

## Severe Conditions

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**Severe Conditions Breakout Session**

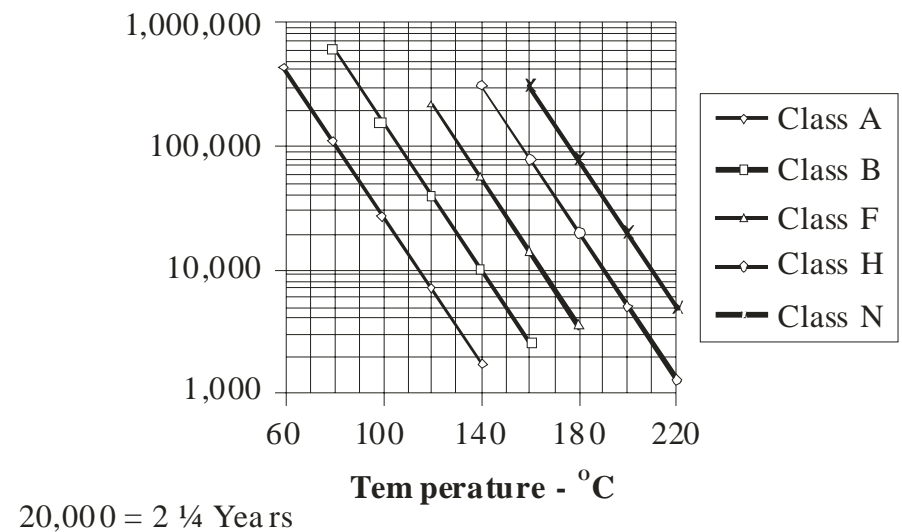
## ESP Challenges

- Temperature
- Abrasive Solids
- Scales
- Asphaltenes
- Corrosive Gasses
- Free gas
- High viscosity
- Treating Chemicals
- Power Quality
- Misapplication

## High Temperature

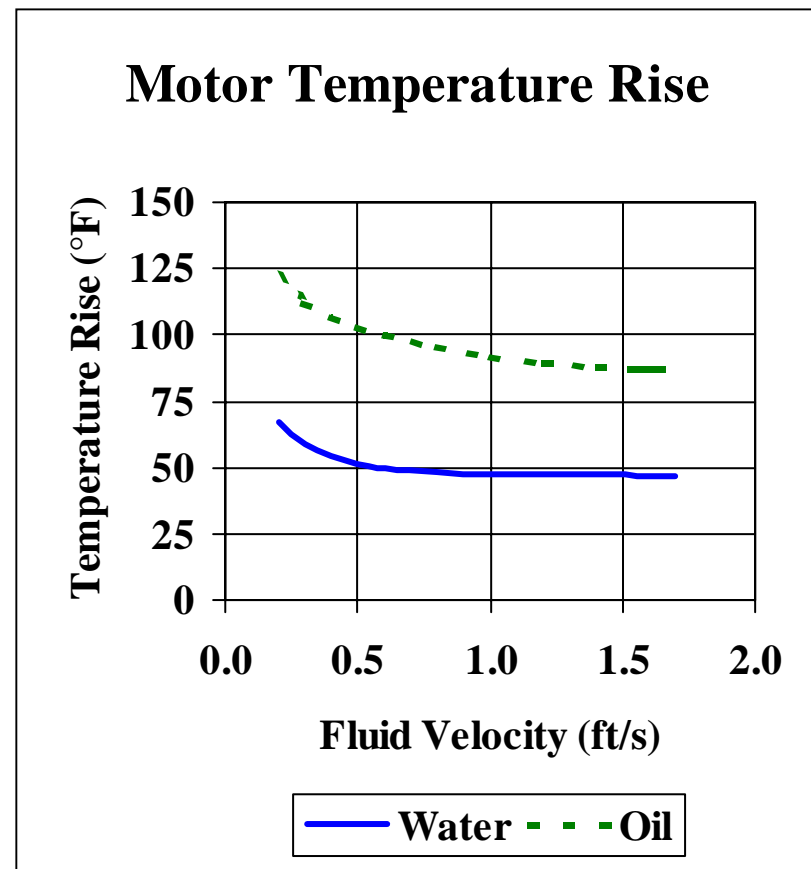
- Weakens elastomers
- Weakens motor and cable insulation
- Increases conductor resistance
- Encourages scale formation
- Disables downhole sensor semiconductors
- Dissimilar thermal expansion

