

Differentiating Through-the-weave PU Covered hoses from 3-ply PU covered hoses

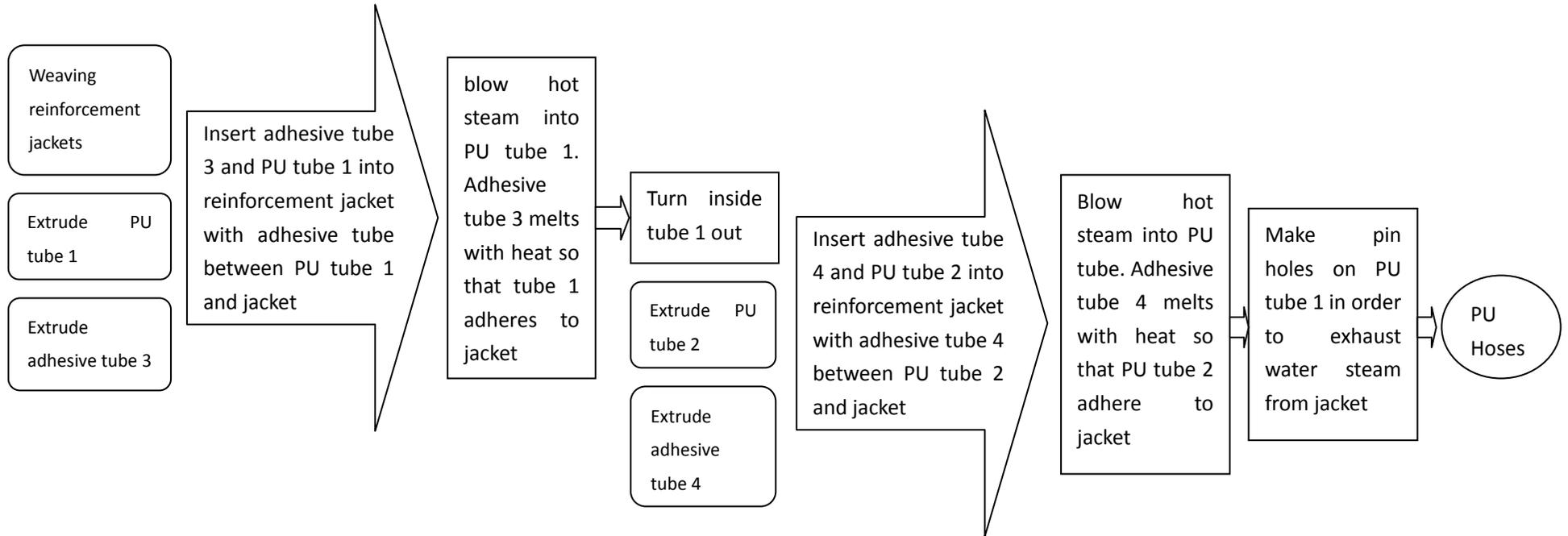
By Aaron Homing Ni and David Xihui Zhao*

The manufacturers of Polyurethane (PU) layflat hose in the world might apply two types of technologies to extrude hoses: through-the-weave (or single extrusion) technology and 3-ply technology (or four extrusions or 5 plies, because 2 plies of adhesive tubes are necessary). Most of manufacturers in the world apply through-the-weave technology to get PU covered layflat hoses because through-the-weave PU covered hoses contains a lot of advantage on 3-ply PU covered hoses. For ordinary water discharge, both 3-ply PU covered layflat hoses and through-the-weave PU hoses are applicable. However, for frac water transfer, through-the-weave PU covered hoses are better options.

This article will details the production procedures of both types of PU covered hoses and the advantage of through-the-weave PU hoses so that users of PU covered hoses can understand why most of manufacturers in the world choose through-the-weave technology to produce hoses.

Production procedure of 3-ply PU hoses

The following flow chart addresses the production procedure of 3-ply PU hoses.

