SAFETY NEWSLETTER

No. 142
FIRES AND EXPLOSIONS

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The Hazards of hotels

Best Wishes to all our readers for a Merry Christmas and a Safe New Year.

ICI
IMPERIAL CHEMICAL INDUSTRIES LIMITED
PETROCHEMICALS DIVISION

142/1 HOW TO MAKE FIRES AND EXPLOSIONS SMALLER

Earlier Newsletters, especially 95/1, have suggested that the best way to reduce the size of fires or explosions (or releases of toxic gas) is to reduce the amount of flammable (or toxic) material in the plant. Report No HO/SD/740009/8B and articles in *Chemistry and Industry*, 6 May 1978, p 287 and *Hydrocarbon Processing*, August 1980, p 137 described ways in which this has been or might be done. Copies of the articles are available on request.

In a recent study of a new design the amount of flammable liquid in the plant was reduced by critically examining the need for each vessel and its size. The plant was designed to separate liquefied gases and the first design of one of the distillation columns was as shown in Figure 1.

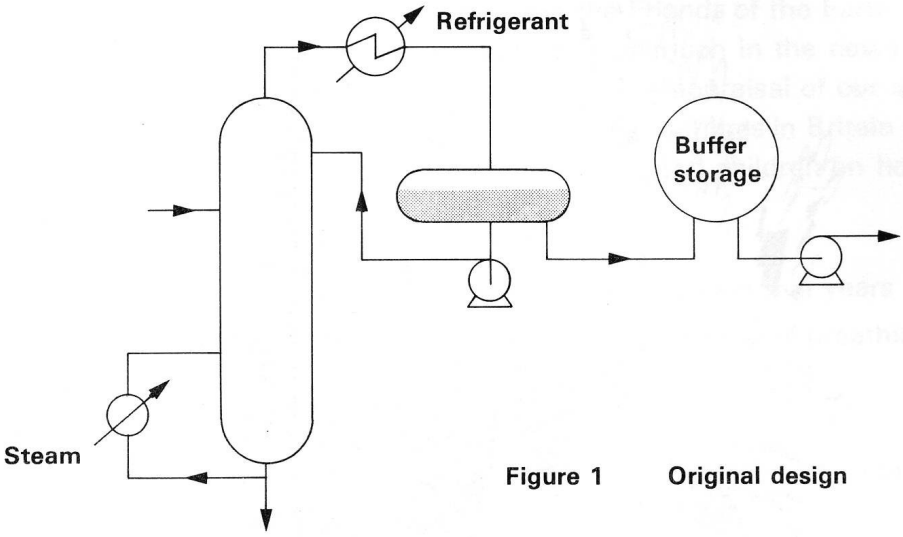


Figure 1 Original design

The design was then modified in several ways.

(a) The reflux drum was left out, the reflux pump taking suction from the liquid level in the condenser. The design of the overheads condenser had to be reversed so that the process material is on the shell side and the refrigerant on the tube side; this reduced the inventory of refrigerant and the total inventory of flammable liquids.

(b) Buffer storage for the raw material and products was left out, flows going directly to or from the main off-plot storage areas from small surge drums.

(c) A low hold-up packing was used in the column and the hold-up in the base was reduced to 2 minutes residence time.

Figure 2 shows the revised plant.

There were altogether three similar distillation columns in the plant and the following table shows the reductions in inventory (in tonnes) that were achieved.

	Original		Revised	
	Working	**Maximum**	**Working**	**Maximum**
Storage vessels	450	850	nil	nil
Plant	85	150	50	80

“What you don’t have, can’t leak”.

Sometimes inventories have been reduced by using new processes or new ideas. This example shows what can be done by applying well-known technology.

