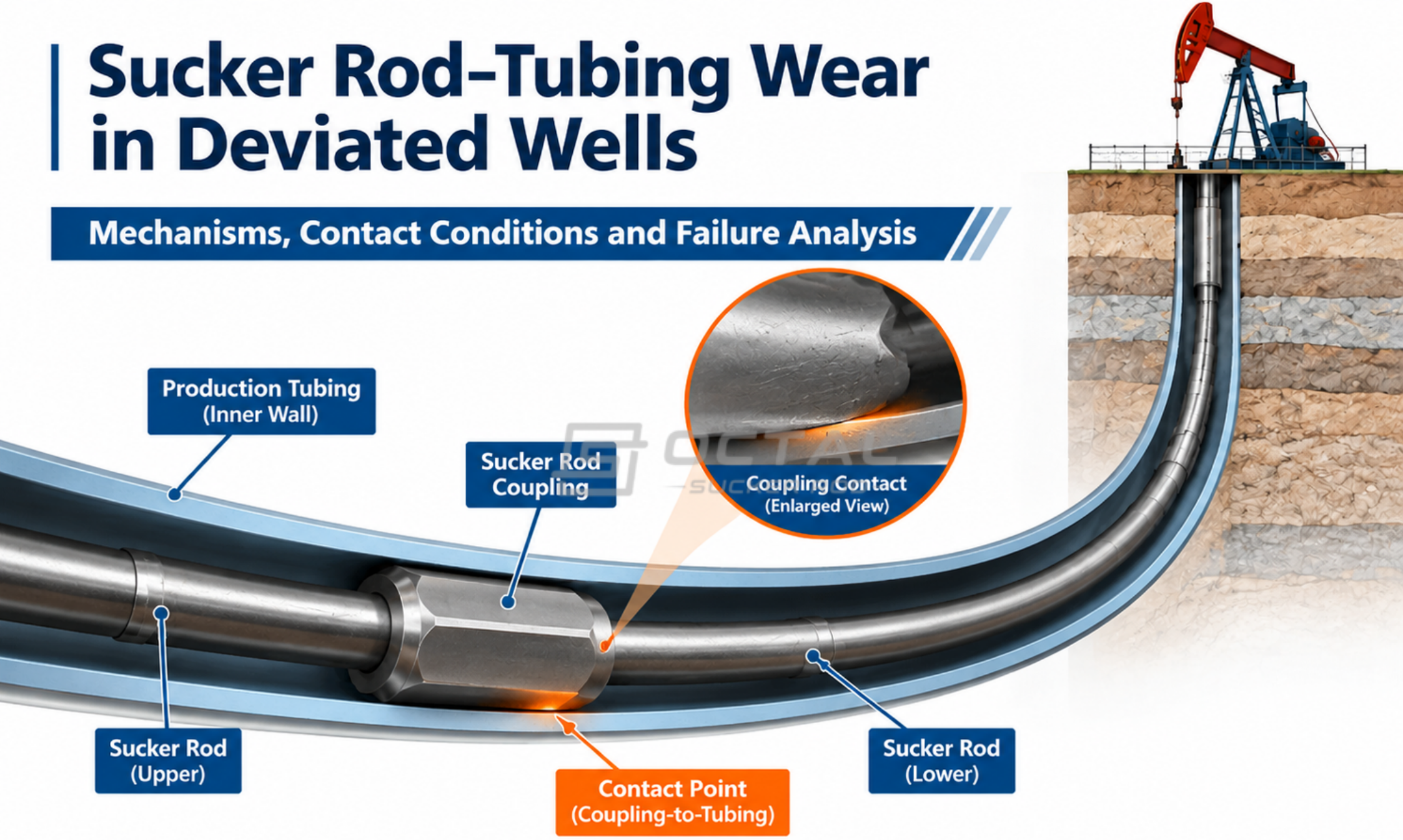
# Sucker Rod–Tubing Wear in Deviated Wells