### Insulation Life vs. Temperature



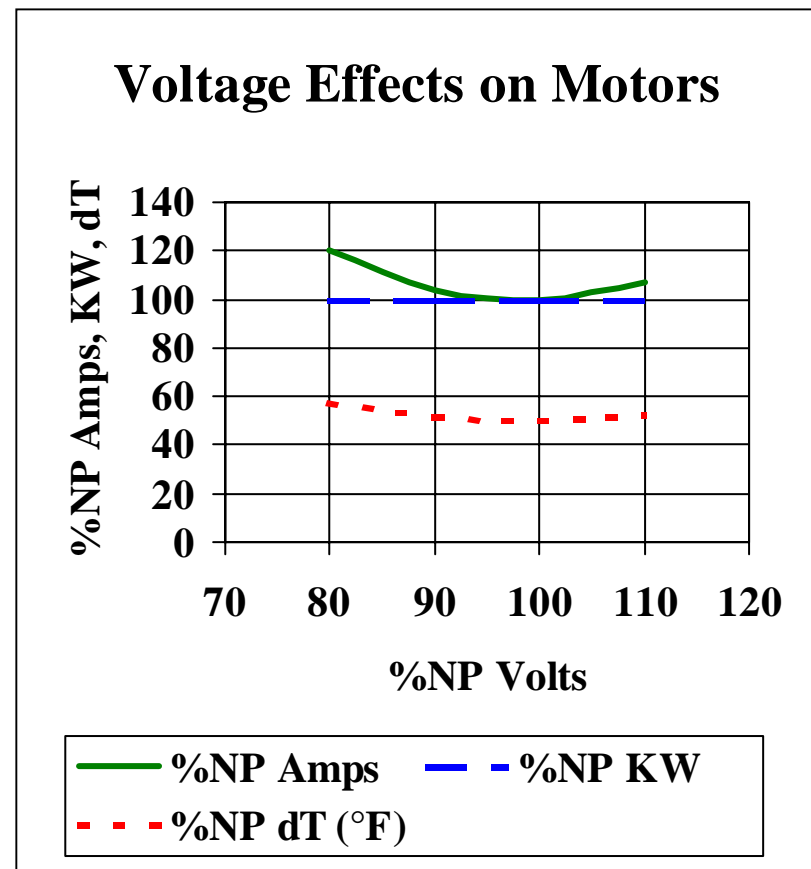
## High Temperature Causes

- Overloaded motor
- High well temperature
- Insufficient fluid velocity past motor
- Low specific heat fluids
- Scaling
- Poor power quality



## High Temperature Solutions

- Rate the motor for the application
- Use shrouds or larger OD motors
- Use high temperature equipment
- Avoid unfiltered 6-step and PWM drives
- Optimize motor voltage



## Abrasive Solids

- Accelerate pump wear
- Degrade pump performance
- May cause mechanical seal failure due to vibration
- Housing erosion



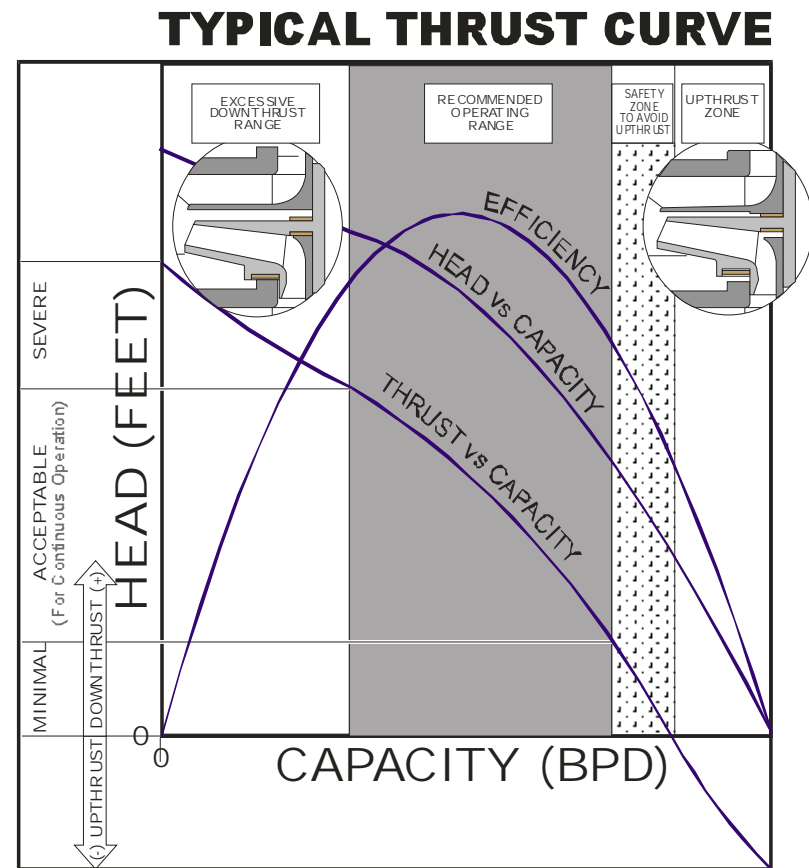
## Abrasive Solids Sources

- Semi/unconsolidated sandstone reservoirs
- Post frac cleanup
- Some scales



## Abrasive Solids Solutions

- Control startup
- Operate floater pumps near maximum rate
- Use compression pumps
- Use abrasion resistant pumps
- Use stage coatings
- Reduce RPM
- Use sacrificial pumps
- Use screens or filters

