issa | INTERNATIONAL SOCIAL SECURITY ASSOCIATION

Section on Prevention in the Chemical Industry

Reactive chemicals and chemical reactions

Training tool for safety instructions

Version 06/2020

Notes

Topic:

This safety instruction points out some aspects of plant and process safety. Chemical reactions often release energy – they are exothermic and produce heat. If this heat is dissipated in a controlled manner, the process is safe. Deviations in the course of the reaction or insufficient cooling may lead to a dangerous runaway reaction.

Reaction heat can also be released inadvertently – if chemicals decompose during thermal stress (e.g. due to decay during distillation or drying) or react unplanned (e.g. due to polymerisation during storage of monomers).

The prerequisites for a safe implementation and management of chemical processes therefore include knowledge and control of the process parameters.

Lesson 1: The right chemical in the right vessel

Mix up of chemicals (especially when filling storage tanks or reaction vessels) can cause violent reactions, if a false chemical is added. This can lead to a pressure rise, so that there may be a product release or even a rupture of the containment. Or toxic gases can be formed. This also may happen if the right chemical is handled, but is poured into the wrong vessel.

It is therefore important to have clearly labelled containers and filling openings, as well as to check the labelling before the addition.

Lesson 2: The right amount in the right order

An excessive amount of chemicals can overfill a vessel, which may cause hazards to the environment. In addition, too much or too little chemicals (especially catalysts and solvents) form a wrong mixing ratio, so that the reaction can be more severe and a runaway may occur.

Adding in the wrong order can also result in a wrong mixing ratio and a runaway.

It is therefore important to control the right quantity and to monitor the filling.

Lesson 3: Free flow in correct lines

An incorrectly closed valve can lead to a pressure build-up and subsequently to the failure of the line.

Through a false open valve, liquid can pour in a wrong vessel or into the environment.

The use of a false hose material (as well as a leaking pipeline) can lead to failure and product loss.

Therefore, it is important to check and monitor the position of the fittings on the conveyor path, as well as clear trainings for the correct hose material and regular tests.

Notes

Lesson 4: Not too warm but not too cold

Due to a higher temperature, a chemical reaction runs faster. Then heat is released more quickly, so that cooling may not be sufficient and a runaway reaction is caused.

Due to a temperature that is too low, a chemical reaction runs slowly. Then, at the end of the planned time, not everything has reacted, and there is still reaction energy left. This can react abruptly later, so that a runaway may happen.

Some vessels are combined with external coolers. If the cooling doesn't work, the boiling liquid evaporates and doesn't run back into the vessel. Then there is a lack of solvent (consequence see lesson 2).

It is therefore important to control and monitor the temperature in the container as well as to control and monitor the cooling circulation.

Lesson 5: Not too fast but not too slow

If a component is added too fast, the desired reaction may not run in a sufficient speed. Then, at the end of the reaction period, the component – and the reaction energy – is left (consequence see lesson 4).

If the stirring is too fast, viscous chemicals can heat up inadmissibly, caused by "shear energy" (you can generate this energy yourself if you quickly rub your hands). Then the system becomes too warm and the reaction runs too fast.

It is therefore important to control and monitor the dosing speed and the stirring effect.

Method:

This training tool is not to be used for E-learning. The set of slides is intended to assist managers for the personal instruction of employees and to start an open discussion on the topic of occupational safety.

Text and images included in the lessons provide information on which aspects are most important to the topic. Using this as a basis, discussions should be held on whether and where similar issues occur at the company in question, which specific technical and organisational measures are already in place, and which solutions could improve the situation. Safety instructions can thus be used not just to fulfil legal requirements but also as a tool for promoting ongoing improvement within the company.

Analysing thematically related events and “near misses” at the company (or other incidents known of from literature) can help the staff involved become aware of the relevance of the topic and thus encourage safety-conscious conduct for the long term. This may require further preparation and/or research.

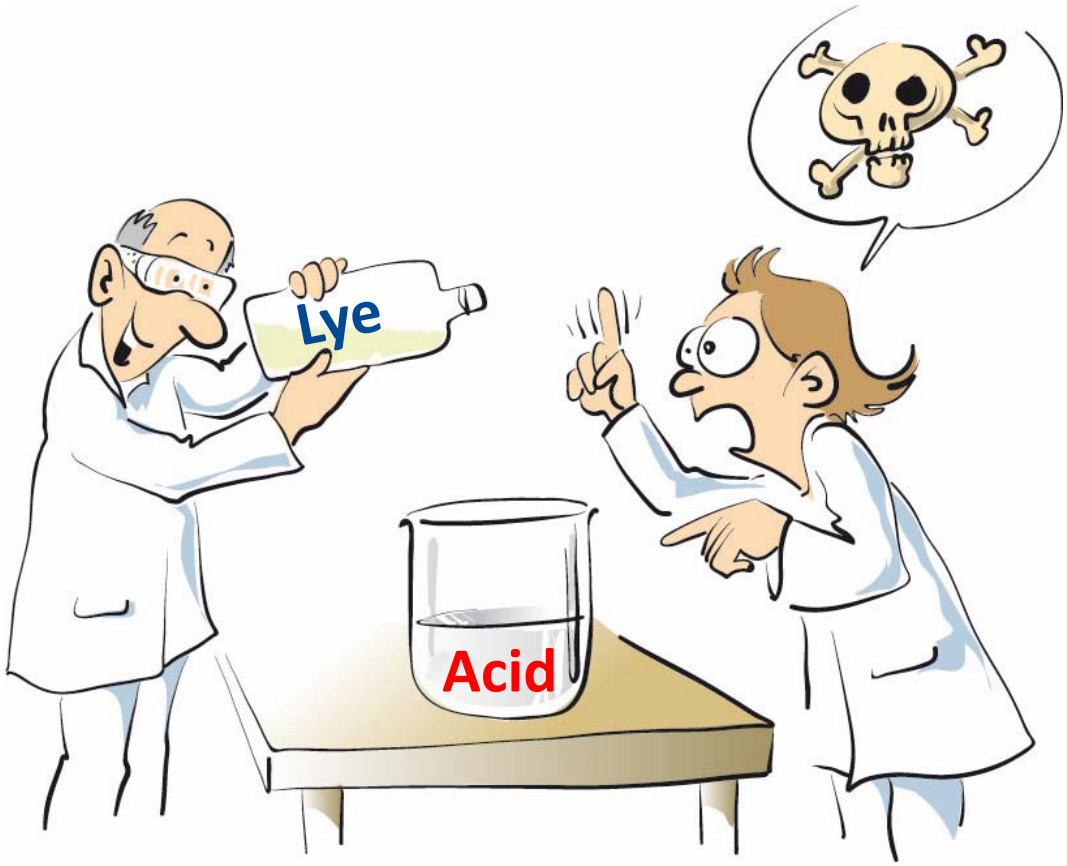
The content of the safety courses is always focused on the staff involved. They therefore do not include information on measures to be undertaken by the employer.

