NeTIRail

Needs Tailored Interoperable Railway Infrastructure

Tailoring lubrication to duty and climate

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Hasret SAHIN

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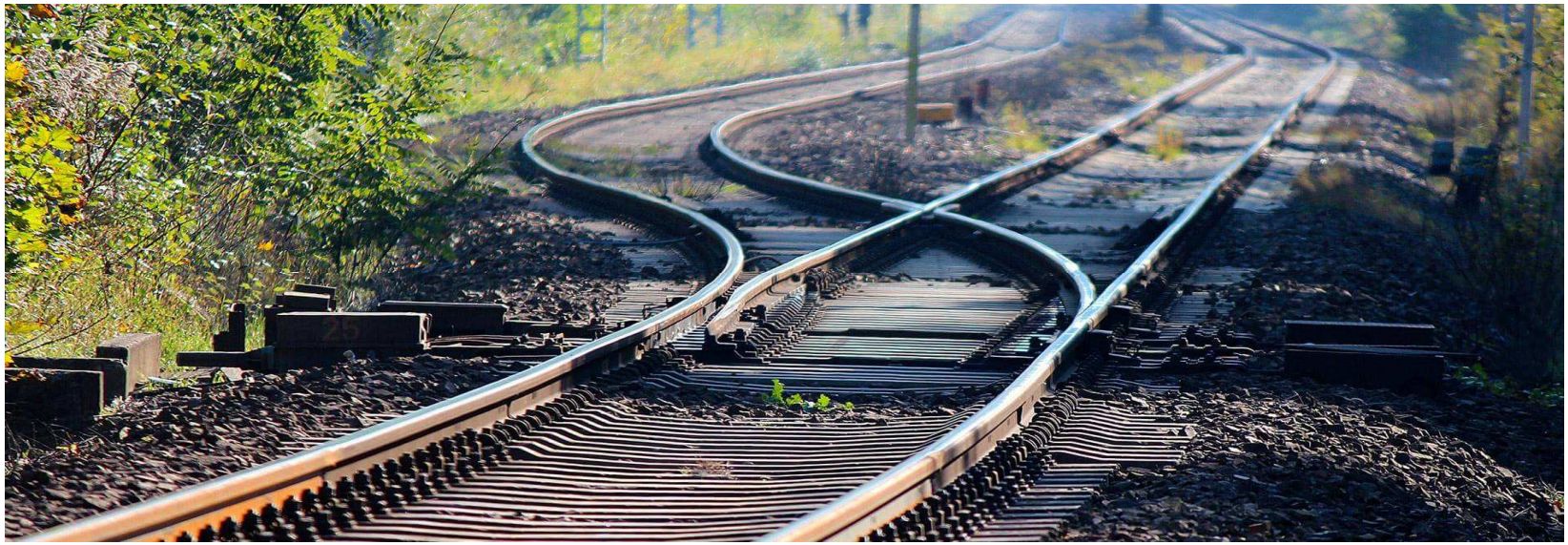
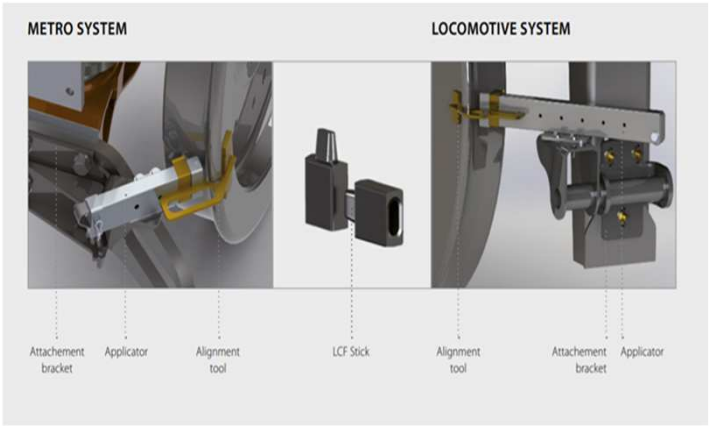
Research-Technology-Innovation

Lubrication? Why we need?



