Application of MELCO™ tapes on moisture-permeable waterproof *3-ply* laminates

Moisture-permeable 3-ply waterproof laminates can be grouped into two categories, according to the structure of the middle membrane. Most moisture-permeable waterproof laminates that are currently available use a microporous hydrophobic membrane (which repels water completely) as the middle layer. However, non-porous hydrophilic membranes (which absorb water to a degree) are also available. It is essential to know which type of moisture-permeable middle membrane is used in the material, so you can choose the appropriate tape. The following chart shows which MELCO™ tape is best suited to each type of middle membrane.

type of moisture-permeable waterproof membrane	membrane structure	* MELCO™ tape
microporous hydrophobic membrane	microporous polytetrafluoroethylene membrane (such as *GoreTex*®)	———
	microporous hydrophobic polyurethane membrane — standard-type polyurethane, which is polycondensated with polyester-type polyol and isocyate, (the majority of the moisture-permeable water- proof materials being on the market).	**T-2000 series**
non-porous hydrophilic membrane	non-porous hydrophilic polyurethane membrane — polyurethane containing a large percentage of "special diol group" (such as polyether-type polyol or aromatic polyol). non-porous hydrophilic polyester membrane — block copolymer with polybutylene-terephthalate and long-chain polyol (such as "*Sympatex*® *ASM elastic*").	**XT-2755**

* There is an area of overlap. Under certain circumstances T-2000 series tapes can be used on non-porous hydrophilic membranes, and XT-2755 tape can be applied to microporous hydrophobic membranes. Please contact us for more specific information.

A. MELCO™ T-2000 series tape for 3-ply laminates with a microporous hydrophobic membrane

MELCO™ T-2000 series tape can be welded onto various materials. MELCO™ T-2000 series tapes are classified below according to material type:

1. **moisture-permeable waterproof 3-ply laminate *garment* materials**
   - **T-2000X tape:** standard type
   - **T-2100 tape:** for application onto 3-ply waterproof materials with an extremely thin backing tricot layer (knit with fine denier yarn)
   - **T-2500 tape:** a flexible version of T-2000X

2. **moisture-permeable waterproof 3-ply laminate *shoe* materials**
   - **T-2010 tape**

B. MELCO™ XT-2755 tape for 3-ply laminates with a non-porous hydrophilic membrane

MELCO™ XT-2755 tape can be applied to 3-ply moisture-permeable waterproof materials, especially with non-porous hydrophilic membrane:

- **XT-2755 tape:** mainly for garment materials

When welding 3-ply waterproof materials, it is important to keep in mind that *the surface is not film*, but instead is a porous textile. For good adhesion, the glue must completely penetrate and saturate the textile for the following reasons:

a) The glue must saturate the textile layer completely through to the middle layer, to prevent leakage.

b) Textile surfaces can absorb water. If the glue has only partially saturated the textile layer, subsequent cycles of absorption and dehydration (swelling/contracting) will change the dimensions of textile underneath the tape, possibly loosening the glue eventually.

Thus, the adhesive *must* saturate the textile layer thoroughly, covering each individual fiber, and preventing fibers from swelling. This protects the textile beneath the weld from the absorption/dehydration cycle, and insures firm bonding.

The following factors are important to consider in order to achieve satisfactory welding with MELCO™ T-2000 series and XT-2755 tapes.

1. Construction of the backing tricot

   The construction of the backing fabric (fineness of the yarn, number of wales/course, twist yarn or brushed tricot, etc.) affects the saturation of the tape adhesive into the fabric layer. Theoretically, adhesive with a very low melting viscosity would saturate any kind of fabric layer thoroughly; however practically speaking, it is impossible to produce a heat-sealing tape with such a low melting viscosity due to its effects on the flexibility of the tape, etc. Therefore, you should take construction of the backing fabric into consideration in setting a production plan.

2. The binder used to laminate the membrane and the backing tricot

   The type of the binder used to bond the membrane and the tricot is one of the key factors (regretfully not a well-known factor) that determines the dry-cleaning resistance of a welded material. It is common knowledge in the field that a two-part liquid system binder should be used to bond the membrane to the tricot in the production of 3-ply waterproof materials. As a crosslinking structure has been applied to this type of binder, its absorption capacity of dry-cleaning solvent is comparatively small. In other words, its swelling/desolvating rate of the dry-cleaning solvent is well-suited to the tape adhesive (which is also dry-cleaning resistant). Consequently, the welded material will be dry-cleaning resistant.

