TERRIN™

Technical Data Sheet

INVISTA TERRIN™ Polyols

Cost-Effective Alternative to Conventional Polyether and Polyester Polyols

Introduction

TERRIN™ polyols can be used in lieu of or in combination with conventional polyether or polyester polyols to formulate a variety of polyurethane products designed to be soft and flexible—or hard and stiff. These versatile, aliphatic, polyester polyols can be used in applications ranging from viscoelastic foam to spray coatings and adhesives to elastomeric resins. TERRIN™ polyols:

- Are cost competitive in comparison to conventional polyols
- Contain a minimum of 50% recycled or renewable[1] content
- Have similar hydroxyl values to castor oil, and can be substituted on a nearly equal weight basis
- Are REACH and TSCA compliant

In addition, TERRIN™ polyols are an easily handled, low-viscosity liquid at room temperature. TERRIN™ product offerings — especially 168 and 168G — remain pourable liquids at -15°C/5°F and below[2]. TERRIN™ polyols do not crystallize and exhibit Tg in a range of approximately -60°C to -75°C.

Application

Controlled-Release Fertilizer

This Technical Data Sheet is intended to illustrate how TERRIN™ polyols can be used in controlled-release fertilizer (CRF). Lab tests show release rates may be obtained that are comparable to or slower than current commercially-available CRF. Release can be customized over a wide range by careful selection of the TERRIN™ polyol, formulation of the polyurethane, and adjustment of coating weight. The formulations herein are not optimized and aren't intended to cover the entire range of possibilities but are meant to provide the experienced polyurethane formulator with ideas and starting points for CRF formulations.

[1]As defined by ISO 14021, Section 7.8; preliminary estimate based on small-scale production.
[2]Patents pending; consult the SDS for additional physical-chemical, safety and health information

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Background

When applying fertilizer such as urea to plants it is often desirable to control (i.e. slow) the release of the fertilizer because too rapid release can damage the plants and is wasteful; valuable fertilizer components can be lost by leaching or degradation in the soil. One method for controlling release of fertilizer is to encapsulate the fertilizer by applying a coating. The patent literature describes a multitude of fertilizer coating processes in detail. Polyurethane (PU) coatings have been known for nearly 50 years, but continue to be an active research area to this day. The versatility of PU and the many variations possible in the coating formulation and process provide the means to optimize fertilizer performance.

PU-coated CRF were prepared using TERRIN™ polyols and tested as described below. For benchmarking, CRF was prepared using castor oil, a polyol widely referenced in the patent literature, and a variety of commercial CRF from different manufacturers were purchased at retail and tested by the same procedures.

Table 1: Coating weight and release of commercial CRF

Commercial Sample Comparison	Coating Weight %	Release %
A	6.0	3
B	4.4	9
C	2.7	40
D	3.1	47
E	6.4	64
F	3.1	70
G	4.3	78
Average	4.3	45

Table 1 shows the experimentally-measured coating weight and release for the seven commercial comparison materials tested. Even though these samples do not represent the entire range of commercially-available materials, release varies widely and doesn't correlate well with coating weight, which might be expected considering these are different products from different suppliers and likely made using different technologies.

Results

Figure 1 shows the performance of TERRIN™ polyols in PU-coated urea prepared by the lab procedures below. Release comparable to the commercial benchmarks can be achieved even with lower coating weight. Release can be tailored over a very wide range by selection of TERRIN™ polyol and adjustment of coating weight. Other common polyurethane formulation techniques can also be used to advantage. For example, adding diethylene glycol (DEG) chain extender to increase hard segment content of the TERRIN™ 168-based polyurethane significantly reduced release compared to the unextended TERRIN™ 168-based PU.