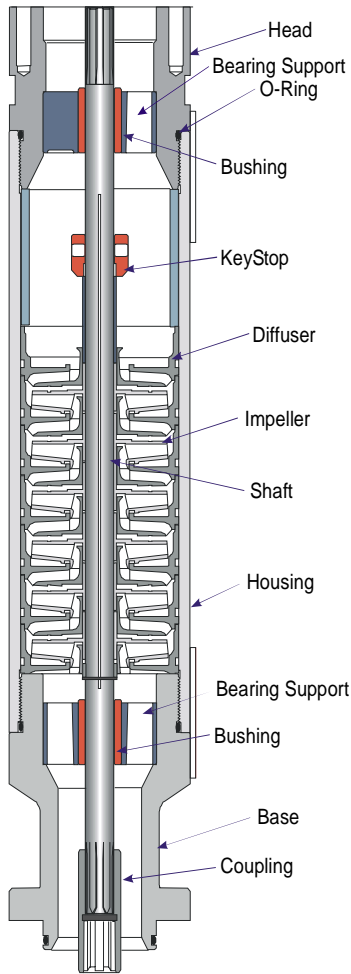


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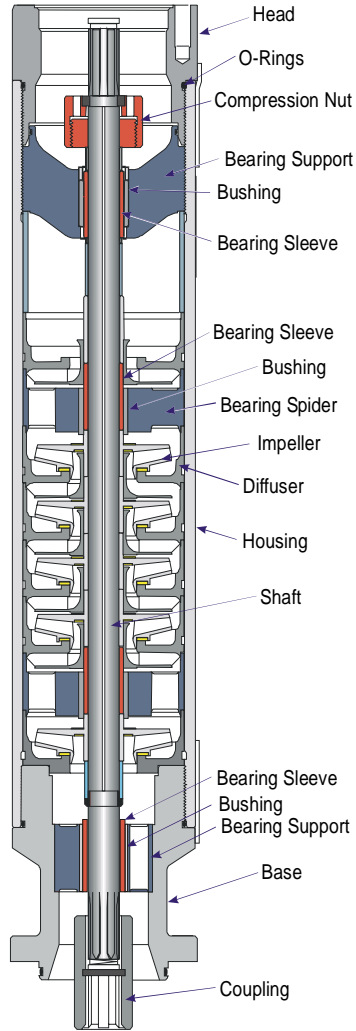
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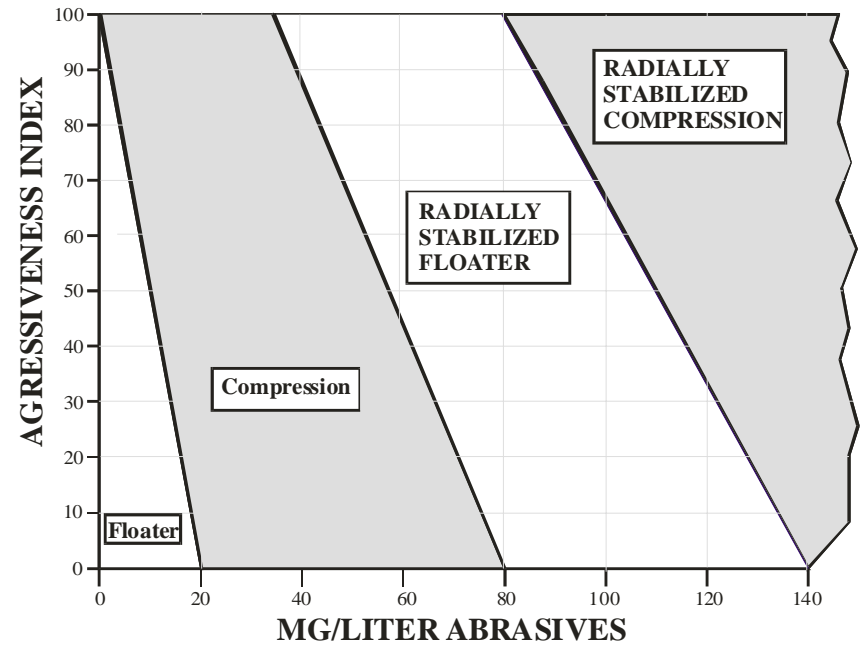
**PUMP, STD FLOATER RADIAL FLOW**



