"Questions to Ask" When Choosing and Designing Elastomers for Rubber Roller Applications

May 2012

Overview

This article describes the wide range of materials available to make rubber rollers, and provides a list of the many questions to consider in selecting a roll covering. To ensure that a broad range of design parameters are considered, it suggests six key areas of inquiry:

1) Current Roller Specifications
2) Mechanism for Roll Failure
3) Mechanical Operating Conditions
4) Environmental Operating Conditions
5) Chemical Conditions
6) Realistic Objectives

Background

The choice of rubber (elastomer) materials for rubber roller applications is more challenging than choosing rubber materials for static applications. There are many dynamic conditions which affect the performance and longevity of the rubber compound. Some of the operating conditions present distinct challenges to the engineer since choosing a rubber material selected to maximize a physical property (release characteristic for example) minimizes another much needed property (the bonding of the rubber to the metal core can become nearly impossible with high levels of release agent chemistry).

Developments in recent years of new rubber compounds, elastomeric alloys, high performance fillers and polyurethane technologies have made the engineer's job more difficult in selecting the best material for an application.

In years past, the rubber compounds available to choose from were the old tried and true compounds of natural rubber, nitrile (Buna-N), SBR (Buna-S), Neoprene, silicone, Hypalon and EPDM. Some of the formulas for these materials date back to the 1930's and 1940's. The advent of new high performance fillers, vulcanizing (curing agents), plasticizers and processing additives have given new life to some of these older materials. An increase in wear resistance, durability and performance can be achieved if the supplier has the capability to innovate, design and test their materials.

Rubber roller covers from recently developed elastomer families have also emerged. Some of these materials have wear indexes ten to twenty times greater than conventional materials. A few of these materials have manufacturing costs of the completed polymer that are four to five times greater than conventional materials. This means that their selection and use is generally best accomplished by the joint efforts of the supplier and the end user. In-depth discussions between the supplier's design team and the user's engineering, maintenance and operating personnel will enable the objectives for each rubber roller to be met with success.

Technology-driven rubber and rubber roller companies invest a significant percentage of their revenues in the continual improvement of existing materials and development of new compounds. Some of these are cutting-edge technologies. This explains why the same family of materials (like Hypalon or urethane) from one company operates in your equipment with much greater life than a seemingly similar material from other rubber roller companies.

Efforts at designing or redesigning a roll cover material can become frustrating if clear objectives are not first established.

By maximizing the collaborative effort between engineers and operating technicians with chemists and design staff, the best possible choice of materials will be successfully accomplished. If an existing compound is not performing as intended or designed, our design team will evaluate the application and develop materials to achieve the objective.

Design Criteria & Operating Conditions

This section provides a list of the many questions to consider in selecting a roll covering.

1) Review the *current roll specifications* including:

- Roll diameter
  - Maximum and minimum diameters
- Cover thickness
  - Maximum and minimum
- Hardness specification
  - Shore A (durometer)
  - P&J (plastometer)
- Edge relief (end dub)
- Surface finish process critical?
  - Specified numerically?
    - Ra, Rz, Rt, other
    - Cut off length (filtering length, 0.03 std)
- Tolerances
  - Total runout (TIR, concentricity, etc.)
  - Crown amount and shape
  - Profile (taper, straightness, etc.)
  - Bearing journal influence

2) Understand the mechanism for roll failure or cause for removal from service

- When does this first appear?
- At what point will it render the roll unsuitable for service?
- What condition is the roll cover in when removed from service?
- If the roll is crowned, how much crown is remaining?
- Are there cracks in the cover?
  - Direction of cracks
  - Estimated depth
  - Location of cracks
- Is there a change in hardness before regrinding?
- Can the roll be reground and placed back in service?
- How much minimum material is removed each time it is reground?
- Will a reground roll operate as long between grinds as a new cover?
- Is there a change in hardness after grinding?
- Are nip impressions taken and analyzed?

3) Review the *mechanical operating conditions* including:

- Is the roll nipped?
  - Number of nips
- Operating speed
  - Surface fpm or rpm
- Is the roll driven?
  - Surface speed differential between nipped rolls?
- Pressures (loading-PLI) both existing and future plans
  - Deflection of roll

Operating speeds
- Continuous or intermittent and future speed upgrade consideration

Nip widths (uniformity)
- Actual nip pressure (psi)
- Nip dwell time (residence time in milliseconds)

Web tension

Wrap angle

Balancing considerations
- Dynamic (ISO 1940/1 grade level?)
- Static (static unbalance tolerance on roll periphery)

Crown shape
- Parabolic
- Cosine (what degree?)
- Simple (tapered)
- Empirical

Is a release characteristic important?

Surface finish

Static electricity potential

Does cover need to be non-marking?

4) Review the *environmental operating conditions* including:

Temperature (continuous duty, intermittent)

Source of thermal input (rolls, web or other)
- Steam heated (rotary joint)
- Hot oil heated
- Induction heated
- Recirculated chilled water
- Resistance heated
- Direct heat
- Indirect, etc.

5) Review the *chemical conditions* and other considerations

Process chemicals
- Solvents
- Surfactants
- Adhesives
- pH of chemicals
- Temperature

Chemical contact
- Immersed
- Saturated
- Fumes

Cleaning chemicals
- Immersed
- Saturated
- Wiped only
- Does roll have opportunity to "dry off' from cleaning chemicals

FDA compliant materials needed?

Is hydrolysis a factor to be considered (affects mostly urethane)?

6) **Define a *realistic objective* in redesigning the roll covering material**

Inputs from machine operators, maintenance, engineering

Can any adverse operating conditions be changed to affect this objective?

Changes in speeds, pressures, temperatures, chemicals, etc.

Add internal cooling of roll as necessary

Will changing any roll parameter help achieve the objective?

Changing diameter, crown, dub, cover thickness, runout, etc.

Is there an existing material in process to accommodate these conditions?

If not can an existing material be modified?

Does a new material need to be developed?

Is the material cost effective for this application?

Discussions with a Qualified Partner

If you'd like to partner with a supplier who can deliver high-precision rolls consistently and on faster turn-around time than other sources, please contact me. Our company is implementing lean manufacturing principles and we're often holding kaizen events to continuously improve the way we create valuable deliverables for our customers. And I'd welcome the chance to discuss how we can help your organization improve results.

About the Author

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About Imperial Rubber Products, Inc.

Based in Chino, California, Imperial Rubber focuses on manufacturing and reconditioning rollers for demanding applications. These precision products are used by printers, converters and manufacturers to convert, coat, paint, emboss, laminate, and squeegee. These companies typically work with primary materials such as paper, plastic, steel, aluminum, wood, glass, non-wovens, and textiles.

The company offers considerable product development and custom capabilities, fashioning rollers in a wide array of materials including rubber, polyurethane, silicone, nylon, Teflon™, Rilsan™, chrome, and copper. The company's facilities include its headquarters and main manufacturing facility in the southern California city of Chino (about 35 miles east of Los Angeles); a depot with local support in Sacramento, California; and a fleet of local and long-haul trucks. Imperial Rubber was founded in 1989. It is privately held and owned by operating management. Additional information is available at www.imperialrubber.com.