



# K-KAT<sup>®</sup> Catalysts

## for Urethane Elastomers, Adhesives & Polymer Synthesis

### K-KAT<sup>®</sup> Catalyst Introduction

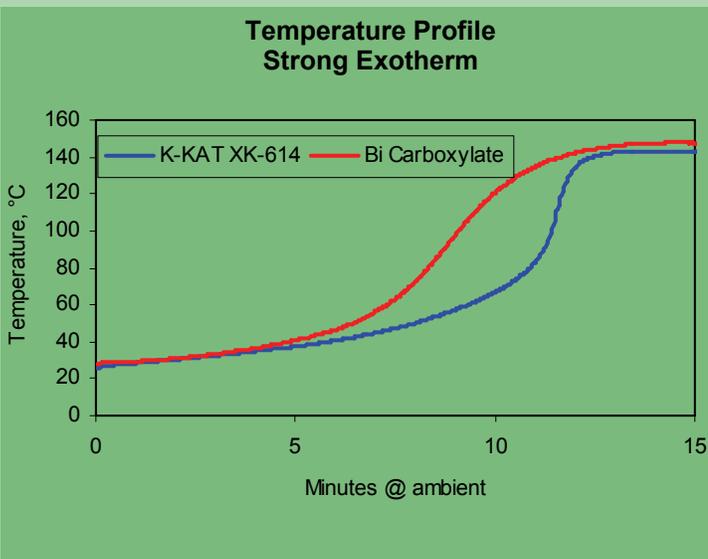
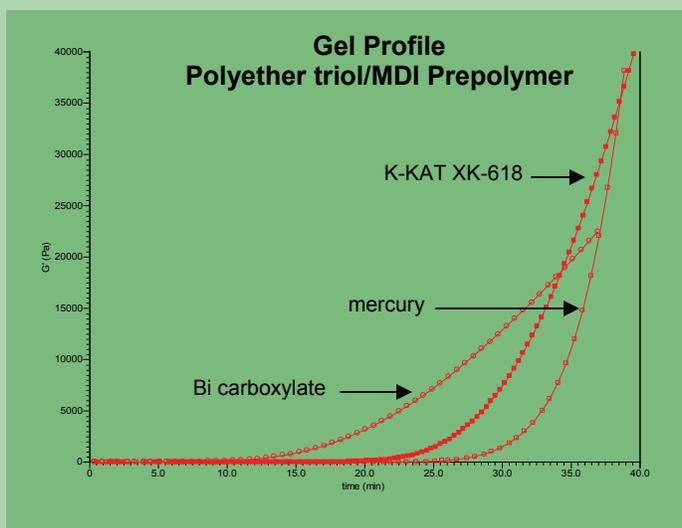
King Industries has developed a line of non-tin and mercury-free catalysts (K-KAT<sup>®</sup>) designed for a variety of urethane applications. In the area of elastomer, adhesive and other non-coating urethane applications, catalyst requirements can vary depending on cure conditions and formulation components. Urethane elastomer applications can range from soft microcellular foams to rigid structural composites. Issues related to catalyst selection for these systems include selectivity (gassing, whether desirable or undesirable), latency and activity stability.

Achieving the full cure profile of mercury is a challenge. In the field of urethane elastomers and adhesives, organomercury compounds provide excellent “snap cure” and selectivity, but they are also very toxic. Increasing regulatory restrictions on mercury and tin have made finding alternative catalysts a higher priority. Guidelines provided in this text can help select a K-KAT catalyst that can provide many of the relevant characteristics.

Preparation of a polyurethane prepolymer may also require the use of a catalyst. For this application it is preferred that the catalyst only remain active during the synthesis process and be inactive in the finished product. Tin catalysts can remain active after synthesis of the prepolymer is complete. Active catalyst in the prepolymer can accelerate degradation of the final product. The zirconium and bismuth K-KAT catalysts can provide the desired balance of activation and deactivation required for resin synthesis.