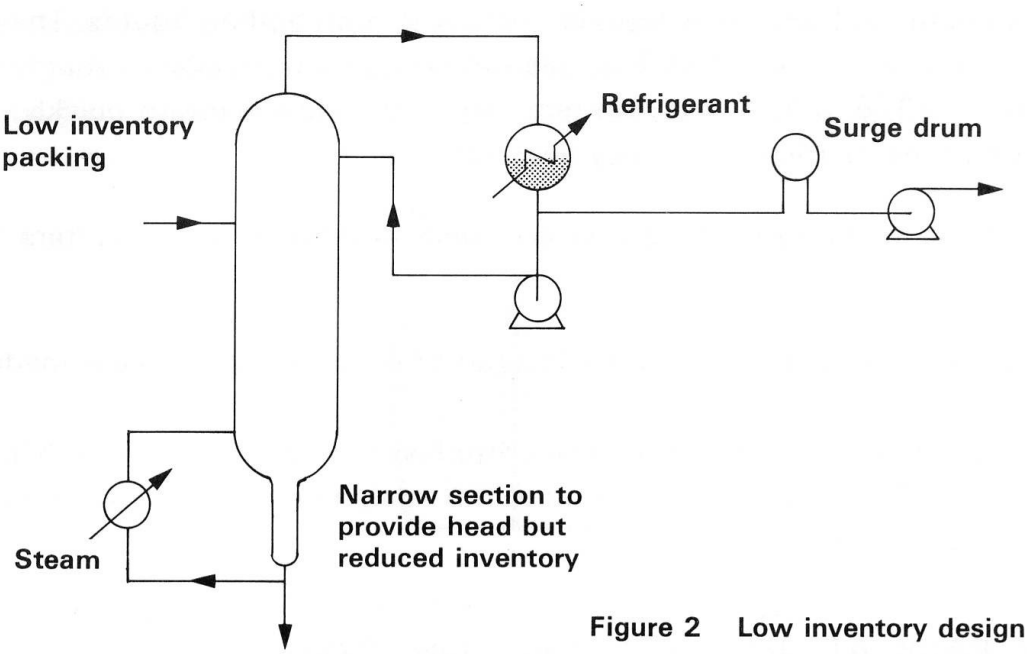


Figure 2 Low inventory design

The new design is not only safer than the original one; it is also cheaper.

142/2 STORE EXPLOSIVES IN THE ATTIC

In 1772 there was an explosion in Chester in the cellar of a warehouse in which gunpowder was stored. A puppet show was taking place above the warehouse, so that 23 people were killed and 80 injured. The local paper, the *Courant*, after describing the explosion, said, “Do not these facts evidently prove that even the smallest quantity of gunpowder should always be kept in garrets?”.

We are tempted to smile — obviously gunpowder should not be stored in any building in which there are numbers of people. The recommendation does not go far enough, though it was a step in the right direction.

However, before we smile, how often in considering a hazard do we tinker with the problem instead of making a fundamental change?

The official report on the Flixborough explosion, for example, though thorough and excellent in many ways, missed the fundamental point that, in the long run, the best way of preventing similar incidents is to develop processes that do not require such large inventories of hazardous materials.

The official report on the explosion at British Steel’s Appleby-Frodingham Works in 1975 (see Newsletter 88/1) missed the point that we need to develop techniques for foreseeing the effects of technical change.

The information on the 1772 explosion is taken from “Victorian and Edwardian Chester”, by J Tomlinson, Deesider publication, 1976, price £1.50.

142/3 OIL CAUGHT FIRE A MONTH AFTER IT WAS SPILT.

The heat transfer section of a plant in another Division is filled with heat transfer oil after maintenance by opening a vent at the highest point and pumping oil into the system until it overflows out of the

vent. The overflow is supposed to be collected in a bucket but sometimes a bucket was not used or the bucket was overfilled. Nobody worried very much about small spillages because the boiling point and auto-ignition temperatures of the oil are both high, above 300 °C.

A month after such a spillage the oil caught fire. It may have soaked into lagging and, if so, this will have caused it to degrade, lowering its boiling point and auto-ignition temperatures, but this is not certain as plant temperatures are close to the auto-ignition temperature. The oil fire caused a leak of process gas and this produced two explosions followed by a short but intense fire.

Always clean up spillages of flammable liquids, including high boiling liquids. They may not burn or explode when cold but will do so when hot. See the incidents described in *Journal of Hazardous Materials*, Vol 1, No 2, 1976, p 165 (copy on request). Light oils evaporate quickly, but heavy oils hang about for a long time, particularly if they soak into lagging.

Other fires or explosions involving heat transfer oils were described in Newsletters 110/1, 107/1, 78/7 and 67/1.

