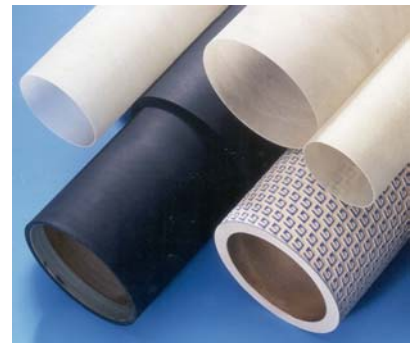


Technical Guide

Basic Principles of Sleeve Systems



Sleeve technology has been used to an increasing extent in a wide range of graphic and technical applications during the past several years. The technology offers a number of advantages:

- Elastomer roller coverings can be changed quickly.
- Different working widths/offset dimensions can be realized on a single core.
- Fewer additional cores are needed for a given press (lower investment costs).
- Low sleeve weight facilitates handling.
- Only sleeves are transported; metal mandrels and rollers remain in place.
- Storage of covered press roller cores is no longer necessary.
- Less warehouse space is required, as sleeves can be stored vertically.

This technical guide explains the basic principles of sleeve technology in the interest of facilitating your entry into this technology. Should you have further questions, we shall be pleased to assist you.

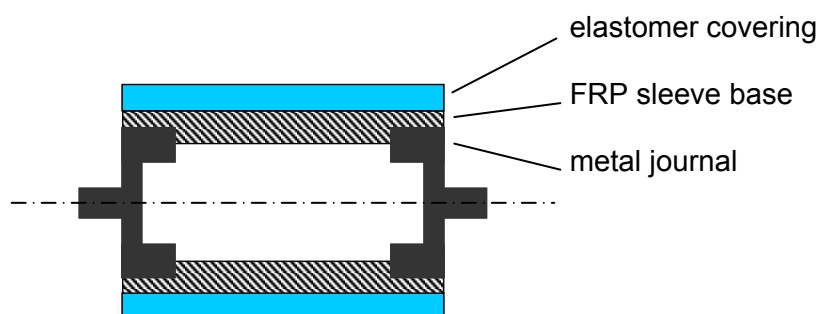
1. Basic principle and definitions

Böttcher has been covering metal cores made of such materials as steel or aluminum with rubber and polyurethane compounds for decades.

The development of fiber-reinforced plastics - **CFRPs** (carbon-fiber-reinforced plastics) or **GFRPs** (glass-fiber-reinforced plastics) – now offers press and machine manufacturers new materials for the construction of rollers used in printing presses and converting lines.

There are two different types of fiber-reinforced-plastic core systems:

- a) **CFRP** cores for lightweight rollers
Thick-walled (5-10 mm) tubes made of carbon-fiber-reinforced plastic are used in the production of lightweight rollers. Metal journals are integrated (glued or pressed) into the plastic tube to produce a roller body that is comparable to traditional metal cores.



After coating, **CFRP** cores can be installed in the press without further processing. The advantages of CFRP cores as opposed to pure metal cores include lower weight and a higher maximum press speed (higher critical rpm limit).

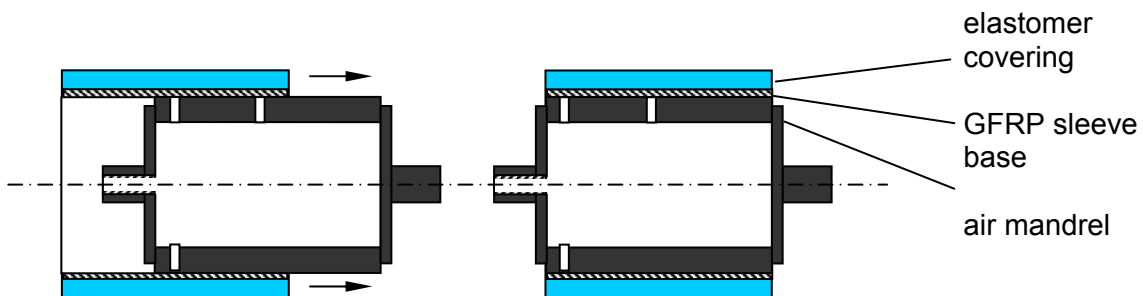
CFRP cores differ significantly from GFRP sleeve bases in terms of structure, production process and performance characteristics.

