1.00 Development of Drying Adjuvants for Waterborne Traffic Paints

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ABSTRACT:
Waterborne Paints used in Traffic markings have been used worldwide since first introduced in the late 1970's. However it was the use of breakthrough patented FASTRACK™ Quickset technology in the early 1990's that afforded the fast dry attributes we see today under adverse drying conditions of low temperatures, high humidity and no wind. Most of the waterborne applications have commonly targeted 375um WFT and increasing use of 500um WFT and larger glass beads for wet night visibility. Efforts to further improve dry speed particularly if WFT>500um has focussed on externally applied drying adjuvants using a variety of unique technologies. This paper looks at the development of appropriate drying adjuvants and assesses their relative merits in lead up to commercial release.

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Introduction:
Waterborne Traffic Paints have been around for since the late 1970's as a replacement for the solvent based incumbents. Their adoption was driven initially by the need to remove solvent based paints and the associated good experience most people had seen with the rapid uptake of water based decorative paints made this an easier changeover.

Designed for use as longitudinal highway maintenance markings the application was limited to 375 micron Wet Film Thickness (WFT) and often in conjunction with 300 micron drop on glass beads to provide retroreflectivity. The paint formulations had to rely on the 100% acrylic emulsions available at the time which had no advanced chemistry but rather a high solids content to maximise the dry speed of these paints. The high solids content was aimed to deliver the final formulated paint containing as little water as possible. While these high solids emulsions produced paints with significantly better performance than 100% acrylic house paints in common use, they still suffered from very slow dry which lead to poor washout resistance combined with lack of adhesion to both glass beads and the road itself.

Quickset or FASTRACK™ Technology:
The industry required a breakthrough technology to improve drying speeds. Rohm and Haas Company developed and patented a "quick set" emulsion technology branded FASTRACK™ allowing waterborne traffic paints to dry under the adverse conditions of low temperature, high humidity and low air movement. The waterborne paints made from products such as FASTRACK 2706 (1992-1998), FASTRACK 3427 (1998- current, enhanced adhesion) served the Australian and New Zealand markets well. Newer generations of FASTRACK emulsion technology have different attributes such as HD-21A with cross linking chemistry for greater durability and glass bead adhesion and XSR™ for use in cooler climates (not commercialised for ANZ use). During the 1990's waterborne was universally adopted and the benefits of increased durability, high retroreflectivity, speed of application, low toxicity and water clean up were quickly banked by the industry. Road Authorities progressively instituted specifications for 1mm diameter wet night visible glass beads as waterborne paints demonstrated they could hold these new large beads in place.

New Customer Demands:
The advent of large glass beads has driven paint specifications from 375 micron to 500 micron WFT. As Road Authorities strive for even better durability, road use data has demonstrated that a moderate increase in WFT to 550-600 micron has a significant improvement in durability. This increase in WFT requires extended drying time. This trend in higher film weights is occurring when Road Authorities prefer to see workers

spending less time on roads collecting protective cones or carrying out night work when traffic volumes are lower for workers.
As its stands the chemical routes available in emulsion manufacture or the paint manufacturers access to formulation solutions for speedier dry of waterborne traffic paints are at their current limit.

Drying Adjuvants:
The need to further improve the speed of dry without compromising glass bead adhesion forced Rohm and Haas Researchers to look at externally or post applied drying “boosters”.

This has lead to a number of different approaches. One system produced a rapid pH drop and subsequent skinning when acid was applied to a newly laid line. This is generally limited to approx 400 micron WFT. This approach is both licensed and patented. Equally creative approaches (and patented) using super absorbent materials usually found in nappies and Sanatory products can do the job but are have operational concerns in their use . Other ideas included addition of materials to destabilise the paint best described as controlled flocculation. These ideas did not deliver the durability required.

However combining the need to both rapidly drop the pH and isolate the water, has produced a Rohm and Haas patented product that balances speedier dry with sufficient free water to allow glass bead adhesion to fully develop. The product is best known as a drying adjuvant.

The first generation of these drying adjuvants were tested on the Desert Road in New Zealand in 2000 and again in Canberra in 2001. Extended trials were carried out in Canberra from 2002-2004. As the market was not fully committed to higher WFT it was not until 2007 when second generation drying adjuvants become a necessity for these thicker wet paint films.

Best described as Water Absorbing, Acidified Spherical Beads, these drying adjuvants rapidly drop the pH and their large surface area efficiently absorbs water (up to 3 times their volume). The absorbed water is then slowly released after the paint film has set.

To understand how these drying adjuvants work synergistically with waterborne paints we need to first understand how the FASTRACK emulsion used in the paint manufacture is designed to function.

FASTRACK emulsions and interaction with Drying Adjuvants:
FASTRACK emulsions when they are used to manufacture waterborne paints produce a very stable paint because the quick set technology is neutralised in the wet paint stage. This stability is maintained while the pH remains >9.7. Hence all FASTRACK based waterborne traffic paints have the characteristic “ammonia” smell.
As the ammonia flashes off, the pH drops and quick set technology is no longer neutralised. It is attracted to the FASTRACK emulsion forming a multitude of bridges across the emulsion appearing as the paint quickly setting or drying.