Lesson 1

The right chemical in the right vessel

Check before adding chemicals:

- Is it the correct chemical, is the same name mentioned on the container and in the operation procedure?
- Is it the correct container, does the name on the container match the name at the filling hole?



Lesson 2

The right amount in the right order

Check before adding chemicals:

- Is the correct number of containers provided, is the correct amount set at the flow meter?
- Have all the previous steps been taken, is the order of the components correct?

Free flow in correct lines

Check before turning pumps on:

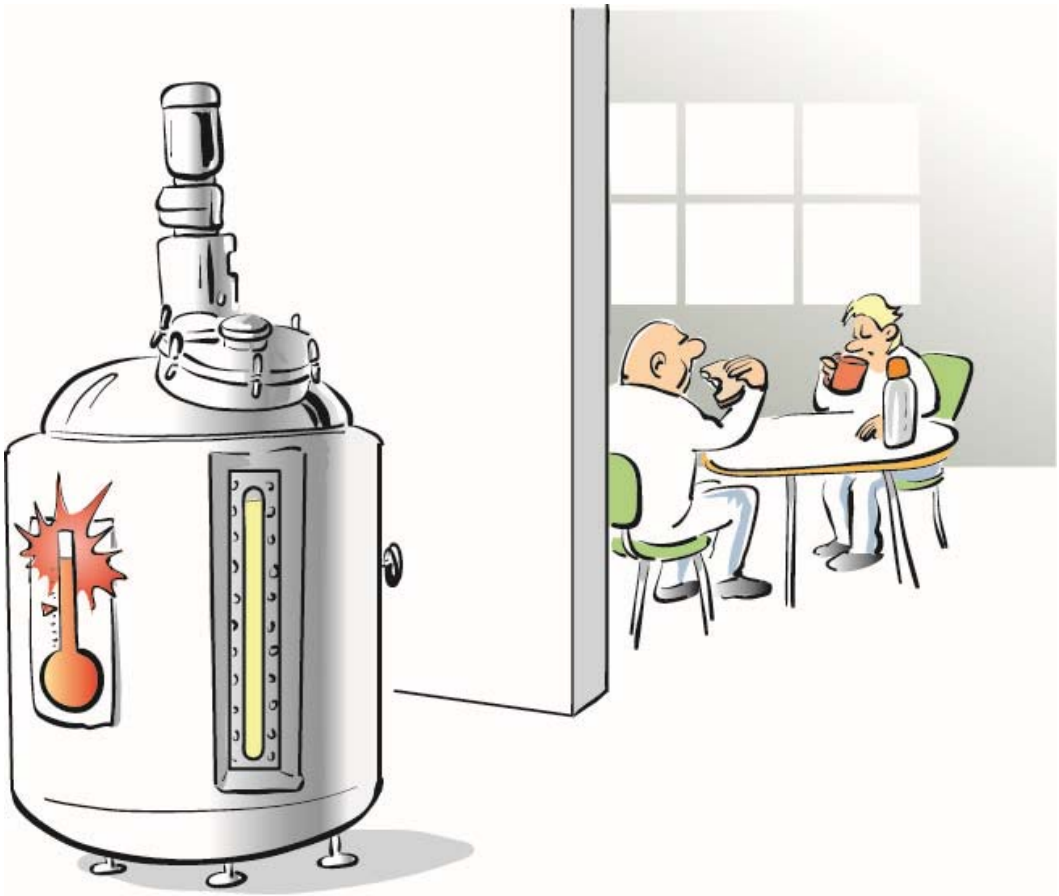
- Are the fittings set correctly (open/closed)?
- Are the correct hoses used (correct material)?
- Is the correct pump used (explosion-proofed)?

Lesson 4

Not too warm but not too cold

Control before and during reaction period:

- Is the right temperature set on the heating&cooling circuit?
- Is the "temperature window" in the vessel adhered to?
- Does the reflux work (when using external coolers)?



Lesson 5

Not too fast
but not too slow

Control before and during reaction period:

- Is the correct speed set to the stirrer?
- Does stirrer and reaction mixture move?
- Is the correct dosing speed set?
- Can the course of the reaction be verified?