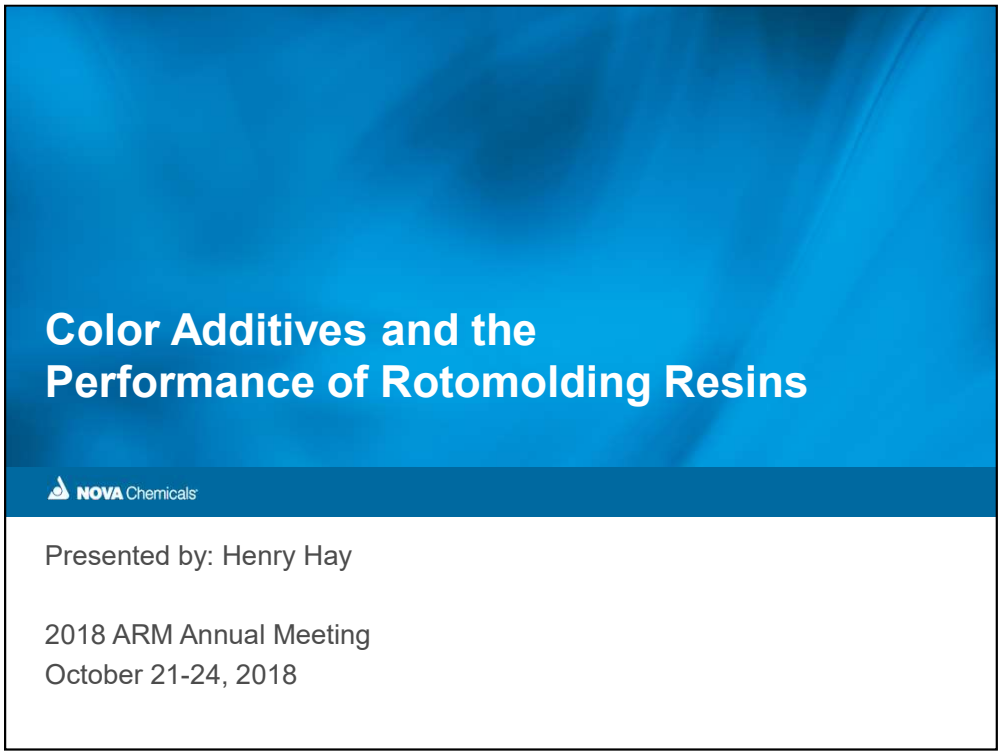
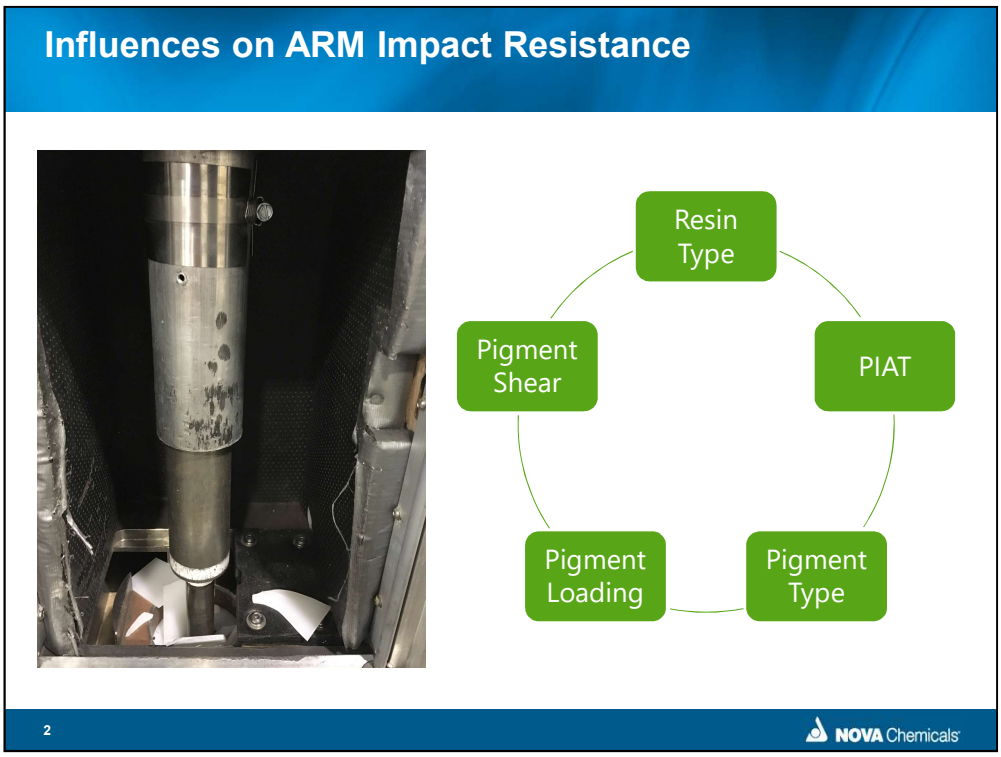
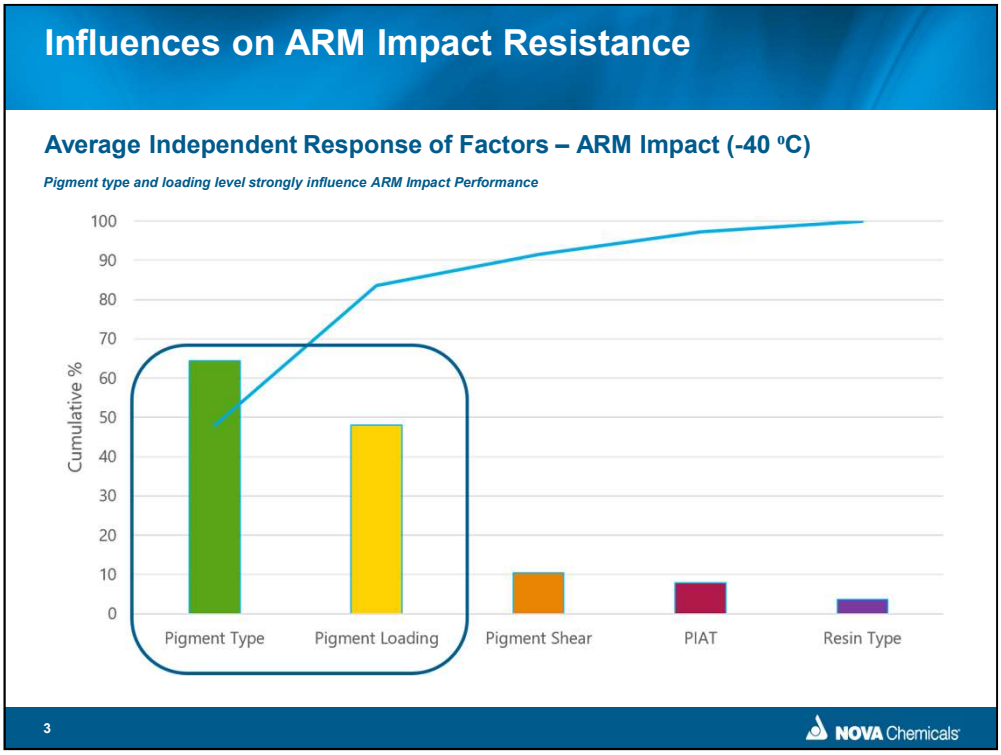


