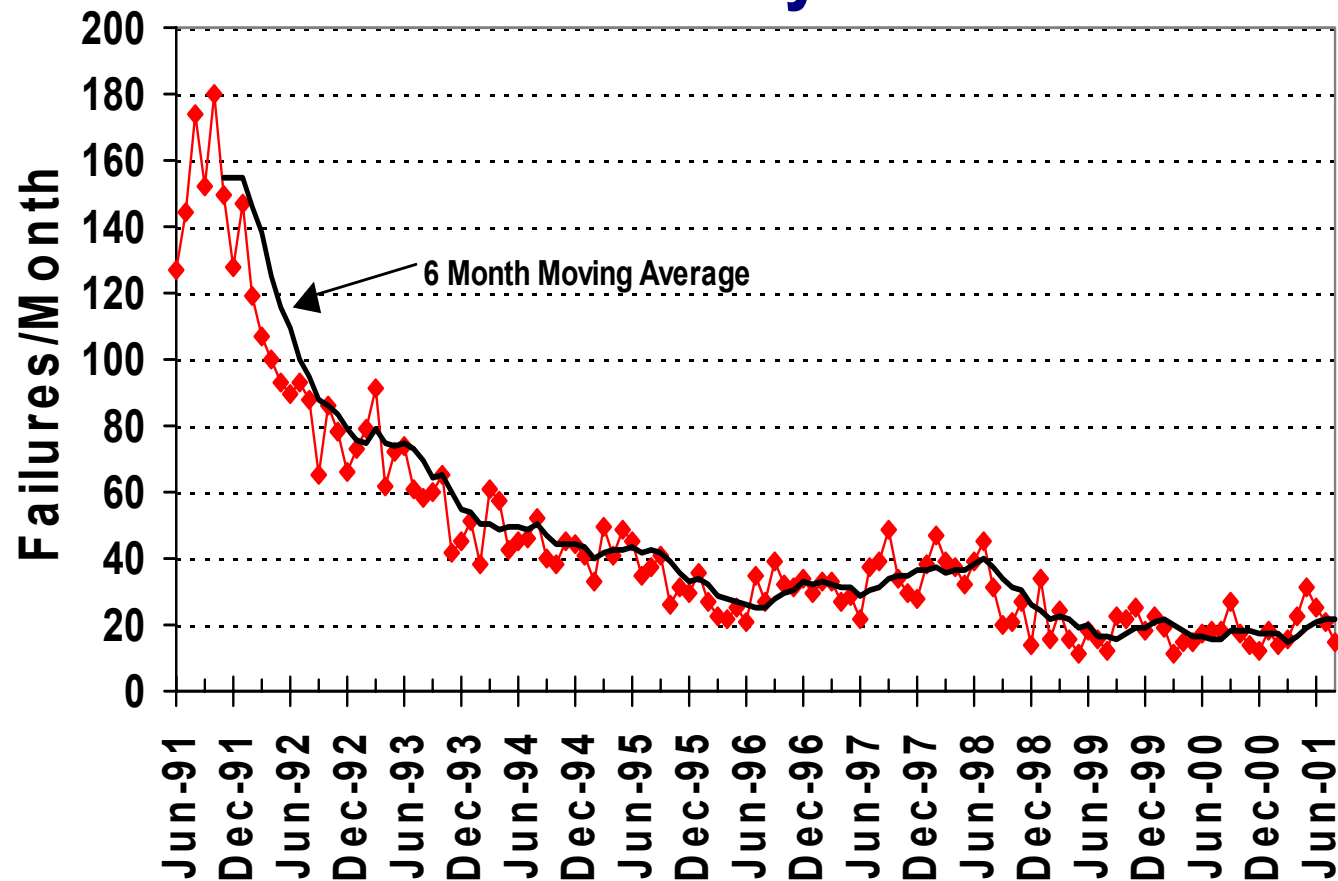
- FOR SUCCESSFUL PROGRAMS < 1.0
- GOOD RANGES ARE .3 TO .6
- FEW AS LOW AS 0.15
- SHOW SOME SLIDES ON RATES