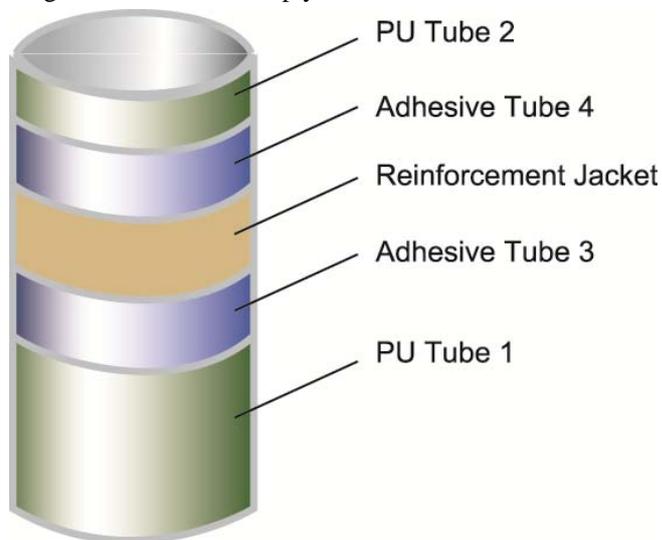


According to the production procedures of 3-ply PU hoses, one piece of PU covered hoses need four extrusions of different tubes. Adhesive tubes melt so the finished hoses seem contain only 3 plies: cover tube, inside tube and reinforcement jacket, which is the reason why some manufacturers call these four extrusion PU hoses as 3-ply PU covered hoses. In order to exhaust moisture on reinforcement jacket, a lot of pin-holes have to be made on the cover of 3-ply PU hoses.

There are three main chemical classes of TPU: polyester, polyether and a smaller class known as polycaprolactone (Huntsman)¹. Usually the cover and tube of PU hoses are made of Polyether Polyurethane. Polyether TPUs are slightly lower in specific gravity than polyester and polycaprolactone grades. They offer low temperature flexibility and good abrasion and tear resilience. They are also durable against microbial attack and provide excellent hydrolysis resistance – making them suitable for applications where water is a consideration.

However, In order to adhere PU tube and jacket together, usually only Polyester-Polyurethane-based adhesive is applied because Polyester TPUs are compatible with PVC and other polar plastics and are perfect for use in polyblends. However, Polyester-polyurethane-based adhesive is easy to be destroyed by temperature² or water or moisture³ which will re-enter jackets through pin-holes on the cover of 3-ply PU hoses, which results in cover tube delaminating from reinforcement jacket.

Diagram 1 Structure of 3-ply PU hoses



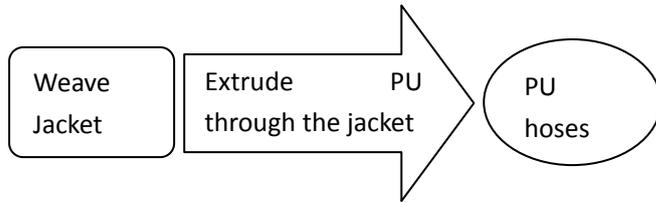
Production of through-the-weave PU hoses

The following is the production procedure of through-the-weave PU hoses.

¹ http://www.huntsman.com/portal/page/portal/polyurethanes/Media%20Library/global/files/guide_tpu.pdf

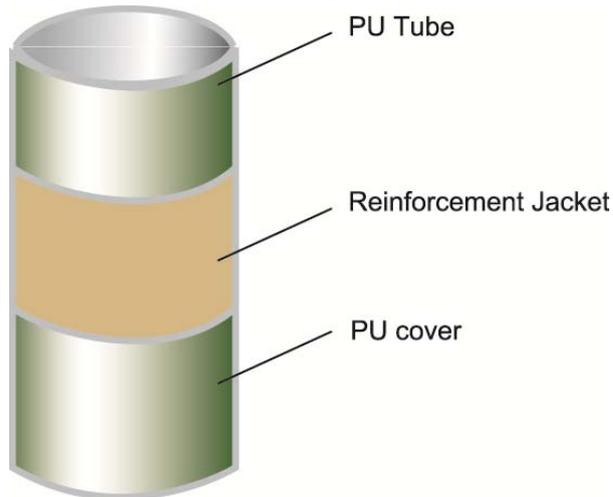
² Polyester-based TPU glue can melt again at around 120 C Degrees (248 F Degrees).

