IMPERIAL CHEMICAL INDUSTRIES
PETROCHEMICALS DIVISION

SAFETY NEWSLETTER NUMBER 34

By Trevor Kletz

34/1 THE SUPPLY OF COMPRESSED AIR TO A MASK RUNS OUT WHILE A MAN IS IN A PIT

A man was working in a pit wearing a compressed air mask supplied from two large cylinders. The one in use was nearly empty and the other was full. The man who was standing by the cylinders failed to change over from the empty to the full cylinder in sufficient time and the supply to the mask ran out. The man in the pit pulled off his mask and scrambled out, fortunately without Ill effects.

The air in the pit was smelly but not harmful to breathe for a minute or two. If the air had contained a poisonous gas or had been deficient in oxygen, the result might have been more serious.

The investigation showed that the man standing by had been trained in the use of compressed air breathing apparatus *but his training did not include the use of the large cylinder sets.*

Are there any gaps in the training in the use of breathing apparatus on your Works?

Small compressed air cylinders are fitted with a whistle which sounds when the pressure is sufficient for another 7 minutes or so. Perhaps the large cylinders should also be fitted with a whistle as a reminder to the man standing by.

34/2 DEALING WITH LEAKS OF LIQUEFIED FLAMMABLE GAS

With this Newsletter you will receive a little booklet on ways of dealing with a leak of flammable gas or vapour. It was drawn by D. A. who also prepared the booklet given out with the last issue.

One of our overseas companies recently stopped a leak of LPG in one of the ways suggested — by injecting water.

Water was being drained from a reflux drum which contained butenes. When all the water had been drained, the operator found that closing the drain valve did not stop the flow. Butenes continued to flow out. Fortunately they did not catch fire and the leak was stopped by injecting water via the level glass drain valve.

At Feyzin in France in 1966 a similar incident led to 18 deaths, 81 injuries and the destruction of a refinery. An operator was drawing water from a propane tank when propane started to come out and he could not get the valve shut. The propane vapour caught fire and the fire burst the tank.

We now fit two Isolation valves on all LPG drain lines and the size of the second valve is restricted to 3/4 inch. For details see “Liquefied Flammable Gases—Storage and Handling”, ICI Engineering Codes and Regulations, Group D, Volume 1.6, available from Standards Section, Petrochemicals Engineering Department and the corresponding sections in other Divisions, Report 0.21,186/B (Summarised in the Supplement to Newsletter 26) and a note we can let you have on Feyzln.

34/3 A PRESSURE GAUGE IS DAMAGED BECAUSE ITS CORRECT RATING IS NOT KNOWN

Plant pressures are usually transmitted from the plant to the control room by a pneumatic signal. This pneumatic signal, which is generated within the pressure sensing element, usually has a range of 3 to 15 psig covering the plant pressure from zero to maximum pressure, for example, 3-15 psig might correspond to 0 to 1200 psig plant pressure.

The receiving gauge in the control room works on the transmitted pneumatic pressure, 15 psi giving full scale, but has its dial calibrated in terms of the plant pressure which it is indicating. Clearly the Bourdon tube of such a gauge is only capable of withstanding a limited amount of overpressure above 15 psi before it will burst. Furthermore, the material of the Bourdon tube is chosen for air and may be unsuitable for direct measurement of the process fluid pressure.

Recently a pressure gauge of this sort, with a scale reading up to 1200 psig, was installed directly on the plant. The plant pressure was 800 psig and the gauge was damaged.

The report recommends that gauges of this type should have the maximum safe working pressure marked in red letters on the face.

34/4 MAKE SURE YOU USE THE RIGHT MATERIAL OF CONSTRUCTION

Several recent incidents have shown what can happen if the wrong material of construction is used. The most spectacular incident occurred in another Company. The exit pipe from the synthesis converter on an ammonia plant was supposed to be made of 1/2% Mo steel. Ordinary carbon steel was used instead. As would be expected it suffered hydrogen attack; the pipe broke and the reaction forces caused the converter to fall over.