- The railway infrastructure managers have been paying very high costs for the maintenance of the track and its components. The amount generally covers **at least 50,000 Euro/km/year**[1].
- ***American Railways*** spend **more than USD 2 million / year**[2].
- ***Canadian Pacific Rail*** announced the increment of **rail life** increased to **110%** by effective lubrication on their systems[2].
- ***HKMTRC*** saved **£783,000 / year** by using solid lubricant[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 ; aapplicable 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[7]

Ecofriendly/ Biodegradable

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**[8].

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** [8] .

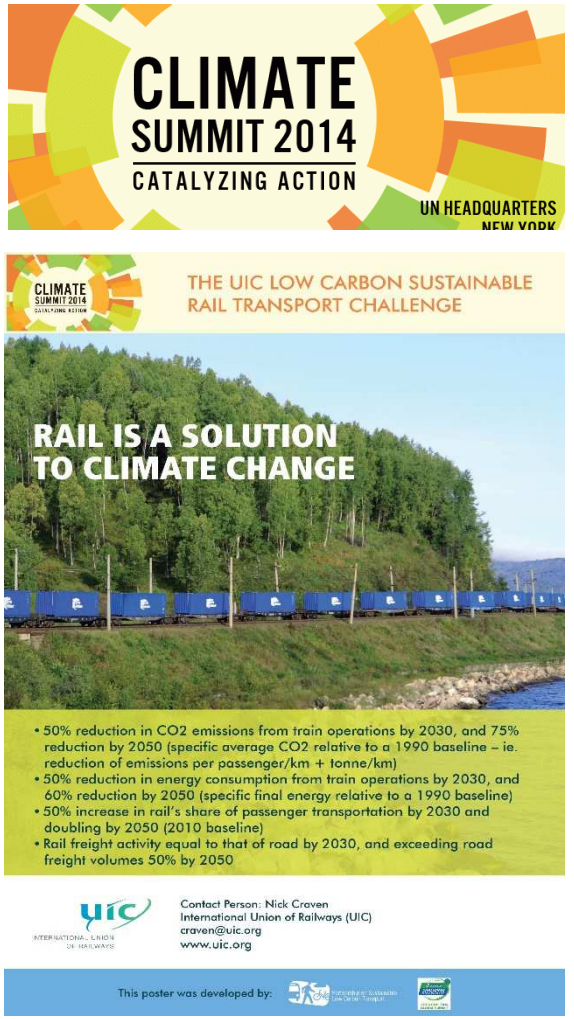
Most known tests are OECD 301C or CEC-L-33-A-93 test (Biodegradation Test Procedure)[9]. Four ecolabels/ standards have been examined for labeling the lubricants as well: Blue Angel, Swedish Standard, Nordic Swan and

Brief introduction to the innovation

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



Köppen-Geiger Climate Classification

This map was presented by the German scientist Wladimir Köppen in 1990 and was updated by Rudolf Geiger in 1954 and 1961[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 [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