**PUMP, RS CPRSN RADIAL FLOW**



**PUMP CONSTRUCTION CHART**



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## Scales

- Block flow paths
- Lock stages and/or bearing to shaft
- Degrade pump performance
- Increase motor operating temperature



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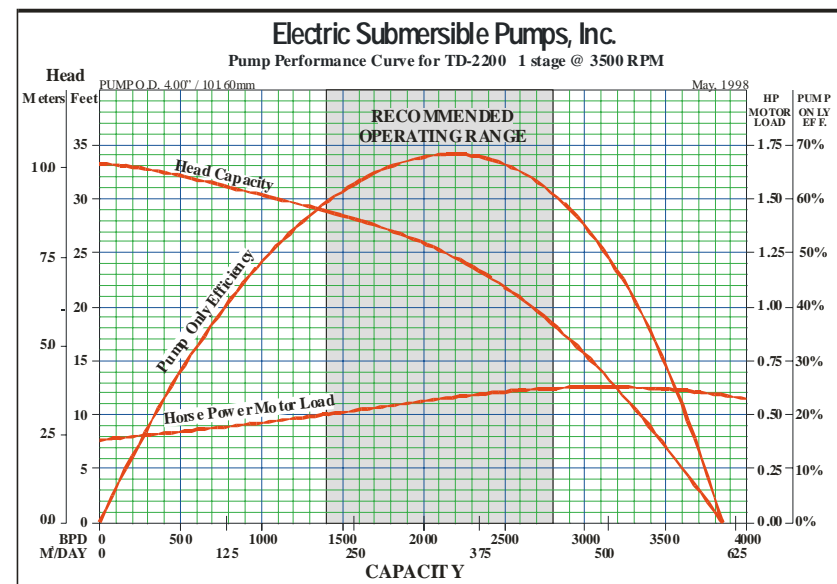
## Scaling Causes

- Saturated brines
- Pressure/temperature changes
- Scale coated motors run hotter creating more scale
- Scale coated stages are less efficient – more heat rise causing more scale



## Scaling Solutions

- Use efficient stages and operate at BEP
- Use compression pumps
- Minimize motor operating temperature
- Monitor and limit motor operating temperature
- Use coatings ( housings, stages and shafts)
- Use scale inhibitor



## Asphaltenes

- Block flow paths
- Degrade pump performance
- Increase motor operating temperature

## Asphaltene Sources

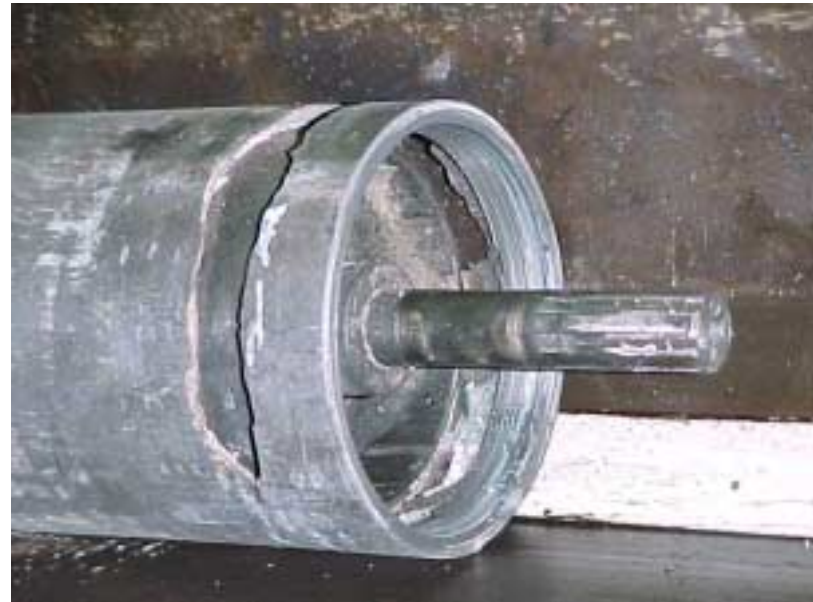
- Asphaltenic crudes
- Pressure/temperature/pH changes
- Acidizing
- EOR processes

## Asphaltene Solutions

- Use efficient stages and operate at BEP
- Minimize motor operating temperature
- Monitor and limit motor operating temperature
- Use coatings ( housings, stages and shafts)
- Use dispersants

## Corrosive Gas Problems

- Corrosion
- H<sub>2</sub>S damages certain elastomers
- H<sub>2</sub>S attacks copper



## Corrosive Gas Sources

- Natural occurrence
- EOR processes (CO<sub>2</sub> flooding)
- Bacterial contamination of reservoir (waterflooding)

