IMPERIAL CHEMICAL INDUSTRIES
HEAVY ORGANICS DIVISION

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By Trevor Kletz

23/1 DIESEL ENGINES

In May last year there was an escape of hot cyclohexane on one of the Works on Teesside. The vapour caught fire and it is believed that the source of ignition was a diesel-engined vehicle which was working in the area. When the vapour reached the engine it raced out of control, emitting black smoke and banging. The driver tried to stop the engine by shutting off the fuel supply but this made no difference as the engine was running on cyclohexane vapour sucked through the air inlet. After $1^1/_2$ minutes flash back occurred and ignited the vapour cloud.

Several similar incidents have been reported elsewhere. The British Internal Combustion Engine Research Institute Ltd (BICERI) were therefore asked to devise a means of stopping a diesel engine when it is running on vapour sucked in through the air inlet. They have now developed and tested a device and prototypes are being made for trial. The device is fitted in place of the air filter and consists of a disc valve, a carbon dioxide cylinder and a flame trap. When the driver wishes to stop the engine he releases the carbon dioxide, the gas pressure closes the disc valve and the gas itself also helps to stop the engine. A valve alone is not sufficient as enough air and vapour can be sucked past it to keep the engine running. The flame trap prevents flash back occurring before the engine is stopped. A disadvantage of the flame trap may be the difficulty of keeping it clean; this will be watched during the Works tests.

BICERI have also shown that a diesel engine will run more easily in some vapours than others, for example they could not get an engine to continue running on propylene when the normal fuel supply was cut off. However we cannot be certain that an engine will never continue running on propylene under any certain circumstances.

Esso have developed an alternative device (see “Chemistry in Industry”, 25.9.70) – a spring loaded valve which closes automatically if the engine speed exceeds a set value. The advantage of this device is that it is fully automatic and does not require any action by the driver. A disadvantage is that the adjustment is critical.

Another device has been developed by May and Baker (see “Industrial Safety”, September 70, page 391) using carbon dioxide alone.

There are other ways in which diesel engines can ignite a cloud of flammable gas or vapour apart from the means described above. Sparks or flames can come out of the exhaust, the exhaust pipe can be hot enough to ignite the vapour, the electrical equipment on the engine itself or on a diesel electric crane can cause ignition and it is also possible that the brakes can get hot enough. One explosion occurred because an engine was stopped by the use of the decompression control. Diesels in fact are much more dangerous than is generally realised. We used to be taught that petrol engines are dangerous and should not be used in an area where flammable vapours may be present but that diesels are OK; permission might be needed to bring them in but this was a formality. This traditional view is nonsense. Diesels are dangerous and must be treated with almost as much respect as naked flames.

What therefore should we do? We cannot get rid of diesel engines completely and I suggest a four pronged approach:

Be aware of the danger

Avoid the use of diesels when possible

Locate diesels when possible in safe areas

Make the engines safer, i.e. less likely to cause ignition

1. Be aware of the danger.

   Men who have to authorise the entry of diesels into hazardous areas must be aware of the danger. They must realise that when they sign a permit to admit a diesel this is not a formality but similar to signing a permit for welding. Once this is accepted the rest of this note follows logically.

2. Avoid the use of diesels when possible.

   Electric fork lift trucks of approved design can be used instead of diesel driven ones. (Unfortunately a trial on one of our Works is showing that the models at present available have disadvantages for certain uses – they are slow and are unstable on rough ground).

   Compressed air pumps or eductors can be used instead of diesel driven pumps for pumping out drains and excavations.

   Diesel engines should not be used at all during start-ups and at other times when leaks are more likely than usual.

3. Locate diesels when possible in safe areas.

   By using long leads diesel driven welding sets and air compressors can be located in safe areas. If this is not possible, perhaps they can be placed up-wind of equipment which might leak.

4. Make the engine, safer, i.e., less likely to cause ignition.

   It is difficult to make diesel engines completely safe but we can do a lot to make them safer and taken together with other suggestions above this should give us an acceptable level of safety.

   The extent to which we try to make the engine safe depends on how much it is used and it is convenient to consider three categories:

   4.1 Engines used continuously, say for more than 1000 hrs/yr.

   The only mobile vehicles which are likely to be used continuously are fork-lift trucks. These require the full treatment. They should be fitted with flame traps on the air inlet and the exhaust, a water-sealed spark arrestor on the exhaust and flameproof electrics or no electrics.

   Note that a spark arrestor is required on the exhaust as well as a flame trap; the two have different functions. If necessary, the exhaust manifold must be water-jacketed or fitted with cooling fins so that its temperature is well below the auto-ignition temperature of the materials used on the plant.

   The water-sealed spark arrestor must be serviced every shift or it will run dry and not operate successfully. Supervisors should look out for the steam; if the steam stops the engine is dangerous. The flame trap on the exhaust also requires frequent servicing as it becomes choked with carbon.

   The vehicles should be started by compressed air or spring starters or other non-electric methods.

   When the BICERI device is available it should also be fitted.

   If fixed engines cannot be located in a safe area the air inlet should be piped from a safe area and the exhaust piped to a safe area. The exhaust should be fitted with a spark arrestor if sparks can be carried by the wind into a hazardous area. Inlet and exhaust flame traps are not necessary. The exhaust manifold should be water-jacketed and the engine should never be stopped by decompression.

   4.2 Intermittent Use, say for less than 1000 and more than 10 hrs/yr

   Vehicles which come into this category are cranes, plant tractors, welding sets and portable pumps — the last two can often be placed in safe areas by using long leads.

These vehicles should be fitted with the BICERI device as soon as it is available commercially.