CFRP cores (lightweight rollers) are not discussed in detail in this technical guide. Should you have further question regarding rollers with CFRP cores, we shall be pleased to assist you.

b) **GFRP sleeve bases for sleeves**

A thin tube (wall thickness 1-2 mm) made of glass-fiber-reinforced plastic is used in this core system. The finished sleeve consists of the plastic sleeve base and an elastomer covering.

The sleeve base is fitted over a steel air mandrel with the aid of compressed air. It glides over an air cushion and can be fitted easily by hand.



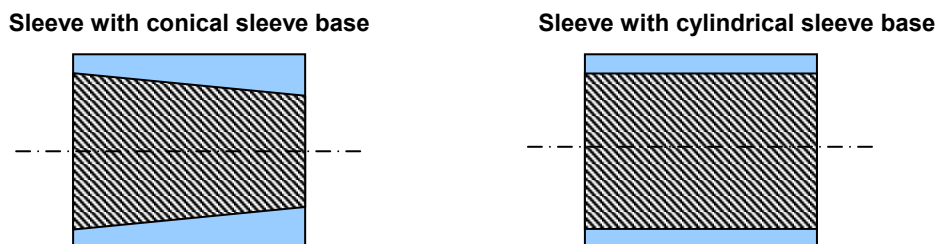
When air pressure is released, the sleeve base is firmly fixed to the mandrel. When compressed air is applied again, the covered sleeve can be removed from the air mandrel. Due to their thin walls, sleeve bases can ordinarily be processed only on suitable air mandrels.

1.1. Sleeve bases and sleeves

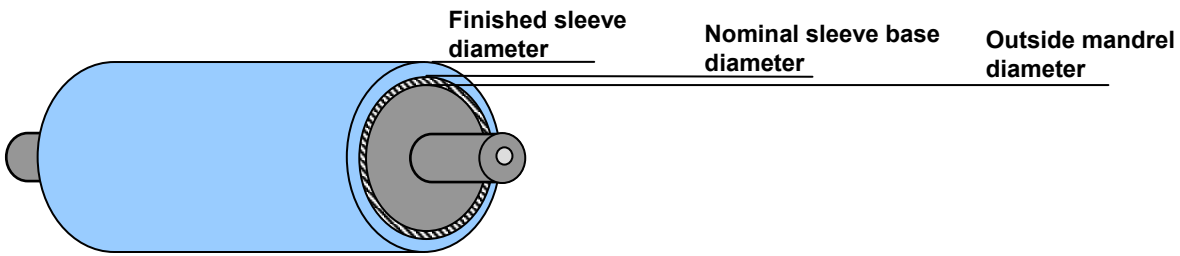
Sleeve bases ordinarily consist of epoxy or polyester resins reinforced with special fiberglass mesh. Depending upon the type of tubing and the number of layers of mesh applied, the wall thickness of these sleeve bases varies between 1 and 2 mm. The sleeve base covered with an elastomer compound – rubber or polyurethane – is referred to as a **sleeve**.



Depending upon the specific application, sleeve bases may be conical or cylindrical. Conical sleeve bases are normally used in gravure printing, while cylindrical sleeve bases are used primarily in flexo printing.



The **nominal diameter** corresponds approximately to the outside diameter of a sleeve base. Thus it is comparable to the core diameter of a conventional steel roller.

