Sports shoe producers have been under extreme pressure to eliminate solvents (or reduce VOC) in their manufacturing processes, and in particular, when bonding outsoles. However, is there now really no VOC present and if not, what can realistically be achieved? Emil Schmid, President of Tack-Services, Germany, analyses the current situation.

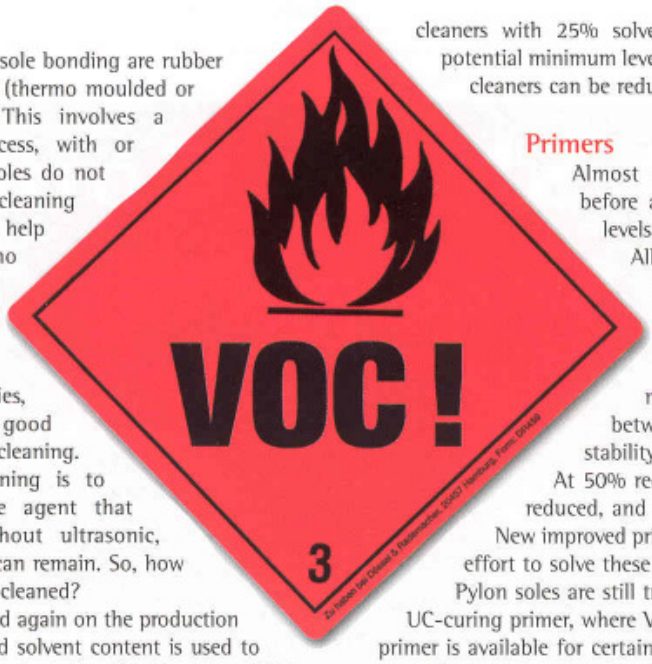
Zero VOC – where are the solvents in sole bonding?

Cleaners

The most cleaned parts in sole bonding are rubber outsoles and pylon midsoles (thermo moulded or injection moulded EVA). This involves a solvent-free ultrasonic process, with or without, additives. Rubber soles do not require the addition of any cleaning agent, only some acids to help reduce blooming, while no additives are normally used for EVA. So, in ultrasonic cleaning, no solvents are actually present.

However, in some countries, factories still achieve good bonding without ultrasonic cleaning. The main aim of all cleaning is to remove any mould release agent that may be present, but without ultrasonic, considerable contamination can remain. So, how are the components actually cleaned?

Rubber soles are not cleaned again on the production line, as a primer with reduced solvent content is used to perform two jobs - cleaning and priming. But for pylon, MEK or a primer with 50% water, or a mixture of MEK and IPA, is still used on the production line. PU, EPDM, nylon and metal components are also treated in the same way. Actual VOC reduction during cleaning is therefore only 50%, although cleaners with 25% solvent are now under test. The potential minimum level to which VOC in conventional cleaners can be reduced is therefore still 25%.



Primers

Almost all materials need priming before applying the adhesive if good levels of bonding are to be achieved. All primers contain solvents such as Acetone, MEK, Ethylacetate or IPA, either in combination, or mixed with water. Rubber soles see a maximum VOC reduction of between 50% and 75%, though the stability of the primer is best at 100%. At 50% reduction, shelf life is drastically reduced, and at 75%, is still relatively short. New improved primers are again under test in an effort to solve these problems.

Pylon soles are still treated with a solvent base and UC-curing primer, where VOC is 95%. A solvent free PU-primer is available for certain materials, but at present, this covers only 5% of the market. There is considerable potential for development here, as release agent residues will reduce the adhesion of any water base primer. Other options, including an improved cleaning process to remove more release agent, are now being developed.

Material	Actual % VOC	Possible % VOC
Rubber	N/A	N/A
Pylon	50-100	25
PU, EPDM, nylon & metal	50-100	25

Material	Actual % VOC	Possible % VOC
Rubber	50-100	25-50
Pylon	100	25
PU, EDPM & metal	50-100	25
Nylon & all leathers	100	Unclear at present

For all other materials such as PU and all types of leather, water base PU primer can be used. However, we must not overlook the 'hidden' VOC present during the production of raw PU material, or indeed, water base adhesives themselves. EPDM and nylon both still require solvent based primers.

Adhesives

The highest VOC reduction is already achieved by changing from solvent to water base PU adhesives. However, while VOC has been reduced in the shoe factory, solvents such as Acetone, are used in the production of any PU material. 3-5% is used in cleaning the reactor, and a further 30%, when producing the actual PU emulsion. This acetone becomes so contaminated by catalyst and water that it cannot be re-cycled, and has to be incinerated.

So in total, we still have 35% VOC during production, although the problem has moved from the shoe factory to the raw material supplier. This is the 'hidden' VOC referred to earlier. All in all, the change from solvent to water base adhesives, has provided only around 45% VOC reduction. This of course, also includes the PU raw materials used for primers.

To improve wetting and distribution, the hardener in the adhesive contains 25% solvent. If 5% hardener is added to a PU adhesive, the total mixture contains 1% VOC, so what might appear to be 'Zero VOC', is not actually 'Zero VOC'. For technical reasons, a small amount of solvent is still needed for better wetting and penetration. Most sports shoe factories recognise this and do not insist on a complete 'zero' factor, so allowing small amounts of non-dangerous solvents to be used.

Product	Actual % VOC	+ hidden % VOC
Solvent base PU adhesive	80	N/A
Water base PU adhesive	00	35
Hardener for water base adhesive	25	N/A
Water base PU adhesive plus hardener	1	36

Summary

Other adhesive systems, like Reactive Hot Melt, still have limitations in regard to the materials they can be used with. Monomer content is very critical and long-term carcinogenic factors are as yet unknown. So is 'Zero VOC' still a dream? Yes, I'm afraid so, as can be seen from the information provided here. However, the sports shoe industry is getting there, though when it will finally arrive is anybody's guess. My lab manager once remarked that, "Tomorrow we will work only with water base". We are still waiting for that tomorrow.