CAV (non-sparking) electrics should be specified for all new vehicles.

The use of lights, horns and windscreen wipers, should be discouraged but need not be prohibited completely in congested areas or someone may get run over.

The current trend towards diesel-hydraulic cranes, away from diesel-electric cranes, should be encouraged.

Vehicles should never be left unattended with the engine running.

There is need for a portable combustible gas detector alarm which sounds a loud alarm if gas appears in an area where a crane is working and, of course, in an area where welding is taking place. Such a detector has been developed by J & S Sieger Ltd in conjunction with HOC Instrument Development Group and should be available commercially very soon.

4.3 Vehicles passing through, say present for less than 10 hrs/yr

Vehicles which come into this category are those delivering raw materials, stores or spares and collecting product or scrap. Their entry should be acceptable without special precautions but with the permission of the process supervisor. This permission should be refused if leaks are known to be present or if the plant is in an abnormal condition which makes leaks more likely than usual. The entry of vehicles should be discouraged when the plant is starting up.

On new plants the extent to which sundry vehicles have to enter the plant area can be reduced by laying out the plant so that loading and off-loading takes place near the plant perimeter rather than in the middle of the plant.

If frequent traffic through an area of risk is unavoidable then the use of traffic lights initiated by combustible gas detectors should be considered.

5. Tanker Loading and Off-loading Areas.

Engines should be switched off during filling and other vehicles should not pass by or approach too close. Vehicles waiting to be filled should park well back and vehicles which have been filled but are not yet ready to leave should park well out of the way. Sieger gas detectors should be installed unless operators are continuously present.

If you would like further information we can let you have Safety Note 69/9A and a summary of the investigation carried out by BICERI.

23/2 TELEPHONE WIRES IN HAZARDOUS AREAS.

An incident in another Division last year shows the need to choose safe routes for telephone wires and not let the Post Office engineer run them where he wants.

Drips from a valve gland removed the insulation from a telephone cable; the resultant sparking ignited the leak.

So on new plants, or if new cables are being run on old plants, tell the Post Office where to run them.

23/3 LADDERS AND HANDRAILS

There have been several accidents recently in the Division as the result of ladders or handrails breaking.

A man was hurt when the rung of a metal ladder broke. The ladder was an old one and the rungs did not pass right through the side members but had been fitted into shallow countersinks and welded. Nowadays ladders are made to British Standard 4211 which specifies that the rungs must pass right through the side members.

Look out for any similar old ladders on your plant.

A member of staff was badly hurt at home when a wooden step ladder broke under his weight. The ladder was an old one, patched up, and, as the injured man admits, obviously in poor condition.

Another man narrowly escaped serious injury when the handrail on a tank broke and he was left suspended horizontally in mid-air — his feet on the toe-boards and his hands on the end of the handrail. The handrail was an old one, made of non-galvanised tube and had corroded where it passed through the stanch ions. New and replacement handrails are now made of galvanised tube or, if the atmosphere is corrosive, of solid bar (Standard G76/77).

23/4 SAFETY TRAINING FOR MANAGERS

One HOC Division Works has introduced a new session into their safety training course for managers and engineers. The managers are shown a piece of equipment such as a pump, told it needs removing for maintenance and asked to complete the permits-to-work for the isolation and removal of the equipment.

Supervisors do this every day but for many managers it is a new experience and ha given them a better understanding of the permit-to-work system.

23/5 Brown for Danger (from "Which?" August 1970)

A member has written to ask us why, in the new international colour coding for electric flexes, the earth is green and yellow (which earth isn't), the live is brown (a de colour), and neutral is blue (a positive colour).

There were sound reasons for the apparently odd choice. Green was already widely used for the earth wire. But a single colour is not safe enough, since the greatest danger of electrocution is in getting the earth connection wrong. So the earth had to stand out for people with defective colour vision, and in the dimmest light. Therefore green and yellow stripes were chosen — which coincided with an already existing British Standard.

There was not a free choice of colour for the other wires. For instance, certain countries objected to using red for the live, since they were already using it for the earth and wished to avoid confusion in the changeover. Britain objected to black for the live, since in Britain it was being used for the neutral. Blue and brown were two of the few colours which would cause the least confusion. And they had the advantage that they would not be confused by most colour-blind people or in bad light.

23/6 RECENT AND FORTHCOMING PUBLICATIONS

(a) "It is not the complete answer to call on design sections to remove the risk by the excellence of their design". This quotation from a letter from Engineering Dept. to a Works is quoted at the front of Report No 0.21,200/B "Prevention of Loss through Fire, Explosion, and other Accidents: The Part to be Played by Better Training, Auditing, Operating Methods Etc.", available from Division Reports Centres. The report points out that perfect hardware would prevent only half our fires and explosions; to prevent the other half we need better "software". The action taken in recent years or recommended to improve the software is described.

(b) HOC Safety Note 70/13 describes how someone got an electric shock while using a carbon dioxide extinguisher to put out a fire. The way this came about is explained and the use of a different type of hose is recommended.

(c) There is an excellent account of the properties of petroleum hydrocarbons and the precautions to be taken in handling them in "Storage and Handling of Petroleum Liquids: Practice and Law". A revised edition has recently been published by John Hughes, Chief Safety Engineer of BP (Griffin, £5.60). As "Which?" would, say, of all books on the subject, this is the "Best Buy".

(d) The subject of the 1970 Reith lectures will be on "The mysterious process of public learning — the time lapse between the emergence of a crucial problem and the public's recognition of the problem as crucial".

For "public" can we read "manager" or "supervisor" or "operator".

The Reith lectures start on November 15th on Radio 4, will be repeated on Radio 3 and will be printed in "The Listener".

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