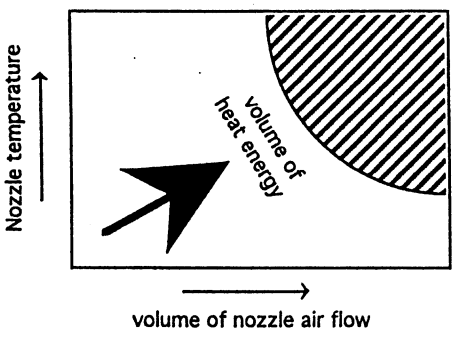
However, due to a lack of proper technical knowledge, sometimes the membrane is bonded to the tricot using a dry-laminating method in some 3-ply waterproof materials for garments. In this lamination, a one-part liquid system elastomer is used as a binder, and the binder is thermoplastic in nature. As it does not go through the cross-linking process, the binder absorbs a certain amount of dry-cleaning solvent (in proportion to its molecular weight). Since the binder's swelling/desolvating rate of dry-cleaning solvent is high, and differs considerably from that of the tape adhesive, adhesion is weakened when the welded material is soaked in dry cleaning solvent.

3. Heat energy

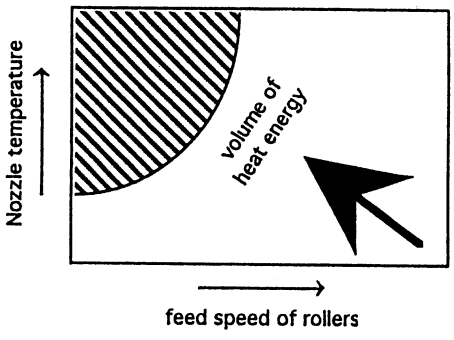
Hot-melt adhesive becomes increasingly pliant and liquefied as heat is applied. Hot-melt cloth tape contains three distinct layers: cloth backing, a primer layer, and the adhesive layer. If heat is lightly applied to the tape, the adhesive layer will start to melt, and the bond between the adhesive layer and the primer layer is actually weakened. To regain the original strong bond between the two layers, enough heat energy must be applied to the tape to melt the adhesive *completely* (thus re-saturating the primer layer).

The heat energy applied to the tape adhesive by a hot-air sealing machine is determined by the three separate variables: (a) the air temperature from the nozzle, (b) the volume of nozzle air flow, and (c) the feed speed of the rollers. When the tape is welded over stitches on 3-ply waterproof materials, the conditions under which successful welds (welds that achieve sufficient water pressure resistance) may be achieved are shown in the shaded areas of the charts as below.

When the pressure and the feed speed of rollers remain constant:



When the pressure and the volume of nozzle air flow remain constant:



Please keep in mind the relationship of these three variables, when choosing the ideal machine settings for your particular application.

4. Welding tips

When welding tape using a heat-sealing machine, it is important to supply the correct amount of heat energy to the tape. The *upper roller temperature* is a key factor for an optimum weld. The lower the temperature of the upper roller, the greater the loss of heat energy (required for melting the tape adhesive). Usually, machines are equipped with a metal lower roller and a silicone rubber upper roller. The hot air from the nozzle of the machine is the only heat source. If you do actual welding immediately after the machine is turned on (and after it has been set to a certain temperature), not all of the heat is used to melt the adhesive on the tape; some heat will dissipate on the upper silicone rubber roller and into the surrounding air. This problem is magnified when the surrounding room temperature is low. Therefore, you should do some dry runs before doing actual welding at the beginning of a day, or after a break. This will help disperse heat across the upper roller, and will minimize the lost heat energy. We recommend that the dry runs continue until the upper roller heats up to at least 50℃ (preferably 70-80℃). It would be a good idea to use a digital thermometer to check the upper roller temperature often, so that the above temperature can be maintained throughout operation.

If the welding is done with insufficient upper roller temperature (such as below 30-40℃), it will result in incomplete welding. The feed speed of the rollers should be set rather slow in order to minimize the loss of the heat energy (when a heated upper roller is not used).

When hot air strikes the middle of the tape, heat energy flows from the center out to the sides of the tape. Thus, the sides of the tape have less heat than the center. When the tape is fed through the rollers, this difference in delivered heat energy is magnified, and results in uneven welding (unsatisfactory saturation of the adhesive).

However, when a *heated* upper roller is used, the upper roller helps disperse heat energy equally over the tape, and compensates for the loss of heat energy at the sides. This results in even welds all the way across the tape (from one edge to the other).

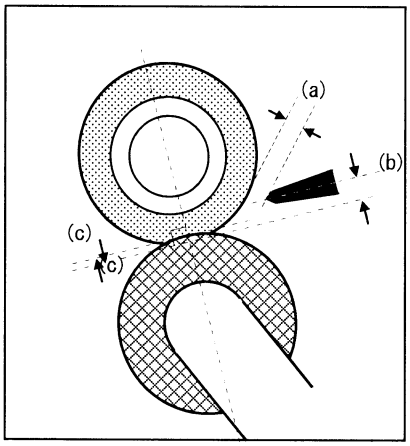
5. Machine settings and welding conditions

When using a hot-air sealing machine, you must become familiar with the machine's structural characteristics. Acquaint yourself with all of the adjustments you will be required to make. These adjustments greatly affect the integrity of the welds.