### Guidelines

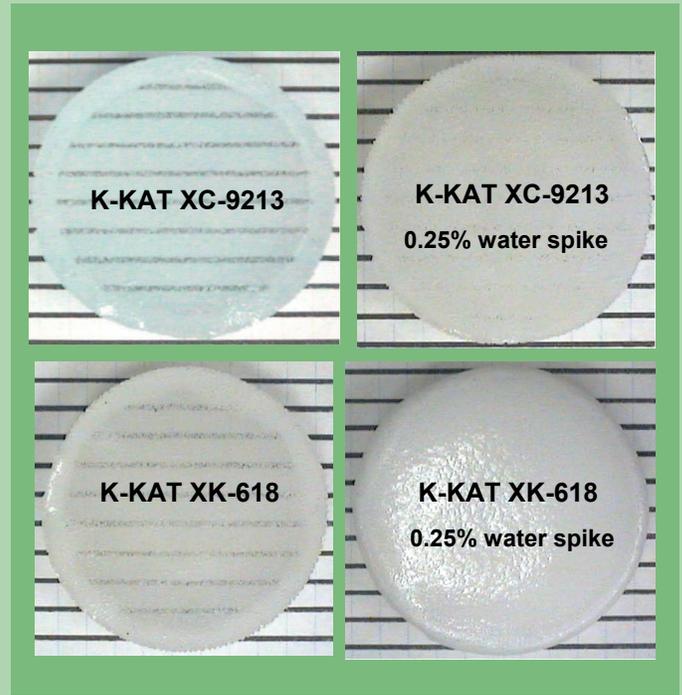
**Latency/Snap Cure:** This desirable characteristic of organomercury catalyzed systems is often a primary concern for formulators, particularly formulators of cast elastomer systems. A mercury alternative catalyst recommendation will depend on the cure conditions and the thermodynamics of the reaction. The mixed metal carboxylates, **K-KAT XK-604** and **K-KAT XK-618**, are generally recommended for ambient cured systems that do not generate strong exotherms. The graph on the right depicts gel profiles of a polyether triol/MDI prepolymer system. The profile of the system catalyzed with **K-KAT XK-618** approaches the organomercury catalyzed profile. Similar gel profiles are possible with **K-KAT XK-604** and **K-KAT XK-617**. **K-KAT XK-618** can be recommended for microcellular foam applications or very dry elastomer systems.



**Exotherm and Cure:** **K-KAT XK-614** provides excellent snap cure in strong exotherm systems and in systems that are cured at elevated temperatures. The graph on the left demonstrates the snap cure capabilities of a strong exothermic reaction when catalyzed with **K-KAT XK-614**.

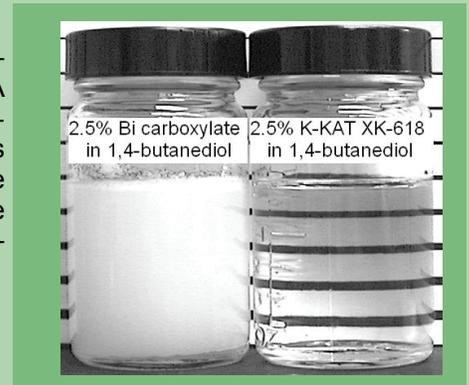
Resin types and filler content have to be considered in the selection process. Systems that use MDI or TDI prepolymers tend to generate less exotherm compared to their analogous polymeric versions. Lower molecular weight polyols with primary hydroxyl groups generate stronger exothermic reactions. Fillers dissipate generated heat, reducing the overall temperature of the system. Heat is an important factor in the activation of **K-KAT XK-614**.

**Selectivity (Gassing):** Another characteristic of organomercury catalyzed systems is low gassing tendency. Gassing, resulting from CO<sub>2</sub> generation during the water/polyisocyanate reaction, is not desirable in most applications. However, some applications tolerate it better than others and some, like microcellular elastomer applications, require a certain amount of foam generation. The zirconium chelate catalysts, **K-KAT 6212, XC-9213 and A209**, provide excellent selectivity towards acceleration of the polyol/polyisocyanate reaction in the presence of moisture, resulting in less gassing. They can also provide very good snap cure. It is recommended that each of these zirconium catalysts should be added to the polyisocyanate component of 2K systems. A consideration for applications that contain some moisture and require some foaming along with good snap cure is **K-KAT XK-618**. This catalyst can also be considered as a non-fugitive, less toxic, non-yellowing alternative to amine catalysts used in foam applications.



