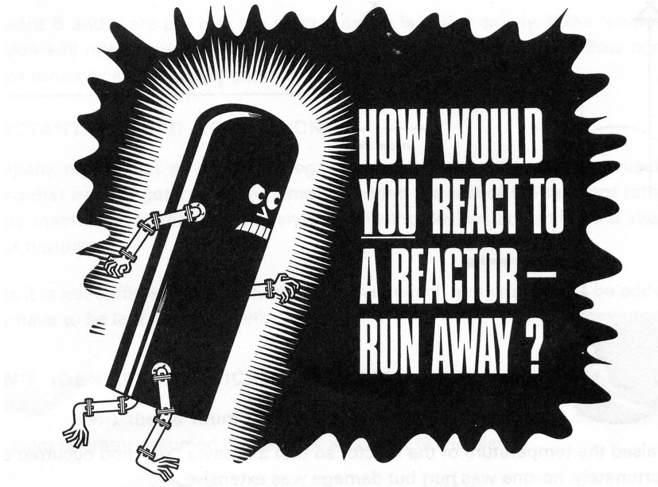
SAFETY NEWSLETTER

No. 141

SOME REACTIONS THAT WENT WRONG



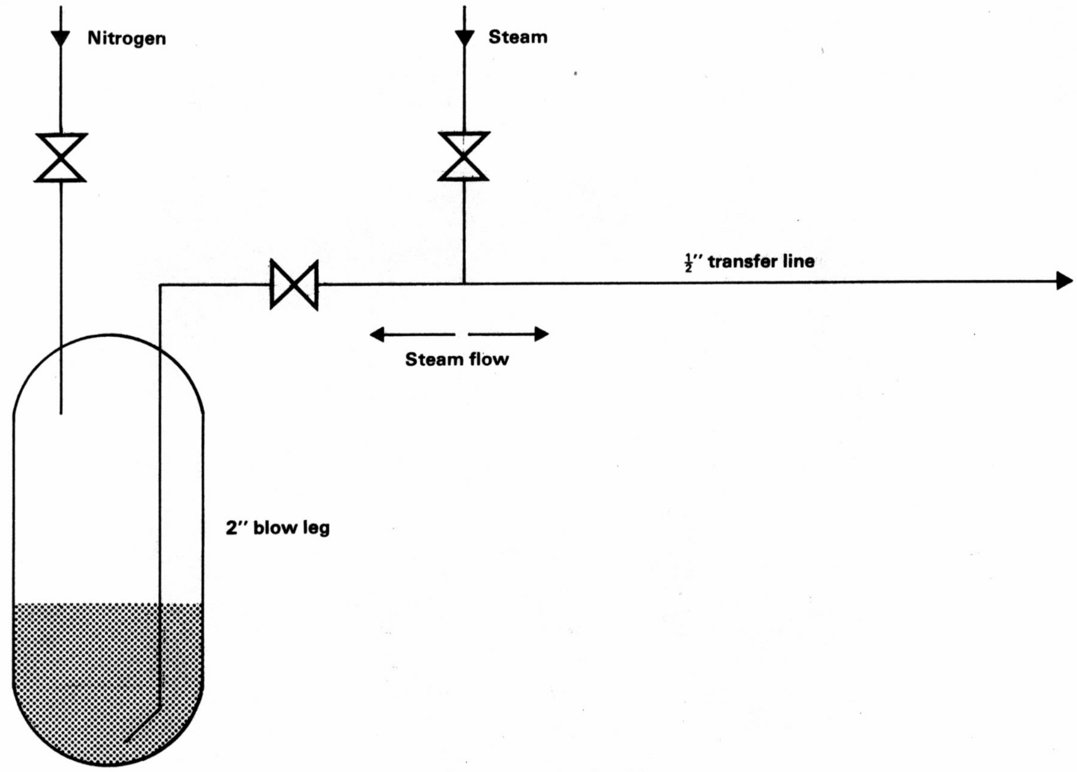
IMPERIAL CHEMICAL INDUSTRIES LIMITED

PETROCHEMICALS DIVISION

141/1 STEAM USED TO CLEAR A CHOKE OVERHEATED A REACTOR

Another Division has described an explosion in a batch reactor.

