DOUBLE R CONTROLS

TECHNICAL INFORMATION ON THE PRINCIPLES OF SPOOLING

written by

Neal Rothwell
Managing Director

e-mail: neal.r@drc.co.uk

Date: 1st July, 2001

DOUBLE R CONTROLS LTD
4 Broadfield Business Park, Pilsworth Road, Heywood, Lancs. OL10 2TA.
England
Tel. +44 (0)1706 623625 Fax. +44 (0)1706 366881
Web Site: www.drc.co.uk

DOUBLE R CONTROLS

Updates To Spooling Document

1. Original Document, date November 1999
2. Page 18. Addition of Hints and Tips for Spooling, date February 2000
3. Page 24. Addition of Length Calculation Software, date August 2000
4. Page 26. Addition of Spooling Pattern Generator, date July 2001
5. Page 9. Updated description of lobbing, date August 2003
6. Updated address details.

DOUBLE R CONTROLS LTD
4 Broadfield Business Park, Pilsworth Road, Heywood, Lancs. OL10 2TA.
England
Tel. +44 (0)1706 623625 Fax. +44 (0)1706 366881
Web Site: www.drc.co.uk

SPOOLING - THE WAY TO HIGHER PRODUCTIVITY

It is essential that anyone wishing to spool material has an understanding of the technical terminology used when processing this type of product. To this end, Double R Controls Ltd. attach herewith information with regards to the terminology which can then be downloaded and printed by individuals for use by them to ensure that everyone has a full understanding of this technology. This document will be continually updated and shows the revision number so that anyone printing this document is fully aware of which version they have. Spooling a product is one relatively simple way to increase the productivity on any process as it can increase the length of feedstock provided to the machine. This means that the process can run for longer periods without reel changes and also reduces the downtime in changing the feedstock reels.

Spooling is the creation of a wound product into a continuous long length. Spooling/traverse winding originated in the textile industry and was used as a method of creating very long lengths from a cheese or winding thread and yarn. The long lengths could then be easily transported and handled in their final application. This principle of spooling the thread is still widely used in the textile industry but the advent of spooling flexible packaging materials is a recent innovation and, with modern techniques and novel principles of operation, such as the ones implemented by Double R Controls Ltd. means that extremely delicate and fragile materials can be processed.

When spooling, different flexible packaging materials each have their own problems. Narrow width materials, such as metallised polyester in the widths of 0.1 - 0.2 mm, suffer from being easily broken whereby when processing unsupported paper this can easily be damaged by any edge contact.

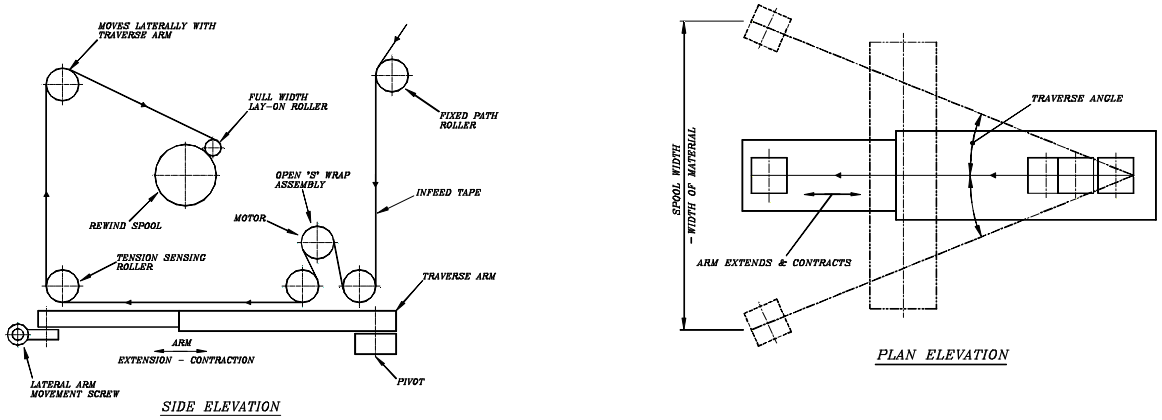
The principle of spooling product in the flexible packaging industry is being recognised in other industries as an excellent technique for creating longer lengths. Essentially, the requirement is to increase the efficiency of the final process by having a longer length and also create a package that is capable of being transported and handled without damage. The spooling characteristics are of paramount importance to optimise the reliability of transportation and the reliability and consistency of de-spooling in the final process.

A tape product is essentially a narrow width material which is flat and thin compared to its width. The normal process is to wind this in a pancake which is a reel having a narrow width relative to its diameter. However, when wound as a pancake the length of material is restricted due to the instability of the final wound package.

Both adhesive and non adhesive tapes are used extensively in the manufacturing industry and the ability to have longer lengths is a method of increasing efficiency and productivity. Typical industries which benefit from the use of spooled products are those such as disposable products, personal care, tobacco, food, medical, aerospace, graphic and many others. Basically, any continuous process using a narrow width tape will benefit from a spooled product. Many new and innovative techniques have been developed to enable the spooling of these diverse products, whether they be adhesive or non adhesive and a complete new industry is emerging offering contract spooling as well as industries to develop the principles of spooling or traverse winding.

The information given below is based on the novel techniques developed by Double R Controls Ltd. for the creation of spooled packages. Package density equates to longer lengths in a given volume and, therefore, the density of wind and the volume of the finished spool are all measurable parameters relating to the length of product in the spool. This is not a black art it is a science.

Many materials cannot be wound at high density due to the sensitivity of the material and, therefore, the density of the package is the true relationship of the quality of the package wound The drawing below depicts the unique principle developed by Double R Controls in spooling material by making no side contact with the material and therefore reducing the possibility of edge damage or twist in the material being wound.



DEFINITIONS

Throughout the packaging industry there are many definitions relating to the various aspects of wound reels. The list below relates to the standards used by Double R Controls Ltd. and many other manufacturers of spooling equipment and are recognised by most manufacturing companies throughout the world.

LEVEL WOUND SPOOLS.

Level winding is the generic term used for spooling products. The principle is to form a spool by traversing the material across the face of the core and, at the appropriate time, reverse its direction so the material traverses in the opposite direction, thus building up a number of layers until a finished spool is created. The general characteristics of a spool wound product are essentially a very poor wound pancake. However, the industry accepts the appearance of the spool which has annular rings at the end, which are created by the reversal point of the tape during the spooling process. The edge of the spool is the most vulnerable point and it is of paramount importance that anyone handling the spool does not press the side as it will cause damage to this product. This is a particular problem if the material is adhesive, as the layers of material that protrude at the end of the spool will then adhere together and create a problem during the de-spooling process. To optimise the efficiency of de-spooling, it is important that the equipment used is designed for de-spooling the particular product being unwound.

Quite often, users of a spooled product do not use the correct technique and, therefore, do not obtain the maximum advantage of a spooled product. This is the reason why Double R Controls Ltd. work as a partner with their customers and we have a wide range of de-spooling equipment to optimise the efficiency of unwinding the material. There are many ways the quality of the spool wound product can be increased and, therefore, it is essential that the winding characteristics for a particular product are optimised to ensure both the stability and the appearance of the finished spool are the best. Using the latest technology, once the winding characteristics have been optimised for a particular product, these can be stored electronically within a computer programme. This data can then be retrieved and applied to the winding principles for the particular product to be processed, thus reducing any second learning curve for that particular material.