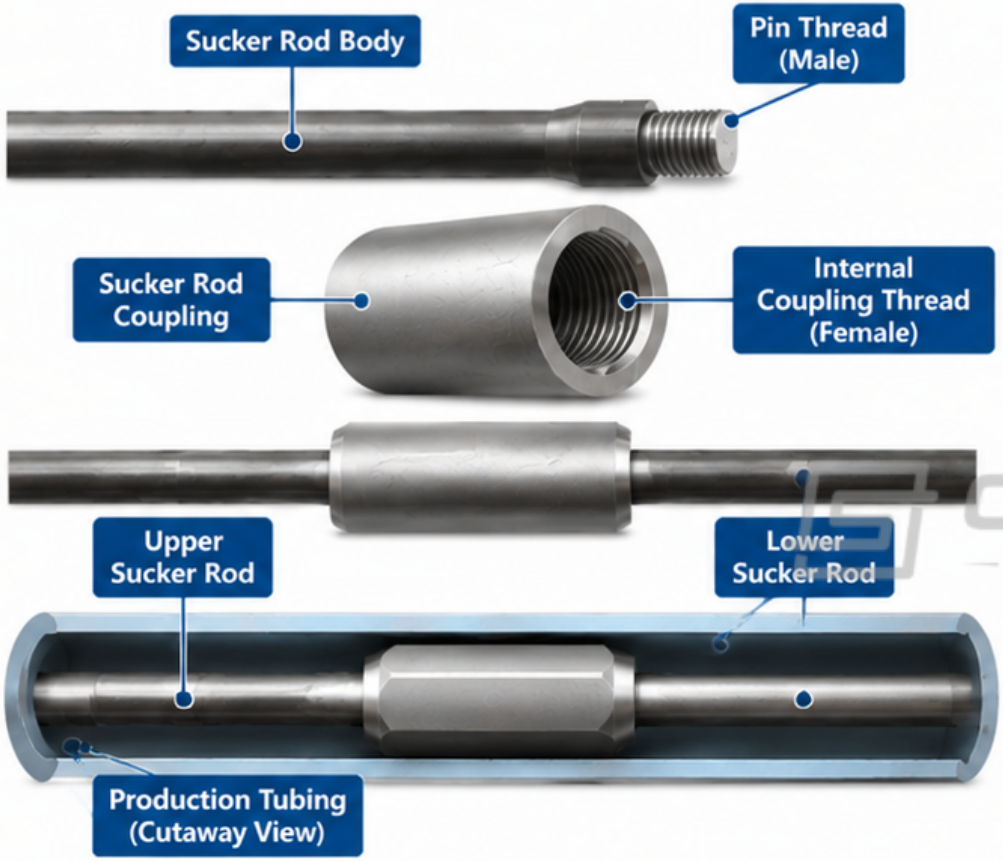
## Mechanisms, Contact Conditions and Failure Analysis



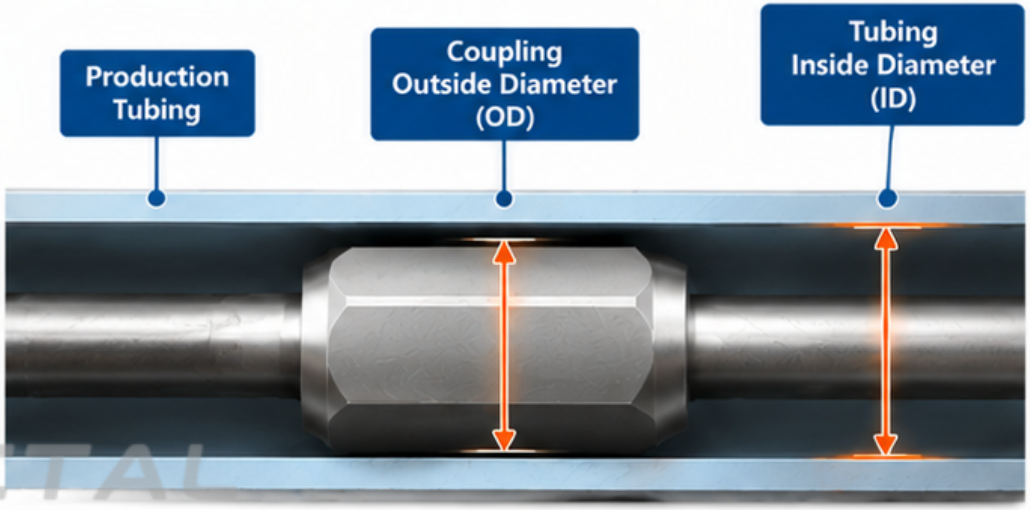

An Engineering Guide to Rod-Tubing Contact, Coupling Wear, Tubing Damage and Inspection.