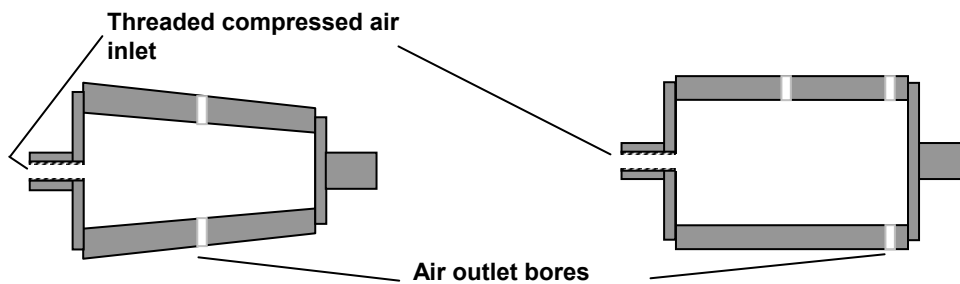


The sleeve or sleeve base is stabilized by fitting it over a steel fixture known as an **air mandrel** or **air cylinder**.

A suitable air mandrel is required for sleeve base production and coating, equalization and installation.

1.2. Air mandrels

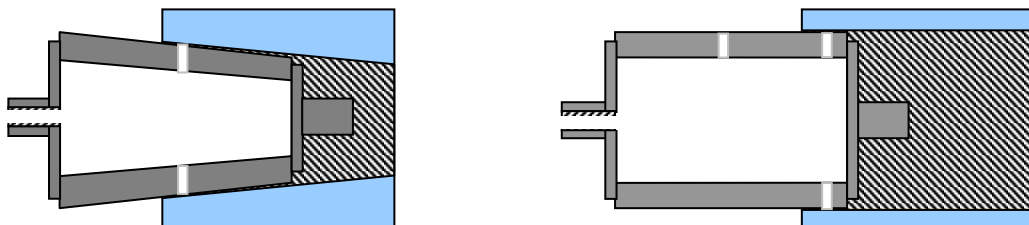
Air mandrels are hollow steel cores which can be pressurized with compressed air through a threaded inlet in the end plate wall (generally $\frac{1}{4}$ inch). Small holes bored in the cylindrical or conical wall serve as air outlets.



Air outlet bores in conical air mandrels are positioned near the middle of the mandrel. In cylindrical systems, they are ordinarily located on the same side near one end. The number of outlet bores depends primarily on the length and diameter of the mandrel. The surface of the air mandrel is protected against corrosion and mechanical damage by a hard chromium coating.

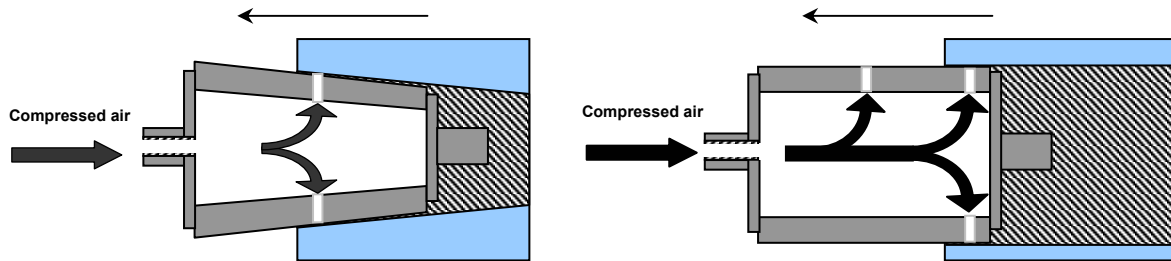
1.3. Mounting and removal of sleeves

Step 1 The sleeve is fitted over the mandrel, covering the air outlets.



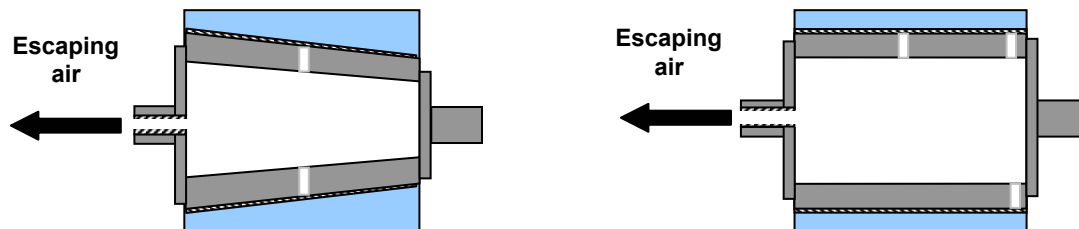
Step 2 Compressed air is applied and the sleeve expands slightly. It glides over an air cushion and can thus be fitted and positioned easily by hand.