JUMBO REEL.

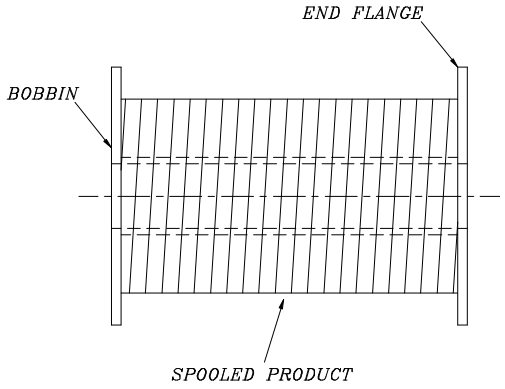
A jumbo reel is considered to be a reel which has a relatively large width to its diameter and is a term used for a master reel or the original reel of material at initial manufacture

MINI JUMBO.

This is a reel which has been created from a jumbo reel and now typically has a width less that its diameter. However, it is normally still of significant width, typically in the range 300 - 600 mm (12" - 24") wide.

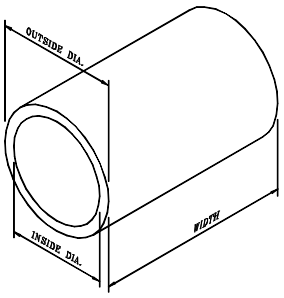
SPOOL.

A spool is a package of material which is much wider than the material that has been wound. Typically, it has been wound using a traversing method, this allows the material to be overlapped or underlapped during the winding process.



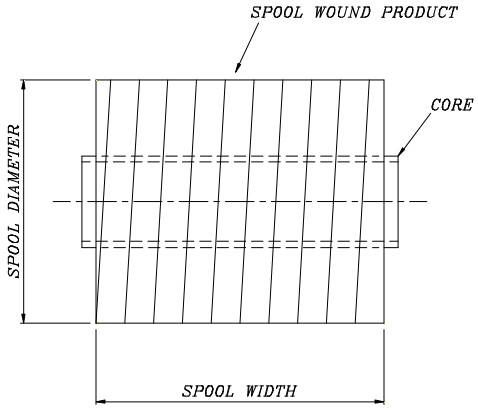
CORE.

Cores are simple cylindrical tubes having no side flanges. Material, both mini jumbos and spools, are wound onto cores.



BOBBINS.

Bobbins are similar to a core but have cylindrical flanges mounted on the side. The principle of using a bobbin is to reduce the possibility of spooled material falling off the end of the core. The side flanges also provide additional protection to the material which has been spooled on the core.



SPOOLING.

Spooling, Traverse Winding, Level Winding. All these terms are used to depict the principle of winding a tape having narrow widths into a spooled package to create a longer length.

TAPE WIDTH.

This is the width of the material to be spooled or traverse wound.

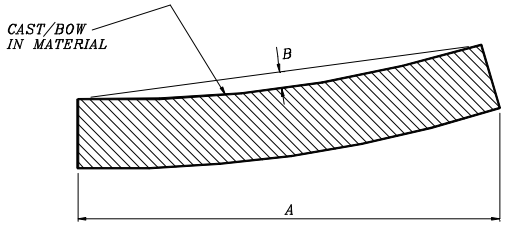
SPOOLED WIDTH.
This relates to the width of traverse wound material. It is the width of the finished spool when wound onto the core.

SPOOL DIAMETER.
This is the finished diameter of the spooled wound package.

REEL DENSITY.
Reel density is the mass per unit volume of the finished spool.

J-BOX.
A j-box originates from the textile industry where narrow width materials are simply festooned or layered into the box. It is an alternative technique to spooling or winding the material to create a longer length in a single package. However this has the disadvantage when unwinding that material can become tangled during the next process. It also takes up greater volume and the finished package is less dense.

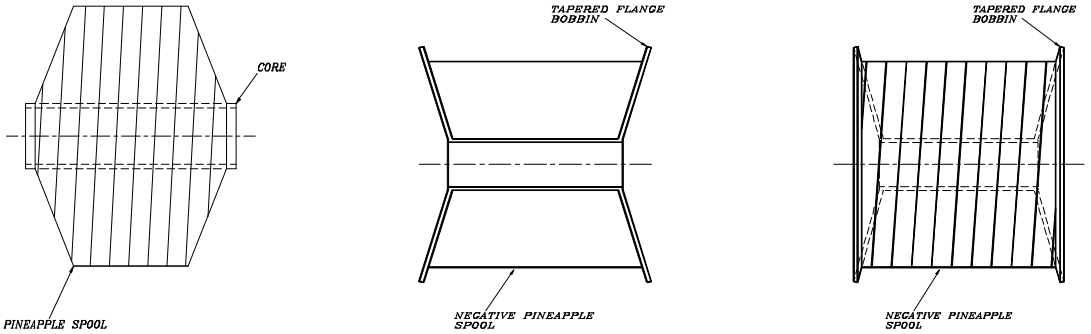
MATERIAL CAST OR BOW.
It is necessary to know the degree of cast or bow in a material to ensure it is not excessive. The principle of measuring the cast or bow is to lay the material out on the floor over a distance in the region of three metres. The material should be laid in such a way that both edges of the material are flat on the floor and it will then be found that one edge of the material is slightly longer length than the other. The height created is the degree of cast or bow in the material and can be expressed as a percentage. It is important that the material taken from the spool is from the turnround point of the spool as opposed to the centre of the spool to determine the maximum degree of cast or bow.



$\frac{B}{A} \times 100 = \text{PERCENTAGE CAST}$

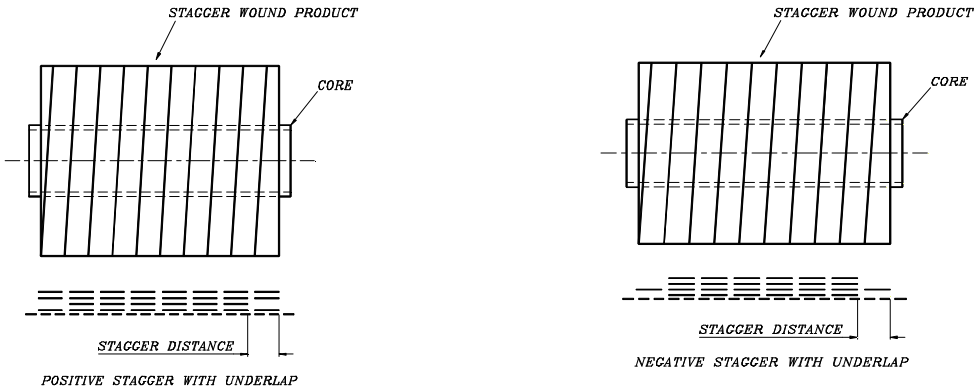
PINEAPPLE WINDING.

When processing many materials, it is necessary to reduce the width of the spooled package as each layer is wound. This is to give additional support to the material at the ends and is normally used when processing thick materials i.e. greater than 1 mm.



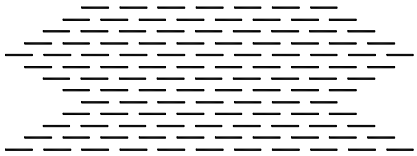
STAGGER WIND.

