

## Printing Sleeve Information

By Dirk Kroll, Webconvert Ltd.

### Background:

Tapered Sleeves were first developed by Strachan Henshaw company for Gravure Impression Rollers and Coating applications. These were fiberglass sleeves with tapered bore, installed over a mandrel. The mandrel has air holes drilled in it to allow compressed air to escape from the mandrel, thus lightly stretching the sleeve to allow it to float onto the mandrel on a cushion of air. When the compressed air is shut off, the sleeve “shrinks” onto the mandrel. For gravure, this allows the easy change of impression rollers without removing the entire roller. For Coatings, this allows different width undercuts, and different rubber compounds to be used.

While the Strachan Henshaw Company no longer exists, these tapered sleeves are still found in the rotogravure and laminating nip applications. Tapered sleeves were also used for a period of time, with a non-tapered outside diameter, for the mounting of flexographic plates. (esp. on PCMC Vision presses) The idea is to have less printing cylinders, and use sleeves to either change repeat (diameter) or to leave jobs mounted when they will be run again.

Competing technologies for flexographic printers included “Mosstype” shells that were like a heavy magnesium alloy tube that would be shrink-fit onto an arbor/base cylinder. Other competing sleeves were made of very thin Nickel (often referred to as Stork sleeves) or Mylar (often referred to as Dupont Sleeves, now made by Xymid)

Today’s Flexo Sleeves (Parallel Sleeves) do not have a taper. They install with compressed air onto mandrels, and the printing plates are mounted onto the sleeve. Many flexo sleeves are used on conventional presses which are running Integral Cylinders, where the integral cylinder has been drilled for air passages to allow the sleeves to be used. In addition to this market, the more recent trend in Flexographic presses is to have just one mandrel (instead of many cylinders) that stays in the press all the time. This mandrel accepts different diameters of printing sleeves to achieve different repeats. These newer presses are also equipped with mandrels to have the anilox roller as a sleeve. The advantage is that anilox rollers can be changed quickly also.

### The Math:

An understanding of Gear pitch, repeat length and diameter, and printing materials, is important to understanding sleeves.

- Gear Pitch in North American machines is typically 1/4CP or 10DP
- Gear Pitch in European machines is typically metric, 5mm or 10mm

Pitch Diameter is the diameter at which the teeth are engaging with the mating gear, and is therefore the Printing Diameter. The raised parts of the Printing Plates (that apply the ink) must be equal to the pitch diameter. In practice, the raised parts of the plate are actually .002" higher than the pitch diameter, to give an "impression squeeze" when the gears are perfectly meshed.

**CP is Circular Pitch** – it is the distance between each tooth on the gear, as you go around the circumference. Therefore ¼ CP is a quarter inch from tooth – to – tooth around the circumference. Likewise, 5mm pitch means that there are 5mm from tooth – to – tooth on a metric gear.

#### Example:

If a ¼ CP gear has 60 teeth, we know there are 4 teeth per inch, so we have:

$$60 / 4 = 15 \text{ inches around the pitch diameter / printing diameter}$$

***This is a 15 inch repeat.***

#### Example:

If a 5mm gear has 60 teeth, we know that there are 5mm per tooth, so we have:

$$60 \times 5 = 300 \text{ mm around the pitch diameter / printing diameter}$$

***This is a 300 mm repeat, or 11.811 inches repeat***

**DP is Diametral Pitch** – it is the number of teeth per inch of diameter. If we want to print 15 inches of repeat, we must find the closest diameter that has a corresponding number of teeth. (you can't have a fraction of a tooth!)

#### Example:

15 inches repeat / pi 3.14159 = 4.775 pitch diameter.