# Sucker Rod and Production Tubing System

## Components and Connection




## Assembly in Production Tubing



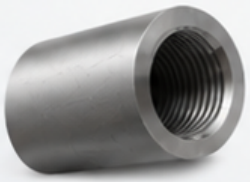

**Engineering Note:**
The coupling outside diameter is larger than the rod body diameter. This dimensional difference reduces the available radial clearance between the coupling and tubing.

## Sucker Rod



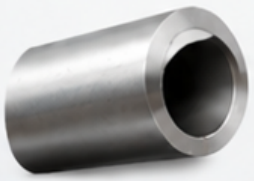
Transfers reciprocating motion and axial load from the surface pumping equipment to the downhole pump.

## Sucker Rod Coupling



Connects adjacent sucker rods through threaded connections and forms part of the continuous rod string.

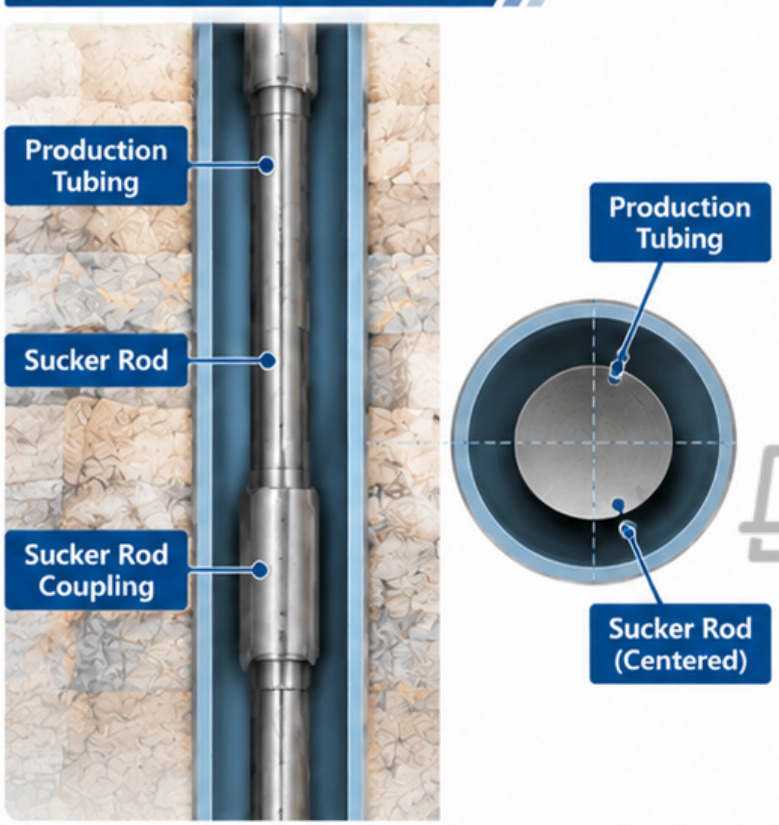
## Production Tubing



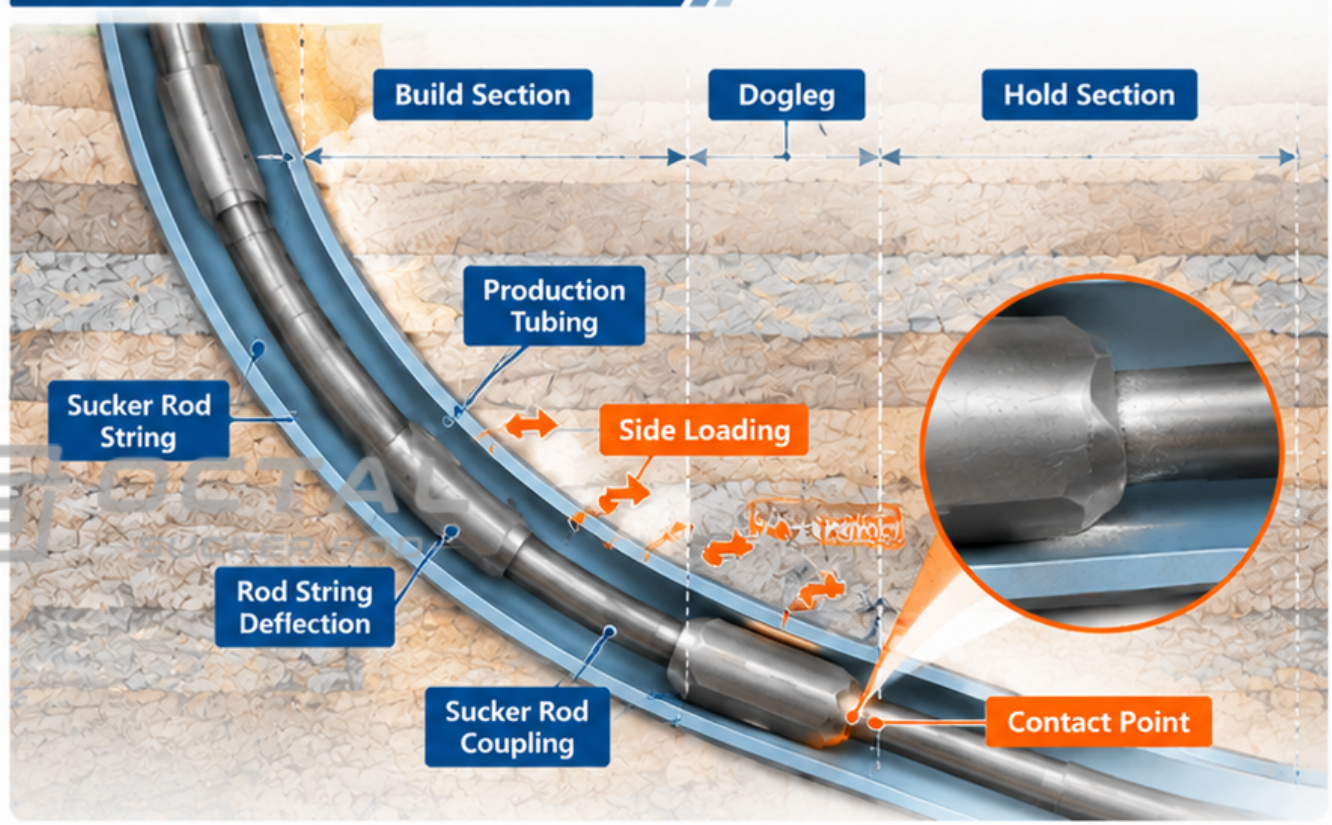
Provides the flow path for produced fluids from the downhole pump to the surface while surrounding the moving rod string.

