Incident investigation:
Thermal stability improvement of water-contaminated epoxy resin

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During a down-stream treatment of an epoxy resin, a steam-fed heat exchanger on a recirculation loop failed, contaminating the resin with water. Due to the nature of the product, this contamination introduced the risk of an unwanted hydrolysis reaction, followed by a cross-linking reaction.

After doing a stability screening of the mixture, a vacuum distillation of the water was performed, to restore the product stability and allow a safe discharge. Unfortunately, such screening failed in detecting the ongoing cross-linking reaction, and the increase of viscosity caused the stirrer to stop. Emergency discharge of the reactor was carried out, allowing the almost complete transfer of the contaminated product in drums; only a few hundreds of kg of highly viscous product remained in the reactor.

The next day, while a specialized contractor was cleaning the reactor with high pressure water, decomposition fumes started to be released from the material inside the reactor. At the same time, several drums containing the discharged product initiated an exothermic decomposition with the release of black smoke, triggering the immediate evacuation of the production building and the intervention of the fire-fighter brigade.

After the incident, corrective measures were taken. Water content in the resin is now measured every 6 hours. Moreover, the piping line redirecting the resin in the tank and the heat exchanger were physically removed from the installation.

In parallel, a safe procedure for product decontamination was developed based on the use of apolar solvents, allowing physical separation of water from the resin before water distillation. The use of xylene was preferred for its high boiling point, high heat capacity and its availability on site (storage tank next to the production building).

Thermokinetic simulation of the decomposition reaction of the resin was performed using the isoconversional model, embedded in a dedicated software[1]. Thermal risks of three samples were assessed: (1) pure resin, (2) water-contaminated resin and (3) water-contaminated resin + xylene. The results present the strong stabilizing effect of xylene on the water-contaminated resin. According to the simulation, at 130°C, approximate TMR_{ad} values are 24h, 5h and 216h for sample (1), (2) and (3) respectively.

In case of water contamination, xylene could be added in the contaminated resin, increasing its stability, decreasing the cross-linking reaction rate and decreasing the overall viscosity. Water could then be distilled safely.

[1] AKTS AG, http://www.akts.com (AKTS - Thermokinetics software and AKTS – Thermal Safety software).