In new plants, we should consider using water instead of oil as a heat transfer medium.

The plant where the fire occurred had recently been fitted with a simple fire alarm. A length of plastic tubing, filled with air at 40 psig, was draped around the equipment. Fire causes the plastic to melt, the air pressure is lost and an alarm sounds.

142/4 A LOOK BACK AT NEWSLETTER 42 (July 1972)

Another explosion in a centrifuge

Newsletter 40/6 (quoting Newsletter 10/2) described an explosion in a centrifuge which occurred because the nitrogen blanketing failed. There was no alarm system and no regular analysis for oxygen content. There was no clearly visible indication of the flow of nitrogen. Ignition was caused by the friction between parts of the machine. A similar incident in another company, which killed two men, was described in Newsletter 5/6.

Now a centrifuge explosion has occurred in the Division. Although the centrifuge was blanketed with nitrogen, the nitrogen flow was too small and the oxygen content rose to about 11%, just above the minimum level necessary for an explosion.

The nitrogen flow was too small because the range of the nitrogen rotameter was 0-2 ft^3/min although 5 ft^3/min is needed to reduce the oxygen content to a safe level. The nitrogen valve had been gagged but this did not show on the flowmeter.

The continuous oxygen analyser had been off-line for some time. Occasional checks were carried out with a portable analyser; the last one was taken ten days before the explosion.

The source of ignition was friction between parts of the centrifuge which had worked loose.

Obviously there should be a clear indication of nitrogen flow and either a low flow alarm, a low pressure alarm or a high oxygen concentration alarm. If reliance is placed on a low flow or low pressure alarm, the occasional check should be made with an oxygen analyser.

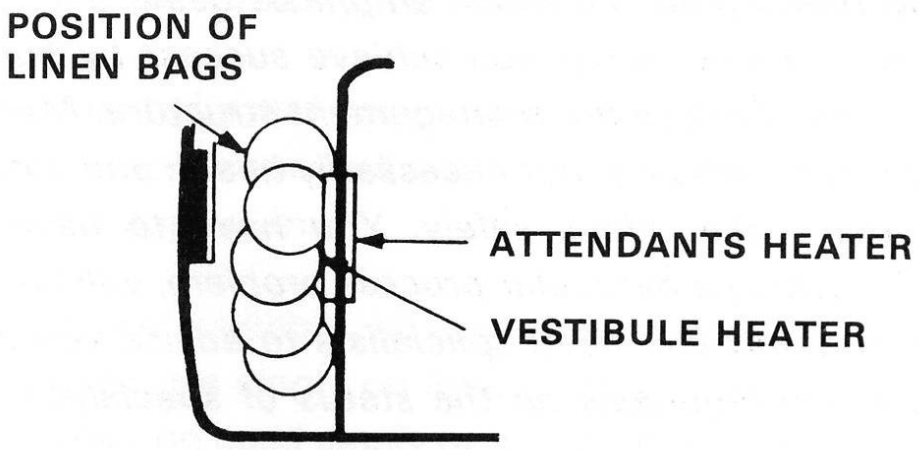
Fortunately, because the oxygen content was just above the minimum level the explosion was not very violent and caused little or no damage. The explosion reminded those concerned of the need for nitrogen blanketing, without injuring anyone or damaging any equipment. Unfortunately, we cannot be sure that all our explosions will be as harmless.

You may not have centrifuges on your plant, but do you check the inerting of storage tanks, stacks and other equipment?

142/5 A MODIFICATION CAUSED A LITTLE FIRE — FIVE YEARS LATER IT CAUSED A BIG FIRE

One of the worst railway accidents in the UK in recent years was the fire in a sleeping car at Taunton in July 1978 which killed 12 people. The official report (HMSO, £2.50) shows that the fire was the unforeseen result of a modification.

When the sleeping car was built in 1960 it was fitted with steam heating. In 1978 this was replaced by electric heating and electric convector heaters were placed in the vestibules. Bags of dirty linen from the previous journey were placed next to the heater, as shown below.



The linen got too hot, caught fire and the fire spread down the coach.

Similar heaters in luggage vans are fitted with guards and notices warn people not to place luggage next to the heater. Guards and notices were not fitted in the vestibules as it was not foreseen that luggage would be left there.