Presented by: Henry Hay

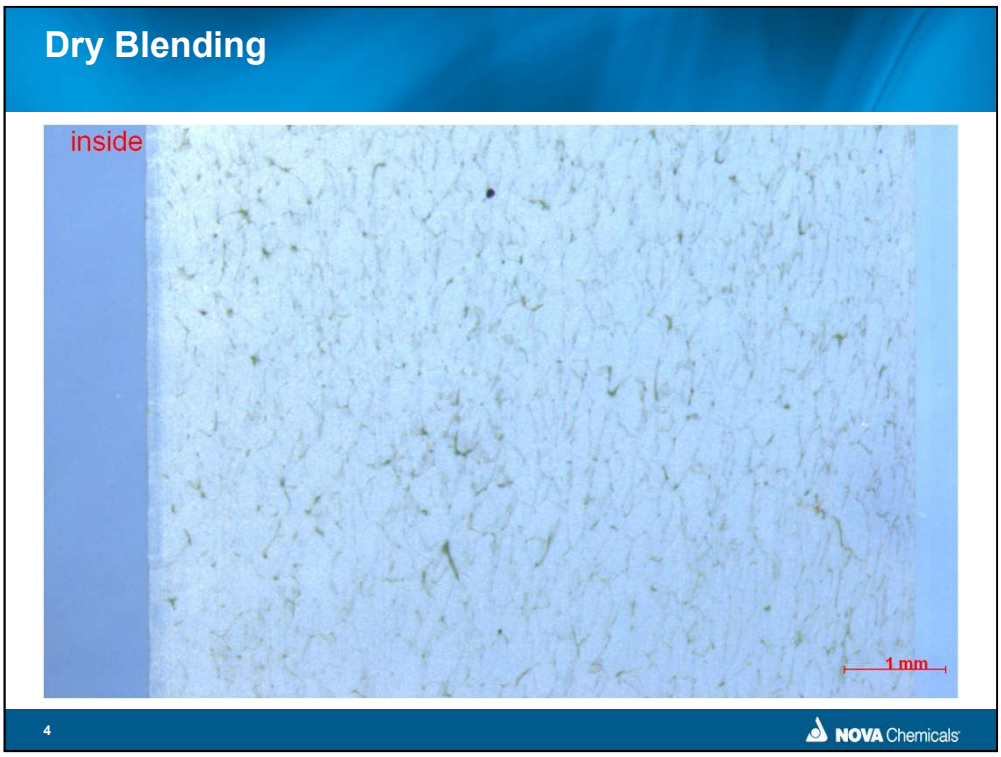
2018 ARM Annual Meeting
October 21-24, 2018