SUCCESSFUL PROGRAMS

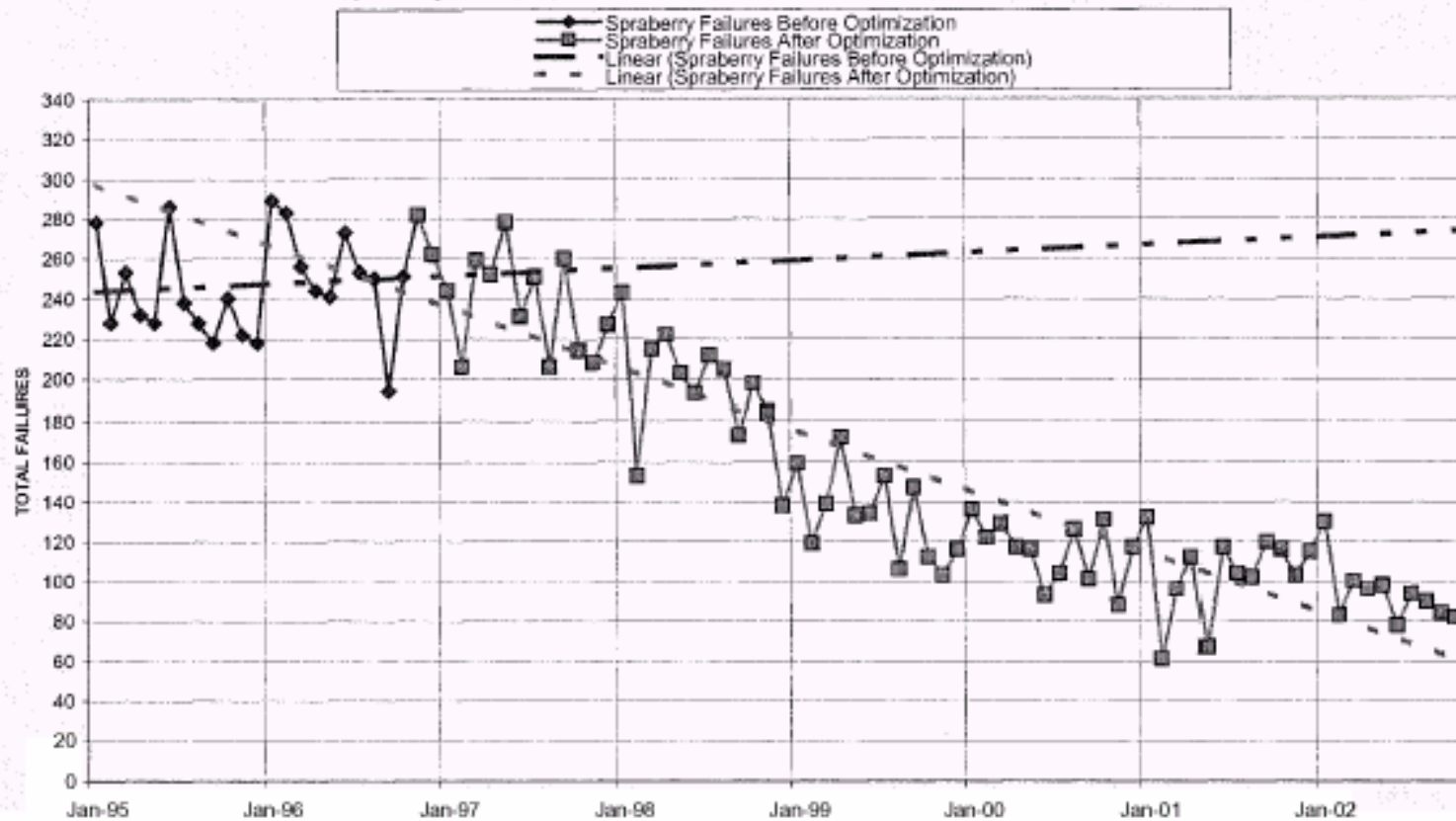
- PAY ME NOW OR PAY ME LATER*

West Texas Project

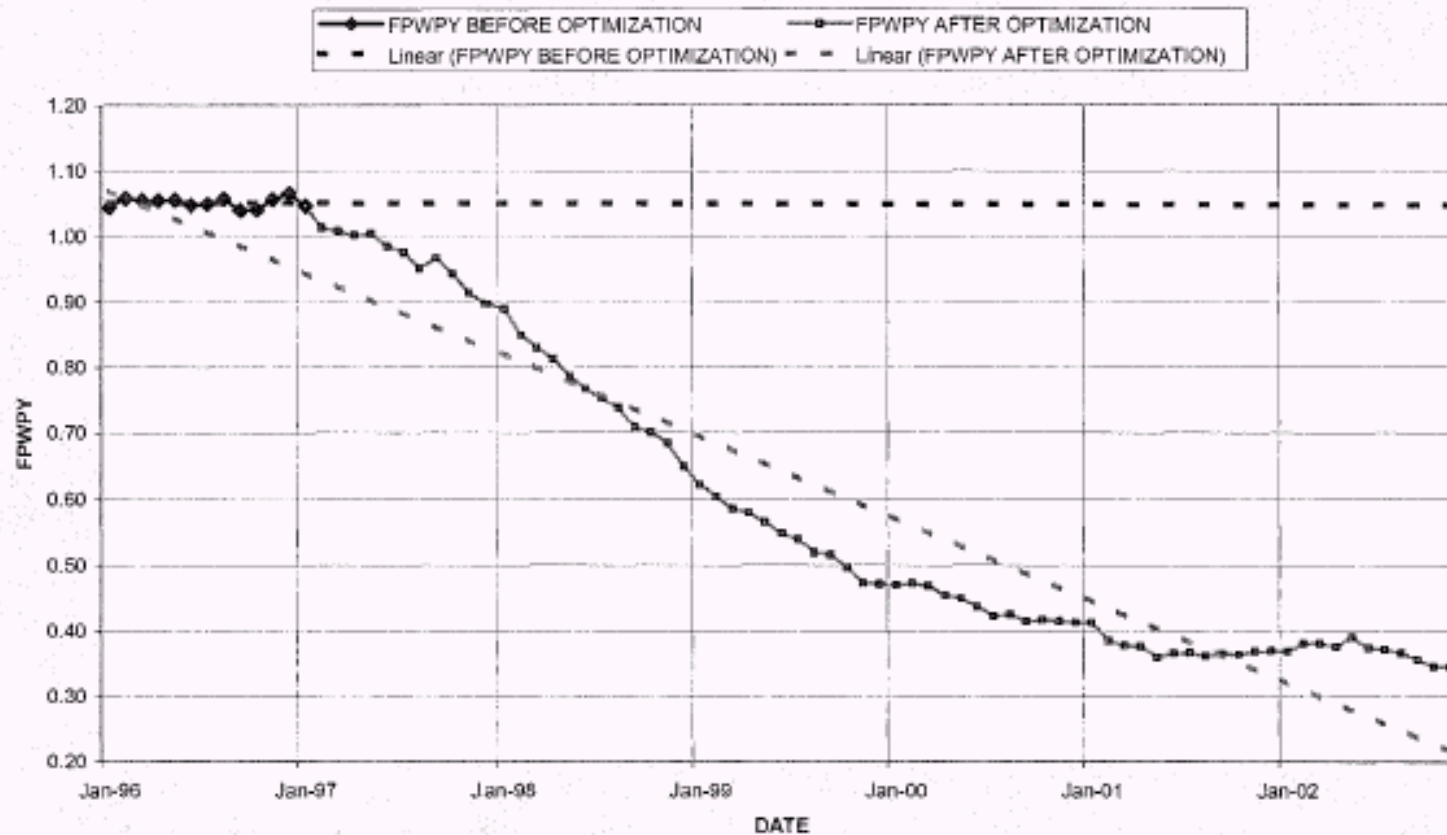
1991-2001 Monthly Well Failures



Spraberry Trend Area Total Failures - Before & After Optimization - Graph 4



SPRABERRY FAILURE FREQUENCY -GRAPH 6



PREFERRED OPERATING PRACTICES CONTINUED

SPECIFIC PRACTICES OF SUCCESSFUL PROGRAMS INCLUDE:

- VISUALLY INSPECT ROD AND TUBING FAILURES**
- DISCUSS THE PROBLEM AND REVIEW THE WELL HISTORY WITH TEAM MEMBERS (COMPANY, CHEMICAL, SERVICE CO.,EQUIPMENT VENDORS,ROD AND TUBING INSPECTION PERSONNEL.**
- ESTABLISH AND MAINTAIN A DATABASE**
- TRACK FAILURES AND CORRECTIVE ACTION**
- ESTABLISH “BEST OPERATING PRACTICES” WITH CURRENT TECHNOLOGY**

Artificial Lift Energy Optimization Consortium (ALEOC)



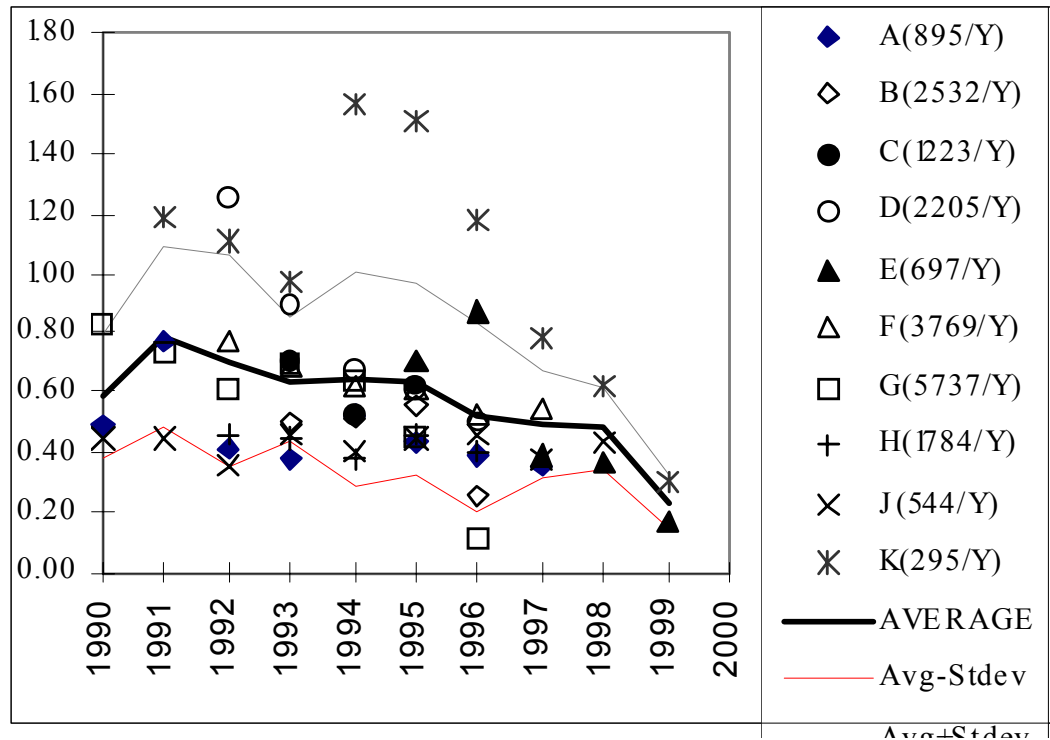
- Made up of eleven oil and gas companies operating in the Permian Basin and Texas Tech University.
- Performed a beam pump failure/performance study of the entire Permian Basin.
- The study covered about 25,000 wells which comprises approximately 25% of the total number of beam pumped wells in this basin.
- Failure data was organized into a database for easy manipulation of data.
- Failure frequency was used for comparative studies among different companies, areas, and system components.