As a result of this Incident much of the equipment on critical duties in the Division is being checked to see it is made of the right materials.

The second incident occurred in the Division. A mild steel bolt was used instead of a stainless steel one to secure a flanged Joint on a stainless steel line. The bolt corroded and the joint leaked.

In the third incident a titanium flange was fitted by mistake on a line carrying chlorine. The titanium caught fire.

The fourth Incident occurred in another Company. A line was made of the wrong material and it corroded so much that when an ultra-sonic probe was being used to test its thickness, the probe was pushed right through the metal.

What methods do you use to make sure the right materials of construction are used?

34/5 LEVEL GLASS ISOLATIONS

Level glasses are always liable to break and it is, therefore, the policy of the Division to install ball check cocks in the lines connecting a level glass to the parent vessel. If the level glass breaks the pressure of the liquid in the vessel pushes a ball against a seat and stops the leak.

The ball check cocks form part of an Isolation valve. *They will operate correctly only if the isolation valve is fully open or almost fully open.* They will not work correctly if the isolation valve is half-shut.

When a level glass connection broke recently there was a large escape of gas which caught fire and injured a man. The ball check cock did not operate because the isolation valve was nearly closed.

Please make sure that your operators know that these valves must be fully opened and then left just cracked off the back seat position.

On some plants the bails have been found to be missing. You may like to check that on your plant they are all present.

34/6 EXTRACT FROM A SURVEY REPORT

‘The Works Electrical Section has initial records of 433 torches issued since 1963. Records of those maintained by the electrical section exist for seven only. The remaining 426 torches may or may not still be on the Works. It they are, they are unlikely to have been maintained satisfactorily and are, in consequence, a potential source of Ignition.”

34/7 HIGH PRESSURE WATER WASH EQUIPMENT

In one of our overseas companies a man who was using high pressure water wash equipment allowed the Jet to Impinge on the side of his boot. The cutting action of the water jet was so strong that it cut out a piece of his boot, sock and foot.

As mentioned in Safety Newsletter 32, Item 10(g), we can let you have a copy of the Wilton Works Guide to the Safe Operation of High Pressure Water Wash Equipment.

34/8 SCREW COUPLINGS ON HOSES MUST BE SCREWED RIGHT UP

Hoses are sometimes secured by screwed couplings. Another Division has described how a man was killed because the coupling was secured by only two threads. When pressure was applied the coupling came undone and the end of the hose hit a man and killed him.

The use of screwed couplings on hoses which are used at pressure is not recommended.

If you do use them on your plant it is worth making sure that everyone realises the importance of screwing them right up.

34/9 KEEP YOUR HAIR ON!

An accident which illustrates that even smooth rotating shafts driven by small motors and often at slow speeds are capable of inflicting serious injuries, has been reported by another Division (Mond Mail, 24 September 71). Examples of this type of shaft can be seen in many of our laboratories.

A youth trainee was cleaning out a laboratory fume cupboard. The shaft, which ran close to the rear wall, was unguarded as it was considered safe by its position. The youth had been instructed to switch off the motor but failed to do so; his hair was caught up by the revolving shaft and he was partially scalped.

34/10 I LIKE MY COFFEE WITH SUGAR—SOME THOUGHTS ON HUMAN RELIABILITY

The other day I pressed the wrong button on a beverage machine and had to drink my coffee without sugar. It was not the first time this had happened and, looking back. It seems that every 100 times I use the machine I press the wrong button twice.

Operators of plant and other equipment make mistakes from time to time and sometimes these can be dangerous or costly. Is it possible to estimate the frequency with which operators will make mistakes? If we could do so it would help us to decide whether automatic protective equipment ought to be provided.