A similar fire had occurred on another line in 1973 but it was soon detected and extinguished. Damage was slight, no-one was injured and so no great attention was paid to it.

The lessons of this railway fire are familiar ones:

We should try to foresee the results of modifications. See Newsletters 139/2, 111 and 83.

We should learn from near-misses — next time the results may be serious.

To quote from the report of the disaster at Aberfan in 1966 in which a tip collapsed killing 144 people, most of them children:

'The stark truth is that the tragedy of Aberfan flowed from the fact that, notwithstanding the lessons of the recent past, not for one fleeting moment did many otherwise conscientious and able men turn their minds to the problem of tip stability. With all respect to Mr Geoffrey Howe, QC, no such "intuitive flash", "jump in comprehension" or "leap in awareness" as he spoke of was called for. These men were not thinking and working in a vacuum. All that was required of them was a sober and intelligent consideration of the established facts."

"Why was there this general neglect?". Human nature being what it is, we think the answer to this question lies in the fact that, … while the coal industry has had a high accident rate, until this horrible disaster there is no previous case of loss of life due to tip instability."

Perhaps these words should be framed and put on the wall of every manager and engineer.

142/6 UNSUITABLE MATERIALS OF CONSTRUCTION AGAIN

While an engineer was tightening the stopper of a steel mercury bottle, the top came off. It had been fixed with silver solder which dissolves in mercury!

The engineer was kept under observation to see if he showed any signs of mercury poisoning. However, mercury causes irrational behaviour and his colleagues considered that this would not be noticed!

Reminder: Other incidents due to the use of unsuitable materials of construction were described in Newsletters 132/4, 125/3, 117/4, 113/3 & 4, 104/2, 98/8, 78/4, 71/6, 61/7(4) and 34/4.

142/7 OTHER MEN'S VIEWS No22

Two views on the role of the safety adviser.

I am always slightly worried about too much emphasis being placed on the status of specialists in health and safety. As in so many things you achieve success by building a consciousness of health and safety matters into the whole of the management structure. Many of the things that you need to do have to be done by people who are not necessarily health and safety specialists. You have to have engineers to design and make things safely. You have to have researchers who, in choosing alternative methods of cracking a particular process problem, will have regard to safety in the choices they make. Therefore, certainly you need specialists to advise you on certain points but I think it is dangerous to put too much emphasis on the status of specialists as though they can control the whole process.

B Rigby, Deputy Director-General of the Confederation of British Industry.

Given that, for example, a director of technical services is responsible for ensuring that a safe system of work is devised and implemented in relation to sewer maintenance work, what action should be taken by a central safety officer when he finds that a gang is laying a sewer without the appropriate shoring to the trench? The view could be taken that he should report the facts by the quickest available route to the director and leave the situation to him but such a delay could literally be fatal. In situations where there is an immediate risk the safety officer should obviously be given the power to act on behalf of that chief officer. This requires clear definition in the safety policy.

Both quotations, the second anonymous, occur in *Health and Safety at Work*, October 1980, pages 28 and 77.

142/8 UNUSUAL ACCIDENTS No 102

Foot jammed in lavatory

When Mr Tom Read decided to repair his lavatory system his foot slipped and he slid down the bowl and jammed. After trying for an hour to free him, his wife dialled 999, and six firemen, two ambulancemen and a policeman arrived at their home. Firemen smashed through the bowl with a chisel which struck Mr Read's foot, which required four stitches. He has had to cancel a camping holiday in South Wales while he rests at home.

Daily Telegraph, 10 July 1980

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.

December 1980

An Engineer's Casebook No 42
VEE BELTS

Endless vee belt drives can be of three basic types which are covered by current British Standards.

BS 1440:1971 covers standard vee belts and vee pulleys in metric dimensions. The vee belts consist of fabric and/or cord and elastomeric compound(s) bonded together to form an endless belt with a cross-section shaped roughly like a trapezium.

Six different sizes of cross-section are available; all have their sides tapered at a 40° included angle. Y and Z section belts are suitable for use singly on light domestic drives. A, B, C and D section belts are for normal industrial use and may be used singly or in greater number in which case matched sets should be used.

A correctly fitted vee belt drives on the sides of the groove in the pulley and should not bottom. A figure of 3% slip is normal with a correctly tightened belt.