³ Polyester-based TPU may be put at risk by hydrolysis when exposed to high temperature levels and in humid environments. Problems typically start to occur when water molecules cause ester groups to split.



According to the production procedures of through-the-weave PU hoses, only one extrusion is necessary and no adhesive is needed. In fact PU tube, reinforcement jacket and PU cover are in one section.

Diagram 2 Structure of Through-the-weave PU hoses



Comparison through-the-weave PU hoses with 3-ply PU hoses

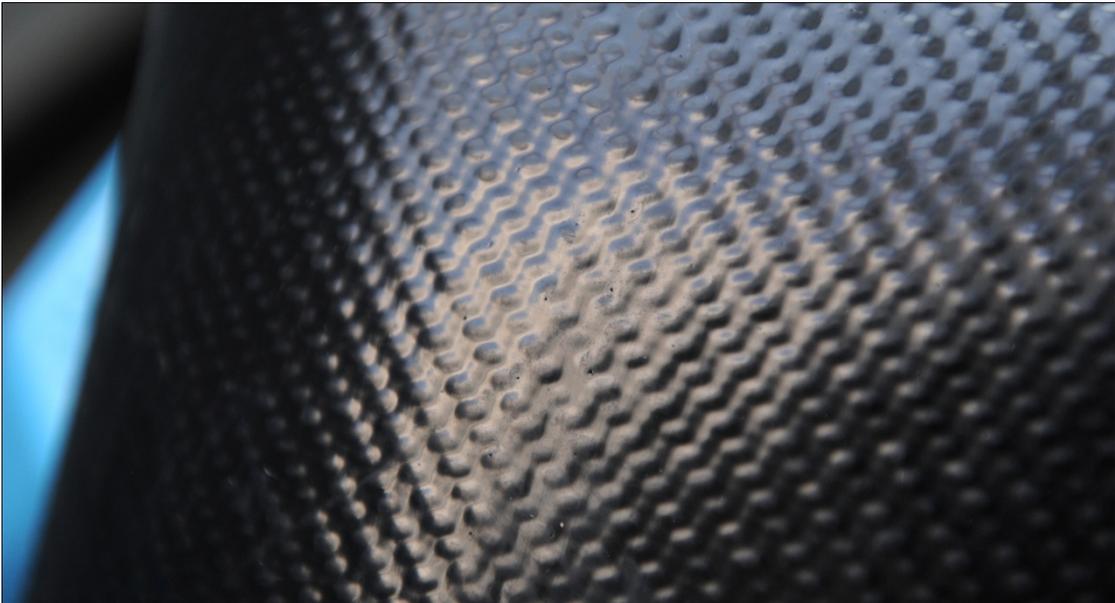
1. No adhesive is needed for through-the-weave PU hoses. PU cover, tube and jacket of through-the-weave PU hoses are in one section. 3-ply PU hoses need adhesive to combine cover, tube and jackets together.
2. A lot of pin holes on the PU cover (PU tube 1) are necessary, in long term usage, moisture can get back to jacket through pin-holes on the PU cover and destroy the performance of adhesive. Therefore, 3-ply PU hoses have much higher possibility of delamination risk than through-the-weave PU hoses.
3. 3-ply technology contains one procedure “turn inside tube out” so that the PU cover/PU tube 1 can’t be thick enough. If PU tube 1 is very thick, it is very difficult to turn the inside tube out. This is the reason why some manufacturers of 3-ply PU hoses offer PU hoses with thin wall thickness. However, the thicker wall, the better performance in abrasion and abuse resistance.
4. 3-ply PU hoses have much higher elongation rate, which is about 8-10%. Through-the-weave PU hoses have about 1% elongation rate. For the long-distance project, high elongation rate result in hose management out of control.
5. If end-users increase water pressure to working pressure in 3-ply PU hoses, PU hoses will

