Tailoring lubrication to duty and climate

Ljubljana, Slovenske železnice, d.o.o.- 24 May 2018

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The railway infrastructure managers have been paying very high costs for the maintenance of the track and its components. The amount generally covers \textbf{at least 50,000 Euro/km/year}\textsuperscript{1}.

\textbf{American Railways} spend \textbf{more than USD 2 million / year}\textsuperscript{2}.

\textbf{Canadian Pacific Rail} announced the increment of \textbf{rail life} increased to \textbf{110\%} by effective lubrication on their systems\textsuperscript{2}.

\textbf{HKMTRC} saved \textbf{£783,000 / year} by using solid lubricant\textsuperscript{2}. 
Lubrication system types

- **Wayside lubrication system**³
  - **Some Pros**: Able to work in island mode (off-grid); integration with micro-scale renewable energy sources
  - **Some Cons**: Exposed to the environment and extreme weather; difficulty in monitoring the system in remote areas

- **On-board lubrication system**⁴,⁵
  - **Some Pros**: Low maintenance cost; more protected from environmental damages compared to other lubrication systems
  - **Some Cons**: High installation cost; not having any mechanism to prevent the fall of solid sticks

- **Hi-rail lubrication system**⁴,⁶
  - **Some Pros**: Applicable in usually during periodic inspections; applicable for shorter and plain lines.
  - **Some Cons**: Low efficiency for application of lubricants; difficult to find repair parts because of not commonly used in several countries

- Each of them has their Pros & Cons please check out D 2.8. at [http://netirail.eu](http://netirail.eu)
What is eco-friendly/biodegradable lubricant?

- Mineral oil, synthetic, vegetable oil as a base
- Easily broken down by the microorganisms/bacteria
- Cannot be said that eco-friendly or biodegradable lubricants have a zero impact on the environment but can be said that they are less harmful than traditional lubricants.

**Inherently biodegradable**: The product will turn into its natural state when it exposed to sunlight, water and microbial activities. The biodegradable percentage is changing from 20% to 60% in 28 days.

**Readily biodegradable**: The product has a natural ability to be degraded or dissolve in nature while it is exposed to sunlight, water and microbial activities. The biodegradable percentage for readily biodegradable products generally range from 60% to 100% in 28 days.

Most known tests are OECD 301C or CEC-L-33-A-93 test (Biodegradation Test Procedure). Four ecolabels/standards have been examined for labeling the lubricants as well: Blue Angel, Swedish Standard, Nordic Swan and
In 2014, “Low Carbon Rail Transport Challenge Action Plan” was published United Nations (UN) with the support of UIC\(^10\).

- 50% reduction in specific average CO\(_2\) emissions
- Foci points: energy efficiency and management, decarbonization of electricity supply, improving load factors, procurement of more efficient rolling stocks and efficient driving

- In the development of this innovation
  - In-depth examination of lubrication systems including pros and cons
  - Possible environmental damage and safety issues
  - Focusing on biodegradable lubricants and their distinguishable characteristics
  - Examining available best practices/implementations over the World to see how lubricant behaviour changes according to climate conditions
  - Explanation of Köppen-Geiger climate classification
  - Selection of the lubrication systems and lubricant types based on Köppen-Geiger classification and density of the lines
  - 3 case study implementation: Slovenia, Romania and Turkey
This map was presented by the German scientist Wladimir Köppen in 1990 and was updated by Rudolf Geiger in 1954 and 1961\textsuperscript{11}.