The principle of stagger winding to increase the amount of material at the turnround point of the reel to reduce the effect of creating a cambered rewound spool. This principle is particularly useful when processing extremely narrow width material (in the region of 0.2 mm wide). Typically, you would set up the equipment to create a stagger distance of *x* mm, relative to the width of spool being wound and the number of layers before a stagger layer is introduced.



SINUSOIDAL STAGGER.

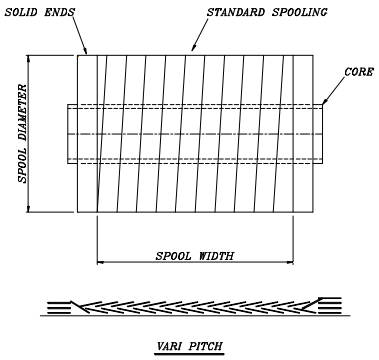
This is basically the same as the step stagger with the additional feature of gradually increasing the step from one spooled width to another. The parameters are set in the same way as a step stagger but the change in width required by the stagger is gradual over the number of passes entered.



SINOSODIAL STAGGER

STEPPED-ENDS™.

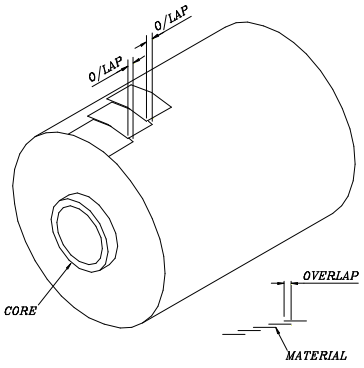
The Stepped-EndÊ winding technique is a KT Industries Patented spooling technique when the dwell at the end of the stepped end package is greater than 720º enabling an overlapped wound spooled package to be created with solid ends. Essentially, it is a combination of a pancake and a spool. When spooling product, the end of the package is vulnerable to damage due to the interleaved edges of the material at the end of the spool. The basic principle is to create a pancake at the end of the spool providing protection and then to conventionally spool between the pancakes BUT create a longer length. This technique significantly reduces the distortion created from a Step-PacÊ (KT Industries Patent) product. This principle of spooling is particularly beneficial when processing a thin product (see KT Industries US Patent number 4,568,033).

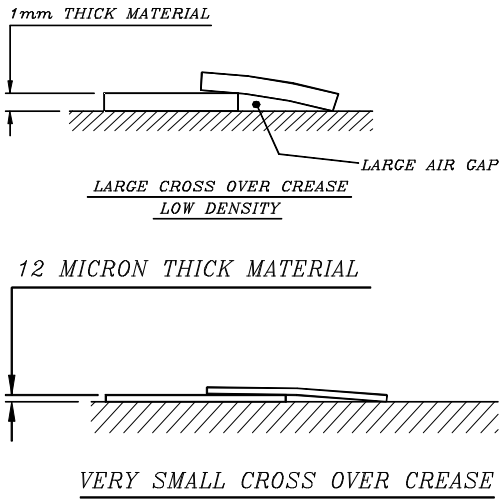


VARI PITCH

OVERLAP.

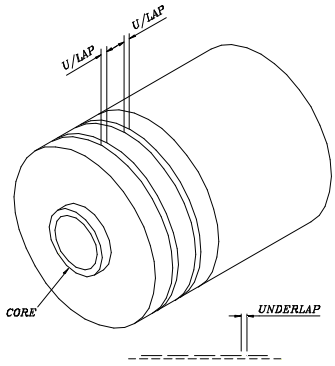
When winding a narrow width tape, if it is wound with 100% overlap you would create a pancake. As you reduce the degree of overlap, the principle of spooling/traverse winding comes into its own. When one layer of material covers the preceding layer of material this is the amount of overlap.

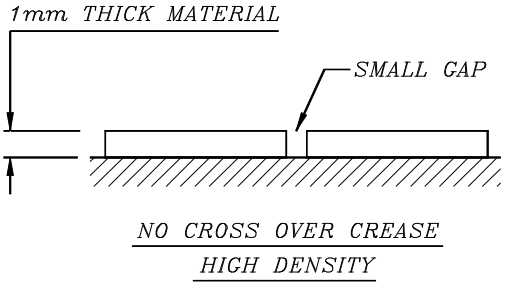




UNDERLAP (NEGATIVE OVERLAP).

When traverse winding a package, if one layer does not overlap the preceding layer, but leaves a gap between it, then this is said to be winding with an underlap or negative overlap. As this negative overlap becomes large compared to the width of material being processed (typically 10 - 20 times) then the spool is said to be winding using a cross winding principle. The cross winding principle originated from the textile industry when winding small diameter threads.





LOBBING.

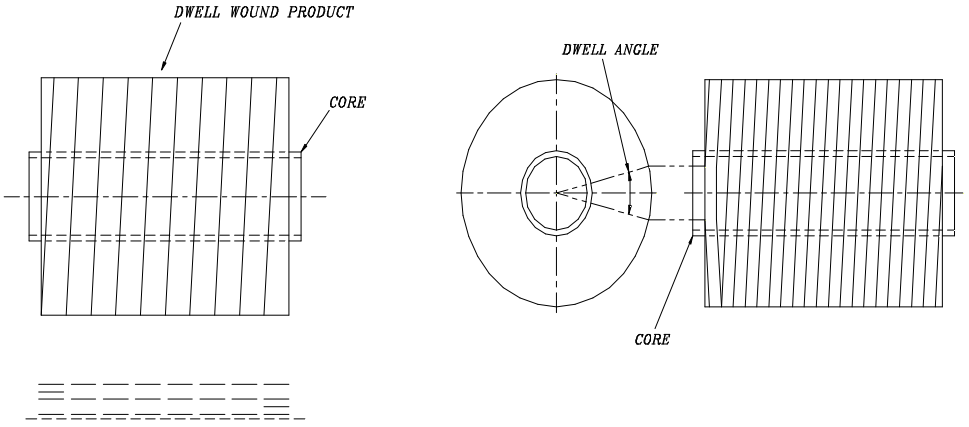
This is a particularly difficult principle to explain but has a great advantage when winding relatively thick materials without the use of pineappling. Essentially, it is the point at the end of the spool where the material reverses direction. When creating a lobed package, the position of reversal is calculated mathematically and retained in exactly the same position throughout the production of the spool. If you imagine a four lobed package, this would mean on one side of the spool there would be four fixed points for reversal, 12 o'clock, 3 o'clock, 6 o'clock and 9 o'clock and at the opposite side of the spool the reversal points would be the same, four of them, 12 o'clock, 3 o'clock, 6 o'clock and 9 o'clock but they will be displaced by 45º. This is because the lobes are spaced at 90º. The displacement will always be half the angle between the lobes.

CYCLIC LOBBING.

Cyclic lobbing is based on the principle of lobbing, however, the reversal point cycles as required. Typically, when processing material using cyclic lobbing the cyclic amount is in the region of a few degrees, so that the reversal changes a small amount each time the traverse reverses until the spool is completed. Depending on the particular product being processed this can create an abnormal spiral effect on the end of the spool.

