

WATER-BASED WOOD SEAL AND PANELIZATION

In recent years, the wood coating industry has had to continually adapt technology in order to keep pace with ever changing VOC regulations. This has proven to be a challenge with both solvent-based and water-based systems.

Solvent-based systems have had to reduce the VOC content by either formulating coatings with exempt solvents or by modifying the polymer to handle the reduction of solvent. As the regulations have become even more stringent, adapting the traditional solvent-based system has become more challenging, thus opening the door for water-based coatings.

Water-based technologies have been accepted for decades in recoating floors that have been previously sealed with solvent based sealers. However, they have not found wide acceptance (especially on large installations like gymnasiums) being used as a sealer on newly installed or newly sanded floors. The primary reason for this is that water-based sealers can cause side-bonding which is otherwise known in the trade as panelization. The Maple Flooring Manufacturing Association, MFMA, defines panelization “as a condition where localized excessive cracks develop between some strip flooring boards while adjacent boards remain tightly bonded together with no apparent separations.”

In order for panelization to occur, two things must happen. If either one of these factors is controlled, the floor will not panelize. The two conditions are:

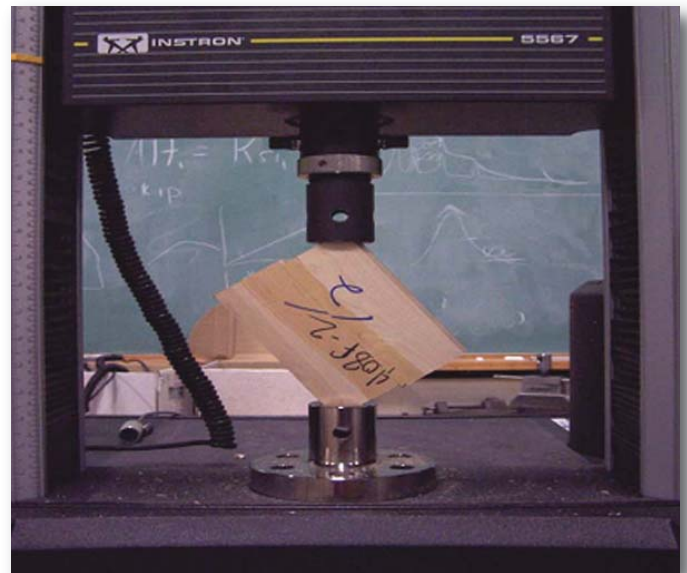
1. The environment changes significantly. When this happens, the individual boards will want to expand or contract.
2. The individual floor boards are tightly bonded together. When this happens, the net effect will be that the floor will move as one large panel.

Maintaining constant humidity, so the wood floor doesn't over expand or contract is very difficult and not very practical. Therefore, it becomes very important that the sealer used doesn't “glue” the boards together.

In order to predict whether a sealer will cause panelization, a testing methodology had to be developed. Essential Industries, in conjunction with the Mechanical Engineering Department of North Dakota State University, has developed a test that measures the shear force required to separate boards along the tongue and groove. This test was then used to measure the adhesive properties of typical solvent-based and water-based gym floor sealers.

To prepare the boards the sealers were applied to the tongue and groove. The boards were then put together and excess sealer was brushed out onto the surface. The boards were clamped and allowed to completely dry. The boards were tested using an Instron 5567 load frame under displacement control to determine the shear force required to separate the boards along the tongue and groove, as shown in Figure 1.

FIGURE 1



A constant rate of 0.15 in/min was used to apply the compressive load, which in turn transferred stress to the joint, leading to eventual failure. The maximum resultant load observed, corresponding to the required compressive force to cause shear failure at the specimen joints, was recorded. These loads were normalized against the length of the bond; in order to arrive at a force per joint length value in lbf/in.

10 specimens were tested for each sample set (2 from each of the 5 specimens provided for each sample set). Of these 10 specimens, the high and low values found were discarded and subsequent standard deviation values were obtained from the remaining 8. These results can be found tabulated in Table 1.

TABLE 1:
Joint bond performance for various sample sets.

SAMPLE SET	LOAD PER JOINT LENGTH (LBF/IN)
Commercial Water-based sealer	414 ± 51
Commercial Water-based acrylic sealer	218 ± 37
Solvent-based OMU sealer	9 ± 12

The traditional oil-modified urethane (OMU), sealer had very minimal bond strength, 9 lbf/in. The amount of energy to shear the two boards apart is more in line with the simple frictional forces required to move the tongue against the groove, not any chemical bond formed by an adhesive. Thus solvent-based OMUs allow for individual strips to move and therefore do not have a tendency to cause panelization. This data supports traditional field experience.

Testing of two commercially available water-based sealers showed significantly higher shear forces of 218 and 414 lbf/in. Therefore, this data would also be very much in line with the historical perspective that water-based sealers are more inclined to be associated with sidebonding. In MFMA's position statement they write; *"the problem (panelization) has been closely associated with the use of water-based sealers and finishes on raw (untreated) maple strip flooring."*

Therefore, in order for water-based chemistry to be received as an alternative to solvent-based OMU sealers, the adhesive forces of the sealer must be more in line with a solvent-based OMU. Water-based OMUs are very similar to their solvent-based counterparts, but are modified with acid functionality to facilitate the dispersion process into water. Therefore, they should be a logical replacement for a solvent-based OMU.

To test this thought process, we compared a solvent based OMU with 2 commercially available water-based OMUs. The results were surprising. The adhesive properties of the water-based OMUs were significantly higher than their solvent-based counterparts. (Table 2).

TABLE 2:
Comparison of Solvent-based OMU's vs. Water-based OMU's adhesive forces.

SAMPLE SET	LOAD PER JOINT LENGTH (LBF/IN)
Commercial Water-based OMU (1)	676 ± 138
Commercial Water-based OMU (2)	391 ± 112
Solvent-based OMU sealer	9 ± 12

This data proves that the water-based OMU has a much greater tendency to cause panelization than its solvent-based counterpart.

With this testing methodology in hand, the technical team at Essential Industries set out to create a polymer that, when formulated into a sealer, would have adhesive forces similar to those of a solvent-based OMU. The end product was an acrylic polymer formulation that had adhesive forces (12 lbf/in) very close to the solvent based OMU (9 lbf/in). This product was later commercialized.

CONCLUSION

The shear force test created by NDSU correlates well with historical data. This test verifies that solvent-based OMUs do not cause panelization while water-based sealers have a much greater tendency to do so. Also, this test proves that water-based OMUs have much higher adhesive forces than their solvent-based counterparts. Consequently, they do not act the same and their use can lead to panelization in the field. This test method allows formulators the ability to formulate low VOC, water-based sealers that have similar adhesive characteristics to a solvent-based OMU.



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