IMPERIAL CHEMICAL INDUSTRIES
HEAVY ORGANICS DIVISION

SAFETY NEWSLETTER NUMBER 28

By Trevor Kletz

Many of the incidents described in past Newsletters have occurred because the system of working was wrong or because the people concerned did not fully understand the hazards.

Some of the incidents described in this Newsletter occurred because well-known and well-understood methods of working were not followed.

28/1 A TANK IS OVERFILLED

A tank was overfilled recently and nearly 100 tons of 'petrol' was spilt. It happened because the operator forgot to shut the isolation valve when he changed over the tanks.

There are several lessons of general interest to be learnt from this incident.

1. It was an hour after the spillage was discovered before the Fire Brigade were called to cove the spillage with foam. Any spillage of petrol or similar liquids is liable to ignite and the Fire Service should be called straight away.

2. The supervisor sent an operator to check that the compound drain valve was shut. It was shut, but unknown to the operator, the valve had a left-hand thread. The operator therefore opened the valve, thinking he was shutting it, and let out some of the petrol.

   Are there any left-hand valves in your compounds and, if so, have they got warning labels on them?

3. If a tank can be filled very rapidly it should be fitted with a high level alarm. If a tank can go from its normal maximum working level to overflow in 20 minutes or less, the case for a high level alarm is very strong.

   If a high level alarm is installed it must be tested regularly.

   If you do not have the resources to do this, it is better not to install the alarm. The next item tells you why.

28/2 WHY SHOULD WE TEST ALARMS AND TRIPS?

On nearly every plant we have a number of alarms which sound if a temperature, or pressure or level gets too high or too low; and we have a number of trips which close a valve or open a valve if a temperature or pressure or level gets too high or too low.

These alarms and trips are not perfect. From time to time they develop faults. Some of these are 'fail-safe' faults and cause spurious trips or alarms. Others are 'fail-danger' faults which prevent the trip or alarms operating when we want it to.

The rate at which faults develop depends on the detailed design and the components used and varies from one trip to another, but most trips will develop a fail-danger fault about once every year or two, say once in eighteen months.

Suppose the trip is tested weekly. On average it will fail half-way between tests and so it will be out-of-action for $3^1/2$ days every 18 months, i.e. for 0.64% of the time. This is called the fractional dead time.

Now suppose the trip is called upon to operate once per year. We say that the demand rate is once/year. Sometimes the demand and the dead time will coincide and the temperature or pressure or level will reach a dangerous level. The chance of this happening is:

(Demand rate) x (Fractional dead time)

= 1.0 x 0.64/100

= 0.0064 per year or once in 150 years.

This figure is called the *hazard rate*. It is the rate at which dangerous conditions arise.

Now suppose instead of testing the trip weekly, we test it every 4 weeks. On average it will be out of action for 2 weeks every 18 months and the fraction dead time will be 2.6%

The hazard rate will now be.

(Demand rate) x (Fractional dead time)

= 1.0 x 2.6/100

= 0.026 per year or once in 33 years.

If the trip is tested once per year, on average it will be out of action for 6 months every 18 months and the fractional dead time will be 33%.

The hazard rate will be.

= 1.0 x 33/100

= 0.33 per year or once in 3 years.

If there was no trip at all the hazard rate would be once/year. So we see that if a trip is tested only once/year, it is not doing much good at all. If it is never tested, it is doing no good at all and might as well be put back into store.

The figures in this example are typical of most instrument trips, the sort that close a valve when a temperature or pressure or level gets too high. Mechanical trips, such as the overspeed trips on steam engines go wrong less often and yearly testing may be sufficient. But the same principles apply; if the trip is never tested, one day it will go out-of-order and this will not be detected.

28/3 TWO LFG LEAKS WHILE FILLING ROAD TANKERS

On two occasions recently, whilst tankers were being filled with liquefied flammable gas, there was a leak from the coupling between the hose and the tanker. In one incident, the screw coupling was stiff so the operator rotated it only 4 turns instead of the 6 turns needed to fix it properly. He did not leak test the hose with nitrogen. When LFG was put into the hose it leaked out.