BS 3790:1973 covers wedge belts which are of similar cross-section to standard vee belts but of increased height. The pitch line width is the same as with standard vee belts. However the deeper section allows for greater power transmission for equivalent widths and consequently can lead to more compact drives.

Wedge belts are designated SPZ, SPA, SPB and SPC. Pulley grooves to BS 3790 are suitable for belts of equivalent pitch width specified in BS 1440 and will therefore accept belts of either Z or SPZ, A or SPA, B or SPB and C or SPC sections. Belts made to BS 1440 are however not suitable as substitutes for wedge belts to BS 3790.

The constant slip between a vee belt and the pulleys which it connects may give rise to the build up of an electrostatic voltage which could be undesirable in certain circumstances. Special anti-static belts are available, of either standard or wedge cross-section, which are of low resistance and should be used on belt drives in flammable areas.

In some applications of belt drives it is important that there shall be no slip between the driving and driven shafts, for example, timing belt drives. BS 4548:1970 covers endless synchronous belt drives which meet this requirement using a belt which has a flat flexible backing to which teeth are integrally moulded. No lubrication is required. Belts are available in five standard pitches: XL (extra light), L (light), H (heavy), XH (extra heavy) and XXH (double extra heavy). Pulleys for use with synchronous belts have either involute or straight-sided teeth.

A service factor has to be applied to all belt drives to make the drive adequate for the actual operating conditions. The service factor depends on the operational hours/day, the type of driver and the type of driven machine. It varies from 1 for light duty drives such as fans operated for less than 10 hours/day to 2 for heavy duty continuous duties powered by internal combustion engines. Details are given in the various British Standards.

E H Frank

*As usual in the December Newsletter there is an item that is not intended to be taken too seriously. This year we describe the hazards of hotels. Hotels **are** hazardous; the figures for people killed are correct. But we do not set out to ban hotels. Instead we try to understand the causes of the fires and then design and operate our hotels so that fires are less likely in the future.*

Earlier Newsletters described the hazards of coal (No 70), water (No 94), wheels (No 106) and wool (No 118), while Newsletter 130 recommended lunar plants.

Hotels Offer a Total End to Life

Another grass-roots protest group has been formed to join the Friends of the Earth, the Anti-Nuclear League and the other environmental lobbies that have been so much in the news. The new group, called SHAM (Stop Hotels Annihilating Men), are asking for a re-appraisal of our attitude to hotels. They point out that as many as seven people are incinerated in hotel fires in Britain every year, many of them people in the prime of life, and including many parents and children on holiday. They want

— an immediate ban on the building of new hotels

— existing hotels to be gradually phased out so they are all closed in five years time

— in the meantime all hotel guests to be issued with fire extinguishers and breathing apparatus and to be trained in their use

— a ban on hotel advertising

— each guest to be issued with a written warning of the dangers they are undertaking

In support of their demands SHAM point out that

— 163 people were burnt alive in a hotel fire in Seoul in 1971

— 35 people were killed in a hotel fire in Copenhagen in 1973

— 33 people met their deaths in a hotel fire in Amsterdam in 1977

In the last case it was a miracle that more people were not killed as there were 109 guests in the hotel at the time.

Nearer home, 11 people who had saved up for a Christmas holiday were incinerated in a hotel fire in Saffron Walden on Boxing Day 1969.

The hotel industry point out that they are as deeply concerned as anyone but hotels provide employment and foreign exchange, are now built to much higher standards than in the past and that a lot of money has been spent in improving the safety standards of old hotels. However, SHAM remind them that this did not prevent a fire in July 1979 in Spain which killed over 70 people and injured many more and that there were 16 hotel fires in the UK in 1979. The hotel industry itself admits that hotels are not completely safe and SHAM says that until they are, they should be banned.

Hotels exist only to increase the profits of the owners — many of them multi-nationals. People who have to spend a night away from home could easily find lodgings in private houses, particularly if we set up agencies to help them do so. Hazards which kill as many people as hotels kill should not be permitted, say SHAM.

By the time you have read this, hotels will have claimed another victim.

If you wish to stop this massive loss of life, if you want to change the climate of opinion, then support SHAM.