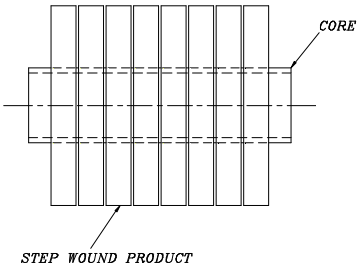
DWELL.

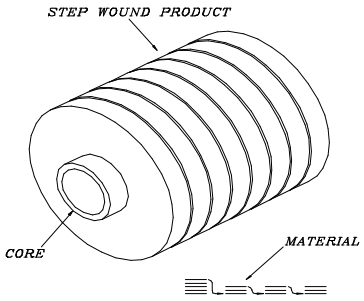
When processing compressive, thin material it is often advantageous to create a dwell or Stepped-EndsÊ (as defined by the KT US Industries Ltd. Patent 4,568,033) at the end of the traverse. This increases the amount of material at the end of the spool and, therefore, creates a more dense package at this point. When processing thin foam or non woven materials the introduction of a dwell at the end of the spool gives greater stability to the finished package. These dwells can vary from a few degrees to hundreds of degrees, depending on the particular type and width of material being processed.



STEP WIND.

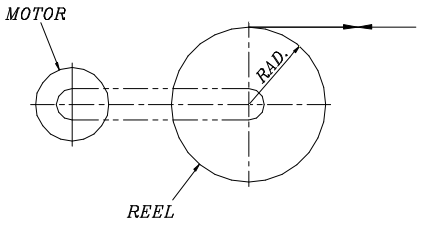
A step wound reel or Step-PacÊ (trademark of KT Industries Ltd., Patent number 4603817) is a reel which is a combination of a pancake and a spool. 3M have a license from KT Industries to process product to create a Step-PacÊ spool called an Opti-Pac. Step wound spools are essentially a combination of winding pancakes and traverse winding. The principle is to wind the material for a given number of revolutions and then traverse the material to the next position for winding again. The layers which have been wound in the fixed position are creating a pancake and then by traversing to the next position and leaving a gap, i.e. a negative overlap or an underlap, the next pancake is wound. This principle is repeated the full width of the core until you end up with a number of pancakes wound next to each other. The multiple pancakes then give support to each other and, therefore, reduce the possibility of telescoping. The overall width of the finished spool is typically a multiple of the width of the tape being processed. There always has to be one layer of material per rewind, prior to traversing taking place for each pancake being wound and at least two winds of material on the end pancakes. The package density of step wound spool is normally much greater than the density of the standard level wound spool due to the reduction in overlap of the material. The higher density means more material is provided in the same volume. The normal process is to step from one position to another in one revolution but this is dependent upon the material being processed, however, it can step in more than one revolution if required. However, in the event of it being possible to traverse the material in this way then the increased package density at the end of a step wound spool increases its stability and reduces its vulnerability due to the pancake type wind. The step wound spool has a number of advantages over the conventional traverse wound spool. During high speed payout the tape is not subjected to inertia problems at the end of the package as it is unwinding as a pancake. This minimises the possibility of the tape dropping off the edge of the spool during the de-spooling process. There are pros and cons when processing all different types of spool wound products and it is necessary to evaluate the particular material being processed prior to determining whether a level wound spool or a step wound spool should be used.





TENSION.

Tension is the force applied to the material to transport it through a machine and wind the material into the finished package. Tension profiles are of paramount importance when winding pancakes or spool wound product. It is possible to spool wind tapes at far lower tensions than planetary wind them. Because of the spooling action, the layers of material are held together by the spooling action, whereas when planetary winding it is necessary to apply forces between the winding layers to hold the material in the planetary package. Compressive forces generated by the rewind tension in a planetary wound narrow width package can be excessive, this will cause distortion to the material and/or the collapsing of the core the material is wound on. Typically, planetary wound narrow width tapes have to be wound at a constant tension profile to give the stability to the package, whereby when winding a spool wound product it is possible to wind the material under a taper tension profile and, therefore, reduce the compressive forces created during the winding of the material. The spooling characteristics used for a particular material and the tension in the material being processed, all contribute towards the density of the package and the compressive forces generated during the winding process. All these factors have to be taken into account to optimise the finished spooled package.



$$MOTOR\ TORQUE = TENSION \times REEL\ RAD.$$

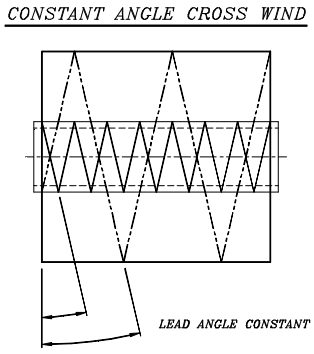
$$\therefore TENSION = \frac{MOTOR\ TORQUE}{REEL\ RADIUS}$$

CROSS WIND.

The principle of cross winding is when the underlap of the material is extremely large. Typically, 20 - 50 times the width of the material being processed. The technique of cross winding comes from the textile industry when a yarn was being spooled. The large underlap was necessary to hold the yarn onto the spool being wound.

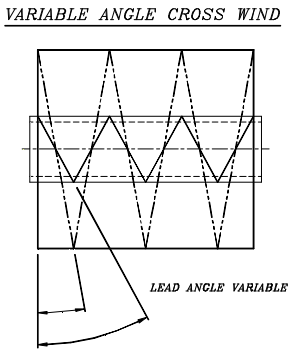
CONSTANT ANGLE CROSS WIND.

This format of winding is the result of a constant traverse speed of the material across the spool during the winding process, irrespective of the diameter of the reel. The basic principle for the constant angle cross wind was the initial technique used when winding yarn, however, this technique is rarely used today when processing flexible packaging materials with the advent of new technologies to enable the winding angle to be varied as the spool diameter increases. The constant angle cross wind has the disadvantage that a pattern is generated during the winding process and, therefore, the layers of the material are continually being laid on top of each other which is a disadvantage as far as stability of the package is concerned. The main advantage of a constant angle cross wind is that the stability of the package created by the cross winding principle is maintained irrespective of the diameter. An inherent characteristic (advantage or disadvantage) of the constant angle cross wind is the varying density of the spool as it is wound.



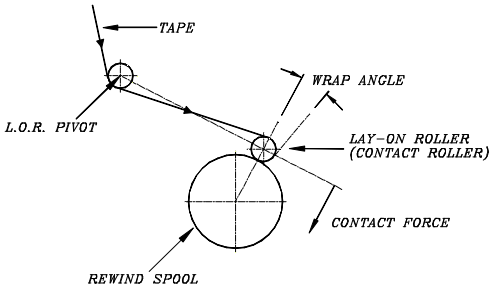
VARIABLE ANGLE CROSS WIND.

The characteristic of a variable angle cross wind is that there is an identical number of traverses across the width of the spool irrespective of the diameter. This ensures that the density of the reel is maintained from minimum diameter to maximum diameter. However, the disadvantage is that the lead angle is reducing as the diameter increases and, therefore, the stability of the spool is reduced, in particular at the edges of the spool.



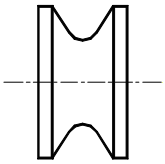
LAY-ON ROLLER.