# Rod-Tubing Contact in Deviated Wells

## Vertical Well (Reference Condition)




## Deviated Well (Rod-Tubing Contact Condition)




### Wellbore Inclination

The angle between the wellbore direction and the vertical reference.

### Dogleg Severity (DLS)

A measure of the change in wellbore direction over a specified measured-depth interval, commonly expressed in degrees per 30 m or degrees per 100 ft.

### Side Loading

The lateral force acting between the rod string and surrounding tubing.

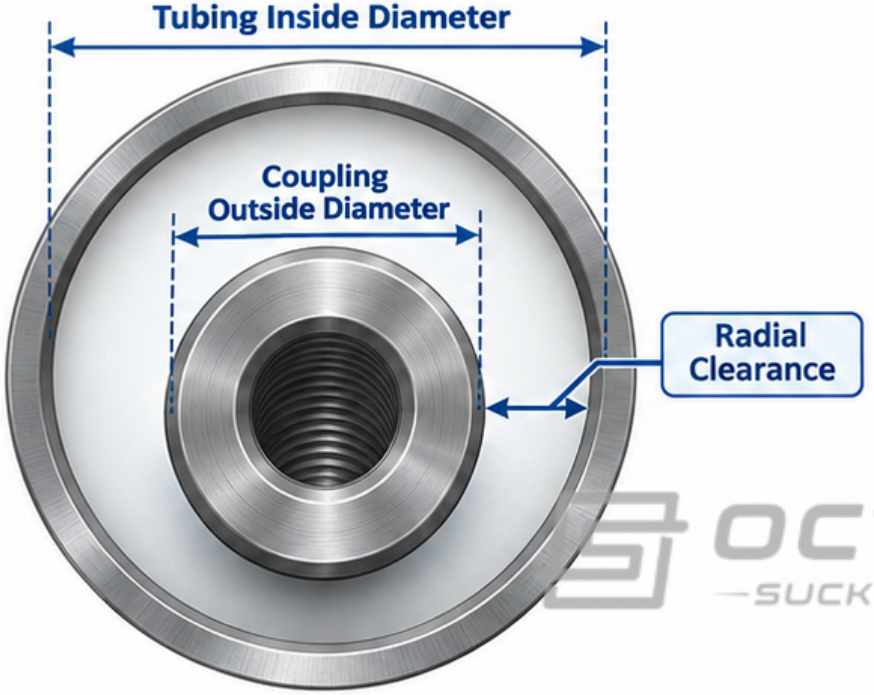
### Engineering Note:

Inclination alone does not determine tubing wear. Wellbore curvature, rod-string stiffness, rod weight, pumping conditions and tubing configuration also affect contact conditions.

