印刷胶辊在低温环境下运输的基本知识

Basic Knowledge of Transporting Printing Rubber Rolls in Low-Temperature Environments

Q1：在低温环境下的运输，是否对橡胶辊有不可逆转的影响？

Q1: Does transportation in a low-temperature environment have an irreversible impact on rubber rollers?

A： 这是一个非常实际且重要的工程问题。在俄罗斯等高寒地区（冬季室外温度可达 -40° C），胶辊在运输过程中暴露于极低温环境，确实可能对其性能产生影响，尤其是橡胶材料的物理状态和微观结构。下面分别从 NBR（丁腈橡胶） 和 EPDM（三元乙丙橡胶）两种材料的角度进行分析：

A: This is a highly practical and significant engineering issue. In cold regions such as Russia, where winter outdoor temperatures can drop to -40°C, rollers are subjected to extremely low-temperature environments during transportation, which can indeed impact their performance, especially the physical state and microstructure of the rubber material. The following analysis will be conducted from the perspectives of two materials: NBR (nitrile butadiene rubber) and EPDM (ethylene propylene diene monomer rubber).

橡胶的玻璃化转变温度（Tg）是关键

The glass transition temperature (Tg) of rubber is critical

橡胶在低于其 **玻璃化转变温度（Tg）** 时会从弹性态转变为硬脆的“玻璃态”，失去柔韧性，容易开裂或产生微裂纹。若在此状态下受到机械应力（如搬运、碰撞、弯曲），就可能发生**不可逆损伤**。

Rubber transitions from an elastic state to a hard and brittle 'glassy state' when its temperature is below its glass transition temperature (Tg), losing flexibility and becoming prone to cracking or the formation of microcracks. If subjected to mechanical stress (such as handling, impact, or bending) in this state, irreversible damage may occur.

NBR（用于普通油墨胶辊）

NBR (for general ink roller)

- **典型 Tg 范围：-40° C 至 -20° C**（取决于丙烯腈含量；含量越高，耐油性越好，但 Tg 越高、耐寒性越差）

Typical Tg range: -40°C to -20°C (depending on acrylonitrile content; higher content results in better oil resistance, but higher Tg and poorer low-temperature resistance)

• **常见印刷用 NBR**（中高丙烯腈含量）：Tg ≈ **-25° C ~ -30° C**
Common printing-grade NBR (medium to high acrylonitrile content): Tg ≈ -25° C ~ -30° C
结论：
Conclusion:

- 在 **-40° C** 下，NBR 很可能已处于或低于其 Tg；
  At -40° C, NBR is likely to be at or below its Tg;
- 材料变硬变脆，若在运输中受冲击或弯曲，**极易产生微裂纹或永久变形**；
  The material becomes harder and more brittle, and is prone to micro-cracks or permanent deformation if subjected to impact or bending during transportation.
- 即使回暖后恢复弹性，**已有裂纹无法自愈**，会导致胶辊寿命缩短、表面不平整、甚至剥落。
  Even if elasticity is restored after warming up, existing cracks cannot heal themselves, which will lead to shortened roller life, uneven surface, and even peeling off.

EPDM（用于 UV 油墨胶辊）
EPDM (for UV ink rollers)

- **典型 Tg 范围：-60° C 至 -50° C**
  Typical Tg range: -60° C to -50° C
- **耐寒性优异**，是所有通用橡胶中低温性能最好的之一；
  It exhibits excellent cold resistance and is one of the best in terms of low-temperature performance among all general-purpose rubbers;
- **结论：**
  Conclusion:
  - 在 **-40° C** 时仍处于高弹态，保持柔韧；
    Remains in a highly elastic state and maintains flexibility at -40° C;
  - 正常运输条件下（无剧烈冲击），**一般不会造成不可逆损伤**；
    Under normal transportation conditions (without severe impact), irreversible damage generally will not occur;
  - 回温后性能基本完全恢复。
    After warming up, the performance is basically fully restored.

Q2：在低温环境下的运输，需要考虑哪些风险因素？

Q2: What risk factors need to be considered for transportation in a low-temperature environment?

A：运输过程中的风险因素

A: Risk factors during the transportation process

即使材料本身能耐受低温，还需考虑：
Even if the material itself can withstand low temperatures, consideration must also be given to:

- **是否受力**：胶辊若被堆叠、挤压、跌落，在脆化状态下更危险；
  Whether subjected to force: If the rubber roller is stacked, squeezed, or dropped, it is more dangerous in a brittle state;
- **升温速率**：快速回温可能导致内部应力不均（但通常影响较小）；
  Heating rate: Rapid reheating may cause uneven internal stress (but the impact is usually minor);
- **长期暴露**：数周以上的极低温储存比短期运输风险更高。
  Long-term exposure: Storage at extremely low temperatures for more than several weeks poses a higher risk than short-term transportation.

Q3：在低温环境下的运输，需要考虑哪些防护措施？

Q3: What protective measures need to be considered for transportation in a low-temperature environment?

A：建议与防护措施

A: Recommendations and Protective Measures

为避免胶辊在寒冷地区运输中受损，推荐以下做法：
To prevent damage to the rubber rolls during transportation in cold regions, the following practices are recommended:

措施 Measures	**说明** Explanation
保温包装 Insulated packaging	使用泡沫、保温箱或加热运输（尤其对 NBR 胶辊） Use foam, insulated boxes, or heated transportation (especially for NBR rubber rolls)
避免机械应力 Avoid mechanical	运输中固定胶辊，防止滚动、碰撞、受压 Secure the rubber rolls during transportation to prevent rolling, collision, and compression

措施 Measures	**说明** Explanation
stress	
到货后缓温 After delivery, keep at room temperature	到达目的地后，在室温下静置 12－24 小时再拆包使用，避免冷热剧变 After arriving at the destination, allow it to stand at room temperature for 12–24 hours before unpacking and using, to avoid drastic temperature changes.

Q4：总结及结论

Q4: Summary and Conclusion

A： 总结

A: Summary

胶辊类型 Types of Rubber Rolls	橡胶材料 Rubber materials	-40°C 运输风险 Transportation risks at -40°C	是否可能造成不可逆损伤？ Is it possible to cause irreversible damage?
普通油墨胶辊 Ordinary ink roller	NBR NBR	高风险 High risk	是（尤其标准配方 NBR） Yes (especially the standard formula NBR)
UV 油墨胶辊 UV Ink Roller	EPDM EPDM	低风险 Low risk	通常不会 Usually not

📌 **总结及结论：**在俄罗斯等极寒地区运输 NBR 胶辊时，**必须采取保温或控温物流措施**；而 EPDM 胶辊相对安全，但仍建议避免剧烈冲击。

📌Summary and Conclusion: When transporting NBR rollers to extremely cold regions such as Russia, thermal insulation or temperature-controlled logistics measures must be implemented. In contrast, EPDM rollers are relatively safer, but severe impacts should still be avoided.