



Characteristics of Ryno During Curing

Ryno in its uncured state is a plastisol. By this, we mean that it is a dispersion of powdered polyvinyl chloride (PVC) resin in a mixture of liquid plasticizers and pigments. These plasticizers consist of stabilizers for heat during curing, primary plasticizers, and fast fusing plasticizers which assist in the process. Different durometer mixtures are simply different ratios of plasticizer to PVC resin. This dispersion, or plastisol, is homogenous in that the viscosity and specific gravities are balanced so that the powdered PVC resin stays in suspension rather than settling out.

Plastisols all have viscosity characteristics that vary with temperature. When you heat a thick liquid like the plasticizers used in Ryno, the liquid becomes thinner and pours more easily. This characteristic also applies to Ryno up to a certain point, then other factors affect the viscosity.

When uncured Ryno is heated from room temperature, the viscosity begins to drop due to the viscosity characteristic of the plasticizers. At about 170 F (76 C), Ryno reaches its minimum viscosity. At this point, the viscosity of the plastisol begins to increase. If you remove the heat just after 170 F, the Ryno will cool down to its original state or close to it. Above 170 F we reach a point of no return where the plastisol will not return to its original state. This temperature is called the gel point, although the Ryno is not cured at this temperature. It is the beginning of cure.

Continuing up the temperature curve, we reach fusion, which is the point where the PVC resin melts and fuses to itself, cross linking and bonding in the plasticizer. At this point we begin to reach a measurable tensile strength of the material. Maximum tensile strength is reached at 360 F (182 C). For actual curing practice though, we use 350 F (177C) because it creates less chance of burning affecting the adhesive system.

Another way to picture the various states of Ryno is to look at the process of solvation. Solvation is the absorption of plasticizer into the resin and thereby the swelling of the resin particles. When we add the PVC resin to the plasticizers during mixing the Ryno, the shear of the mixer not only disperses these particles, by it also causes the particles to begin to absorb some of the plasticizers. When this happens, the particles begin to swell. After mixing, this process stabilizes until you begin to cure your rollers. With the addition of heat in your oven, the PVC particles again begin to swell as they absorb more of the plasticizer. At 170 F, this is what makes the viscosity begin to increase.

When we reach the gel temperature, the particles have become saturated, and because they have expanded from all of the absorption, they are much closer together. An analogy is the difference between ping-pong balls and basketballs. There is now more plasticizer inside the swollen particles than there is outside them. When we reach fusion temperatures, the PVC particles melt and fuse together, locking in the plasticizer.

So what!? The above concepts are very valuable in understanding what happens in your roller molds during the curing cycle in the oven. A mold full of Ryno around a core can be considered like a food baking in the oven. Food cooks from the outside in, and so do your rollers. The outside of the mold reaches gel and fusion temperatures first and then the cure spreads inward to the core. Yes, the core conducts heat also, but there is still Ryno in varying states of cure throughout the mold.

If we consider all of the above, it is evident that the outer layer of Ryno on top of the mold reaches the high viscosity levels first, and that the Ryno under it is still thin. When you consider that air bubbles trapped in the mold during the pouring process can only travel upward, and in lower viscosity material, it is obvious that there is a "skin effect" near the top of the mold that will trap these bubbles, preventing their escape. You have all seen the result of these air bubbles during grinding and finishing.

Luckily, there is something you can do to prevent this from happening. Care in pouring technique eliminates the source of air entrapment to begin with. Letting molds sit before placement in the oven also helps let air get out. But if we recall the viscosity curve of Ryno, letting your molds sit in the oven at a temperature below 170 F, say around 140 F (60 C) for about an hour, will cut down drastically on any air related defects you may encounter. We call this a low temperature "soak" while the oven is "ramping" up to temperature.