Basic Flowchart for the selection method

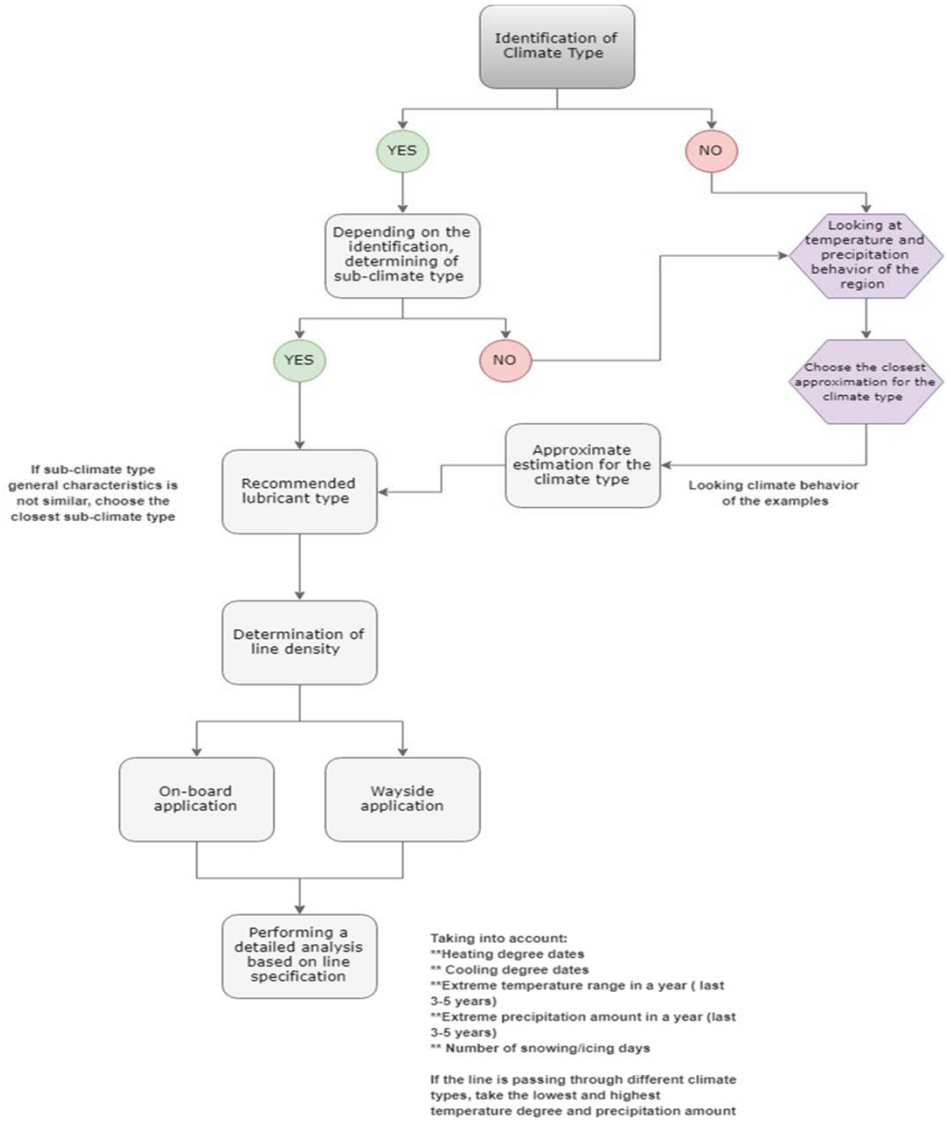
Selection method

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



Identification of Lubricant/ Lubrication System Types

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.

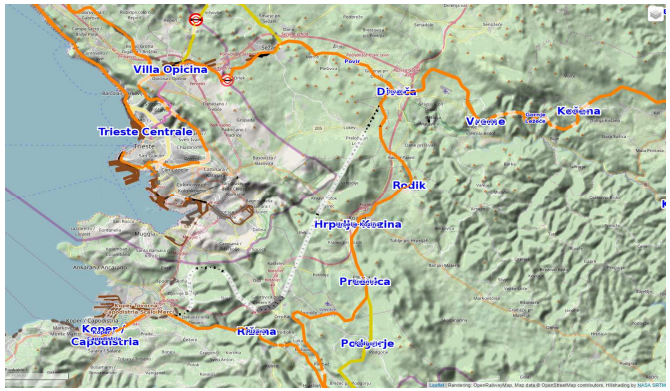
An example table for identification of lubricant/lubrication system types