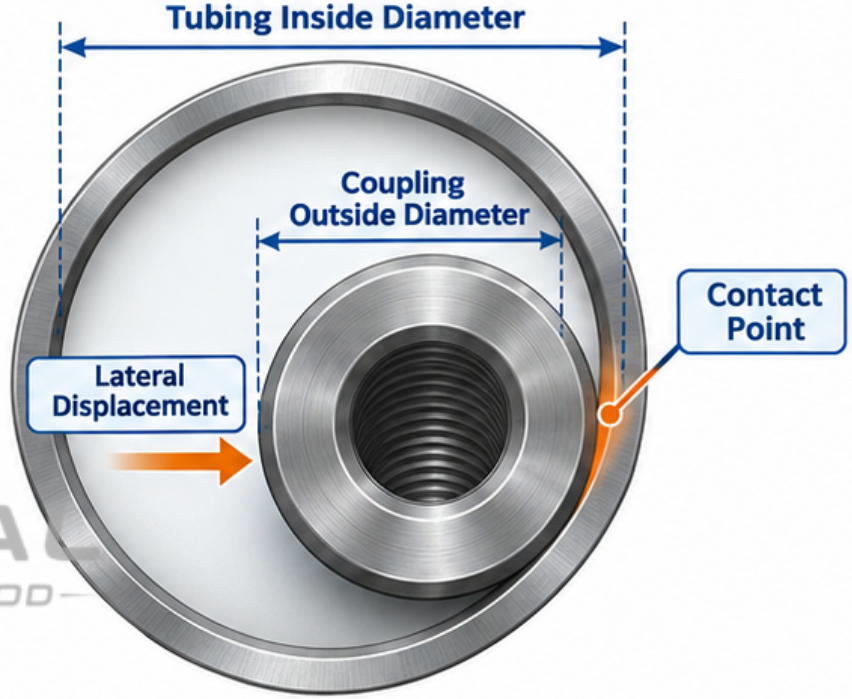
# Coupling Clearance and Contact Mechanics

This section explains the relationship between the sucker rod coupling outside diameter and the production tubing inside diameter, and how lateral rod movement can result in coupling-to-tubing contact.

## Centered Coupling




## Laterally Displaced Coupling




OCTAL
SUCKER ROD

## Dimension Example

| | |
|---|---|
| **Tubing Inside Diameter:** | 62 mm |
| **Coupling Outside Diameter:** | 38 mm |
| **Total Diametral Clearance:** | 24 mm |
| **Centered Radial Clearance:** | 12 mm per side |

## Calculation

**Diametral Clearance** = 62 - 38 = 24 mm

**Radial Clearance** = 24 / 2 = 12 mm per side

⚠ These dimensions are illustrative values used to explain geometric clearance. They are not universal API dimensions or guaranteed product specifications.