The operator isolated both ends of the hose. He was trying to tighten the coupling when he dropped a tool onto the concrete and ignited the LFG.

The operator should not have attempted to tighten the coupling until the LFG had been dispersed with steam or water (this particular LFG is soluble in water). Leaks of LFG are liable to catch fire and the operator was lucky he escaped without injury.

In the other incident the coupling was a different type which is secured with a bolt. As a result of wear the bolt holes in the two halves were out of line and the operators had got into the habit of leaving out the bolt. One day, when filling was complete, the operator moved the hose to drain the contents into the tanker and it came uncoupled.

Five tons of LFG were blown out by the pressure in the tanker.

The filling line is already fitted with a remotely operated valve. The possibility of fitting one on the tanker is being looked at. (We cannot fit a non-return valve as the same line is being used for filling and emptying.)

The real cause of the spillage, however, was the failure of the operators to do anything or tell anyone when they could not use the coupling in the correct way. Can you use this incident as a cautionary tale?

28/4 DO NOT HANDLE DANGEROUS LIQUIDS IN OPEN BUCKETS AND DRUMS

Accidents keep on happening because flammable or corrosive liquids are handled in open topped buckets or drums.

A few years ago a man was badly burnt when he was carrying some petrol in a bucket and ii caught fire.

An employee of another company was carrying phenol in a bucket. He slipped and fell. The phenol was spilt onto his legs and half-an-hour later he was dead.

Recently another incident occurred in the Division. While moving a drum of hot cleaning fluid an operator slipped; liquid splashed onto him and scalded his ankle.

Handle dangerous liquids in closed cans or drums.

28/5 NITROGEN IS NOT SAFE

There have been several incidents recently — one of them fatal — in which men have been affected by nitrogen. See Newsletter 22, Item 1 and Newsletter 25, Item 3. Now another incident has occurred, fortunately without causing injury.

An air driven light was used to illuminate a vessel which had to be kept full of nitrogen — so the motor was driven by nitrogen instead of air.

Later the vessel was prepared for entry. As a man was about to enter the vessel he noticed that the light was still inside and was still connected to the nitrogen supply. Had he entered he might have been affected by lack of oxygen.

Never use nitrogen to operate air-driven equipment if you can avoid doing so.

If nitrogen has to be used to operate “air” driven lights (or other equipment) a warning label should be put on them.

Nitrogen is used so often to prevent explosions that we come to look on it as a safe material. The real lesson of the recent incidents is that there is a need to tell everyone that nitrogen can reduce the oxygen content of the air so that it will not support life.

28/6 PRESSURE TESTING OF PIPEWORK

A new ICI Specification, B.80 ‘The Pressure Testing of Erected Metallic Pipework’ has recently been approved and will be available from Divisional Standards Sections in the course of the next few weeks.

The Specification consists of a Foreword for use in design and construction management offices together with two Specifications, B.80 (Hyd) and B.80 (Pneu) for hydrostatic and pneumatic pressure (and leak) testing which it is intended should form part of the Contract between an ICI Division and a site piping contractor.

The Foreword insists that wherever possible the preferred method of pressure testing should be hydrostatic but recognises that, under certain circumstances, pneumatic testing (under very carefully supervised conditions) may have to be done. In order to avoid any possibility of a brittle fracture occurring during a pressure test the concept of ‘minimum permitted test temperature’ which varies with the pipe material and its wall thickness is introduced. This ‘minimum permitted test temperature’ is 5°C above the minimum permitted service temperature for the material in the case of hydrostatic testing and 15°C, 20°C or 25°C higher (depending on thickness) in the case of pneumatic testing.

The Foreword restricts pneumatic pressure testing to Class I or II piping systems and insists that any proposal to test a system pneumatically where the multiple of test pressure times volume exceeds 1500 psi x m3, be referred to the appropriate Divisional Safety Authority for special consideration.

> (1500 psi x m^3 is equivalent to 2400 kcal, the amount of energy released by the explosion of 0.2 kg of ethylene mixed with air or 0.7 kg of TNT).

