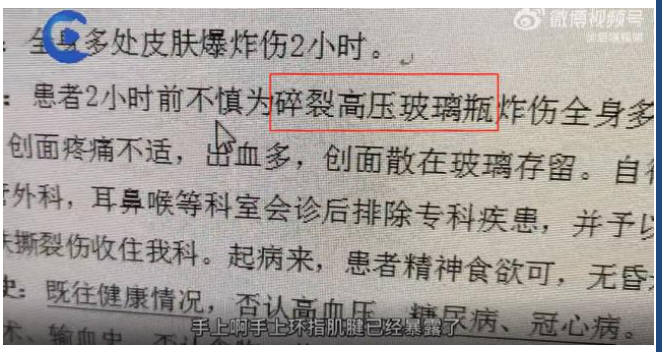
Lesson Learn

Laboratory glassware (sealing tubes) explosion accidents and precautions for equipment use

June. 2022

I. Case Introduction



According to the Shenzhen Evening News, on the afternoon of June 7, a laboratory glass instrument explosion occurred in a university in Shenzhen. The Phd student Sun was doing experiments in the laboratory, the experimental glass bottle suddenly burst in the case without warning, glass slag splash. After the explosion, Sun's whole body was instantly shaken and his ears tingled. He found that his face, neck, arms and other 10 places were injured by the explosion. He was quickly assisted by his classmates in applying simple bandages and pressure, and was taken to the emergency department of Shenzhen University General Hospital for treatment. The carotid sheath was blown open and a further 0.2 mm deep would have cut through the carotid artery.

After a three-way consultation between the hospital's vascular surgery department, otorhinolaryngology-head and neck surgery department and plastic and cosmetic surgery department. After the initial consultation, Xiao Sun's entire body had more than ten wounds of various sizes combined, with

the wounds concentrated on the neck and face of his frontal upper body. In addition to the most dangerous neck wound, the area around the eye socket, the chin, ear, fingers, shoulder and forehead ..... were all injured to varying degrees. The most bleeding of these wounds was on the right side of the neck, which was visually measured to be 3 centimeters long. The deepest wound was on the right side of the jaw, where a "hole" was blown directly into the skin, about a finger knot deep. After a quick ultrasound, the doctor determined that Xiao Sun had not injured the carotid artery or other important blood vessels and nerves, and immediately decided to have the surgery performed by Song Rengang, Director of the Plastic and Reconstructive Surgery Department.

At present, Sun is in hospital and recovering from his injuries.

Other cases:

A student in a university chemistry lab was conducting an experiment when 20mL of ammonia, 1g of ferrous Sulphate and 4g of raw material were added to a glass sealing tube, which was heated at 160°C. While the person was observing the temperature of the oil bath, the sealing tube suddenly exploded and the whole reaction system was completely blown apart. The person was injured on the forehead and was lucky to be wearing eye protection at the time so that both eyes were not harmed

Cause of accident: The glass seal tube is not resistant to high pressure and the pressure inside the tube cannot be detected during the reaction.

Ammonia changes to ammonia and water vapour at high temperatures, generating high pressure and causing the glass seal tube to explode.

Possible causes of explosion when sealing tubes are used：

Damage to the seal： The seal is the most easily damaged component on the entire reactor and should be replaced if damaged. The seal was once damaged during an ammonia reaction with an ethanol solution of ammonia at 120°C and the reaction solution washed out.

No consideration of material properties and reaction conditions： When using the sealer at very low temperatures, the Teflon cap is screwed on too tightly before heating. After heating to 120°C, the Teflon expands faster than the glass and breaks the glass at the mouth of the sealer and the reaction solution is flushed out.

Exceeding use pressure： With the use of a sealing tube, the tube explodes while the reaction is in progress and it is calculated that three times the amount of gas can be produced in the experiment (e.g. 2 times the amount of CH3OH and 1 times the amount of CO2 at 100°C).

II. Cautions

- New seals can withstand up to the marked pressure, but after many uses the maximum pressure withstood will drop and unqualified seals should not be used without rigorous testing.
- They should only be used if a solution with gas is involved, the temperature does not exceed the boiling point of the solvent and the pressure does not exceed the nominal operating pressure of the equipment and vessel.
- The maximum pressure that the seal can withstand is marked, but after many uses, the maximum pressure will drop, unqualified seals have not been rigorously tested and should not be used。
- In the presence of gaseous solutions, the temperature can not exceed the boiling point of the solvent and ensured that the pressure does not exceed the marked operating pressure of the equipment and vessel.
- Complete experimental hazard analysis：在 When using a solution of gas, the pressure estimate should take into account not only the pressure generated by the solvent exceeding the boiling point at that temperature, but also the pressure generated by the volatilization of the gas in the solution at high temperature, as the gas evaporates heavily at high temperatures. It is important to take into account the pressure of the gases that may be generated by the reaction, including those that may be generated by the primary and secondary reactions.
- For reactions where the reaction temperature exceeds the boiling point of the solvent by more than 20°C, the use of an autoclave reactor

is recommended. For unsure reactions, it is recommended to first use a microwave reactor for a small trial, which is fast and relatively safe.

- Seals are the most easily damaged part of the entire reactor. There are two types of seals for sealing tubes, the usual brown Viton seals, which are resistant to oils and acids; the white per fluorinated seals, which are used if strong alkalis are used in the reaction
- 盖- Do not turn the cap too tightly or too loosely when putting it on, never so tightly that it can't be tightened any further, as this could easily cause dangerous leaks or even break the seal.
- The volume of reagents and solvents in the system is strictly limited to less than 1/3 of the volume of the sealing tube, less than 1/5 is recommended.
- When washing sealing tubes, do not soak them in a vat of alkali or use ultrasonic washing. The tubes should be rinsed clean with a suitable solvent according to the reaction and can be washed with a test tube brush, the use of a spatula is strictly forbidden.
- Sealing tubes are pressure instruments and any handling that may cause internal damage such as bumping or scratching is strictly prohibited.
- At the end of the reaction, bring the reaction down to room temperature before opening the cap, not while the tube is still hot。
- **When carrying out tube sealing reactions, protective shields must be placed on the front and on the sides where people may be injured. When observing tube sealing reactions in progress, do not observe directly, but from behind protective glass or shields.**

一定要牢记：拒绝侥幸，别怕麻烦。

Nothing we do is worth getting hurt for !