## Coupling Type Comparison

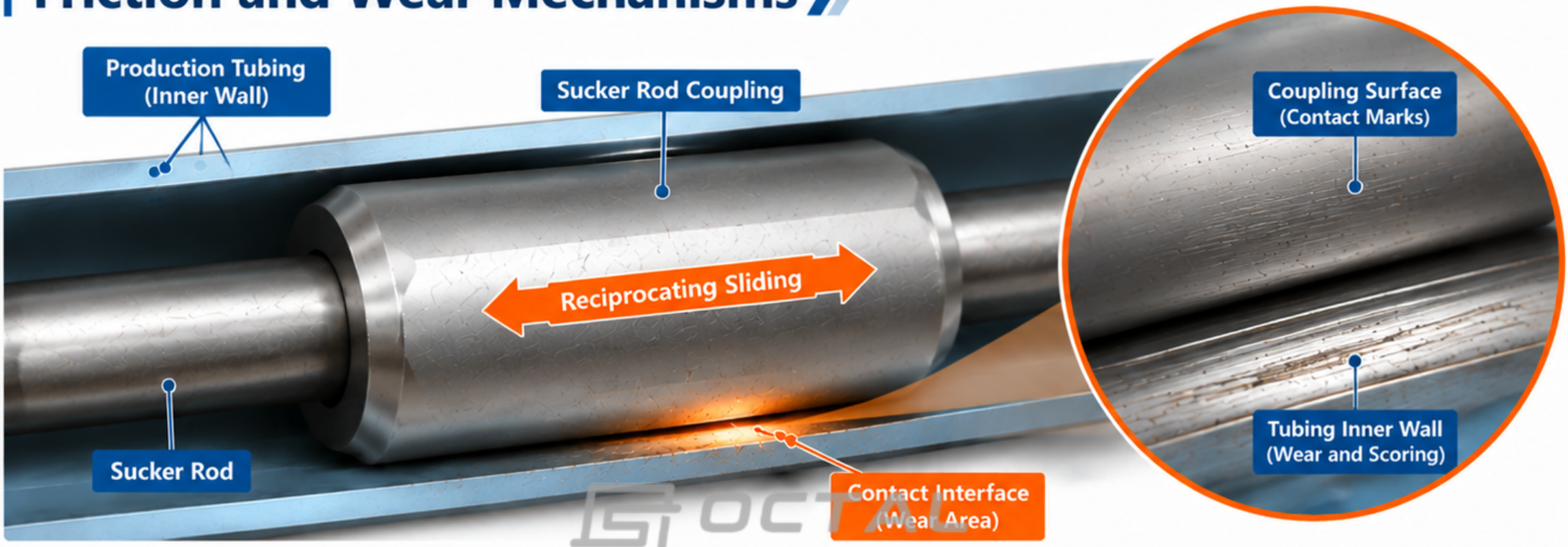


Standard Full-Size Coupling

Slim-Hole Coupling

*A smaller coupling outside diameter increases the available clearance inside the tubing, provided connection strength and dimensional compatibility remain suitable.*

# Friction and Wear Mechanisms




OCTAL SUCKER ROD

### CONTACT LOAD

Affects local contact pressure and material loss.

### STROKE RATE

Affects the frequency of sliding cycles.

### SURFACE ROUGHNESS

Influences contact and friction behavior.

### MATERIAL HARDNESS

Affects surface deformation and wear behavior.

### COEFFICIENT OF FRICTION

Influences friction force during sliding.

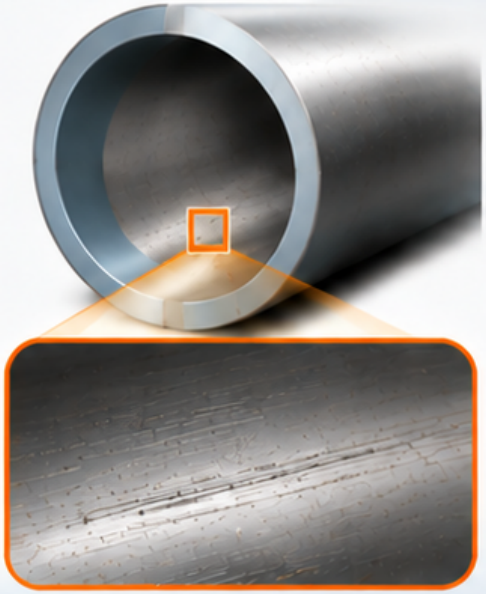
### WELLBORE FLUID

May affect friction, abrasion and corrosion.

**Engineering Note:** Wear behavior depends on the combined effects of contact conditions, material properties, surface condition and operating environment. No single factor independently determines the actual downhole wear rate.