A lay-on roller or contact roller, as it is sometimes called, is of paramount importance when processing adhesive products and, in particular, as far as non-adhesive products are concerned. The lay-on roller force on the rewinding reel can control the reel density as well as controlling the aesthetic appearance of the package. When processing adhesive material, the tape must be presented to the rewinding spool via the lay-on roller to ensure a flat spool is produced free from ridges. By reducing the wrap angle of the lay-on roller, the lag in the material as it enters the spool is significantly reduced at the turnround point. However, as long as this lag is consistent, it will not affect the quality of the rewind spools appearance is concerned.



DIABLO ROLLER.

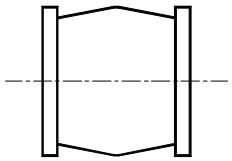
A diablo roller is a roller which is shaped with a groove to try and maintain the position of the tape as it is passing around the roller. You must never use a diablo roller with an adhesive tape making contact with the surface of the roller. It is only suitable for processing narrow width materials up to approximately 5 mm and the material must be flexible, i.e. a filmic substrate as opposed to a paper substrate.



DIABALO ROLLER

CAMBER ROLLER.

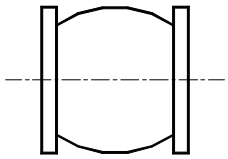
Camber rollers are used to track a material without making any side contact. The shape of the camber is optimised for the particular material being processed. A camber roller must never make contact with an open adhesive otherwise damage will be caused to the product. The principle of a camber roller is that tape will always move to the tight side of the material. Since the camber roller has one tight side, the product should always track on the centre line of the camber. However, if the tape being processed has distortion or poor calliper, the tracking of the material will not be on the centre line of the tape travelling around the roller.



CAMBER ROLLER

BARREL ROLLER.

A barrel roller is another form of camber roller, but is particularly suited to processing flexible materials which suffer from distortion. An open adhesive must never make contact with the surface of a barrel roller even if it is coated with a release coating.

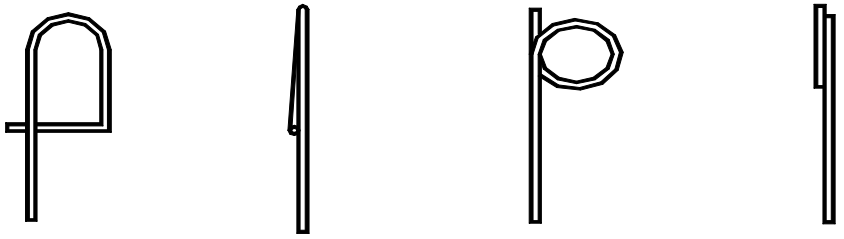


BARREL ROLLER

Note: For the efficient operation of transporting product over a camber roller or a barrel roller, it is necessary to have a minimum of 90° of wrap to ensure roller rotates at web speed. This ensures that the centre line of the tape is aligned to the centre of the camber.

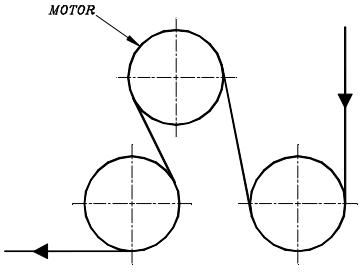
PIGTAIL (PAPERCLIP AND CIRCULAR).

A pigtail is an eyelet which has an opening on its circumference to assist with threading the material through the eye. Pigtails can only be used with narrow width materials of a flexible nature. Typically, the maximum size of tape which can pass through a pigtail is 4 mm. However, by increasing the diameter of the pigtail and the surface finish, larger widths can be processed. It is imperative that an adhesive material does not make contact with a pigtail surface, otherwise damage to the adhesive surface will take place. Pigtails will always introduce friction to the material and, therefore, an increase in tension is necessary to cause the tape to pass through the pigtail. Also, some degree of debris will be created by the rubbing action between the pigtails and the tape being processed.

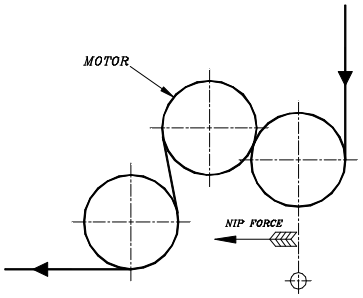


'S' WRAP DRIVE.

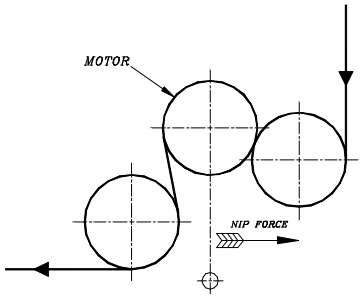
The unique 's' wrap drive system which is incorporated into the pivot point of the traversing arm on the spooling equipment manufactured by Double R Controls Ltd. allows the tape to be drawn from the slitting section of the machine at a constant tension. It also means that the tension in the material is not determined by the rewind tension. It is of paramount importance that the tension of the material as it passes through the machine is at a constant value at all times. Material, on leaving the 's' wrap drive, then enters the rewind section of the spooling machine which can then operate under a constant tension or a taper tension profile. In the event of a taper tension profile being used, the tension imparted into the material at the 's' wrap drive is increased as the rewind torque reduces to ensure that the infeed taper tension to the ósô wrap is constant. The 's' wrap drive motor operates under a torque demand principle with speed limit and, therefore, will accommodate any speed changes and maintain the required tension in the material irrespective of machine speed. Two types of 's' wrap drives are provided, one which uses a nip roller and one which is an open 's' wrap drive. The facility is provided within the nip roller system to adjust the nip roller so that a minimum gap is provided and, therefore, when processing adhesive materials no offset will take place due to the nip contact forces.



OPEN 'S' WRAP DRIVE



'S' WRAP DRIVE WITH NIP



'S' WRAP DRIVE WITH NIP

SPOOLING BENEFITS

The ultimate benefit of a spool wound product is the ability to increase the length of material being presented to the final process. It would be virtually impossible in many narrow width products to achieve a reasonable length material without using this technique. Large quantities of material can be processed in this way, which reduces significantly the down time of the final process. There are other benefits in a spooled product, such as the reduction in the possibility of removing the core from the finished reel due to slippage, since the spooled width of material is far greater than that of a single pancake wound material. The tension requirements of a spooled product are much less than those of a pancake wound material and, therefore, distortion due to elongation is reduced.

Since the material itself is held together on the spool by the spooling action, when de-spooling the ability to control the unwind tension is far easier and also the build-up ratio from outside diameter to inside diameter is much less and, therefore, more controllable. In any process there is always a potential problem in that the operator may miss the end of the reel, thus meaning the equipment needs to be re-threaded. Having a longer length product reduces the number of times this situation could occur. In many applications, users of spooled product are concerned about the de-spooling process and the alignment of the web. This is not a problem at all and, as long as the de-spooling equipment is engineered and optimised for the particular product being processed this perceived disadvantage of a spooled product is totally eliminated. The alignment of the tape to the final product is easily achieved using standard de-spooling equipment. These de-spooling units can vary in costs from tens of pounds to thousands of pounds depending on the size of spools and the types of spools being processed. Both driven and non driven de-spooling units are available to ensure the material is de-spooled at the optimum tension and alignment for the particular process.

There is, however, usually the necessity to install de-spooling equipment in place of the normal pancake unwind unit to ensure that the material from the spool is presented to the final product at the correct position and tension. The responsibility of the company spooling the product should not end there. It is important they ensure the final user has the optimum de-spooling equipment to ensure the maximum efficiency is gained from the use of a spooled product.