A completed batch was being egged into another vessel when the transfer line choked. The operator cleared the transfer line with steam, using a connection supplied for this purpose. He steamed both into the reactor and into the transfer vessel.



The steam raised the temperature of the reactor so that a runaway reaction occurred and the reactor exploded. Fortunately, no-one was hurt but damage was extensive.

A few years ago the size of the transfer line was reduced from 2 inches to ½ inch to prevent frothing. Although frothing stopped, the transfer line now choked from time to time and the chokes were cleared with steam.

There were no detailed instructions for steaming. The operator assumed that the blow leg might have choked, and steamed it. He did not realise that heating the contents of the reactor would be dangerous.

Since the explosion:

Frothing has been prevented by a change in recipe and the transfer line has been restored to 2 inches.

The steam connection has been redesigned so that steam cannot pass into the reactor. (A rotating bend on the steam line faces up to the transfer line but cannot be joined to the blow leg).

The process is an old one. It has been in use for about 50 years, and over that time the plant and process have changed. If an operability study had been carried out it would have drawn attention to the consequences of adding steam to the reactor and this could then have been prevented by plant design or clear instructions.

More fundamentally, new continuous processes have recently been described which operate with a lower inventory, thus minimising the consequences of any explosion.

For more information see Report No. D.87263/B, available within ICI only.

141/2 IS A + B + C the same as C + B + A?

Earlier Newsletters (95/1 and 117/1) and an article in Hydrocarbon Processing, August 1980, have described ways of making a plant safer by changing the design instead of adding on protective equipment. Here is another example, from another Division.

Three raw materials, A, B and C, have to be reacted together in a batch reactor.

The traditional method is to put A and B into the reactor and add C slowly. If the temperature control fails, the reaction will run away, as A and B will react together. If too much C is added, the reaction will run away.

In the latest plant B and C are put into the reactor and A is added slowly. If the temperature control fails the reaction will not runaway as B and C do not react together. If the A flow control fails, the reaction cannot runaway as the rate of addition is limited by the line size.

141/3 REACTANTS ADDED TOO QUICKLY

Another Company report that an operator began adding a reactant to a batch reactor rather too slowly. Finding that he was getting behind time, he added the rest of the reactant rather too quickly and a runaway reaction occurred. Fortunately the relieving devices controlled the situation and the reactor did not rupture.

In many cases it is not sufficient to specify the time over which a reactant must be added; the **rate of addition** may have to be laid down as well.

141/4 DON'T IDENTIFY CHEMICALS BY SMELL

Another Company report that a drum was found without labels. It smelt like methylethylketone (MEK) so the plant operator assumed it was MEK and fed it to the plant.

Unfortunately the drum contained ethanol and few percent of MEK.

The batch was ruined. It was fortunate that nothing more serious occurred as ethanol can react with the other constituents of the batch.

Never rely on smell to identify chemicals.

141/5 TWO PRECAUTIONS - BUT THE WRONG ACID WAS CHARGED

A plant, in another Division, uses three sorts of acid. The acids arrive in identical containers on pallets so to prevent mistakes two precautions are taken:

Only one sort of acid is kept on each pallet.

Each container is marked with a coloured disc — a different colour for each acid.

One day the wrong acid was charged to the plant.

By some means, containers of two different sorts of acid had got into the same pallet. The operators checked the disc on the first container, but then paid no attention to the discs on the other containers, as all the discs on a pallet are usually the same.