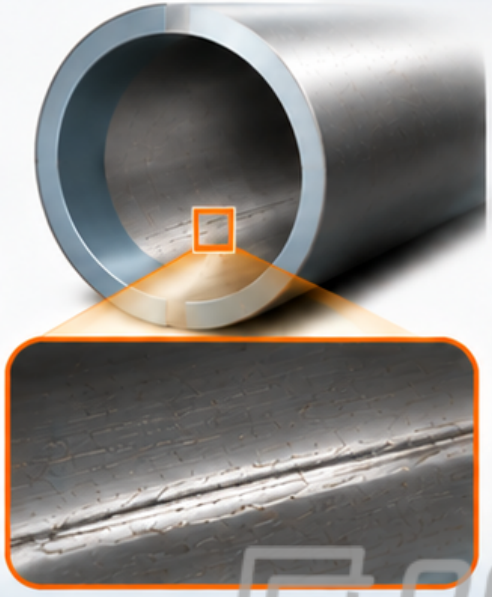
# Tubing Wear Development and Failure

## Stage 1: Surface Scoring



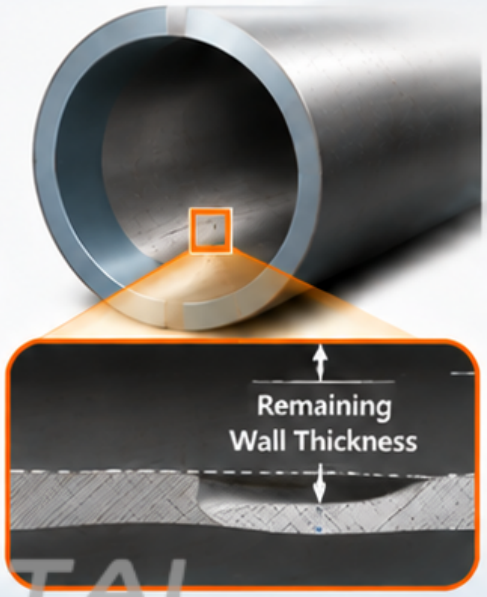
Initial contact produces shallow scratches and surface marks on the tubing inner wall.

## Stage 2: Localized Grooving



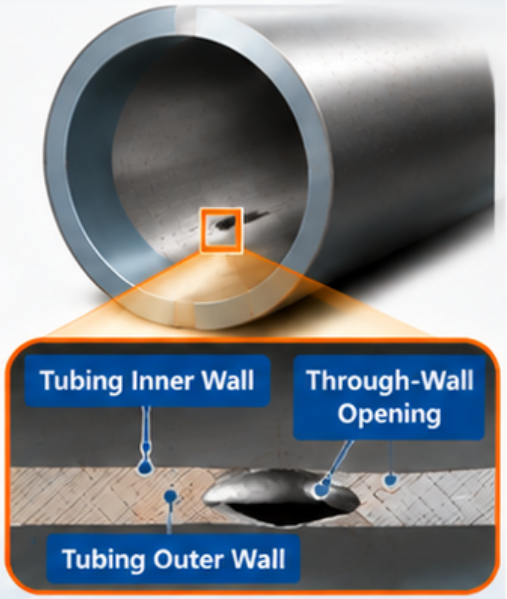
Repeated contact at the same location can form a localized groove on the inner wall.

## Stage 3: Wall Thickness Reduction




Continued wear removes material, leading to a reduction in the remaining tubing wall thickness.

## Stage 4: Through-Wall Damage




Further material loss can result in through-wall damage, creating a flow path between the tubing and the annular space.

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SUCKER ROD

## Possible Consequences of Severe Tubing Damage

- **Loss of Tubing Pressure Integrity**
- **Communication Between Tubing and Annular Space**
- **Reduced Pumping Efficiency**
- **Unplanned Workover Operations**
- **Production Downtime**

**Technical Note:** Mechanical coupling wear is one possible cause of tubing damage. Corrosion and abrasive wear may also contribute to material loss.

# Inspection and Failure Assessment

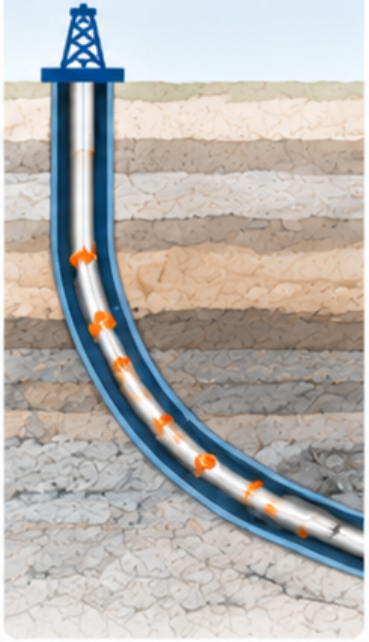
## Sucker Rod and Coupling Inspection




## Production Tubing Inspection




## Wear Location Analysis




- Rod-String Configuration
- Previous Workover Records
- Operating Conditions

**Recovered Components** → **Wear Inspection** → **Well Trajectory Review** → **Failure Assessment**

**Technical Note:** Inspection methods must be selected according to component condition, defect type and equipment detection capability. Ultrasonic thickness measurement is suitable for evaluating remaining wall thickness at accessible measurement locations. Other specialized tubing inspection methods may be required for different defect types.