

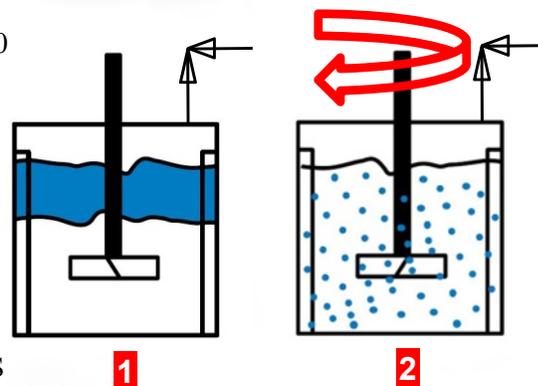
## What if your agitator fails?

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In 1993 in a German factory, o-chloronitrobenzene was reacted with caustic soda dissolved in methanol to produce o-nitroanisole in a 36 m<sup>3</sup> (9500 US gal) batch reactor. This reaction is exothermic (generates heat), and the addition of caustic normally took place at about 80 °C over 5 hours.

Surprisingly, a batch did not require cooling! In fact, rather than needing cooling to maintain the required batch temperature, steam heating was required. Then it was found that the agitator had not been on during the caustic addition. The reactants were not properly mixed (1). The agitator was started, the unreacted chemicals were mixed (2), and the batch temperature quickly increased, exceeding 160 °C (320 °F). At the elevated temperature a different, also exothermic, reaction occurred. 10 m<sup>3</sup> (2650 US gal) of reactor contents were vented to the atmosphere through a

pressure relief valve. A large area, including nearby residences, was contaminated. Nobody was injured, but health risk concerns remain. Direct costs were about 40 million DM (in 1993, equivalent to about US \$ 38 million today).



### Did You Know?

- Chemicals can't react if they do not come into contact with each other. If there is no agitation in a reactor, the reaction will be slow or stop, and unreacted chemicals will accumulate. In an exothermic reaction this is a serious hazard. If you restart the agitator, there will be a lot of unreacted material available and the reaction may be very fast. Your cooling system may not be able to remove the heat fast enough to control the reactor temperature.
- Mixing is clearly important in a vessel containing a multi-phase mixture such as liquid-solid or organic-aqueous liquid phases. It is also important if the materials in the vessel are mutually soluble. In the pictures below, balsamic vinegar, which is completely soluble in water, is added to water without mixing. The vinegar sinks to the bottom of the glass and does not form a uniform solution until the mixture is stirred with a spoon.

### What Can You Do?

- If you lose agitation in a reactor, batch or continuous, get technical assistance before re-starting the agitator. Gather some data to share with technical experts to help decide on the appropriate action. For example, how long was the agitator off, what was added to the vessel while it was off, what is the temperature and pressure history of the vessel?
- Recognize that loss of agitation can be a problem in other vessels even if there is no intended reaction. Without agitation, there can be large temperature and concentration differences in the vessel. This can cause freezing on cooling surfaces, boiling near heating surfaces, precipitation of solids from a solution, or settling of solids from a slurry. Variation in composition of material fed from an improperly mixed vessel to other equipment can cause operating or safety issues in downstream process units.
- Heating or cooling of a vessel without agitation is likely to be inefficient, and temperature indication may be inaccurate if the vessel contents are not mixed.



Reference Gustin, J-L., "How the Study of Accident Case Histories Can Prevent Runaway Reaction Accidents to Occur Again." *ICHEME Symposium Series No. 148*, pp. 27-40, 2001.

**Keep your reactor agitated for safety!**

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