## Corrosive Gas Solutions

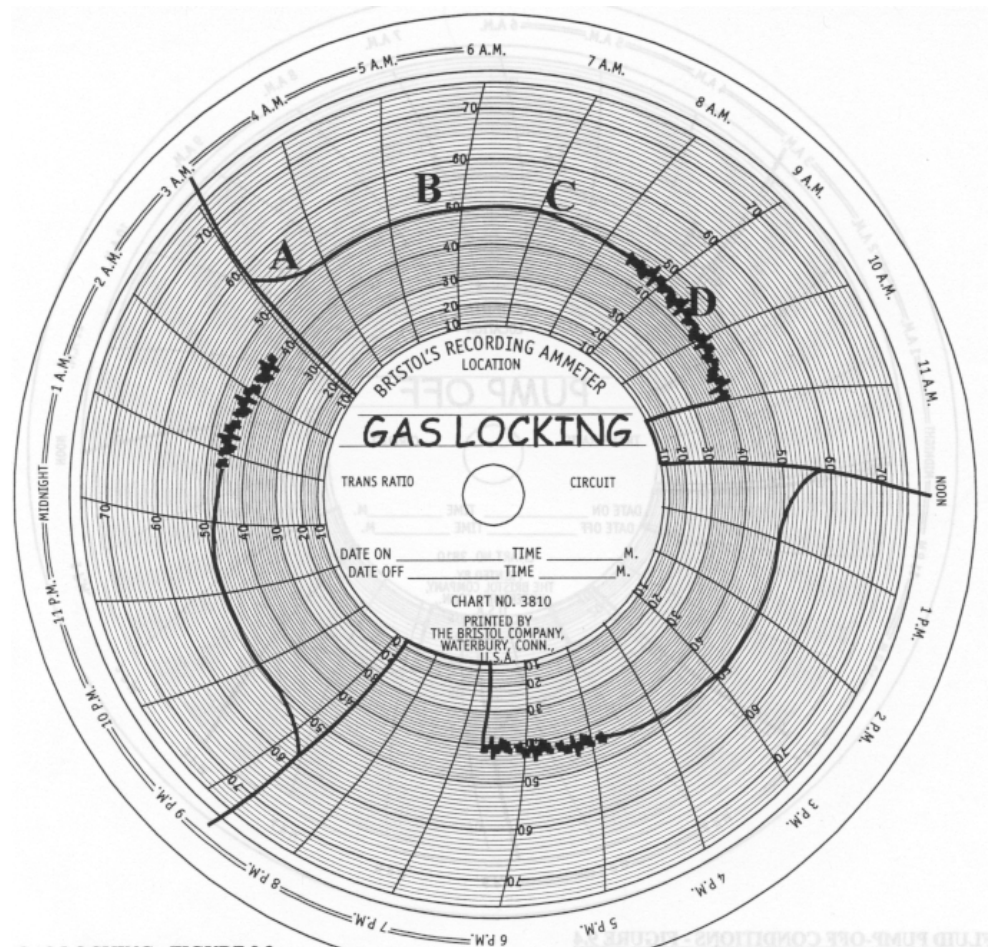
- Bactericide
- Housing/stage coatings
- Material selection
- Inhibitors

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## Free Gas

- Reduces pump efficiency and capacity
- May gas lock pump
- Reduces motor cooling
- Saturates elastomers



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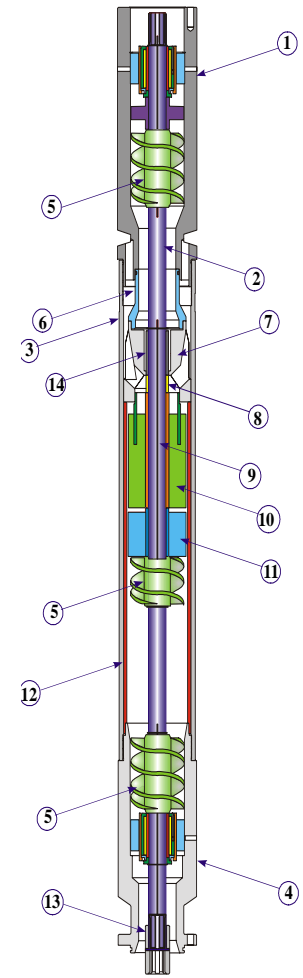
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## Free Gas Sources

- Low intake pressure
- High oil cuts
- Coning
- EOR processes

## Free Gas Solutions

- Operate at higher intake pressure
- Set below perforations with shroud
- Draw fluid below perforations with dip tube
- Use tapered pump designs
- Use gas conditioners/handlers
- Use rotary gas separators
- Use gas barriers in cable/pothead