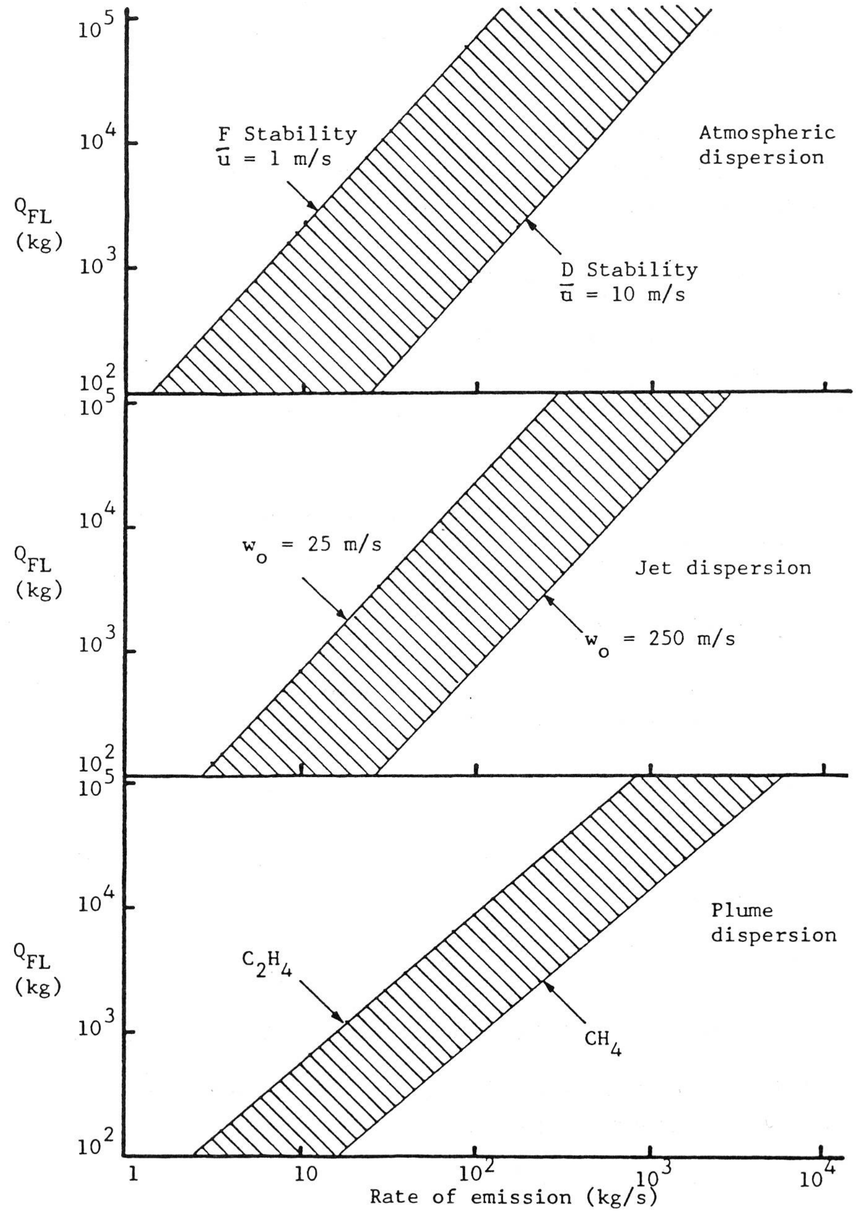
This incident shows that double-labelling systems have snags — people check the first label and then ignore the second because they have never known the first one be wrong.

The manufacturers of the acids are now being asked to provide larger coloured labels for the different acids so that it will be easier to notice them.

141/6 A QUICK METHOD OF ESTIMATING HOW FAR LEAKS WILL SPREAD

A paper by J G Marshall in “Chemical Process Hazards VII”, published by the Institution of Chemical Engineers (1980, p11), gives a quick method of estimating the size of vapour clouds formed by leaks of flammable gas or vapour. The diagrams are taken from the paper.

The horizontal axis gives the rate of leakage in kg/sec and the vertical axis the quantity of material in kg between the flammable limits.



The centre diagram is used for leaks which disperse by jet mixing. For this to occur the gas has to leak out as a jet under pressure. Exit velocities (w_0) between 25 and 250 m/sec are considered.

If the gas is not under pressure, or if the jet loses its energy by striking the ground or other equipment, then the vapour is dispersed by the wind and the top diagram should be used. Wind speeds ($\bar{u}$) between 1 and 10 m/sec are considered.

The bottom diagram is used for gases lighter than air which disperse by buoyancy.

An interesting feature of the diagrams is that even with very high leak rates (100 kg/sec or 360 t/hr) the size of the cloud is only 20 — 50 tes under unfavourable conditions, much less if the wind speed is high or the exit velocity high.

At Flixborough, where there were two 28 inch open ends, the leak rate was estimated as 1 000 kg/sec.