Spooling is not the answer to winding every narrow width tape problem, however, it can dramatically increase the efficiency of the operation and ensures that the term **'Spooled product the way to higher productivity'** is a reality.

HINTS AND TIPS FOR SPOOLING

The production of a good quality spooled package is largely dependent on three factors: material tension, lay-on contact force and spooling configuration.

The lay-on contact force and the rewind tension are closely related. An excessive tension will create a diablo shaped reel which can, to some extent, be reduced by the lay-on contact force. However, increasing the lay-on contact force excessively will cause a bulging of the spool and, therefore, a poorly wound package. The relationship between lay-on contact force and the rewind tension for a particular material should be optimised to provide the required characteristics for the spool. By changing the tension in the material being wound and the lay-on contact force, the reel density can be changed and it is recommended that the finished spool is monitored in relation to reel density. This is measurable and can be used from a QA point of view to ensure consistency of finished spools. Very often the final decision with regards to the optimum winding characteristics for a particular product is determined empirically. However, the following information should provide a starting point for the winding characteristics for both adhesive and non-adhesive products.

Q. What are the optimum spooling characteristics?

A. When spooling products it is important that the position that the spooled product turns round is in the correct place. If this is not in the correct place you will find that the edge of the reel instead of having a series of annular rings will have strange shapes due to the turn round position. Typically it is important that you determine the optimum width of spool in relation to the traverse per revolution to ensure that the turnaround point never occurs in exactly the same position. This can be optimised using fixed lobes, however, sometimes, if a dwell is introduced into the process then the fixed lobe principle cannot be used. Therefore it is necessary to determine a width which will create in effect a fixed lobe in incorporating the dwell into the calculation. Basically, it is important you do not have a set of characteristics where the turnaround point at one side of the reel is always in the same position.

Example 1:

If we say we had a product which is 14mm wide and we wanted to underlap it 1 mm, and it was to spool to a width of 314 mm, this would mean that in one traverse we would have had 20 revolutions and we will assume that that traversed left to right. For a spool of width 314 mm we have a traverse width of 300 mm, i.e. 314 mm minus one width of tape creates the traverse width. If we now traverse right to left we would have another 20 revolutions and we would end up at exactly the same point that we started. This would mean that we would be winding with a single lobe. The consequences of this are that the side of the reel would not have annular rings but would have one single reversal point and would give a bad edge profile.

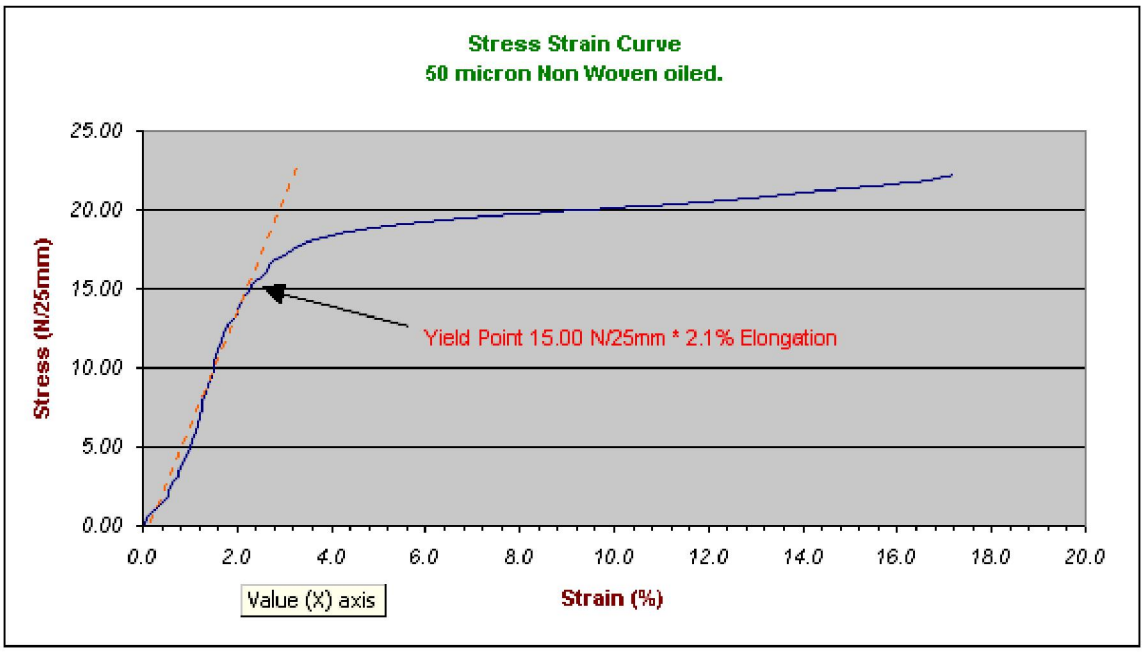
Example 2:

We are winding a material which is 15 mm wide and we have a 1 mm underlap. The width of spool we wish to process is 315 mm and we want to have a 90° dwell. For a spool of width 315 mm we have a traverse width of 300 mm, i.e. 315 mm minus one width of tape creates the traverse width. If we assume we are processing material from left to right we would have a 16 mm pitch, which would mean that over the 300 mm traverse we would have 18.75 revolutions. The traversing mechanism would then stop for 90°, which is a quarter of a revolution, which would then mean that we had done 19 revolutions before we started to return on the traverse. We would then rotate for a further 18.75 revolutions giving a total of 37.75 revolutions. We would dwell for 90° being a quarter of a revolution which would mean that we would have now rotated 38 revolutions and would be back at the point at which we started. Again this is no good.

It is imperative that you do not start and finish at the same place, otherwise you will get a bad profile. It is essential that you create the annular rings by having lobes in the wind. A minimum number of lobes for any process should be 4, however, if you end up with too many lobes you will again create the situation of an unstable package.

Q. What tension should the material be wound at?

A. It is recommended that a load extension curve is created for a material prior to winding it. (See below) This enables you to determine the elastic limit of the material. A starting point for the tension should be in the region of 25 - 30% of the elastic limit of the material being processed.



Q. Should I wind on a bobbin or as a spool?

A. As a general rule of thumb, all adhesive materials can be wound on a spool as opposed to a bobbin. Bobbins are necessary where the material being wound has to be processed at a low tension and has a low co-efficient of friction (i.e. siliconised polythene) or it is very narrow in width and cannot be overlapped for one reason or another. The side flanges of the bobbin then give the finished material support at the edges.

Q. Do I overlap or underlap?

A. Generally, thin flexible materials, whether they are adhesive or non-adhesive, can be overlapped. It is recommended that you never have a 50% overlap, but the actual overlap is determined by experience. Materials of say, 10 - 100 micron thickness, can easily be overlapped without any excessive distortion. Thicker materials should be underlapped to prevent the distortion in the material caused by the overlapping. Reels that are overlapped will have a lower density than reels which are underlapped.

Q. When should I pineapple wind?

A. Pineapple winding reduces the instability of the material at the edges. Typically, pineapple winding has an advantage when processing a thick material of narrow width, i.e. 3 mm thick and 6 mm wide. If the material is not pineapple wound then it would fall off the edges of the spool.

