Effective Gauge Face/Wheel Flange Lubrication: A Solutions Based Approach

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Overview

• Benefits of Lubrication
• Application Systems
  • Mobile (solid sticks and onboard oil spray)
  • Trackside (wayside, drilled rail and spray)
• Implementation
• Case Studies
• Conclusions
Flange/Gauge Face Lubrication

- Friction to a minimum level
- Gauge face lubrication widely implemented in the world
- Rail/Wheel Wear is the primary issue
- Impacts:
  - Rail Wear (gauge face/corner/restraining)
  - Wheel Wear (flange/back of flange)

μ = 0.1 - 0.2

High Rail

not scaled
Additional Benefits

- Rail / Wheel Wear
- Flange Noise
- RCF Development
- Derailment Potential
- Energy Efficiency
Lubrication Approaches

- Application
  - Trackside
    - Wayside
    - Drilled Rail
    - Trackside Spray
  - Mobile
    - Solid Sticks
    - Onboard Spray
Onboard Spray Systems

Oil Spray Components:
- Controls
- Reservoir
- Pump [usually piston]
- Spray nozzles

Key Features:
- Air or airless versions
- Curve sensors
- Multiple vehicle types

Obtained from www.skf.com
Onboard Solid Sticks

Primary Components:
• Interface Bracket
  • Connects frame and applicator
• Applicator
  • Houses sticks

Key Features:
• Safety: design validation
• Optimized for installation and adjustment
Mobile: Considerations

Spray Systems:
- Large install base, commonly used in Europe
- Single application system per train
- Fine tuned controls often with curve sensing capability

Solid Sticks:
- Large install base generating large volumes of engineering and performance data
- High quality lubrication, consistent application/performance with no tread/TOR migration
- Simple, clean system, easy to maintain
Lubrication Approaches

Application

Trackside
- Wayside
- Drilled Rail
- Trackside Spray

Mobile
- Solid Sticks
- Onboard Spray
Trackside Lubrication

History:
• Historical approach to stationary track lubrication
• Many advances in technology over the years [output control, bars]
• Multiple suppliers of equipment

Application Strategies:
• Wayside lubricators
• Drilled rail
• Trackside spray
Wayside Lubricator

Accepted industry standard

Primary Components:

- Tank [reservoir/electrical]
- Control System
- Pump/motor
- Wheel/train sensor
- Distribution hoses
- Application bars
- DC or AC power
Application Bars

Interface with Rail/Wheel:
- Key component of a trackside lubricator for lubricant pickup and distribution

Key Features:
- Multiple distribution ports
- Trough or guide
- Application to running or restraining rails
- Easy to install/maintain
Trackside: Drilled Rail

Drilled Rail Lubricator:
• Wall or pole mounted
• Controls, pump, reservoir

Key Features:
• Application via holes drilled in the head of the rail
• Suitable for embedded track sections
• Gauge, restraining rail, U-rail
Trackside: Spray

Spray System Features:
- Wall or pole mounted
- Controls, pump and reservoir
- Application by nozzles

Key Features:
- Application via nozzles aimed at the wheel or the head of the rail
- Multiple manufacturers
Trackside: Considerations

Wayside:

• Effectively coats entire circumference of the wheel providing longer carrydown distance
• Broad range of application rates

Drilled Rail:

• Can be installed on embedded track, including U-rail guideway

Spray Systems:

• Ability to apply grease or oil
What is the Right Consumable?

- Mobile
  - Solid Sticks
  - Oils
- Trackside
  - Grease
  - Oils
Onboard Spray System

consumable characteristics:

• Oils or low viscosity greases [NLGI 000]
  • May contain oil soluble additives or solid lubricants
• Generally single grade
• Multiple suppliers
• Biodegradable varieties available
Solid Lubricant Sticks

Solid Stick features:

- Solid lubricant in thermosetting resin or other carrier
- Contains no oil or liquid components
- Consistent performance without migration to tread/TOR
- No contamination of the track structure, ballast or vehicle equipment
- Sticks are self extinguishing and non-toxic
Trackside Grease

Characteristics:
• Compositional components
• Stability and consistency
• Retentivity/carrydown is a key feature for performance
• Functional temperature range
• Manufacturing consistency

Three Main Families:
• Ultra High Performance – synthetic or highly refined base oils
• Petroleum Based – industry standard
• Bio Based – readily biodegradable for environmentally sensitive areas
Trackside Grease: Considerations

Ultra High Performance:
- **Advantage**: excellent carrydown at low application rates, wide temperature range
- **Limitations**: high cost per pound/kg

Petroleum Based:
- **Advantage**: good performance at intermediate price
- **Limitations**: wide range of qualities, seasonal temperature range

Bio Based:
- **Advantage**: ranges of biodegradability
- **Limitations**: carrydown performance, seasonal temperature range
Consumable Selection