Failure Frequency

- Failures in a beam pumped well can occur in any one of four major components -
 - Pump
 - Rods
 - Tubing
 - Surface Equipment (not considered in ALEOC study)
- Failure Frequency provides a fair basis for comparison of performance between different companies, areas, and components.
- Total Failure Frequency = Pump ff + Rod ff + Tubing ff

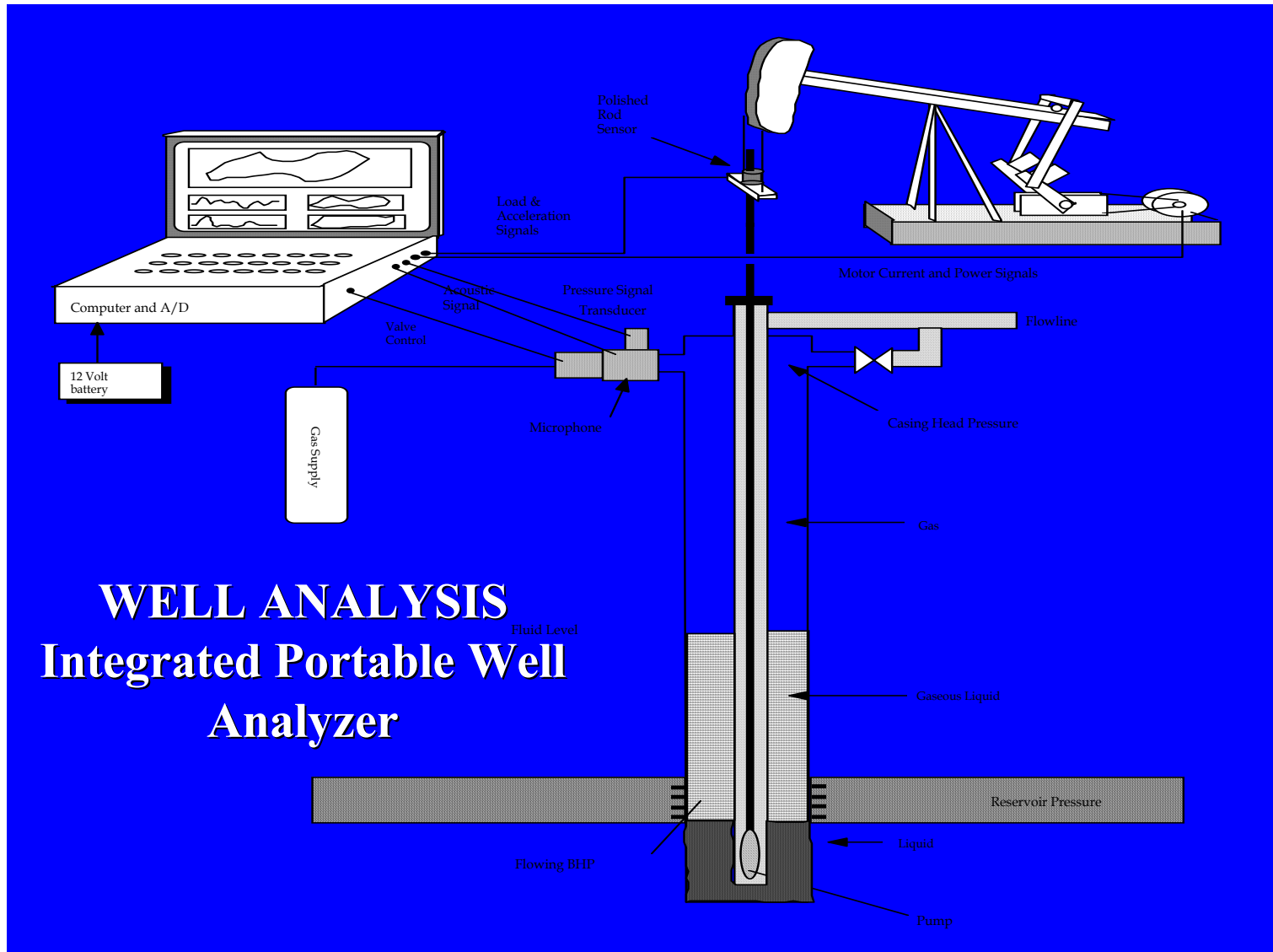
$$ff_i = \frac{\sum Failure_i}{Average\ no.\ of\ wells} \quad (Failures/Well/Year)$$