Climate classification firstly divided into five basic types:

- (A) **Equatorial zone**
- (B) **Arid zone**
- (C) **Temperate zone**
- (D) **Snow zone**
- (E) **Polar zone**

The second letter precipitation

The third letter temperature

**High traffic density**\textsuperscript{12}
- Group 1: 130 000 t/j < Tf
- Group 2: 80 000 t/j < Tf ≤ 130 000 t/j
- Group 3: 40 000 t/j < Tf ≤ 80 000 t/j
- Group 4: 20 000 t/j < Tf ≤ 40 000 t/j

**Low traffic density**
- Group 5: 5 000 t/j < Tf ≤ 20 000 t/j
- Group 6: Tf ≤ 5 000 t/j
**Selection method**

1. Identification of climate type
2. Depending on the climate type, determining of sub-climate type
3. Finding the recommended lubricant type
4. Selection according to line density
5. Analysing the recommended specifications depending on climate conditions and line densities

6. **Performing detailed analysis**
   - HDD, CDD, Extreme temperature range, extreme precipitation amount, number of snowing/icing days
   - Track situation, line specification (speed, fastening system components, rail grade etc.)
   - Using FM and TOR
The critical parameters based on climate type characteristics and risks for the lubrication system are identified. Depending on this, lubricant and lubrication system type are recommended.

### Identification of Lubricant/Lubrication System Types

An example table for identification of lubricant/lubrication system types

<table>
<thead>
<tr>
<th>Type</th>
<th>Specific Climate Type</th>
<th>Köppen-Geiger Classification</th>
<th>Critical Parameters</th>
<th>Risks for Lubrication System</th>
<th>Recommended Lubrication Type</th>
<th>Recommended Lubrication System</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Wet Equatorial Climate</td>
<td>Aequ</td>
<td>High temperatures</td>
<td>High temperature durability</td>
<td>Low density lines</td>
<td>On-board applications</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>High temperature variation</td>
<td>Non-water-based lubricants</td>
<td>- Not efficient for liquid lubricants</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Plentiful precipitation</td>
<td>For high speed lines, flash and autogeneration points</td>
<td>- Recommended to use solid sticks</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>High humidity</td>
<td>High water resistance</td>
<td>- More convenient for application in the coldest region</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Not preferred to use FM</td>
<td>- High efficiency for lubricants have high viscosity</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Combining power supply with micro scale applications</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Ability to combine with FM efficiently</td>
<td></td>
</tr>
</tbody>
</table>

- **Low density lines**
  - On-board applications
    - Not efficient for liquid lubricants
    - Recommended to use solid sticks
  - Wayline applications
    - More convenient for application in the coldest region
    - High efficiency for lubricants have high viscosity
    - Combining power supply with micro scale applications
    - Ability to combine with FM efficiently

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  - On-board applications
    - Not efficient for liquid lubricants
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Selection of Lubrication Systems for Slovenia, Romania and Turkey

**Study lines**

- Slovenia
  - Pivka-Illirski Bistrica-d.m.
  - Divača –Koper
  - Ljubljana Šiška-Kamnik Graben
- Romania
  - Faurei Testing Ring
- Turkey
  - Sincan- Kayaş
  - Malatya Divriği
  - Malatya -İskenderun
Conclusion

The main findings are:

1. Recommendation of the products is done a simple way by looking at the line type and lubricant basic characteristic as well as their customer demands, usually the weather conditions and track situation are discarded.

2. Most of the lubricants products have similar features, the majority of them are composed of synthetic and ester-based oils and few of them includes vegetable oils, therefore, for the railway sector, alternatives are restricted.

3. Climatic conditions have a significant impact on the selection of the lubrication that affects their effectiveness, durability and consumption amount which indirectly influence the maintenance cost of the track and decrease to track wear and damage.

4. In this study, track situation, line specification such as speed and the existing fastening systems are not considered, the selection of the lubricants and the related systems only made according to climate conditions, line densities and the usage area (line type) of the lubrication systems.

5. Through written and/or verbal communication with suppliers, it is realized that although suppliers in Europe have been providing the necessary information about environmental, safety and health impacts of their products and related the protection measures in case of exposure of the lubricant, in Turkey, majority of the suppliers have not informed to their customers about lubricants’ potential negative impacts on human health and environment.
References


[11] UIC 714 – Classification of lines for the purpose of track maintenance