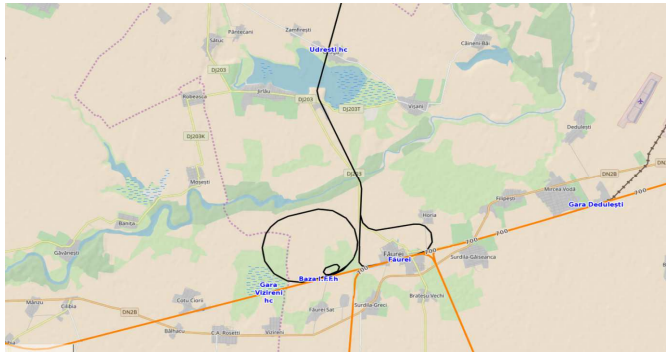
Type	Specific Climate Type	Köppen-Geiger Classification	Critical Parameters	Risks for Lubrication System	Recommended Lubrication Type	Recommended Lubrication System
A	*Wet Equatorial Climate*	Af	▪ High temperatures ▪ High temperature variation ▪ Plentiful precipitation ▪ High humidity	▪ High temperature ▪ Flood risk ▪ Exposure to hot-wet climate ▪ High depreciation rate of the partial equipment ▪ Difficulty in maintenance for long distance areas ▪ Clogging of the nozzles because of sand, dirt available in the environment	▪ High temperature durability ▪ Non-water-based lubricants ▪ For high speed lines, flash and autoignition points ▪ High water resistance ▪ Not preferred to use FM	▪ **Low density lines** *On-board applications* --Not efficient for liquid lubricants --Recommended to use solid sticks *Wayside applications* -- More convenient for application in the closest region -- High efficiency for lubricants have high viscosity -- Combining power supply with micro scale applications -- Ability to combine with FM efficiently ▪ **High density lines** *On-board applications* -- Not efficient for liquid lubricants --Recommended to use solid sticks --Usually not convenient for extreme high temp. *Wayside applications* --More convenient for application in the closest region --High efficiency for lubricants have high viscosity -- Combining power supply with micro scale applications --Ability to combine with FM efficiently
	Tropical monsoon and trade-wind littoral climate	Am	▪ High temperatures ▪ Small temperature variation ▪ Excessive precipitation ▪ High humidity	▪ High temperature ▪ Flood risk ▪ Exposure to hot-wet climate ▪ High depreciation rate of the partial equipment ▪ Difficulty in maintenance for long distance areas	▪ High-low temperature durability ▪ Non-water-based lubricants ▪ High water resistance ▪ Not preferred to use FM	
	Tropical wet-dry climate	As, Aw	▪ Larger annual temperature variation ▪ High and low temperatures ▪ Sudden excessive precipitation in a short time	▪ Temperature variation ▪ Flood risk ▪ High depreciation rate of the partial equipment ▪ Difficulty in maintenance for long distance areas	▪ High-low temperature durability ▪ High water resistance ▪ FM can be used in summer season	

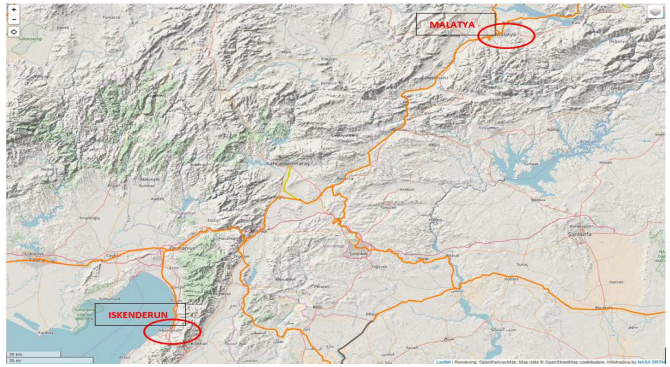
Selection of Lubrication Systems for Slovenia, Romania and Turkey

Study lines

- Slovenia
  - Pivka-Ilirska 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***.

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[2] V. Reddy, G. Chattopadhyay, D. Hargreaves, and P. O. Larsson- Kråik, “Techniques in Developing Economic Decision Model Combining Above,” in WCEAM, 2006, pp. 1–8.

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[10] M. Kottek, J. Grieser, C. Beck, B. Rudolf, and F. Rubel, “World Map of the Köppen-Geiger climate classification updated,” Meteorol. Zeitschrift, vol. 15, no. 3, pp. 259–263, Jul. 2006.

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