- Show of hands: how many of you add color to parts? How many use dry-blended colors? I don't blame you; dry colors are cheaper, and allow the flexibility of changing color shade simply by adding more or less to your parts. I would bet, though, that many or you have noticed that dry blend colors bring their share of problems including reduced impact strength and ductility, and highly variable impact properties. A few years ago, we were asked to examine the factors that affect impact strength of dry-blended pigments in rotomolded parts. We undertook a fairly extensive six-sigma designed-experiment study that considered five variables on impact performance: Pigment shear (or mixing) intensity from hand stirring to high intensity mixing. Resin type (octene single-site resin vs traditional hexene gas phase), Peak internal air temp within a resin's processing window, pigment type (red vs green vs black) and pigment loading.

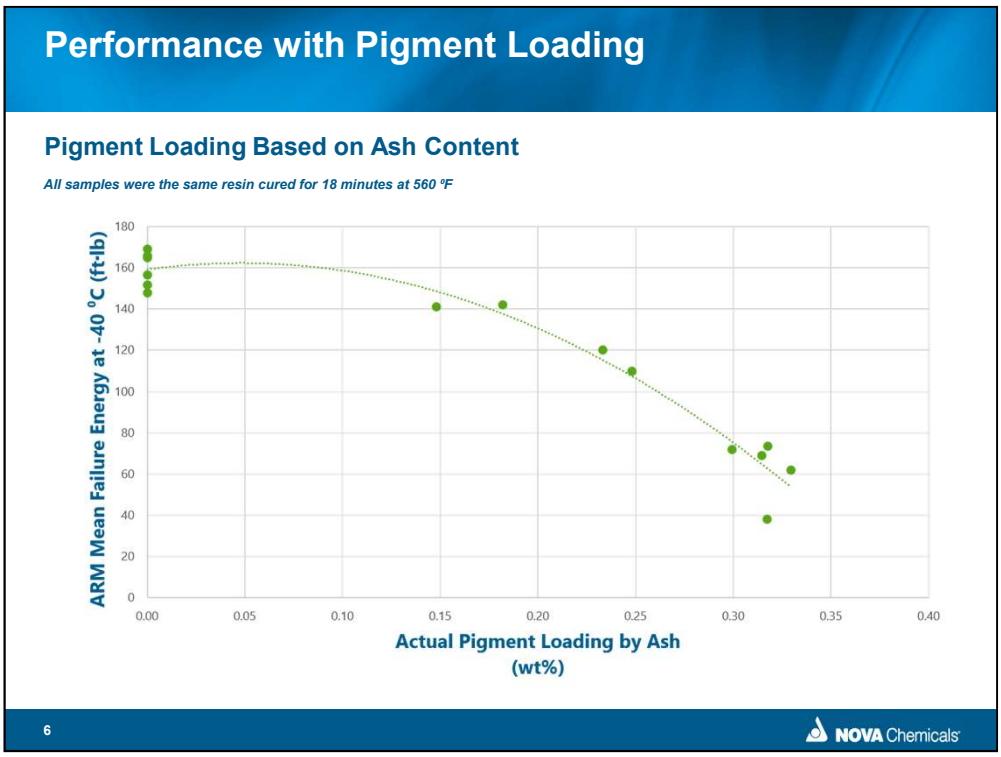


- This chart shows the effect level of each of the five variables examined. Our six sigma study showed that two factors were significant in determining impact performance of a dry-blended rotomolded part; pigment loading and pigment type. PIAT, resin type and (somewhat surprisingly) mixing intensity had only minor influence on impact properties. I think we all know intuitively that some pigments (e.g. black) are more forgiving than others. A recent edition of Rotoworld® magazine featured an article indicating that pigment manufacturers are working to improve the impact performance of dry-blend colors.