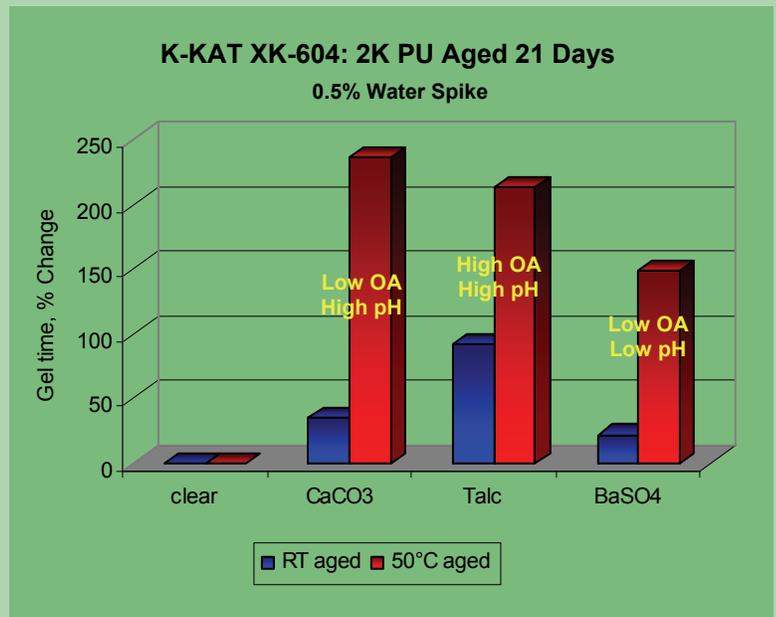
### Catalyst Compatibility in Low Molecular Weight Diols:

Urethane elastomer formulations are often modified with low molecular weight chain extending diols to enhance certain properties. A commonly used low molecular weight diol is 1,4-butanediol. Compatibility of metal carboxylate catalysts in 1,4-butanediol is limited. As demonstrated in the image to the right, **K-KAT XK-618** is much more compatible with 1,4-butanediol compared to a bismuth carboxylate catalyst. **K-KAT XK-618** can be used in non-foam applications provided a very low moisture content is maintained.