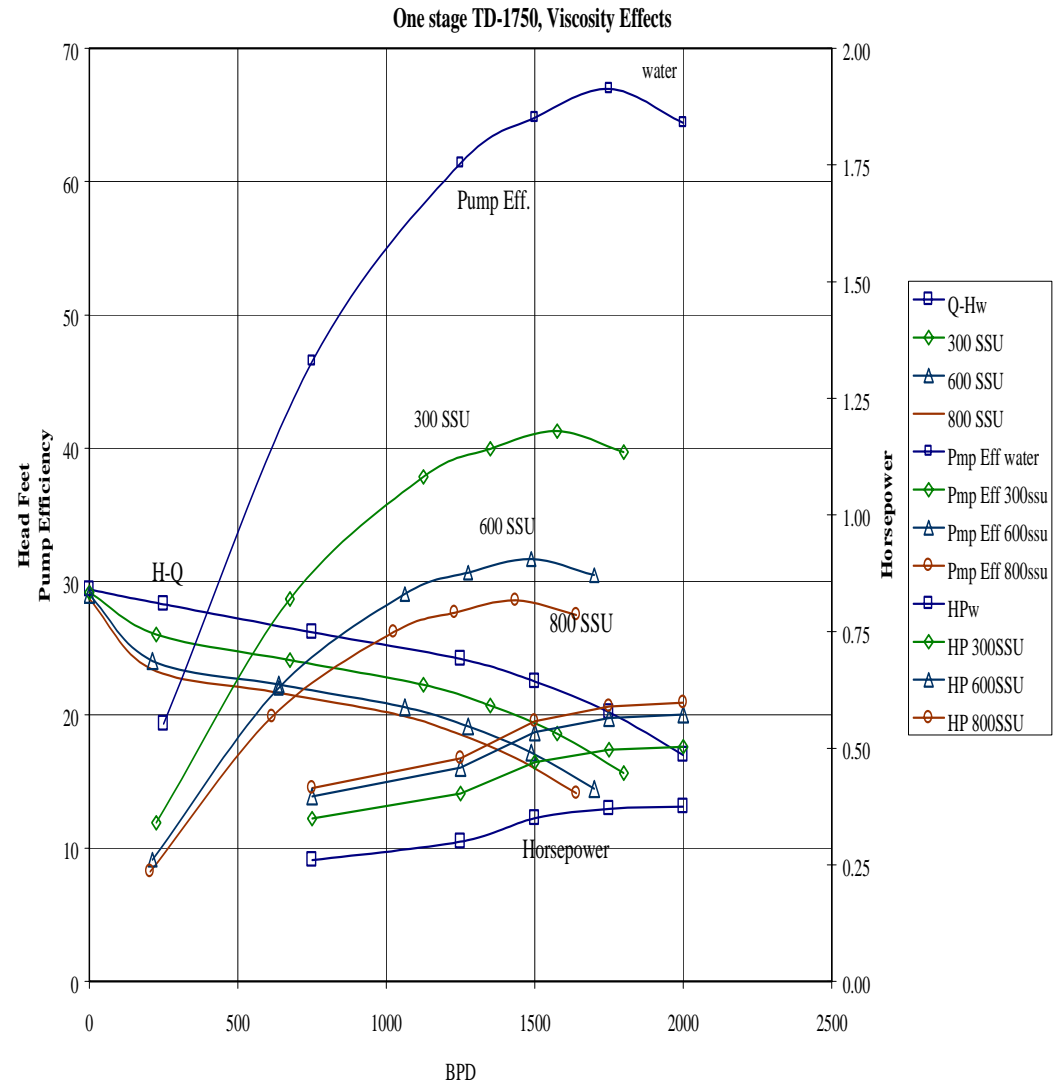


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## Viscous Crude

- Reduces pump efficiency and capacity
- Reduces motor cooling



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## Crude Oil Solutions

- De-rate equipment

## Treating Chemicals

- Amine corrosion inhibitors attack certain elastomers
- Acids attack equipment
- Treating through pump may cause excessive backspin