Introducing a Drying Adjuvant to the mechanism described above does two things. The acidified surface of the Drying Adjuvant quickly neutralises the ammonia and drops the pH which accelerates the activity of the quick set technology in the FASTRACK emulsion. The second effect is the nature of the drying adjuvant allows it to absorb 1/3 to ½ of the water in the paint allowing it to reach its set state much faster without having to rely completely on evaporation of the water.

Performance Attributes of Drying Adjuvants:
The key requirement of a drying adjuvant is to improve the speed of dry and maintain or improve glass bead adhesion.

Table 1 below evaluates the dry through performance of a Rohm and Haas waterborne traffic paint formulation GTC-104-14B based on FASTRACK 3427. Test conditions were altered to reflect moderate and high humidity (45% and 80% resp) and tested two different WFT with and without a drying adjuvant at a constant 23oC and zero airflow. Without a drying adjuvant high humidity has a dramatic impact on dry through speed at WFT varying from 360 micron through to 530um. Much of this effect can be offset by the drying adjuvant.

Please note, these are tough drying conditions and on most occasions while high humidity will be encountered, it is likely there will be some wind or air movement. Therefore the quick set technology provided by the FASTRACK emulsion is usually more than adequate to negate the need for the drying adjuvant under many climatic conditions

TABLE 1

Binder	Fastrack 3427	
Formulation	GTC-104-14B	
Alcohol	Yes	Yes
DA (50-75g/m2)	No	Yes
360 um WFT		
- 45% RH	0:20	0:10
- 80% RH	1:25	0:10
530um WFT		
- 45% RH	0:30	0:20
- 80% RH	2:20	0:20

Of course drying the paint quickly is one thing but ensuring it is not too quick is another. Getting the balance right is critical to ensuring glass bead adhesion is allowed to develop. Data provided is taken from Northern Italy evaluating the performance of FASTRACK HD21A based traffic paints with a drying adjuvant. The test deck was structured to allow lines to be laid with and without drying adjuvant and then opened to traffic after only

10minutes. Data shows retroreflectivity initial and after 2.25M vehicle cross overs in 5 months.

Equally well data from Canberra trails in 2004 show the use of a drying adjuvant provides equal glass bead retention in paints allowed to dry unaided. This was valid for both FASTRACK 3427 and HD21A based paints.

Clearly the significant benefit of improved dry speed and subsequent glass bead retention is important but one of the real benefits is easily overlooked, the effect of the drying adjuvant on Washout Resistance. The practical application of this should read Early Rain Resistance. Some contractors have been unfortunate enough to get rain while in the middle of a job and witness the washing away of wet paint. It is not only the damage to the current work that is of concern but also the cleanup of the white water now being generated. A simple test deck can be used to demonstrate the improved resistance to rain. A test deck is constructed with three sections, two with different levels of drying adjuvant ($40g/m^2$ and $90g/m^2$) and one section with no drying adjuvant and was exposed to heavy rain 1 hour after the last line was painted. After 9 days of subsequent traffic exposure the section with no drying adjuvant is on the verge of failure. The other two sections are functioning as designed. The presence of the drying adjuvant has allowed the paint to sufficiently cure and lock away the water soluble components of the film still evident in the non drying adjuvant section.

Airless Application considerations for Drying Adjuvants:
The drying adjuvant is a free flowing dark coloured bead approx 300-800 micron in diameter. This can be easily introduced into the paint stream by injection via a glass bead dispenser during airless spraying.

The preferred method for introducing the drying adjuvant is via the dual paint gun setup. The diagonally opposed guns create the ideal environment to drop drying adjuvant via a Bell type glass bead dispenser. Other methods such as sandwiching the drying adjuvants between paint layers can also be effective but would require the use of dual paint guns.

Alternatively, as many contractors run single gun setups the drying adjuvant can be loaded to an additional hopper and fed through a camber gun in front of the paint stream. As there is significant turbulence at the point of intersection of the pavement and the paint, the drying adjuvant should be targeted at the same intersection point. Although no consideration is given to air assisted application, a similar arrangement can be used but with the camber gun following the paint gun rather than leading it as found in airless application.

Conclusions:
The use of a drying adjuvant can be recommended when drying conditions are less than optimal. This can be characterised by high humidity, low temperature and low air flow. However as has been demonstrated there is a reasonable case to made for use when there is a chance of rain impacting the work within 2 hours, protection of the work is limited

due to local regulations or road geometry or the specifications calling for a greater thickness of paint than might reasonably dry in the time provided.

While paints based on FASTRACK emulsion don't require a drying adjuvant in most conditions, the increasing performance demands of Road Authorities combined with changing workplace practises may necessitate the utilisation of a drying adjuvant on an as needs basis.

Due to the nature of the drying adjuvant and the need to technically support the adoption and application, Rohm and Haas has decided to supply this product to the market via Potters Industries where it will be marketed and sold under the name Visilok® TPD. The product will also carry the co-brand FASTRACK™ Road Marking Technology logo in recognition of the development efforts and patent status.