Q. When should I step wind?

A. Step winding is basically a combination of pancake winding and underlap spool winding. the first criteria before attempting to step wind is that the material can traverse its width plus the underlap in one revolution. Step winding can be used when processing both adhesive and non-adhesive products.

Q. What lay-on force should I use?

A. On narrow width spooling equipment, the lay-on roller force is normally not adjustable. The lay-on force should be set to the minimum level to ensure the lay-on roller is in contact with the spool over the full diameter range of winding to optimise the appearance of the finished spool. However, when winding product onto spools of large size, i.e. 1.2 metres diameter by 1.0 metre wide, then the lay-on roller contact force has to be controlled for the particular material being processed. Quite often, the lay-on roller force should increase as the speed of the machine increases to optimise the consolidation of the material being wound.

Q. When should I introduce a dwell in the spooling process?

A. The advantage of introducing a dwell, whether it be a few degrees or hundreds of degrees, is that you increase the consolidation of the material at the end of the spool and, therefore, the stability of the finished spool. Normally, it is only possible to introduce a dwell into the winding characteristics if the material being processed is relatively thin, or will not suffer from consolidation. If possible you should always introduce a dwell to reduce the apparent cast in the material being wound. In the event of a dwell being introduced into the winding characteristics, it is not possible to lobe the winding package.

Q. When should I have lobes?

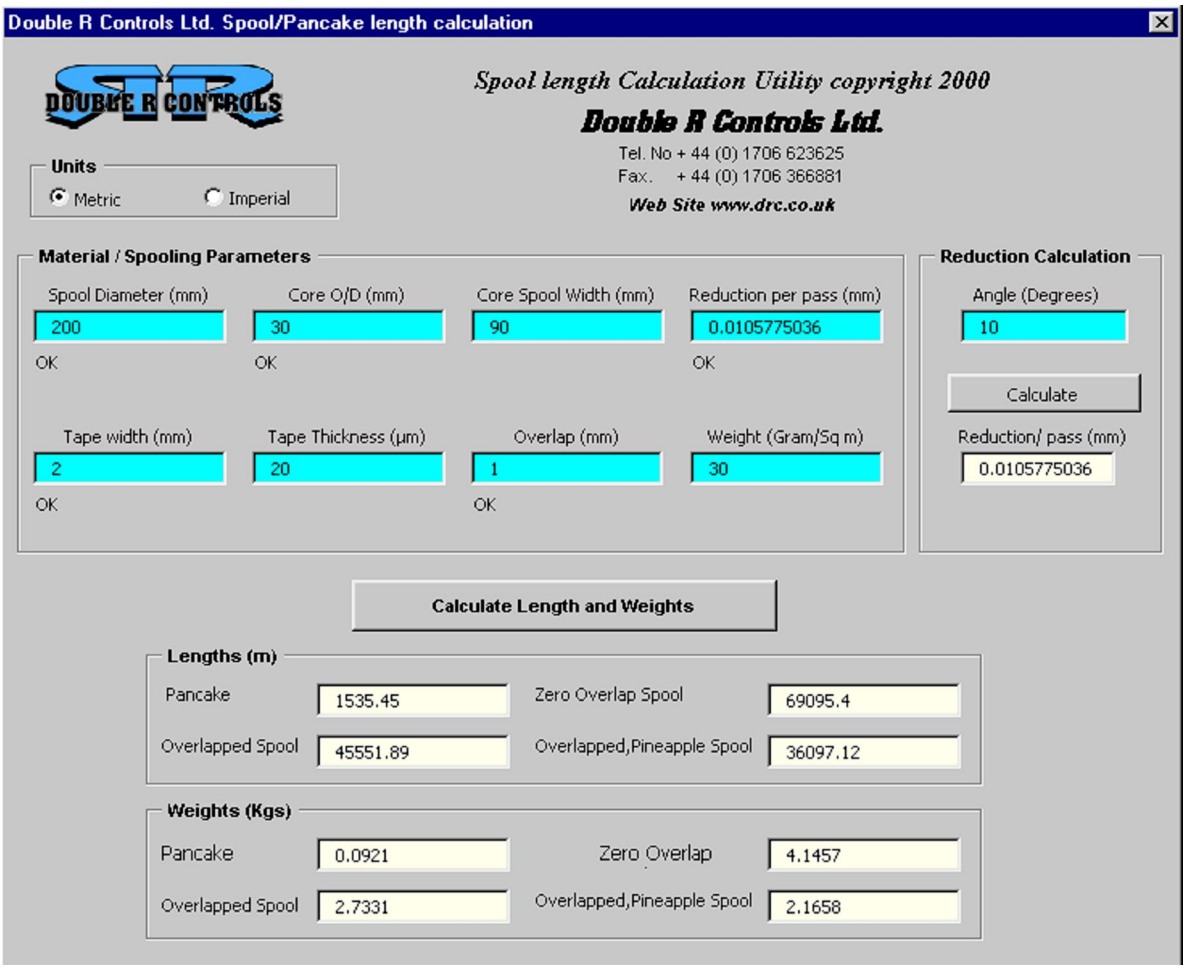
A. Basically, there is always an advantage in winding all materials incorporating a lobe. This ensures uniformity of the finished spool and also gives a pleasing aesthetic appearance to the finished product. When processing thick material, it is of paramount importance that the product is lobed to ensure there is a space available at the turnround point for the material to lie flat. When processing a relatively rigid material, such as a bandoliering tape of width 12 mm and thickness of say, 250 micron, the advantages of lobbing are enormous to ensure the finished package is flat. Lobbing creates a series of consistent annular rings.

Q. What 's' wrap tension should I run at?

A. The unique ósô wrap drive and 's' wrap tension is provided to ensure that the material is drawn from the unwind section of the machine at an acceptable continuous level to maintain alignment of the material as it passes round the various path rollers. The actual value of this tension should be such that the sum of the rewind tension and the 's' wrap tension is no greater than 40% of the elastic limit for the particular material being processed. The unique traversing arm used by Double R Controls Ltd. in its spooling equipment is the heart of the spooling action. The infeed material is pivoted on its natural axis (the position of the ósô wrap drive) to prevent any distortion and this principle ensures no side contact is made to the material at any time and, therefore, prevents twisting of the material or damage to the edges. The position of the traversing arm is controlled electronically to ensure that the desired winding characteristics are imparted to the material during the winding process. The traversing arm has a mechanical slide system incorporated into it to ensure that the infeed material and the outfeed material is maintained in a fixed vertical plane at all times, thus ensuring that no distortion to the material takes place during the traversing and spooling process. The rewind tension is maintained by monitoring the tension in the material by means of the tension sensing roller and a signal from this is fed back to the rewind drive control system to ensure the rewind tension is at the desired level at all times. By incorporating the 's' wrap assembly into the traversing arm, it enables the material to be wound under either a constant tension profile or a taper tension profile depending on the specific requirements of product.

Q. How do I determine the length of material on a spool?

A. The following is an Excel spreadsheet that can be used to calculate both the approximate length on a spool, approximate length on a pancake and the approximate weight in each case



Q. What length of material can I create on a spool?

A. The following software is provided to allow you to enter the required spool parameters and then, by pressing the calculate button, the length of material on the spool will be displayed. It can be seen from figure one below that the information can be entered in both metric and imperial units (the default value is metric).