Total Failure Frequency for All Companies

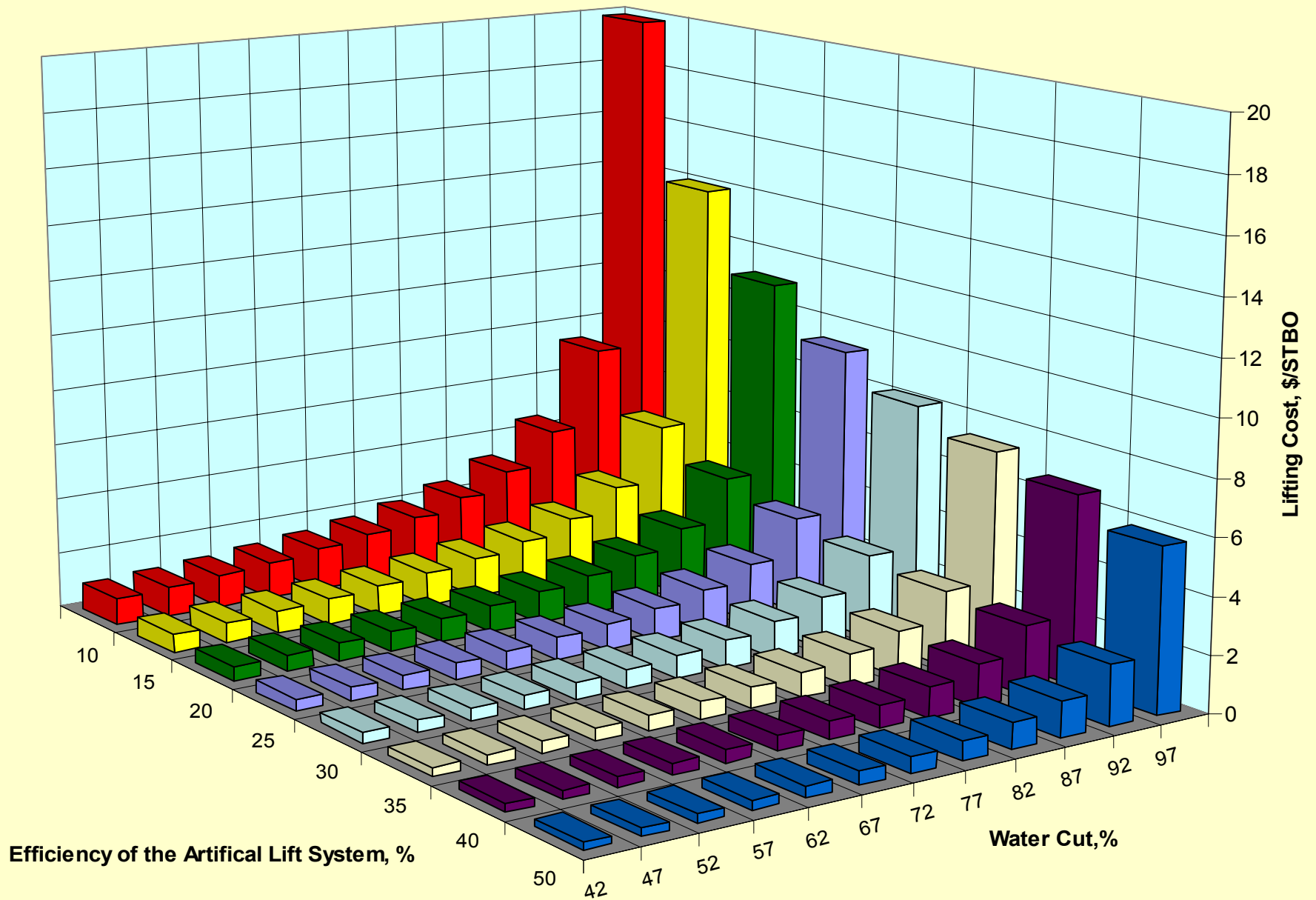


OPTIMIZING ARTIFICIAL LIFT

BEAM PUMPING SYSTEMS



Oil Lifting Cost, 8000 ft net lift, \$0.05/kwh
Water Disposal Cost, \$0.07/Bbl



OTHER ARTIFICIAL LIFT SYSTEM CONSIDERATIONS

ELECTRICAL SUBMERSIBLE PUMPS (ESPs)