In a paper published a few years ago ("An index of Electronic Equipment Availability", Payne et al., American Institute for Research, Report No. AD 607161-5, 1964) a group of American workers described a method of estimating failure rates for operators using electronic equipment. I decided to apply their data to beverage machines and see what answer I got.

The section on pushbuttons considers them under several headings.

The first is *size.* The probability that the correct button will be pressed depends on the size as shown below: —

Miniature	0.9995
1/2 inch	0.9999
more than 1/2 inch	0.9999 ←

The pushbuttons on the beverage machines are 1 1/2 inch by 5/8 inch so I have put an arrow against the last item.

Next we consider the *number of pushbuttons in the group*

Single column or row:

1—5	0.9997
4—l0	0.9995 ←
11—25	0.9990

The next item to be considered is the *number of pushbuttons to be pushed*

2	0.9995
4	0.9991
8	0.9965

On a beverage machine only one button has to be pushed so I assumed that the probability of success is 0.9998.

The fourth item is the distance between *the edges of the buttons*

1/8" - 1/4"	0.9985	←
3/8" - 1/2"	0.9993	
!/2" up	0.9998	

The fifth item is *whether or not the button* stays *down when pressed*

Present	0.9998	←
Absent	0.9993	

The final item is *clarity of the labelling.*

At least 2 indications of control positioning	0.9999	
Single, but clear and concise indication of control positioning	0.9996	←
A potentially ambiguous Indication of control positioning	0.9991	

The total probability of success is obtained by multiplying these six figures together:

Reliability =0.9999 x 0.9995 x 0.9998 x 0.9985 x 0.9998 x 0.9996

=0.9971

i.e., three errors can be expected in every 1000 operations.

This suggests that if I get the wrong drink 2% of the time, I am rather more careless than the average man—most people would be expected to make about 3 mistakes in every 1000 operations. Perhaps I do not have my mind on the job, perhaps I am talking to someone or am under stress—factors which are not taken into account in this rather simple method of calculation.

We ought to apply similar reasoning to process operations. If a man has to carry out a number of operations to change over a tank or a pump, or stop a pressure rising to a dangerous level, how often will an average man make a mistake? If we know the answer, and if the consequences of a mistake are dangerous or expensive, then we can decide whether interlocks or warning devices or automatic equipment should be installed. Unfortunately, at the present time we have very little data on human reliability though various organisations are working on the subject.

When someone makes a mistake we have to decide if he is particularly careless, or if an average man might make the same mistake. Perhaps one day we shall be able to do this more scientifically than we can now.

If you are interested in this subject see "Human Error and Plant Operation" by G.0.W, Agricultural Division Report No. EDN 4073, available from Division Reports Centres.

34/11 THREE YEARS AGO

A tank was sucked in because the flame arrestors in all three vents were choked with dirt. The flame arrestors are scheduled for yearly removal and inspection but because of pressure of work they had not been inspected for 2 years.

In this first incident no-one was hurt but the second incident had serious consequences - two by-standers were killed.

A material which crystallises at 97°C was stored in the molten state in a storage tank, kept hot by a steam coil and vented by means of a 3 inch diameter hole in the top. The inlet line to the tank was blown with air to make sure that it was clear before moving in more material - the usual practice. The vent was choked with solid material. The pressure in the tank rose and the end was blown off.

These two Incidents show that all vents on tanks must be checked regularly. We have systems for checking relief valves; the simplest sort of relief valve—a hole—also needs checking regularly.

For further details see *Safety Newsletter No.* 5, *4* November *1968.*

34/12 UNUSUAL ACCIDENTS NO.4

An operator in the printing section of the Scarborough Evening News caught his forearm against one of the metal plates that fit onto the printing press and carry the impression of the type. The plate, formed from molten metal, was still very hot at the time.

The operator now has burned on his forearm the words, ‘Stop Accidents’.

From “Occupational Safety and Health”, September 1971

For more information on any Item in this Newsletter, please write to Miss M N, Organic House, Biilingham 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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