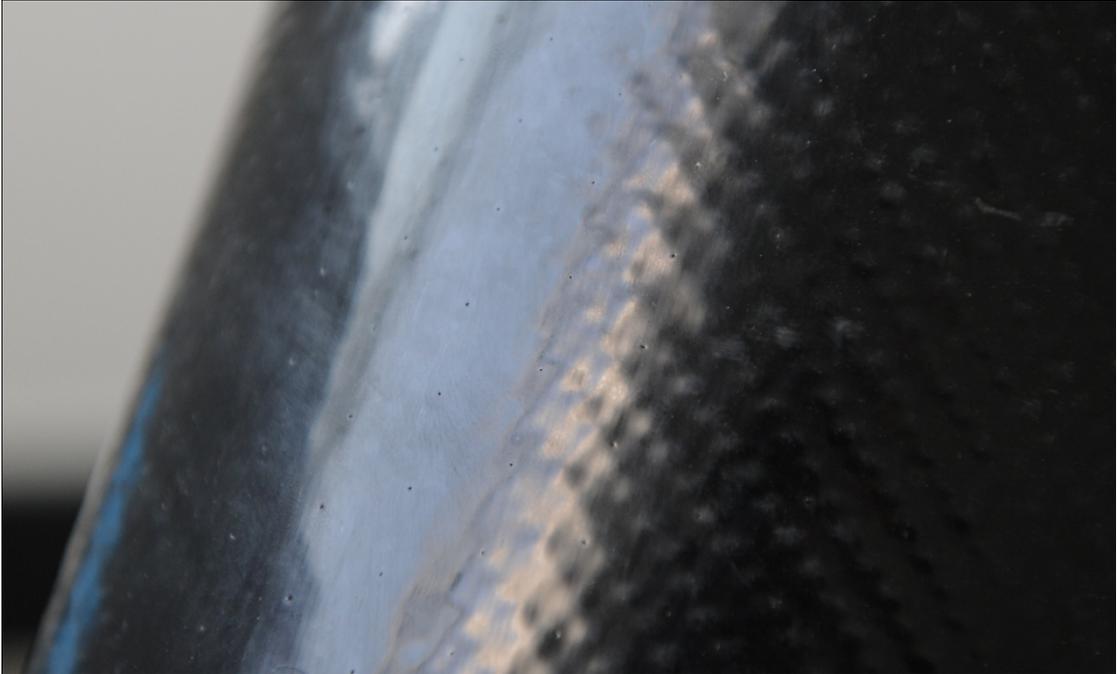
zigzag like a snake so end-user can't make sure that how 3-ply PU hoses will move and what will happen. If end-users increase water pressure to working pressure in through-the-weave PU hoses, PU hoses will be straight.

6. 3-ply technology contains one procedure "turn inside tube out". In order to turn inside tube out easily, the manufacturers have to use soft PU raw material. However, the softer the PU materials, the worse performance in abrasion-resistance. The hardness of through-the-weave PU hoses for fracking application usually is 85. However, the hardness of 3-ply PU hoses is about 80 or less. It is more easier to cut off 3-ply PU hoses than through-the-weave PU hoses. It means that 3-ply PU hoses is not so good in puncture-resistance as through-the-weave PU hoses.
7. The inside tubes of through-the-weave PU hoses are much more smooth than the ones of 3-ply PU hoses so through-the-weave PU hoses have much less flow loss.

Differentiation Through-the-weave PU hoses from 3-ply PU hoses

1. A lot of small pin holes on the cover of 3-ply PU hoses





2. You add water pressure in PU hoses which should be long enough, then you can see snakelike shape of hoses if the hoses are 3-ply ones. If the hoses are through-the-weave ones, the PU hoses should be straight.
3. The covers of through-the-weave PU hoses are very smooth. If there are any ribs, the ribs should be along the hoses from the beginning to the end. However, the cover of 3-ply PU hoses isn't smooth and plain enough. Sometimes there are some spot /bubbles on the cover because the cover tubes are not glued evenly on jackets and the spots /bubbles spread randomly on the cover and tube.