Air pressure: cylindrical systems 6-8 bar / conical systems 10 - 12 bar



In order to expand under air pressure, sleeve bases and sleeves must exhibit a certain degree of **flexibility**. This flexibility is lost if sleeve base walls are too thick or the elastomer covering is too hard (Shore D). As a result, it may be impossible to mount or remove the sleeves.

Step 3 Once the air has escaped, the sleeve shrinks and is fitted firmly to the mandrel by clamping force. No additional clamping is required.



Sleeves are removed with the aid of compressed air.

1.4. Converting machines to sleeve technology.

New machines are often delivered fully equipped with sleeve technology. Many older machines can be converted to the new technology.

Böttcher supplies the complete system: machine mandrels, grinding mandrels and rubberized sleeve bases for various applications.

In order to design the air mandrel, we need a detailed technical drawing of the metal core currently in use (journal geometry, bearing tolerances, wall thickness, built-in components, maximum line force).

A simple mounting device equipped with a compressed air supply system is required for on-site sleeve mounting and removal.

2. Applications and advantages of sleeve systems

2.1. The printing industry

Sleeve systems are already well established in flexo and gravure printing, and several web offset presses are now operating with sleeve technology.

Laser-engraved, rubberized sleeve bases are used as plates in flexo printing. Lettering and simple patterns (fields, lines) can be engraved at Böttcher's lasergravure unit in Cologne.

In gravure printing, impression roller sleeves are used for conventional and electrostatic printing assist (ESA) printing applications.

2.2. Technical industries

Sleeves are widely used as varnishing rollers in the aluminum industry today.

They are also used as coating rollers in the wood-processing industry. Sleeves are now used for laminating, siliconizing and coating in foil and paper processing.

In view of the advantages it offers as opposed to conventional steel cores, such as the realization of different working widths and coatings on a single machine mandrel, the use of sleeve technology in technical industries can be expected to increase significantly in the foreseeable future.

2.3. Advantages of sleeves

As mentioned above, one of the major advantages of sleeve systems is that they enable printers to change roller coverings quickly.

Depending upon the design of a specific machines, it is often possible to change sleeves on site. The use of sleeves reduces machine idle time and thus increases press availability.

Another option is to set up a mounting and removal station near the machine. Machine air mandrels are then removed from the machine only briefly for the period of time required to change sleeves.

The number of cores required for the machine is also reduced, as sleeves are produced separately from the machine mandrel. Only the sleeves themselves are shipped for equalization. In addition, it is also possible to have a supply of sleeves produced in advance and stored at the site. This eliminates the need to maintain stocks of covered machine cores.

These advantages contribute to a significant reduction in purchasing and warehousing costs for machine cores while enhancing production reliability for the user.

The use of sleeves is recommended especially for machine in which roller coverings must be changed frequently due, for example, to heavy exposure to chemical or mechanical influences.

3. Air mandrel dimensions

Standard classification systems for air mandrel outside diameters have been developed for both cylindrical and conical sleeves. Taper angles have also been standardized for conical mandrels.

3.1. Standard dimensions for cylindrical air mandrels

The first cylindrical sleeve bases were developed by the Stork company for use in flexo printing. Thus gradations in outside diameter are oriented indirectly to repeat lengths (sleeve circumference). The Stork system is now in widespread use in the European market.