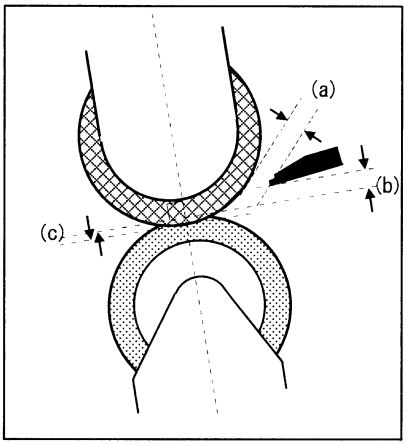
Following are two different sets of welding conditions for different types of hot-air sealing machines: one *does not* have a heated upper roller (such as PFAFF), and the other *does* have a heated upper roller (such as Queen Light).

Machine Settings

PFAFF: 8304-005



Queen Light: QHP905



	PFAFF 8304-005	Queen Light QHP905
Heater capacity	3.0 KW	2.0 KW
Constitution of rollers : (standard specification) upper roller	silicone rubber (hardness: 50)	metal (equipped with heater)
bottom roller	metal	silicone rubber (hardness: 55)
Distance between upper and bottom rollers (c)* (bottom dead center)	-1～-2 mm (-3 mm)	-1～-2 mm (-4 mm)
NOZZLE SETTINGS		
Nozzle air volume	0.5 bar **	0.08 MPa **
Distance between nozzle and tape (a)	3.0 mm	2.0 mm
Distance from material to nozzle bottom (b)	3.0 mm	3.0 mm
ROLLER SETTINGS		
Roller air pressure	5.0 bar **	0.5 MPa **
Upper roller temperature	— ***	75 ± 5℃

* The distance should be set appropriately according to the thickness/ softness/flexibility of the applied material.

** 1.0bar = 0.1MPa = 1.02Kg/cm^2

*** When the machine is not equipped with a heated upper roller (like the PFAFF machine), you should do some dry runs until the upper roller heats up to at least 50℃ before doing actual welding at the beginning of a day, or after a break. This will disperse the heat across the upper roller, minimizing lost heat energy (please note that some heat will dissipate in the upper roller and surrounding air).

a) Welding conditions for MELCO™ T-2000X tape

	PFAFF 8304-005	Queen Light QH905
Distance between upper and lower rollers (c)	-1.0mm*	-2.0mm*
Nozzle temperature	500～550℃	500～550℃
Upper roller temperature	— **	75±5℃
Feed speed of rollers	2.5～3.5m/min***	2.3～3.0m/min

* The distance between the upper and lower rollers is rarely set to "bottom dead center." It is more commonly set near "bottom dead center." This setting accounts for various factors, such as (1) the surface friction between the material and the upper/lower rollers and, (2) the flexibility, elasticity and thickness of the material being welded.

** We highly recommend heating the upper roller to 50℃ by doing some dry runs before doing actual welding.

*** When using PFAFF 8304, the feed speed should be set faster than 2.0 m/min. Otherwise, wrinkles may occur over the tape crossing area.

When the above welding conditions are met, the welds will be sufficiently waterproof (50KPa x 2min. at the tape crossing area, after washing five times at 40℃ and dry cleaning five times in perchloroethylene). All welding conditions mentioned hereafter meet the above waterproof standard.

c) Welding conditions for MELCO™ T-2100 tape

MELCO™ T-2100 tape is designed for application onto soft and thin 3-ply waterproof materials which have a very flexible fabric in the outer layer, and:

- an extremely thin tricot layer that is knit with thin filament of 15 denier and under, and/or
- a loosely knit tricot layer (with fewer numbers of wales/course).

Sometimes, when tape is welded onto thin flexible 3-ply waterproof material (such as an extremely thin tricot layer that is knit with thin filament), the outline of the tape becomes visible from the outside of the material. T-2100 tape minimizes this problem.

	PFAFF 8304-005	Queen Light QH905
Distance between upper and lower rollers (c)	-1.0mm*	-2.0mm*
Nozzle temperature	500～530℃	500～530℃
Upper roller temperature	— **	75±5℃
Feed speed of rollers	2.5～3.5m/min***	2.3～3.0m/min

* The distance between the upper and lower rollers is rarely set to "bottom dead center." It is more commonly set near "bottom dead center." This setting accounts for various factors, such as (1) the surface friction between the material and the upper/lower rollers and, (2) the flexibility, elasticity and thickness of the material being welded.

