

Safety Sharing



Lab Safety Knowledge Sharing

Dec.2022

1. Case description

A student was assisting in freezing some samples by adding liquified nitrogen to a container that was holding the frozen samples.

The container has inner and outer containment areas with liquified ethane inside and liquified nitrogen outside to cool the sample.



The student added the liquified nitrogen to the external part by pouring it from a heavy cylinder (see the attached picture), limiting good control of the pouring speed. In parallel, the student forgot to take out the small inner container with the liquified ethane.

The pouring speed was too fast and the liquified nitrogen flushed into the inner container with the liquified ethane; the two substances mixed together, boiled, and the mixture suddenly burst out and splashed onto the student's forehead, creating skin burns.

The student forgot to wear the protective goggles and it was pure luck that the splash was not hitting the eyes and might have caused blindness.

2. What is boiling explosion

Boiling explosion (or bumping) is the heating of a liquid in the absence of air bubbles or impurities, resulting in an unstable superheated liquid above its boiling point. If the superheated liquid comes into contact with air bubbles or impurities or

the external environment drops sharply, violent boiling will occur due to nucleation, and in severe cases, it will cause high-temperature liquid to splash or even damage the container.

3. Root causes of incident

When the gas in the vessel first expands rapidly, reducing the pressure in the vessel to atmospheric pressure instantaneously. At this time, the saturated liquid in the container is superheated, and the temperature of the solution is higher than its boiling point at atmospheric pressure. As a result, the gas-liquid two-phase is out of balance, the liquid rapidly evaporates and vaporizes in large quantities, and the volume expands rapidly, and the container shell is subjected to high pressure impact, causing it to further rupture.

Possible examples:

- **"Bumping" caused by heat of solution + heat of vaporization**
- **"Bumping" caused by heat of vaporization**

In lab:

1. During the heating process in the oil bath in the laboratory, high-temperature oil is splashed into water droplets;
2. When adding concentrated sulfuric acid to water; or as in a junior high school chemistry experiment, using sulfuric acid to dehydrate ethanol to produce ethylene
3. Coolant ethane is splashed into liquid nitrogen;

In home:

1. When frying food, splash water droplets;
2. Add food powder (coffee powder, tea leaves etc.) after heating water in microwave oven.

4. How to prevent it (the general method)

1. Add one or two zeolite or porcelain pieces

to the reaction vessel, and there will be air in the small pores on it. As the temperature rises, the air expands and escapes, forming bubbles in the liquid to make the liquid boil.

However, these alone may not prevent bumping, so heating liquids in test tubes,

flat-bottomed flasks, and Erlenmeyer flasks is recommended. In addition, the mouth of the test tube during heating should not be pointed at anyone to prevent personal injury in the event of bumping.

Whenever a liquid cools below its boiling temperature, and is reheated to boil, a new zeolite is needed, as the pores in the old zeolite tend to fill with solvent, rendering it useless.



2. **Placing the sealed capillary** in the boiling solution to form the core site reduces the risk of bumping and allows easy removal of the core from the system.

3. **Agitation of the liquid during warming** also reduces the chance of bumping, as the vortex created by the agitation destroys any large bubbles that may form, while the agitation itself creates small bubbles.

4. **Prevent the induction of impurities**, which may also cause bumping. For example, during the oil bath, the heating liquid accidentally overflows into the oil used for heating, which will cause bumping and cause oil splashing.

We must keep in mind: refuse to fluke, avoid anxiety!

Nothing we do is worth getting hurt for!