- Multiple suppliers of consumables
- Different components/formulations
- How to understand the differences?
- Field data and published literature
- Twin Disk - Laboratory testing designed to simulate rail wheel interface
  - Friction levels
  - Retentivity
Solid Stick Lubricant Composition

Twin disk testing of retentivity of various stick compositions

![Graph showing the retentivity of Stick A and Stick B over time. Stick A initially shows a high traction coefficient that drops significantly, while Stick B maintains a steady increase in traction coefficient over time.](image)
Grease Retentivity

Twin Disk Retention Time (Sec)

Premium Grease
Conventional Petroleum Grease
Biodegradable Grease

Grease Retentivity
Implementation

Standards: Application/Equipment

- Standards for lubricant application and equipment are in place in Europe, UK, AUS and North America
- Mainly focused on equipment positioning/usage but beginning to look at consumables
- Rigid process for approval and focused on risk mitigation to fleet operation
Implementation

Standards: Consumables

- Standards for lubricants such as the NLGI specifications
- Tests developed from industrial application but they may not directly correlate to effectiveness in a rail environment
- Do not allow for alternative or new materials
- Improved standards is an area of opportunity for the rail industry
Implementation

Railroad/Infrastructure

• Technical Considerations
• System Details
• Organizational Characteristics
Technical Considerations

“Raw” Engineering Issues:

- What is the issue to be addressed?
  - Wheel wear, rail wear, noise.
- Is it an isolated issue or multiple locations or system wide?
- How severe is the issue?
- Is the track or vehicles accessible?
- What is practical for the application?
System Details

Characteristics:

• Is the system old or new?
  • Were the changes to track or vehicles?
• Who owns/operates the track and vehicles?
  • Outside party contracts?
• Is the track shared by multiple users?
• Vehicle type(s) and configuration?
• Track considerations?
Organizational Features

Culture/Personnel:
• Who has the key decision making power?
• Vehicle and track departments working relationship?
• Where do the concerns come from?
• Who has the budget?
• Who realizes the benefits?
• Commitment to maintenance?
Case Study 1

Solid Sticks – Wheel Flange Wear

Metro System [Suburban]
Wheel Flange Wear: Solid Sticks

- Kuala Lumpur Airport Express with moderate curvature
- Commissioning tests indicated excessive flange wear on all vehicles
- Projected wheel life of 170,000 km (4.5 months operation)
Wheel Flange Wear: Solid Sticks

**Short term action:**

- Manual greasing increased projected wheel life to 290,000 km
- Manual application had a high labor costs.
- Misapplication of grease to railhead caused skid flats.
- Concerns about contamination from wayside lubricators
Wheel Flange Wear: Solid Sticks

- Decision to implement train mounted solid sticks on fleet as a permanent solution.
- Fleet was initially outfitted at 30% coverage.
- Manual lubricant application stopped
- Wheel flange life extended by 10x at 30% coverage.
- Wheel flange life extended by 14x at 45% coverage.
- Reduction in rail wear – extending life of track.
- Increased train availability.
- Environmental cleanliness, both track and train.
- Net savings >US$ 2,000,000 in wheel-related costs.
Case Study 2

Solid Sticks – Gauge Face Wear

Metro System
Rail Wear: Solid Sticks

Ankara Turkey

- Excessive rail gauge corner wear 9 months after commissioning.
- No lubrication planned in the design stages
- Temporary hand application of dry-film lubricant was introduced to mainline switches and some yard check rails.
- Initial reduction of wear rates with hand application of liquid lubricant.
- Concerns over top of rail contamination from onboard or trackside oil/grease application affecting acceleration/braking.
Train mounted solid sticks were introduced due to the following advantages:

- Continuous application
- Precise application - no lubricant migration to TOR
- Simple, reliable, low maintenance requirements
- Clean, non-toxic, non-flammable
- Proven track record
Rail Wear: Solid Sticks

- 25% wheel coverage
- 200-500% reduction in wear achieved
- Extended mainline R300m curve rail life to 20 years
- Also saw reductions in wear on yard curves and switches
Case Study 3

Trackside Grease – Noise Control

Light Rail System
Noise Control: Trackside

North American Transit:
Concern over high noise levels in a new line being constructed.

- Concern in curves with a radius less than 400 meters.
- Trackside application of grease to mainline rails on existing lines had been successful for controlling noise.
- Required carrydown of 0.5 miles to cover multiple curves
Noise Control: Trackside

- Tribometer measurements used to verify application
- Sounds level measurements taking in revenue service
- Successfully controlled noise levels

North American LRT Gauge Corner Friction Level Measurements

Coefficient of Friction

Baseline
Product
Conclusions

• Effective gauge face/wheel flange lubrication can successfully:
  – Mitigate high wear rates of both wheel flanges and rail gauge face/corner
  – Provide additional benefits
• Variety of application strategies and consumable options.
• Selection needs to include review of system details, technical aspects and the railroads culture.
• Ideally looked at with a systems approach as the benefits are realized by both the vehicles and track.
Thank You for Your Attention