- REDUCES WELL FAILURES IN CROOKED HOLES
AND AT HIGH PRODUCTION WATER RATES**
- RUN TIMES OF 2-3 YEARS MORE ECONOMICAL
THAN BEAM PUMPING**
- COATINGS AVAILABLE FOR CORROSION
PROTECTION**

EXAMPLE: Considering total system costs

4800 FT WELL, 5.5 in. csg,-Beam pumping up to 320 BWPD

**However, for the same depth and csg size, considering only
operating and maintenance costs, the beam pumping system is
most economical up to 500 BFPD.**



2. Elimination Process

	Rod Lift	Progressing Cavity	Gas Lift	Plunger Lift	Hydraulic Piston	Hydraulic Jet	Electric Submersible
Operating Depth	100' - 16,000' TVD	2,000' - 6,000' TVD	5,000' - 15,000' TVD	8,000' - 19,000' TVD	7,500' - 17,000' TVD	5,000' - 15,000' TVD	1,000' - 15,000' TVD
Operating Volume (Typical)	5 - 5000 BPD	5 - 4,500 BPD	200 - 30,000 BPD	1 - 5 BPD	50 - 4,000 BPD	300 - >15,000 BPD	200 - 30,000 BPD
Operating Temperature	100° - 550° F	75°-250° F	100° - 400° F	120° - 500° F	100° - 500° F	100° - 500° F	100° - 400° F
Corrosion Handling	Good to Excellent	Fair	Good to Excellent	Excellent	Good	Excellent	Good
Gas Handling	Fair to Good	Good	Excellent	Excellent	Fair	Good	Poor to Fair
Solids Handling	Fair to Good	Excellent	Good	Poor to Fair	Poor	Good	Poor to Fair
Fluid Gravity	>8° API	<35° API	>15° API	GLR Required - 300 SCF/BBL/ 1000' Depth	>8° API	>8° API	>10° API
Servicing	Workover or Pulling Rig	Workover or Pulling Rig	Wireline or Workover Rig	Wellhead Catcher or Wireline	Hydraulic or Wireline	Hydraulic or Wireline	Workover or Pulling Rig
Prime Mover	Gas or Electric	Gas or Electric	Compressor	Wells' Natural Energy	Multicylinder or Electric	Multicylinder or Electric	Electric Motor
Offshore Application	Limited	Good	Excellent	N/A	Good	Excellent	Excellent
Overall System Efficiency	45% - 60%	40% - 70%	10% - 30%	N/A	45% - 55%	10% - 30%	35% - 60%

ARTIFICIAL LIFT SYSTEMS

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FIGURE 3-COMPARISON OF ARTIFICIAL LIFT

SURFACE FACILITIES DESIGN

FLOWLINES AND TANK BATTERY GATHERING LINES

- **LOWPRESSURE-POLYPIPE MOST POPULAR**
- **DR/SDR-RATIO OF OUTSIDE DIAMETER TO THE THICKNESS-LOWER THE SDR THE HIGHER THE PRESSURE RATING**
- **MOST OPERATORS USE A DR/SDR RATING OF 7**
- **SOME USE A RATING OF 11**
- **POLYPIPE HAS TO BE DE-RATED FOR TEMPERATURE**

Table 6. PE 3408 Pipe - Pressure Rating (psi) vs. Temperature (°F)

Temperature °F	Hydrostatic Design Basis, psi	Pipe DR									
		32.5	26	21	19	17	15.5	13.5	11	9	7
50	1,820	58	73	91	101	114	126	146	182	228	303
60	1,730	55	69	87	96	108	119	138	173	216	288
73.4	1,600	51	64	80	89	100	110	128	160	200	267
80	1,520	48	61	76	84	95	105	122	152	190	253
90	1,390	44	56	70	77	87	96	111	139	174	232
100	1,260	40	0	63	70	79	87	101	126	158	210
110	1,130	36	45	57	63	71	78	90	113	141	188
120	1,000	32	40	50	56	63	69	80	100	125	167
130	900	29	36	45	50	56	62	72	90	113	150
140	800	25	32	40	44	50	55	64	80	100	133

Data provided courtesy of Performance (formerly Driscopipe).