Since the gear will have 10 teeth per inch of diameter, we have:

$$4.775 \text{ inches of diameter} \times 10 \text{ teeth per inch} = 47.75 \text{ teeth.}$$

*But we can't have a fraction of a tooth, so we can use 47 teeth or 48 teeth.*

If 48 teeth are used, the pitch diameter is 48 teeth / 10 teeth per inch = 4.8 inches

***The Pitch diameter is 4.8 inches, so the repeat is 4.8 x pi = 15.079***

*(This is why presses with 10DP gears cannot print repeats of nice round numbers like 19.75 or 23.25, they are always fractional numbers like 15.079. But the pitch diameters are always nice round numbers – say 4.800 inches – because they are always the number of teeth divided by 10!)*

If we recall that the printing plate must be mounted to the cylinder so that the top of the plate is the same or .002” higher than the pitch diameter, then we have to subtract the plate thickness, and the mounting tape thickness, to find out what the Bare Cylinder Diameter must be. The bare cylinder diameter is the outside diameter of the cylinder or sleeve that will receive the plate and tape.

#### Plate and Stickyback (Tape) Information

Most Flexo printing plates in the past have been made of Rubber, and they were .107 inches thick. But the practice was to calculate everything based on a theoretical thickness of .105 inches – the difference being the .002” squeeze. Therefore if everybody assumed it was .105”, but the plate was made to be .107”, then everyone will have .002” squeeze. When you add the tape thickness of .020” to the plate thickness, you have  $.105” + .020” = .125”$ , which is 1/8 inch.

This .125 inch is referred to as the undercut. The cylinder diameter is undercut smaller than the pitch diameter, to allow for the plate and tape thickness. Since the plate and tape thickness is working on the radius, (see sketch), the undercut is always doubled when we speak about the diameter

#### Example:

15 inch repeat, Printing Diameter 4.775”  
Bare Cylinder Diameter =  $4.775” - (2 \times .125”)$   
 $= 4.775” - (.250”)$   
 $= 4.525”$

If the customer has existing integral cylinders, they will probably have this undercut, so the Bare Cylinder Diameter (BCD) is always .250 inches less than the Printing or Pitch Diameter.

#### This forms the basis for all the tooling that the sleeves are made on! (more on this later)

As Flexo quality has improved, the rubber plates have been replaced by thinner Photopolymer plates. These plates can have more detail, and they are harder, so they don't distort as much. The thinner plates have the added benefit of allowing printers to use sleeves at the same time, to make up the difference in thickness. This allows a printer to change from rubber to photopolymer, and keep the same gears and bare cylinder diameters. The most popular thickness of the photopolymer plates is .067” (we calculate using .065” to allow the .002” squeeze!). The difference in thickness between .107” plates and .067” plates is .040”

### The importance of .040 inch

In ¼ CP machines, each quarter inch of repeat is equal to one tooth on the gear, and is also equal to .040 inch increase in the radius of the printing cylinder. Therefore, if the printer reduces plate thickness by .040 inch, he has two choices: to use a gear with one less tooth, or to use a .040 sleeve to get back to the original diameter, and then re-use the same gear.

Likewise, if a printer needs to print a longer repeat than his existing cylinder permits, he can simply buy sleeves in .040 increments of wall thickness, and only buy new gears, not entirely new cylinders.

Finally, if a printer will use both .107 plates and .067 plates, he can mix them using the above principle.

### **The Market:**

The flexo sleeve market has several types of sleeve users, depending on what the equipment is and depending on what type of printing is being done.

### Factors in Sleeve Purchasing:

#### Conventional Machines (Integral Cylinders drilled for air to install sleeves)

- Need for new repeats – buy sleeves and gears rather than new cylinders
- Need to accommodate new plate thickness – changing from .107 to .067
- Re-run Jobs – leave plates mounted to save labour of demounting and remounting, and save cost of tape on subsequent runs.

#### Cantilevered Machines (One mandrel stays in machine – all jobs run on sleeves)

- Must have sleeves for each repeat
- Must consider Carrier Sleeves plus thinner “piggyback” sleeves versus all sleeves mounting on the base mandrel (more on this later)
- If Carrier sleeves are to be used, will the carrier stay in the press while the thinner “piggyback” sleeve is changed?
- Concerns about Quality of Printing – build-up of tolerances which could influence performance at high speeds or high line-count artwork.
- Weight and deflection – as it relates to tolerances, bounce, and deflection.
- Weight – as it relates to operator safety and accuracy for installing sleeves on press.