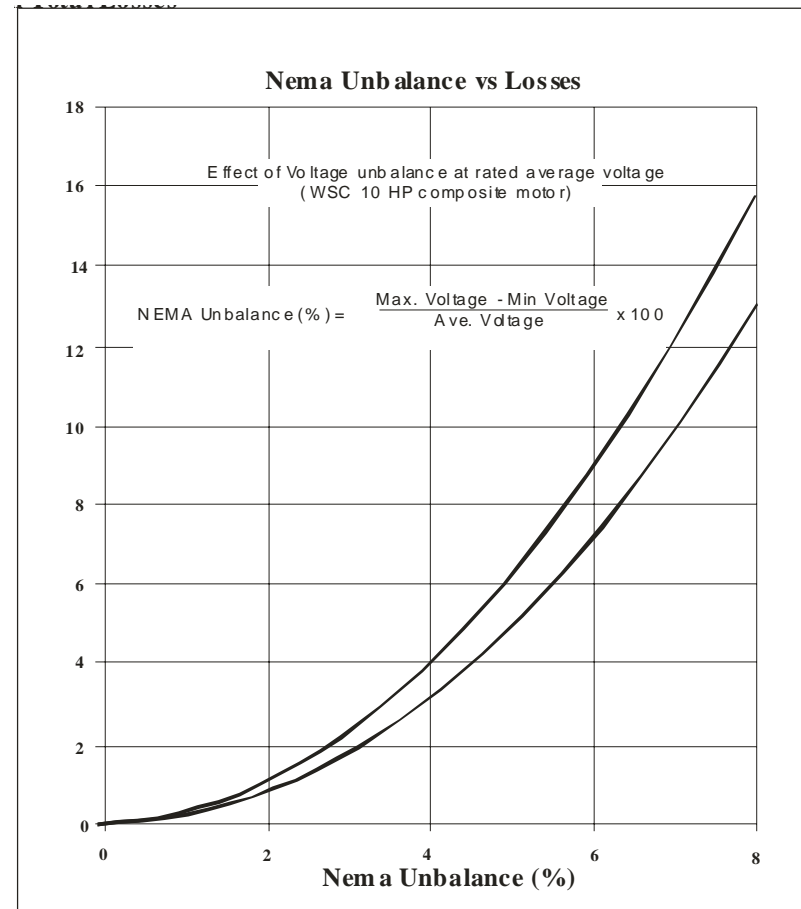


## Treating Chemical Solutions

- Material selection
- Control through-pump injection rates
- Use capillary tubes

## Poor Power Quality

- Distorted output signal result in additional motor heating
- Voltage spikes damage motor and cable insulation



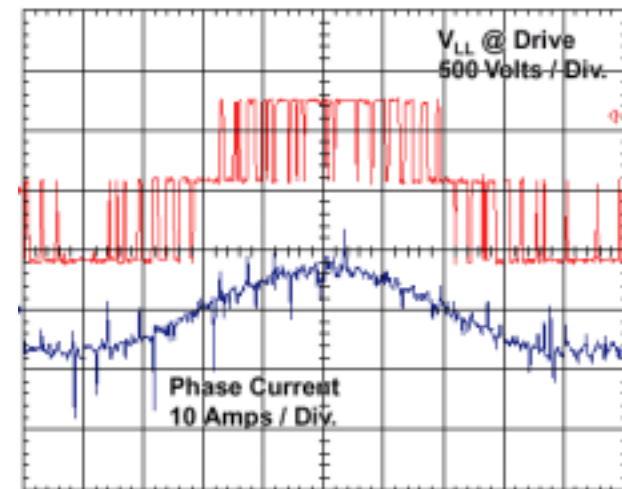
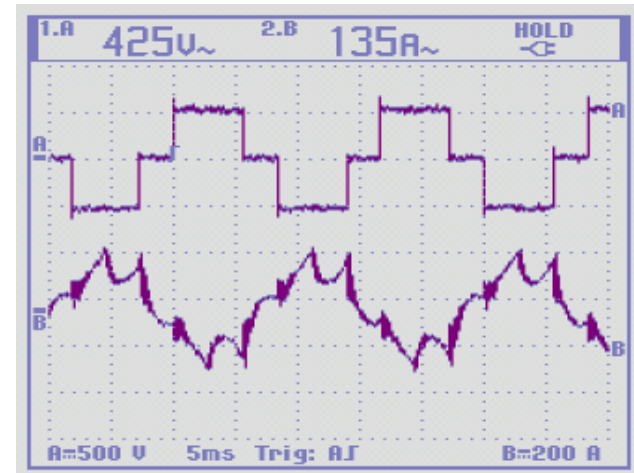
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## Poor Power Sources