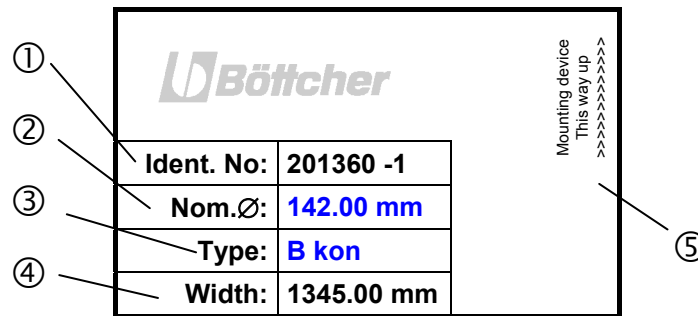
3.2. Standard dimensions for conical air mandrels

For conical systems, both the outside diameter of the mandrel and the taper angle are standardized. Most impression roller sleeves used in gravure printing are based on the Speedwell system developed by Strachan Henshaw Machinery (SHM).

4. Sleeve base identification

Sleeve bases can be labeled during the production process. The label is embedded in the resin matrix and thus cannot be subsequently removed.

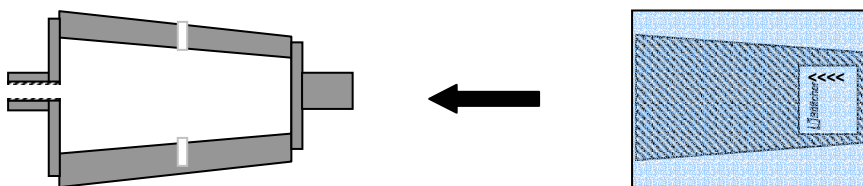
The label has the following structure:



1. The identification number is used to identify and monitor sleeves. It is comparable to the spindle number on metal cores.
2. The nominal outside diameter of conical sleeve bases appears in this line. For cylindrical sleeve bases, this line contains the outside diameter of the air mandrel.
3. The sleeve-type entry shows whether the sleeve base is conductive nor non-conductive, conical or cylindrical. **Three** different types are currently in widespread use in the market:

Type	Electrical conductivity	System
A zyl	non-conductive	cylindrical
B kon	non-conductive	conical
C kon	conductive	conical
D zyl	conductive	cylindrical

4. The length of the sleeve base of the original sleeve is entered here. During later processing, the covered sleeve base may be shortened, meaning that the entry no longer matches the actual length.
5. The mounting device is entered here for conical sleeve bases only. It shows the direction in which the sleeve must be fitted over the air mandrel.



5. Electrical properties of sleeves

In order to assess the electrical properties of a sleeve, both components – the sleeve base and the elastomer covering – must be taken into consideration. The selection of materials for each component depends upon the electrical characteristics required for a specific application.

A certain degree of insulation from the core is required for impression roller sleeves used in gravure presses equipped with electrostatic printing assist (ESA) systems. Insulation is needed in order to maintain the electrical charge generated by the ESA system on the impression roller and to achieve the desired voltage in the nip.

In metal cores, insulation consists of a two-layer system with an insulating lower layer. Sleeves are made with non-conductive fiber-reinforced-plastic sleeve bases.

Electrostatic charges are also generated in turner bar rollers used in the sheeting industry as a result of friction between the material web and the roller surface. This causes the web to adhere to the roller and may generate sparking in the machine.

The problem can be significantly alleviated by using conductive cores (metal cores or conductive sleeve bases) in combination with a covering consisting of conductive elastomers. Static charges are then discharged through the core.

5.1. Non-conductive sleeve bases

An insulating fiber reinforced material is used to manufacture non-conductive sleeve bases. These sleeve bases are electrically non-conductive. Insulation resistance to the core mandrel is > 10⁹ Ω (Gigaohm).