If there is a leak of flashing liquid the centre diagram can be used but, instead of the rate of emission, the rate of production of vapour should be used. This is usually far more than theoretical as some of the liquid forms spray which evaporates on contact with the air. A rule of thumb often used is to double the theoretical rate.

141/7 COOLING TOWER DAMAGED BY ICE

On several occasions in recent years cooling towers have been damaged by ice.

If a plant is shut down during the winter, the cooling water system is usually kept running to prevent it freezing, but the water gradually gets colder and ice may form on the packing. Last winter so much ice formed in one of our cooling towers that a section of packing collapsed.

Cooling towers should be provided with steam lines so that some heat can be put into the water. A 4 inch low pressure steam line should be sufficient for our largest towers.

Reminder: if cooling towers are allowed to get dry they catch fire very easily. See Newsletter 117/5.

141/8 A LOOK BACK AT NEWSLETTER 41 (June 1972)

Vibration caused fatigue failure of an unsupported pipe

Extract from a dangerous occurrence report:

> *"Mr — was requested to check that the isolation valve at the foot of the vent pipe was closed. On grasping the valve handwheel, the vent pipe sheared from the transfer line at the stub weld and fell 35 ft to the ground. The vent pipe was of 2 inch NB stainless steel and was 15 ft long"*

The vent pipe was not secured in any way so that vibration caused fatigue failure. Look out for similar unsecured pipes on your plant. Fifteen more were found on the plant concerned.

Relief valves should be fitted with tail pipes

A steam relief valve lifted just as a man was bending over it to check the number. He was scalded in the face.

The accident could not have occurred if the relief valve had been fitted with a tail pipe. All relief valves should have tail pipes.

The tail pipes must not be bent back by jet reaction when the valve discharges (see Newsletter 125, p8) and must not fold up in a fire (see the next item).

A relief valve exit pipe sagged in a fire and a vessel was overpressured

Another company report that during a serious fire a number of relief valve discharge pipes became overheated. The pipes were not supported for this condition and sagged causing a fold in the pipeline and almost completely restricting the relief valve discharge. The rupture of at least one major vessel was attributed to the fact that it had lost its relief capacity in this way.

141/9 UNUSUAL ACCIDENTS No. 101

The Quarterly Safety Summary of the Chemical Industries Association (formerly the Association of British Chemical Manufacturers) has just completed 50 years of publication. The first issue (January — March 1930) described the following incident:

> *"An accident of a peculiar kind happened to a journeyman smith who had some welding to do, After many vain attempts to light the burner, he smelt it in order to discover whether acetylene was coming through. When the gas was subsequently lit, the acetylene-oxygen mixture that had already escaped exploded, and the explosion extended to the gas in the man's mouth and lungs. Medical examination revealed that as a result, the mouth, throat, and internal walls of the wind pipe and bronchial tubes had been burnt, and in addition the pleura had been torn by the force of the explosion. The man died as a result of his injuries."*

141/10 RECENT PUBLICATION

"Health and Safety — Manufacturing and Service Industries 1978", recently published by HMSO, describes how a man was overcome inside a vessel while using a rag soaked in trichlorethylene to clean the surface (Paragraphs 53 — 55). It also includes photographs of the world's largest crane which collapsed while being prepared for movement to its first working position (p.11).

For more information on any item in this Newsletter please 'phone P.2845 or write to us at Wilton. If you do not see this Newsletter regularly and would like your own copy, please ask us to add your name to the circulation list.

November 1980

An Engineer's Casebook No. 41
CIRCULATING ROTOR CURRENTS

Small voltages may be induced in the rotors of induction motors whilst they are running and, unless precautions are taken to eliminate or isolate these, circulating currents can be set up through external circuits from the bearing areas of the shaft and pedestals via the motor bedplate etc. The problem can usually be ignored on 415 volt motors; however, on the larger 3.3 kV and 11 kV motors precautions may have to be taken.

The induced voltages are low, only a few volts. However, the current flow may be high enough to break down lubrication films leading to premature bearing failure. Plain journal bearings are most likely to be affected, rolling contact bearings much less so since they afford minimum insulation resistance by way of their lubrication film.