28/7 IN A FIRE, SHOULD WE EMPTY PLANT VESSELS OR LEAVE THEM FULL OF LIQUID?

If there was a fire on the plant and it was possible to empty the plant vessels, many people would do so. At first sight, it seems the obvious thing to do. But let us think about it a bit more.

Consider an ordinary domestic kettle on a gas-stove. As long as there is some water in it, the heat from the fire evaporates the water and prevents the metal getting too hot. As soon as all the water has boiled away, the flames rapidly melt the kettle.

A plant vessel in a fire is like the kettle. As long as there is some liquid in the vessel, the part of it in contact with the liquid will not get too hot. If the liquid has boiled away, or has been removed, the metal will very quickly get so hot that it bursts. (The relief valves will not stop the vessel bursting, as if the metal gets too hot it will burst at a low pressure).

So if there is a fire on the plant, leave the liquid levels in the vessels.

Of course, if there is a hole in the vessel below the liquid level and this is providing fuel for the fire, the right thing to do is to empty the vessel. The same is true if there are a lot of joints below the liquid level and they are a type, such as lens ring joints, that soon start to leak. We cannot lay down hard and fast rules — we have to depend to some extent of the judgement of experienced people on the spot.

A few other points to remember in a fire are:

Get cooling water on the vessels as soon as possible, especially on the upper portions which will not be wetted by the liquid inside.

If possible reduce the pressure inside the vessel by venting it to blow-down; this will lower the temperature of the boiling liquid.

If the material in the vessel is near its critical temperature, the latent heat of evaporation will he very small and very little heat will be absorbed by the boiling liquid. See Newsletter 24, Item 8. These vessels should be vented, and the contents will then rapidly evaporate.

If an intense torch from a broken or leaking pipe-line is playing directly onto the vessel, overheating may occur below the liquid level.

Several experienced managers have told me that the advice given in this item is new to them and that in a fire they would have emptied the plant vessels as quickly as possible. I should be grateful for feedback. What would you have done yourself? And do you accept the arguments of this note?

28/8 THE DETECTION AND REMOVAL OF EXPLOSIVE MIXTURES

In the 17th century the following method was used to detect combustible gases in mines:-

> From John Aubrey's "Brief Lives", 1662.
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> "...the workemen being merry with drink fell to play with fire-brands, and to throwe live-coales at one another by the head of the Pitt, where they usually have fires. It fortuned that a fire-brand fell into the bottome of the Pitt : where at there proceeded such a noise as if it had been a Gun: they likeing the Sport, threw down more fire-brands and there followed the like noise, for severall times, and at length it ceased. They went to work after, and were free from Damps, so having by good chance found out this Experiment, they doe now every morning throw-down some Coales, and they work as securely as in any other Mines."

28/9 IN BRIEF

(a) During the start-up of a new plant, all joints were tested with combustible gas detectors every few hours as the temperature and pressure were raised. Twenty-five leaks were detected when they were small and hardened up. To make the leaks easier to detect, a piece of tape with a hole in it was wrapped round the joints.

(b) Some drums were filled with product at 50°C and the bungs fitted. The drums were sucked in.

(c) A Barton dp cell, operating at 250 ats, disintegrated due, it is believed, to corrosion of the bolts, the result of lack of heat treatment after electrolytic coating. Details on request.

(d) The protective cap on a cylinder of LPG was secured by only one thread — the threads were so rusty that the cap could not be screwed right home. When the cylinder was moved by a fork lift truck it was knocked against a post and the valve was knocked off. If you handle cylinders, you may like to check that the caps are fitted properly.

e) Temporary lighting, of a type that is normally unsuitable for use in areas where leaks may occur, is sometimes used on welding jobs. A recent survey on one works showed that it is sometimes left on the job after the fire permit has been withdrawn.

(f) Mond Division have produced a Supervisors Handbook. If you would like to see a copy we can lend you one or you can get one from the Mond Division Safety Adviser, Jack Melluish.

For more information on any item in this Newsletter, please write to Miss M N, Organic House, Billingham, or ring B.3927. If you do not see this Newsletter regularly and would like your own copy please ask Miss N to add your name to the circulation list.

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