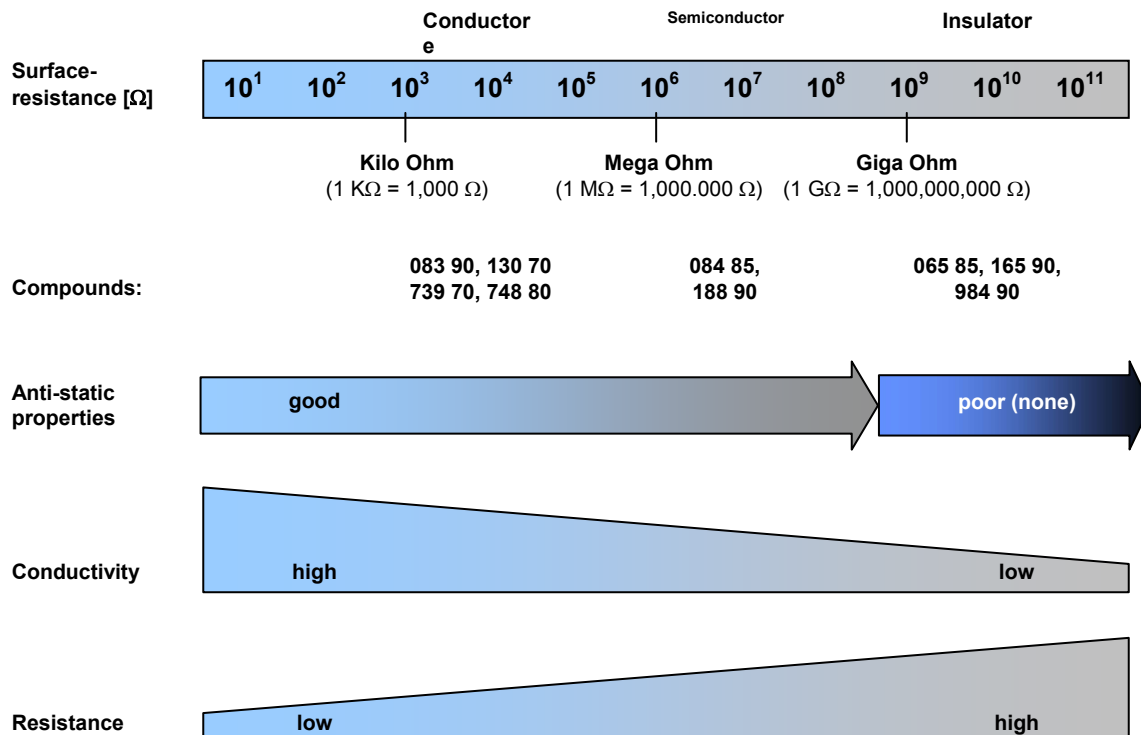
Electrostatic charges applied to the sleeve surface, e.g. by an ESA system, or which result from friction, are not diverted to the core mandrel.

5.2. Conductive sleeve bases

Conductive sleeve bases are produced using a glass-fiber-reinforced compound to which graphite, soot or other additives are added to produce conductivity. The insulation or diversion resistance of these sleeve bases lies within a range of 10⁴ -10⁵ Ω. The conductivity of the sleeve base and the conductive elastomer compound ensure effective diversion of electrostatic charges to the core mandrel.

5.3. Electrical properties of elastomers

As indicated above, the electrical properties of a sleeve – conductive or insulating – depend upon the sleeve base and the elastomer coating. The following graph provides a brief overview of the conductivity ranges of elastomer roller coverings as defined by Böttcher.



Most of the basic ingredients of elastomer compounds, i.e. rubber and polyurethane base polymers, are electrical insulators. By adding soot and/or special additives, a degree of conductivity can be achieved within a specified range.

Thus in order to achieve the desired electrical properties, a suitable combination of sleeve base and elastomer coating must be selected.

The classification of conductivity ranges according to the Böttcher definition is shown in the graph below.

In addition to electrical properties, the physical mechanical properties of sleeves, e.g. dynamic characteristics and abrasion resistance, as well as chemical properties must also be considered in the selection of suitable compounds.

The behavior of specific media in contact with Böttcher compounds can be analyzed through swell testing at our development laboratory.

We shall be happy to assist you in selecting a sleeve system and materials that meet the requirements applicable to use in your presses.

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