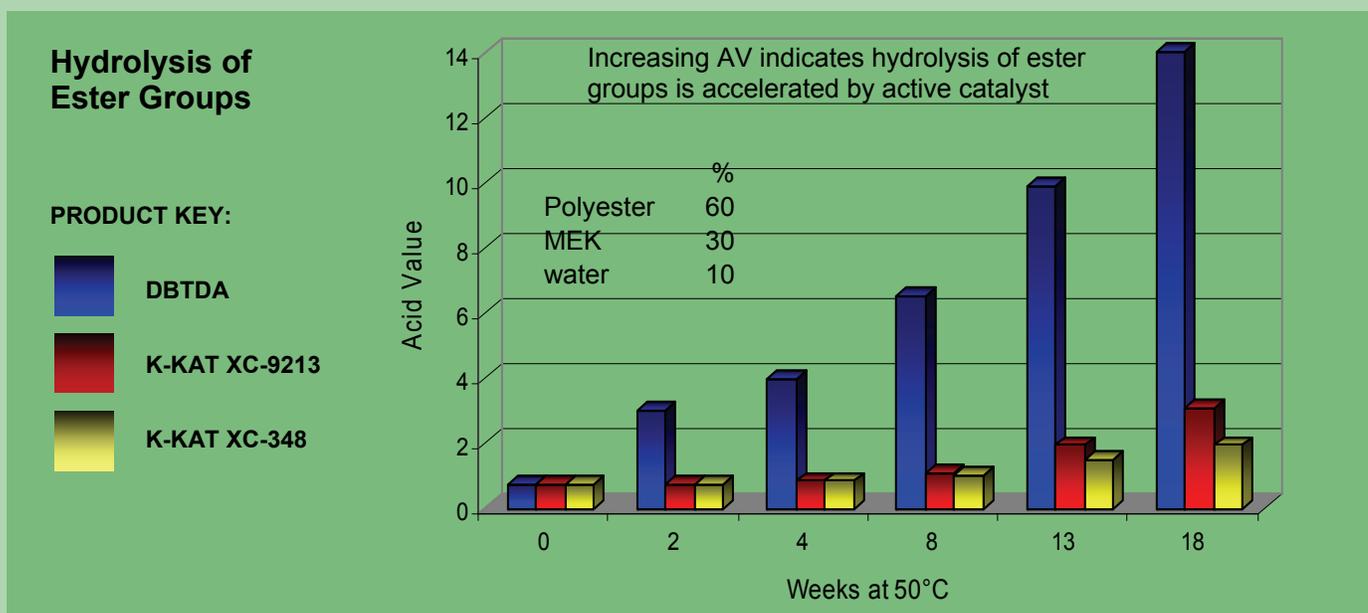


**Catalyst Deactivation/Filler Interaction:** Being a small component of a formulated system, the catalyst can be susceptible to interactions that can cause deactivation. The system pH is an important factor when considering a catalyst. Fillers, such as CaCO<sub>3</sub> and talc, can greatly contribute to the pH of a formula, particularly when used at high concentrations.

The catalysts that are very compatible and stable in acid environments are the metal carboxylates, including the mixed metal catalysts, **K-KAT XK-604, XK-617 and XK-618**, and the bismuth catalysts, **K-KAT 348 and XC-C227**. High oil absorbing fillers are problematic. In this case the apparent deactivation of the catalyst is essentially immediate, as opposed to deactivation on aging in basic systems. The graph to the right demonstrates this point. If the use of a high oil absorbing filler is unavoidable, this issue can be addressed by adding a low cost sacrificial metal compounds to quench the filler. Examples of sacrificial metal compounds are calcium octoate, zinc octoate and potassium octoate. Another approach to minimizing catalyst/filler interaction is to allow the milling temperature to increase to approximately 85°C.