- By comparison, here is a dry-blended part. You can see the differences immediately. The large dark bits are agglomerates of pigment. They are connected by a lace-like network of strings of undispersed pigment particles. This is absolutely typical of a magnified cross section of a dry blended pigmented part, regardless of whether the pigment is mixed with a paint stick or a high-intensity mixer. As mentioned earlier, one artifact of this type of pigment addition is highly variable, often disastrously poor cold impact performance. Another artifact is widely variable results; two impacts six inches apart can yield different results depending on the dispersion of particles below the impact site. If a impact event happens to coincide with a large color agglomerate, poor impact strength will likely be seen.

- Before I go further I want to show you why dry blended pigments perform differently than compounded ones. The picture you are looking at is a magnified cross-section of a compound-color rotomolded part. You can see…not much. Individual pigment particles are invisible at this magnification, these parts' impact performance is virtually indistinguishable from natural resin.



This is the most important user-controllable variable on impact performance; pigment loading. The graph of loading vs. impact performance shows a rapid drop-off in impact performance between 0.2 and 0.25 weight percent. If impact performance is important to your application, keep the pigment ;loading below 0.2%. Above 0.25% it is almost certain that you will lose ductility and impact performance, regardless of whether you use high intensity mixing. Above this level, I strongly suggest compounding color to preserve impact properties.

Blending Intensity

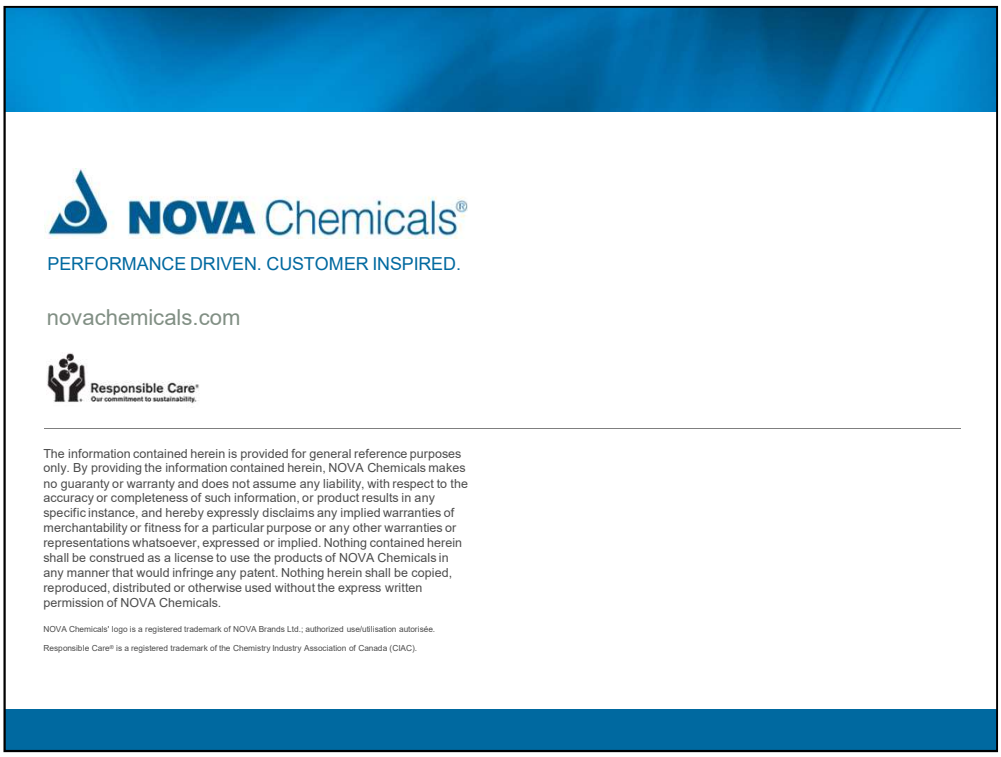
Low-Intensity Mixing
0.3 wt% Pigment
(Tumble)

High Intensity Mixing
0.3 wt% Pigment
(Welex Blender)

7

NOVA Chemicals

- Speaking of high intensity dry color mixing, I don’t want to leave the impression that we don’t advocate that type of color dispersion. In our experiments we noticed that HIM has a significant effect on color intensity. In fact, use of high intensity mixing can allow you to achieve the desired shade while using a lower, safer loading of pigment. These cubes are both blended with ‘John Deere® green’, a complex pigment blend. High-intensity mixing results in a much brighter, truer color. Thank you for listening, we’re happy to answer any questions later on during breaks.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