** We highly recommend to heat the upper roller to 50℃ by doing some dry runs before doing actual welding.

*** When using PFAFF 8304, the feed speed should be set faster than 2.0 m/min. Otherwise, wrinkles may occur over the tape crossing area.

When tape is welded onto a very thin material, perfect welding sometimes can be achieved with lower heat energy (lower nozzle temperatures and faster welding speed), compared with the welding conditions for T-2000X tape. This is due to better heat efficiency in thin materials: less heat is lost as the heat disperses through the material.

Please note that MELCO™ T-2100 tape is not suitable for 3-ply waterproof materials with a tricot backing knitted with 20 denier (or higher) yarn.

d) Welding conditions for MELCO™ T-2500 tape

MELCO™ T-2500 tape is a flexible version of T-2000X tape. It is designed for application onto 3-ply waterproof materials containing a twisted yarn tricot or brushed tricot as a backing fabric. The welding speed needs to be lowered to achieve complete penetration of the tape adhesive into the twisted yarn tricot or brushed tricot.

	PFAFF 8304-005	Queen Light QH905
Distance between upper and lower rollers (c)	-1.0mm*	-2.0mm*
Nozzle temperature	550～600℃	550～600℃
Upper roller temperature	— **	75±5℃
Feed speed of rollers	＜2.3m/min***	＜2.3m/min

* The distance between the upper and lower rollers is rarely set to "bottom dead center." It is more commonly set near "bottom dead center." This setting accounts for various factors, such as (1) the surface friction between the material and the upper/lower rollers and, (2) the flexibility, elasticity and thickness of the material being welded.

** We highly recommend to heat the upper roller to 50℃ by doing some dry runs before doing actual welding.

*** When using PFAFF 8304, the feed speed should be set faster than 2.0 m/min. Otherwise, wrinkles may occur over the tape crossing area.

e) Welding conditions for MELCO™ T-2010 tape

MELCO™ T-2010 tape is usually used for 3-ply waterproof shoe materials. The same welding conditions for T-2000X tape can be applied to T-2010 tape:

	PFAFF 8304-005	Queen Light QH905
Distance between upper and lower rollers (c)	-1.0mm*	-2.0mm*
Nozzle temperature	350～500℃	350～500℃
Upper roller temperature	— **	75±5℃
Feed speed of rollers	2.0～3.0 m/min***	1.5～3.0 m/min

* The distance between the upper and lower rollers is rarely set to "bottom dead center." It is more commonly set near "bottom dead center." This setting accounts for various factors, such as (1) the surface friction between the material and the upper/lower rollers and, (2) the flexibility, elasticity and thickness of the material being welded.

** We highly recommend to heat the upper roller to 50℃ by doing some dry runs before doing actual welding.

*** When using PFAFF 8304, the feed speed should be set faster than 2.0 m/min. Otherwise, wrinkles may occur over the tape crossing area.

When the above welding conditions are met, the welds will be sufficiently waterproof (30KPa x 2min. after washing five times at 40℃). Water pressure resistance can easily be raised to approximately 50Kpa x 2min. by adjusting the above welding conditions slightly.

f) Welding conditions for MELCO™ XT-2755 tape

The same welding conditions for T-2000X can be applied to MELCO™ XT-2755 tape:

	PFAFF 8304-005	Queen Light QH905
Distance between upper and lower rollers (c)	-1.0mm*	-2.0mm*
Nozzle temperature	520～540℃	520～540℃
Upper roller temperature	— **	75±5℃
Feed speed of rollers	2.0～3.5 m/min***	1.5～3.0 m/min

* The distance between the upper and lower rollers is rarely set to "bottom dead center." It is more commonly set near "bottom dead center." This setting accounts for various factors, such as (1) the surface friction between the material and the upper/lower rollers and, (2) the flexibility, elasticity and thickness of the material being welded.

** We highly recommend to heat the upper roller to 50℃ by doing some dry runs before doing actual welding.

*** When using PFAFF 8304, the feed speed should be set faster than 2.0 m/min. Otherwise, wrinkles may occur over the tape crossing area.

When the above welding conditions are met, the welds will be sufficiently waterproof (30KPa x 2min. after washing five times at 40℃, and dry cleaning five times in perchloroethylene). Water pressure resistance can easily be raised to approximately 50Kpa x 2min. by adjusting the above welding conditions slightly.

The above machine settings are recommendations based on assumed conditions. The specific welding conditions required for a particular situation will differ depending on factors such as nozzle placement, model of machine, room temperature, humidity, material being welded, sewing method employed in the material, etc. Please make sure to do enough testing to insure optimum settings for your specific situation.