4. Through-the-weave PU hoses are more shiny than 3-ply PU hoses because the cover of through-the-weave PU hoses are more smooth.

Diagram 3 the surface of through-the-weave PU hoses

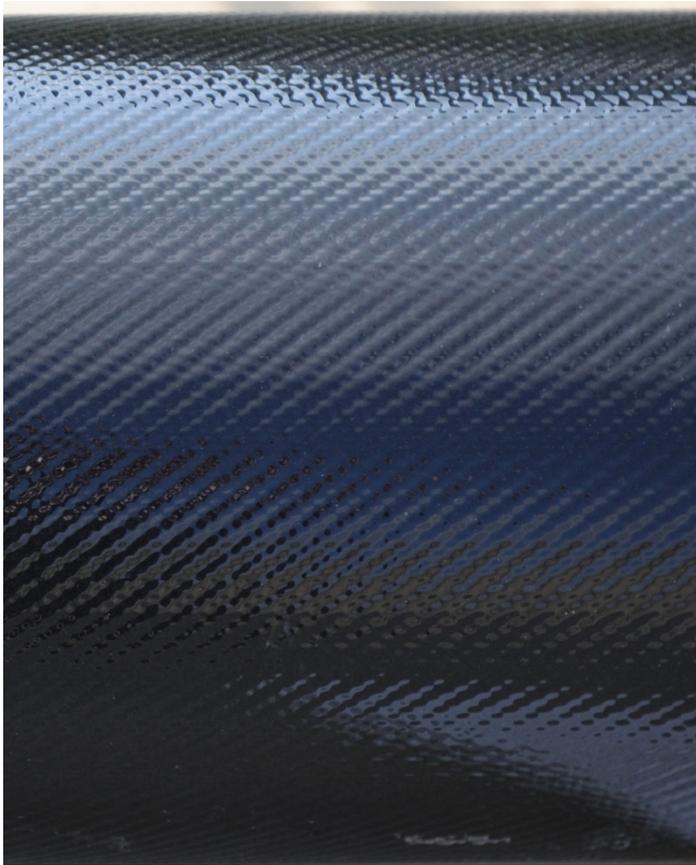


Diagram 4 the surface of 3-ply PU hoses



It is less costly and easier to manufacture 3-ply PU covered hoses than through-the-weave PU covered hoses. However, considering the inherent weakness of performance in application, most of manufacturers of layflat hoses in the world give up 3-ply technology and choose to use more advanced technology to extrude PU covered hoses. Only some manufacturers, who haven't master the through-the-weave technology, still try to offer 3-ply PU covered hoses even though they know the disadvantage of 3-ply PU hoses.

Briefs on authors

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Aaron has got his bachelor degree in art, master degree in economics and PhD training in strategic management. After Aaron changes his scholar life into business life, he becomes an entrepreneur and start up several companies including trading companies and manufacturing companies. Since April, 2008, Aaron begun to enter layflat hose industries. After Aaron successfully represented two Chinese hose manufacturers in USA and Canada for five years and then started up a new hose plant Asoe hose manufacturing Inc. with several best hose engineers in China in Mid 2013. During last five and half years, Aaron visited more than 200 different distributors in USA and Canada, and five manufacturers in USA and Canada. Aaron also made a lot of study on different hose

manufacturers in the world, including many European manufacturers etc. Now Aaron works as the president of sales for Asoe and is ready to share his knowledge and information on layflat hoses with the people of hoses industries over the world.

David Xihui Zhao david@asoehose.com

David Zhao has worked in hose industries for more than 16 years as an engineer. He was the first Chinese who developed EPDM lined hoses in China and the first Chinese who developed through-the-weave Nitrile rubber covered hoses in China. He is not only good at developing hoses and also good at plant management. He started up Asoe Hose manufacturing inc with Aaron and some other partners. Now David works as general manager of Asoe.