The primary cause of induced voltage, though not the only one, is lack of symmetry in the magnetic circuit. It is not possible to achieve complete symmetry, assymmetry arising from uneven air gap between stator and rotor, eccentricity of the rotor and non-uniform magnetic reluctance of the rotor due to blowholes or changes in permeability of the metal and of the stator due to variations in laminations, joints, incidents of bolts etc. These variations cause a voltage to be developed across the shaft ends and can cause high currents to circulate through the bearing pedestals which are coupled together through the bedplate. This can lead to breakdown of the bearing oil film, discharge between wiper glands and shaft, at stator end shield seals etc.

It is not practicable to pick off the induced voltage through the use of slip rings and brushes because of the difficulty in maintaining the necessary low resistance contact path. In any case collector brushes are particularly unwelcome in classified areas.

The solution adopted is to destroy the current path, and so prevent the current circulating, by insulating both pedestals and then earthing one of them, usually the drive end. Insulation must be complete not only under the pedestal where it rests on the baseplate but also insulating sleeves and washers must be used round the holding down bolts.

Everything connected to the pedestals and the drive coupling must also be insulated to effectively destroy the current path to prevent circulation. This requires the use of insulating joints, sleeves round bolts, insulating washers under bolt heads and nuts in lubricating oil supply and drain/return lines; also similar treatment is required in cooling water lines if there is a cooling water supply to the pedestals.

Wiring connections and any cable tray used to support wiring for thermocouples, vibration sensors etc. must not provide a parallel earth path; armoured or screened cable must not be used. The coupling also must be of the insulated type. Any coupling guard must be firmly mounted and clear of the motor pedestal and driven machine.

It is clearly important that the design features built into the motor installation are recognised and maintained during the subsequent service running of the machine. Reference values for insulation and earth resistances should be available for the 'as installed' motor and these should be checked at times of overhaul. Adequate instructions should exist for mechanical and instrument as well as electrical tradesmen since the former may well not appreciate or be aware of the features necessary to prevent circulating currents.

E H Frank

AN EARLY REACTION THAT WENT WRONG

One of the earliest descriptions of a reaction that went wrong was written by Geoffrey Chaucer about 1386 in “The Canon Yeoman’s Tale”, one of “The Canterbury Tales”. The following extract from Neville Coghill’s translation into modern English originally appeared in Newsletter 73/9.

According to the translator the details of alchemical techniques described by Chaucer are accurate and reliable in so far as they can be checked. Some writers think he had first-hand knowledge of alchemy.

It happens, like as not,
There’s an explosion and good-bye the pot!
These metals are so violent when they spilt
Our very walls can scarce stand up to it.
Unless well-built and made of stone and lime,
Bang go the metals through them every time
And some are driven down into the ground
— That way we used to lose them by the pound —
And some are scattered all about the floor;
Some even jump into the roof, what’s more.
………………………………………………..
Some said the way the fire was made was wrong;
Others said, ‘No — the bellows. Blown too strong.’
That frightened me, I blew them as a rule.
‘Stuff!’ said a third. ‘You’re nothing but a fool,
It wasn’t tempered as it ought to be.
’‘No!’ said a fourth. ‘Shut up and listen to me;
I say it should have been a beech-wood fire
And that’s the real cause, or I’m a liar.’

I’ve no idea why the thing went wrong;
Recriminations though were hot and strong.
Well,’ said my lord, ‘there’s nothing more to do.
I’ll note these dangers for another brew,
I’m pretty certain that the pot was cracked,
Be that as may, don’t gape! We’ve got to act.
Don’t be alarmed, help to sweep up the floor
Just as we always do, and try once more.

Chaucer points out that some degree of risk has to be accepted.

‘By God' says one, ‘I saw some metal fall
Some’s saved although we haven’t got it all,
If things went wrong just now and acted tough,
Another time they may go well enough.
We’ve got to risk our goods if we’re to gain,
What about merchants? Lord! They don’t maintain
A fixed prosperity, believe you me.
Sometimes their goods are swallowed by the sea,
And sometimes they come safely back to port.”
“Well, calm yourself,” my master would retort;
“Next time I shall have things in proper frame,

I'll see our ship comes home, or take the blame.
Something went wrong I know, I'll find out what."