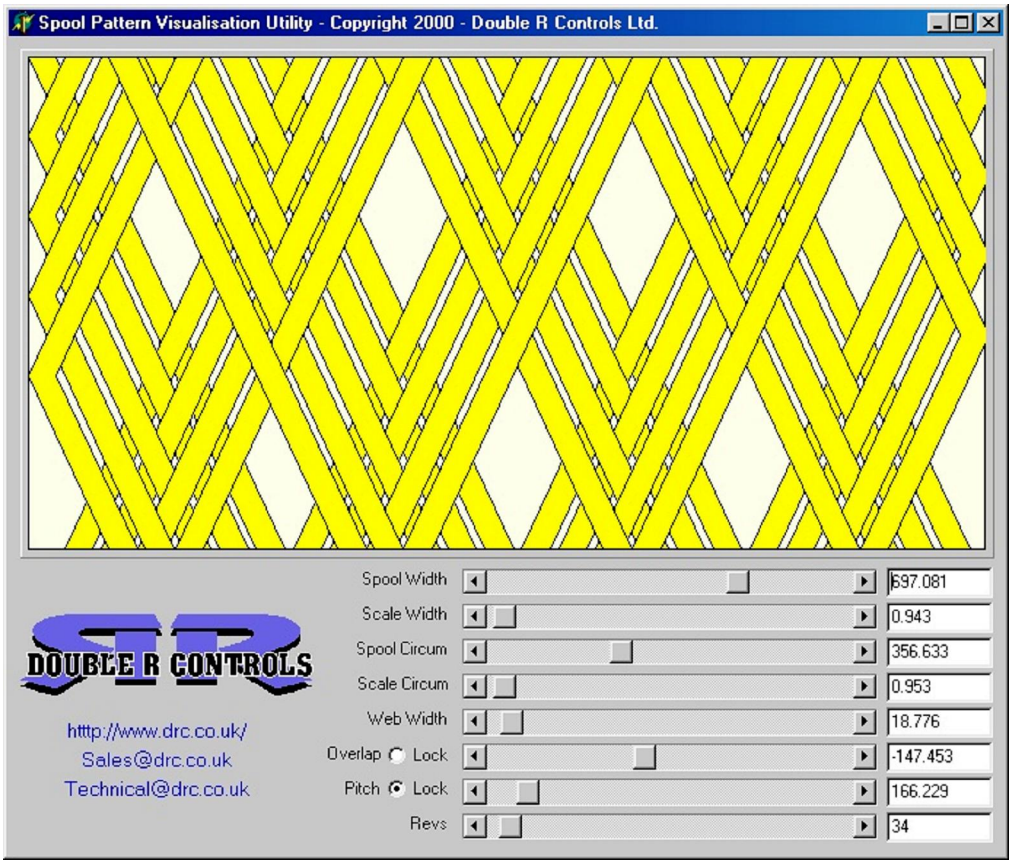
The spool diameter, core outside diameter and core spool width should be entered as well as the width of the tape to be processed, the thickness of the tape and the overlap. The overlap can be entered in as both a positive and negative number. If the overlap is set to the same value as to the tape width then this will give the information associated with a pancake or a reel of material. We also recommend that the weight of the material be entered in grams per square metre to enable the overall weight of the finished spool or reel to be calculated. In the event of the product being spooled with a pineapple format and you do not know the reduction per pass for the pineapple but you do know the angle then this can be calculated from the reduction calculation box and then entered into the material spooling parameter box. If an inverse pineapple is produced then the number is positive and if a standard pineapple is produced then the number should have a negative sign.

By clicking onto the hyperlink below this will open he programme for spool length calculating. SpoolLength.xls.

Q. How can I look at the winding pattern without creating a spool empirically?

A. This is easy with the DRC Spooling Pattern Generator. Attached is a piece of software which allows you adjust the various spooling perameters and then observe how the spool would be created during winding.

By clicking onto the hyperlink below this will open he programme for spool pattern generator spoolpattern.exe

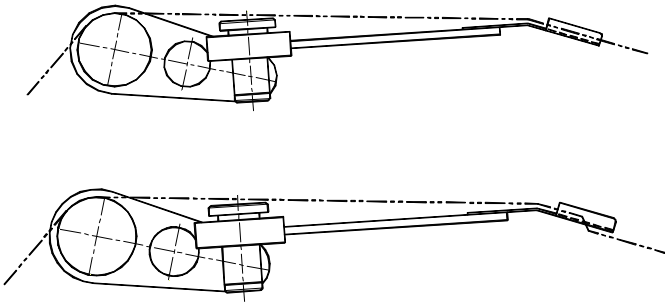


BOBBIN WINDING

When processing material onto bobbins it is not possible to have a full width lay-on roller resting on the material due to the flanges of the bobbin, therefore, alternative techniques have to be used. Double R Controls have developed two types of fingers which are able to process product on bobbins, however depending on the type of finger employed. When processing product using static or dynamic fingers it is not possible to measure the diameter of the reel and therefore feed forward information with regards to the tension profile of the rewinding reel. To overcome this a mathematical calculation is done with regards to the rpm of the reel and the line speed, which then computes the diameter of the reel, which in turn can be used as a feed forward signal in the rewind tension control circuit. This diameter computation is re-set every time the rewind is unloaded as it is assumed that at an unload the bobbin is being changed for a new one. Diameter measurement or calculation is of paramount importance to ensure the feed forward technique can be incorporated into the control philosophy for the rewind tension control.

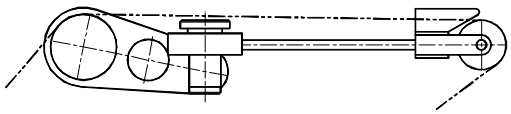
STATIC FINGER

Static fingers are the more traditional technique used for winding material onto bobbins. A static finger has the disadvantage that it makes contact with the material and, if the material susceptible to scratching, it will be damaged by contact with the static finger. In principle the material enters a groove at the end of a finger which reciprocates with the traversing motion to create the spooling action. The static finger can also have an eye in the end of it to allow the material to pass through the eye and therefore give more support to the material during the traversing motion. It must however be remembered that this technique will tend to scratch the material on the surface and will also be making side contact with the material. The force of the dynamic finger onto the rewinding reel is controlled by the weight of the roller and does not have any means of adjustment.



DYNAMIC FINGER

An alternative to the static finger is to use a dynamic finger which can have incorporated into it a chute to assist with directing the material. The surface finish of the dynamic finger roller can be adjusted to suit the type of material being processed, typically this surface is knurled to increase the co-efficient of friction between the material and the roller. Mounted on the infeed to the dynamic roller is chute, which is designed to have a width between the side flanges slightly greater than the material being processed. The combination of the chute and the dynamic finger is an excellent way of processing materials on flanged bobbins. It has the advantage of incorporating the unique traversing system, developed by Double R Controls, and incorporates the lay-on roller effect created by the dynamic finger roller. The force of the dynamic finger onto the rewinding reel is controlled by the weight of the roller and does not have any means of adjustment.



DISCLAIMER.

Whilst every precaution has been taken in the preparation of this document, the author assumes no responsibility for errors and omissions. Neither is any liability assumed for damages resulting from the use of the information contained herein.

All trade marks and tradenames are the property of their respective manufacturers/owners.