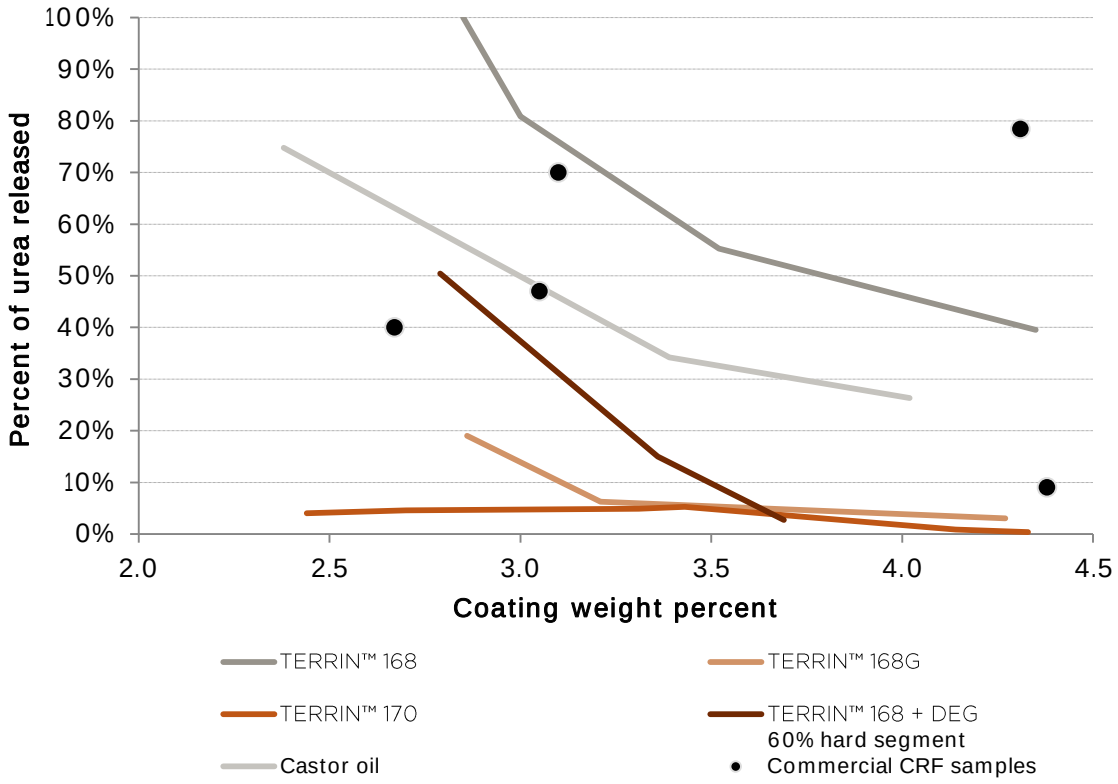

Figure 1: Performance of TERRIN™ polyols in PU-coated urea

Figure 2 shows results of an extended release test comparing three commercially-available CRF with lab-prepared CRF made using TERRIN™ 170 polyol. The TERRIN™ 170 CRF performs similarly to the best commercial benchmark, Comparison A, even though it has much less coating weight.

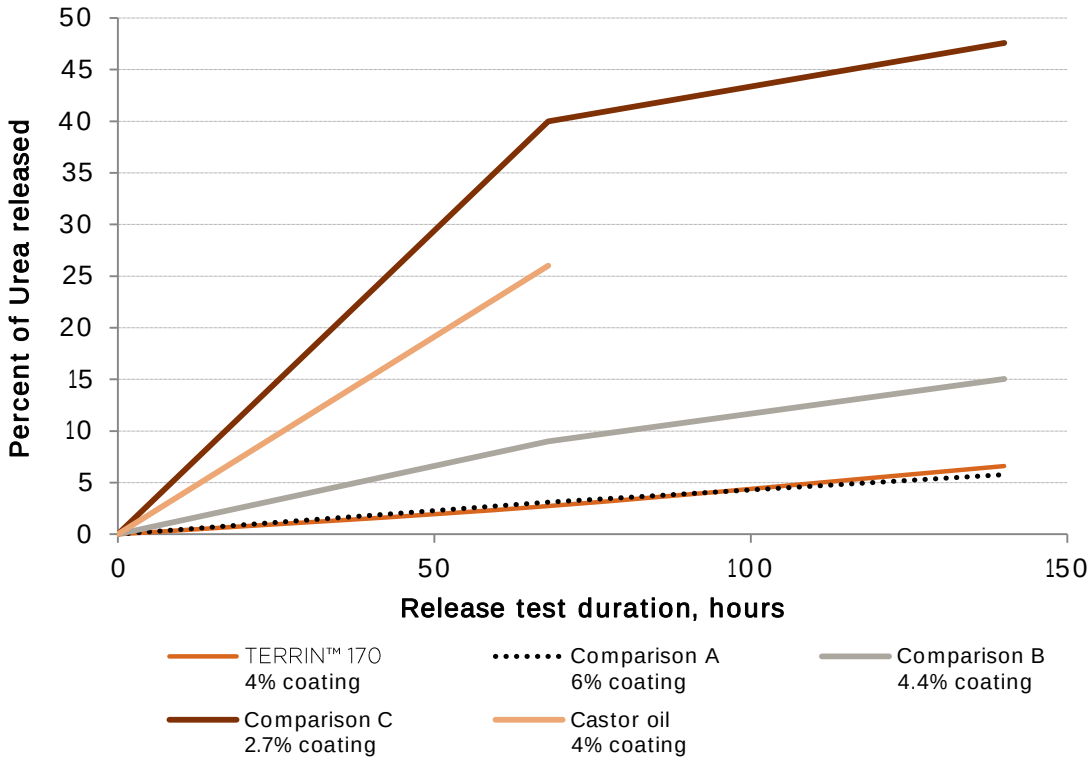

Figure 2: Extended release performance of CRF

Preparation

Lab procedure for coating granular urea

To compare relative performance of different polyols, a simple two-part polyurethane formulation was used. One part comprises a solution of polyol with triethanolamine catalyst/crosslinker and solvent and the other part comprises a solution of PMDI and solvent. Isocyanate index was held constant at 105 for all comparison tests. Each part of the 2-part polyurethane was divided into several equal portions so that a multiple-layer coating could be applied, typically 5-7 coats. For each layer, one portion of each part was combined, mixed, then added to urea granules in a rotary evaporator flask. The rotating flask was then lowered into a heated water bath and vacuum applied (typically 60-80°C / 50 mm Hg) for a time sufficient to cure the coating. This process was repeated until the desired number of coats has been applied. The effect of coating weight was evaluated by varying the number of coats applied.

Coating weight measurement

A weighed amount of coated urea was pulverized using a mortar and pestle then stirred with water to dissolve urea. The insoluble coating was collected on a filter, washed with water, dried and weighed.

Release testing

A weighed amount of coated urea (~2 g) was combined with a weighted amount of water (~8 g) in a 20 mL glass vial and agitated by tumbling end over end at 6 rpm for 68 hours. A weighed portion of the aqueous phase was filtered and the filtrate collected in a tared foil pan then placed in a 100°C oven until dry. The dry urea residue was weighed and the release rate calculated as a percentage of the maximum urea that would be found if all of the coated urea was released, taking account of the coating weight.

An extended release test was also performed for 140 hours.

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