### **The Technology:**

#### Sleeve Manufacturing Processes and their Impact on Delivery, Sizes, Cost

Sleeves are manufactured on Tooling (basically a mandrel that acts like a mold). The tooling is owned by the sleeve manufacturer, and is sized to correspond to popular ¼ CP, 10 DP, and 5mm and 10mm cylinders with “conventional” undercuts, such as .125” in North America. The printer must check that the cylinder (mandrel) that he plans to buy sleeves for, matches the tooling of the manufacturer.

The availability of tooling impacts greatly on lead times (delivery). If the tooling is in use for one customer order, the next order cannot be produced until the previous order is finished. Depending on the manufacturing process, a limited number of sleeves can be made on one mandrel in a day, due to curing times.

For sleeves that require greater wall thickness to build repeat, sleeve manufacturers typically apply various Urethane compounds to achieve the correct size. The Urethane is a very stable, lightweight and easily machined material that also provides a good smooth surface for tape adhesion. For wall thickness over 1", there is an extra layer of lighter material sandwiched between the fiberglass thinsleeve and the Urethane outer layer.

When printers want the benefit of thinner walled sleeves for reduced cost and weight, they can mount the thinner sleeves on a Bridge Sleeve. The Bridge sleeve is not intended for direct plate mounting – it's sole purpose is to act as a bridge between the smaller mandrel and the piggyback sleeve at the desired repeat. For this reason, the Bridge sleeve is manufactured for light weight and long life with the best possible tolerances. Many Bridge Sleeves are made of Carbon Fibre to achieve these goals. The Carbon Fibre Bridge still has a base sleeve at its center, and it still requires the use of a compressible layer. It can have internal piping to deliver separate compressed air to the outer sleeve, or it can have a flow-through design. Despite the compressible layer in this sleeve, the combination of the carrier and the outer piggyback sleeve (with no compressible layer) is capable of reproducing very high quality process artwork. The competing technology to this Air Mounted Bridge sleeve, is a mechanically locking Carrier sleeve, which is considered by some to have an advantage due to the elimination of the compressible layer in the Bridge.

In the event that the Bridge Sleeve approach is not desirable because of cost or perceived loss of tolerance, sleeves can be made with a wall thickness greater than one inch, with the sandwich construction mentioned previously. These sleeves are more costly *per sleeve* at a given repeat, than thinner sleeves. The customer must decide what is the optimal combination for his mix of production. If more than one set of sleeves is desired at a given repeat, the payback on Bridge Sleeves is fast, but the initial investment in carrier sleeves is more if the customer is not buying multiple sets.

### **Anilox Sleeves**

Print sleeves have some common manufacturing processes to the base sleeves for ceramic covering and engraving. The Anilox base construction uses a thinsleeve sandwich with compressible layer, which is then pressed into an aluminum outer sleeve. The aluminum outer sleeve is then covered with the ceramic material and engraved.

## **Special Purpose Sleeves:**

### Compressible sleeves

Some sleeve suppliers have developed sleeves with a soft compressible exterior finish, to eliminate the cushion-stickyback. Cushion sticky-back mounting tape is considered by some printers to be a costly and imprecise variable in the printing process. However, the use of compressible sleeves has not been a universal solution to cushion tapes. The idea that a .005" hard tape could be used to mount plates to the compressible sleeve has met with mixed results. Customers interested in trying this product should set up a trial to prove its worth.

### In-the-Round Sleeves and Rubber Covered Sleeves

Sleeves are available with rubber covering for 100% coverage flexo coating (such as lacquers), and also for direct laser engraving for printing continuous artwork without plate seams.

### Photopolymer Sleeves

A future growth area will be in sleeves that have Photopolymer already applied to the sleeve. This product can only be handled by prepress houses that have the capability to "develop in the round".

## **Mandrel Preparation**

Sleeves are guaranteed to mount and lock on industry standard air mandrels having a diameter tolerance of +0.0005/-0.0000" from the specified standard BCD and a maximum TIR of 0.0005"

The sleeves are guaranteed to have a TIR of no more than .001" with a diameter tolerance from sleeve to sleeve of +/-0.0008"