Secondary damages after fire

Since the end of the 1960's it is a well-known fact, that a number of special problems arise when fires involving plastics occur. These particular problems are associated with the fact that some plastics, and especially PVC (polyvinyl chloride), emit corrosive gases when they burn. During the 1970's, this circumstance led to the concept of secondary damage or non-thermal damage, especially in connection with technical equipment.

In the following, we shall review the way in which this problem presents itself as well as a number of preventive measures which can help to meet it.

PVC is the worst

From a fire-preventive point of view, PVC has a number of obvious advantages because, under normal circumstances, it burns poorly. This, in addition to its low cost and the ease with which it can be used in manufacturing, has made PVC one of the most widespread plastic materials. In spite of these useful qualities, PVC is a controversial material.

As its full name - polyvinyl chloride - indicates, PVC contains the element chloride and it is especially this fact which gives rise to the risk of secondary damage after fires, both in private homes, commercial premises, and on vessels and offshore installations.

Its chloride content means that when it burns much of the gas released is hydrogen chloride, which forms hydrochloric acid in combination with water. When smoke containing hydrochloric acid gets in contact with metal surfaces, it results in immediate corrosion, the seriousness of which is directly dependent on the concentration of acid in the smoke.

How great is the risk?

After any fire which has involved PVC being burned, (and this goes by in almost any fire today), attention will usually be directed towards discovering the degree to which the corrosive smoke has come into contact with such technical equipment as machinery, computers, electrical terminal boards, generators, control panels and so on.

In cases where there has been particularly intense smoke concentration, it will be possible to detect rust forming on iron surfaces only a few hours after a corrosive attack begins, but it will generally be necessary to carry out measurements to determine the potential risk.

During the past ten years, these measurements have become a permanent aspect of the measures which are carried out automatically, especially after a fire, in order to prevent unnecessary losses, both for the individual and society.

Experience from thousands of such measurements and subsequent treatment shows that, depending on the surroundings and the equipment actually involved, the criteria for determining when a risk is present are relatively fixed.

This experience also shows that there are very often circumstances in connection with fires which make it necessary to implement a number of precautionary measures to avoid harmful effects on technical equipment.

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It is naturally important on ships, on the basis of the measurements, to plan the correct measures, partly with regard to a general cleaning of the contaminated area and partly with regard to cleaning the technical equipment.

What happens?

When hydrochloric acid attacks metal it causes corrosion and this in turn creates a substance which comprises one part hydrochloric acid and one part metal.

We know from chemistry that this substance is a salt, which is also called a chloride. The salt is given the name of the metal followed by - chloride. If, for example, the metal in question is iron the salt, iron chloride, will be formed in connection with the attack.

The first phase of corrosion will rarely have serious effects from a purely technical point of view, although cleaning will often be necessary.

If cleaning is not carried out, it is a well known fact that the salt can contribute to a corrosive attack, a circumstance familiar from the effects of sea water and road salt during the winter.

In order to evaluate the actual risk, the quantity of chlorides on the equipment which appears to have been contaminated is measured. As this is normally a question of very small quantities, the result is usually given as micrograms of chlorides per square centimetre. Measurements can be carried out at the scene of the fire with relatively simple equipment.

The most commonly used method in Europe is the so-called titration method, in which a small area of the surface in question is washed down with distilled water. The chloride content can then be determined by titrating the water with silver nitrate. It is generally accepted that the danger limit for electrical equipment and machinery lies between 8 and 14 micrograms of chloride per square centimetre. On sea-going vessels, however, a higher level of background contamination must be accepted due to the effect of the salt water.

Levels of contamination greater than these will in many cases bring about a more frequent occurrence of faults and, in extreme cases, irreparably damage equipment.

Precision mechanical equipment and unprotected iron objects are most vulnerable. But when the scene of a fire is examined, attention must also be paid to electronic and electrical equipment in order to detect secondary damage.

It should be emphasized, however, that the sensitiveness of various items of equipment varies greatly, and the surroundings in which they are placed are also of considerable significance.

Emergency service

In Denmark, there has been a comprehensive emergency service system to combat the problems described here since the middle of the 1970's - a service system which AREPA is part of. Equal systems are adapted in most countries in Northern Europe.

In general, emergency measures immediately after a fire will focus on preventing further damage resulting from water and dampness and - not least - on minimizing the risk of corrosion mentioned above.

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This will typically involve the removal of the water used to put out the fire and the establishment of dry surroundings with the help of dehumidification equipment or heat. The latter will also have a corrosion retarding effect in most cases. Finally, moisture absorbent chemicals can often be used to advantage.

Successful initial measures will often be capable of halting the damage and give both the claimant and any insurance companies which may be involved the time necessary to make the right decisions as to what should now be done.

It has repeatedly proved to be the case that taking rapid action can save significant resources, both with regard to time and money. It is therefore of considerable importance that the employees of those involved are aware of these problems and can make an immediate contribution.

Restoration is possible

After an evaluation has been carried out, the question arises as to whether the damaged equipment should be replaced, or can be repaired or reconditioned. Experience from thousands of accidents shows that reconditioning can often be carried out with good results.

Today, there is a great fund of knowledge regarding reconditioning electrical and electronic equipment and there has been considerable research in this area, particularly in Denmark, Holland, Germany, and Norway.

A comprehensive report from the Danish Research Centre for Applied Electronics - »Effects of corrosive smoke on electronics« - concludes that, correctly carried out, reconditioning will effectively remove possible risks and - in many cases - actually have a beneficial effect.

This beneficial effect is due to the fact that reconditioning includes painstaking cleaning which removes all types of pollution from the equipment.

This also holds true of the pollution which, as a rule, is an unavoidable consequence of industrial and maritime environments, for example, and which will almost certainly have a negative influence on the reliability and lifetime of all types of equipment.

This last circumstance is worth noting, also in connection with normal preventive maintenance!

Cleaning is of great importance

Many faults and probably also much damage to and around technical equipment are due to the influence of the surroundings.

An European survey among electronics manufacturers regarding the problems which would be significant for electronics manufacturing in the future, gave the surprising result that many pointed to the cleaning of electronics as a significant problem.

The reason for this is the increasing compactness of electronic equipment. The distance between conductors on printed circuits becomes smaller and smaller and the dependence on cleaning therefore increases.

Techniques similar to those used after an accident can therefore be used to advantage in preventing accidents.

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This is particularly true of electrical and electronic equipment. Whereas it is possible to measure play, noise from bearings and changes in material properties in connection with mechanical equipment, it is very difficult in practice to predict breakdowns in electronic systems.

Keeping electronic equipment clean is therefore the best form of preventive maintenance.
In connection with fires, there is often extensive soot contamination, which acts as a conductor and will cause problems in itself.

For more information

AREPA has workshops in Denmark, Benelux, United Kingdom, Sweden, and France. For more information about AREPA or assistance on damages (24h) call **+45 8681 1055**.

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