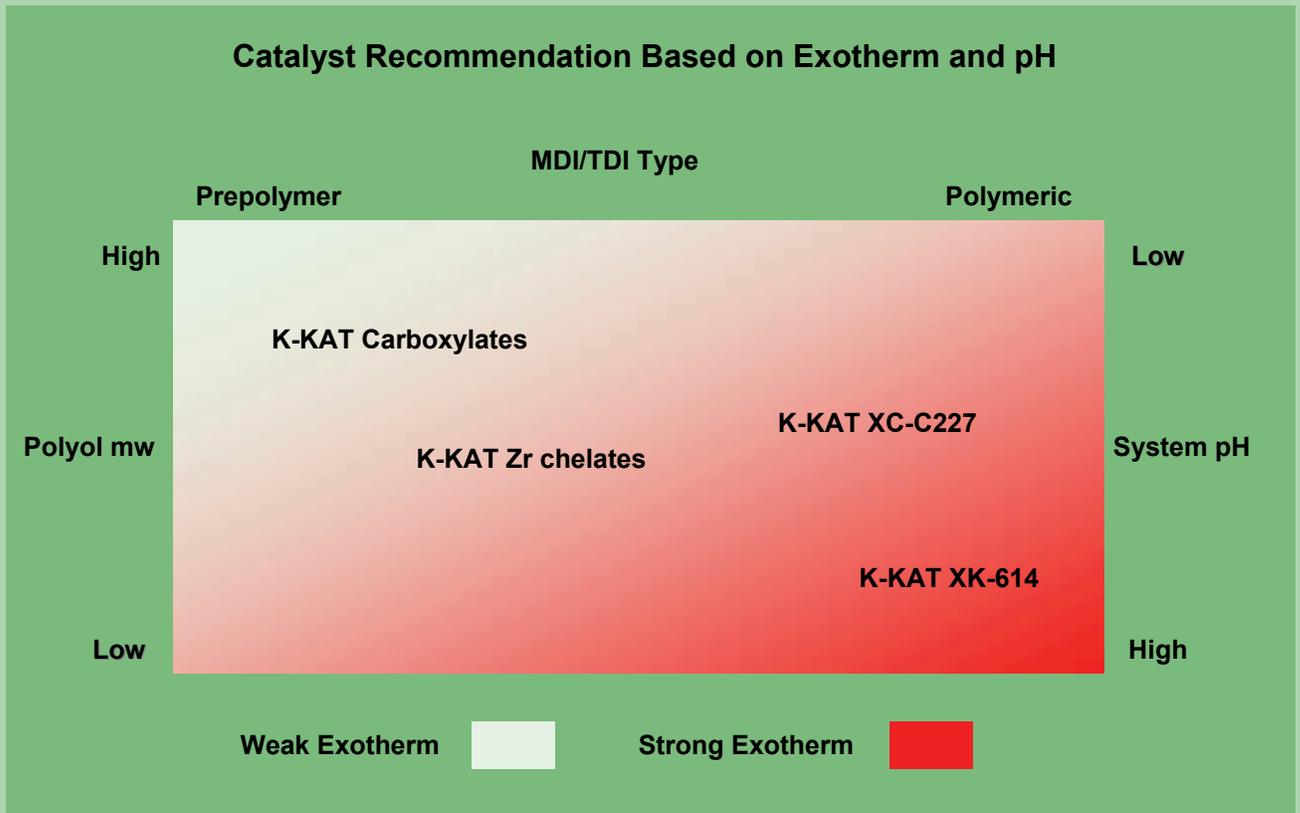


**Resin Synthesis:** Acceleration of the polyol/polyisocyanate reaction during a resin synthesis is a selective process. Although measures are normally taken to minimize moisture, a sufficient amount can remain, resulting in gassing and reduced polyurethane yield. Resin synthesis is an example of an application that would benefit from the use of a catalyst that has limited hydrolytic stability. It is preferable to use a catalyst that is active during the synthesis process and inactive in the finished product. The zirconium and bismuth K-KAT catalysts can provide this characteristic. Tin compounds tend to be more hydrolytically stable and remain active in the finished product for an extended period. Active catalyst in the final product can lead to acceleration of undesirable reactions, for example, acceleration of hydrolysis of ester groups. The graph below demonstrates this point with a low acid value polyester resin stored at 50°C with solvent, water and catalyst. Catalyst levels were based on metal content being 0.01%. The increasing acid value indicates degradation of the polymer as ester groups are converted to carboxylic acid groups. **K-KAT XC-9213 and K-KAT 348**, which can be used in resin synthesis reactions, do not promote the degradation. Dibutyltin diacetate (DBTDA) maintained activity throughout the 18 week storage period.



### K-KAT Catalysts - Typical Properties

K-KAT	Metal	Use Levels (% on resin solids)	Uses
XK-604	Mixed carboxylate	0.1-0.5	Very good gel profile in ambient systems
XK-617	Mixed carboxylate	0.1-0.5	Excellent gel profile in ambient systems Slightly less selective than XK-604
XK-618	Mixed carboxylate	0.1-0.5	Excellent gel profile in ambient systems Promotes more foaming
XK-614	Metal Complex	0.5-3.0	Excellent gel profile in elevated temperature or strong exotherm systems
6212	Zr chelate	0.3-1.0	Very good gel profile—Very selective catalysis (less gassing) - Add to NCO side
A209	Zr chelate	0.05-1.0	Very good gel profile—Very selective catalysis (less gassing) - Add to NCO side
XC-9213	Zr chelate	0.05-1.0	Very good gel profile—Very selective catalysis (less gassing) - Add to NCO side
348	Bi carboxylate	0.03-1.0	Good stability in acidic systems
XC-C227	Bi carboxylate	0.05-1.0	Good stability in acidic systems Best Bi hydrolytic stability



### Applications & Selection Criteria △ highly recommended □ recommended

K-KAT	2K Ambient cure	2K & 1K Elevated temp. cure	2K Strong exotherm	2K Weak exotherm	Acidic pH	Basic pH	Selectivity Less gassing	Selectivity More gassing	Prepolymer Synthesis
XK-604	△	□	□	△	△	□	□		□
XK-617	△	□	□	△	△	□		□	□
XK-618	△	□	□	△	△	□		△	□
XK-614		△	△		□	□			
6212	△	□	□	△	□	□	△		△
A209	△	□	□	△	□	□	△		△
XC-9213	△	□	□	△	□	□	△		△
348	△	□	□	△	△				△
XC-C227		△	△		△				□



### For Additional Information & Formulating Assistance

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