- Lightning
- Unbalanced phases
- VSD's
- Undersized generators

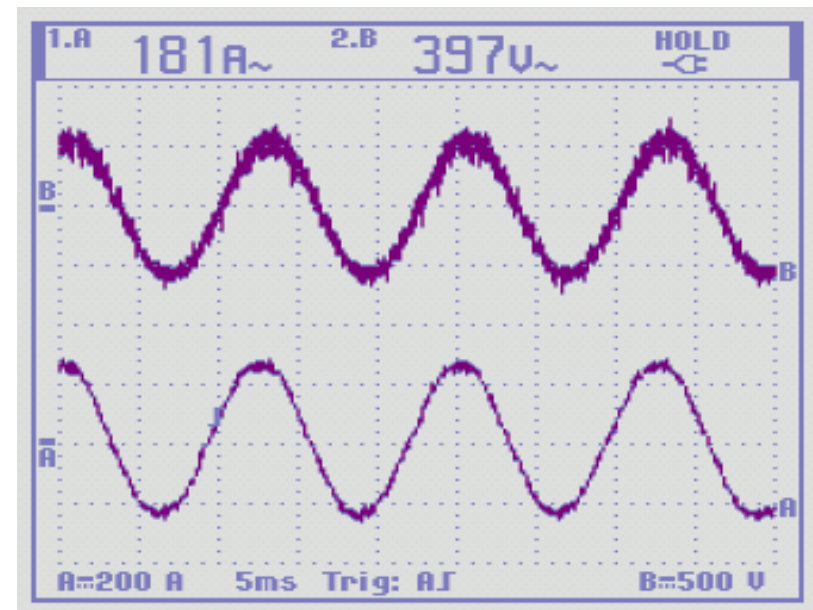
## VSD Issues

- Output voltage spikes damage insulation
- Output harmonics cause additional motor heating
- Input section feeds harmonics back into power grid
- Selecting an operating frequency outside design range can over-stress equipment



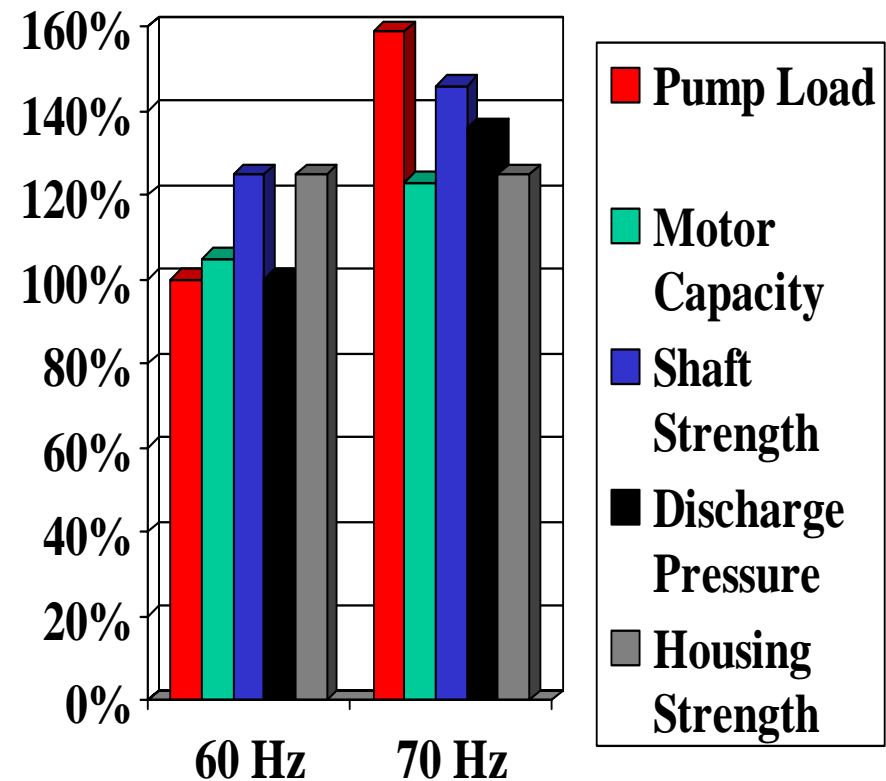
## VSD Solutions

- Eliminate drives operating at 60/50 Hz
- Use well testing to determine well performance
- Design for 60/50 Hz operation
- Consider wellhead control valves
- Use sine wave output VSD's
- Use 18-step input sections



## Misapplication

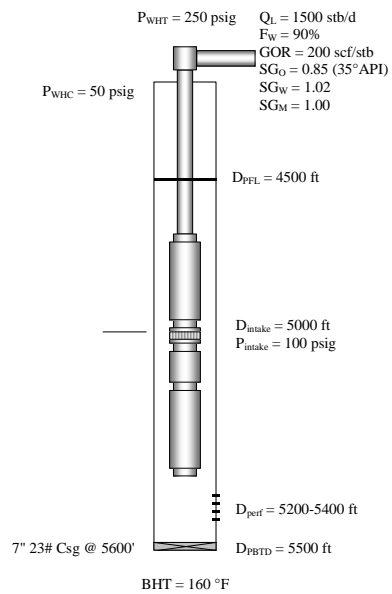
- Operating equipment outside design limits
- Inaccurate design data
- Changing well conditions
- Inappropriate equipment selection
- Operating outside design frequency range



## Conclusions

- We know to take precautions when working with high-temperature or corrosive wells
- We may not be aware we are abusing equipment in "benign" wells
- The equipment does not care if the abuse comes from natural or artificial causes

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