SURFACE FLOWLINES AND GATHERING LINES CONTINUED

HIGH PRESSURE

- **DOWNGRADED GREEN BAND TUBING-FOR HEAT REMOVAL OF PARAFFIN**
- **FIBERGLASS-MORE EXPENSIVE-INJECTION LINES**
- **COATED STEEL PIPING-INJECTION LINES**
- **FIBERSPAR LINE PIPE-750-2500PSI AND UP TO 200°F**

glass fiber reinforced –epoxy laminated

GOOD FOR LONG LINES-SPOOLED UP TO FOUR MILES

WEBSITE <http://www.fiberspar.com>



PROCESSING EQUIPMENT AND STORAGE TANKS

CORROSION PROTECTION

- COATED STEEL TANKS**

- FLAKELINE, AMERON, COAL TAR EPOXY**

- NEW COATING-JOTUN 8 SERIES-
REPLACEMENT FOR MOBIL'S VALSPAR. IT IS
EPOXY**

- SACRIFICIAL ANODES –TANKS**

- FIBERGLASS VESSELS/TANKS**

USE OF FIBERGLASS VESSELS AND TANKS

**CONTROVERSIAL DUE TO POTENTIAL PROBLEM
OF STATIC ELECTRICITY**

SOME USE FIBERGLASS TANKS

- **WHERE THERE IS A GAS BLANKET**
- **NEW FIBERGLASS TANK –POLYMER FIBERGLASS
WITH IMBEDDED GROUND WIRE.**

FIBERGLASS GUNBARRELS- POPULAR

CORROSION PROTECTION FOR SURFACE FACILITIES

SACRIFICIAL ANODES

- **CATHODIC PROTECTION INSIDE THE TANKS**
USED TO PROTECT THE PART EMERSED IN SALT WATER

CHEMICALS

- **-VERY LITTLE USED FOR CORROSION-
CAUSES POTENTIAL OIL CARRYOVER
PROBLEMS**
- **SOME OPERATORS USE EMULSION
BREAKERS AND SCALE INIBITORS**

INJECTION/DISPOSAL SYSTEMS

INJECTION LINES

- **FIBERGLASS-BURRIED**
- **INTERNALLY COATED STEEL**
- **FIBERSPAR**
- **STILL SOME CEMENT LINED**

INJECTION TUBING

- **DUOLINE-MOST POPULAR**

INJECTION PACKERS

- **NICKEL COATED**

FILTRATION

- **VERY FEW USE FOR OIL CARRYOVER-HIGH MAINTENANCE**
- **SOME STILL USED FOR SOLIDS**
- **MOST OPERATORS PREFER TO BACKFLOW INJECTION WELLS FOR CLEANUP**
- **SOME USE SCREENS AT WELLHEADS**

A lot of info on filters used for produced water at Natco Group's website at natcogroup.com-go to produced water and filtration.

MAINTAINING INJECTIVITY

POSITIVE DISPLACEMENT RECIPROCATING PUMPS

- **USED PRIMARILY IN AREAS OF SALTWATER DISPOSAL AND HIGH PRESSURE WATERFLOODS**
- **INITIAL COSTS AND MAINTENANCE COSTS HAVE ENCOURAGED A LOT OF OPERATORS TO START INSTALLING HORIZONTAL CENTRIFUGAL PUMPS**

INJECTION HEADER PRESSURES

- **DETERMINED BY WELL HEAD INJECTION PRESSURES**
- **NEED TO MONITOR CLOSELY TO REDUCE HORSEPOWER REQUIREMENTS**
- **WILL COVER THIS IN MORE DETAIL IN SECTION 6 OF THE MANUAL-POWER REDUCTION**

INJECTION WELLBORE CLEANUPS

- BACKFLOW**
- COIL TUBING**

SCHEDULE SEVERAL PER DAY

TIPS FOR MIT TESTING

- LOAD THE WELLS WITH H₂O DAY BEFORE**
- NEED TEMPERATURE CONSISTENT WITH WELLBORE FLUID**
- AIR BROKEN OUT**
- FIELD PERSONNEL DEVELOP GOOD RELATIONS WITH REGULATORY PERSONNEL**