# Contamination – effects, costs and solutions

Ian Fraser – managing director of Rand Technical Services, (RTS) – discusses contamination in solid/particulate, liquid and gaseous form, highlights some of the modern management solutions available and the importance of implementing them.

*Ian Fraser – managing director of Rand Technical Services, (RTS).*

Contamination can take a variety of different forms, all with their own particular adverse consequences. Arguably one of the most formidable challenges facing industry, and indeed our planet, is the control and management of contamination of one kind or another.

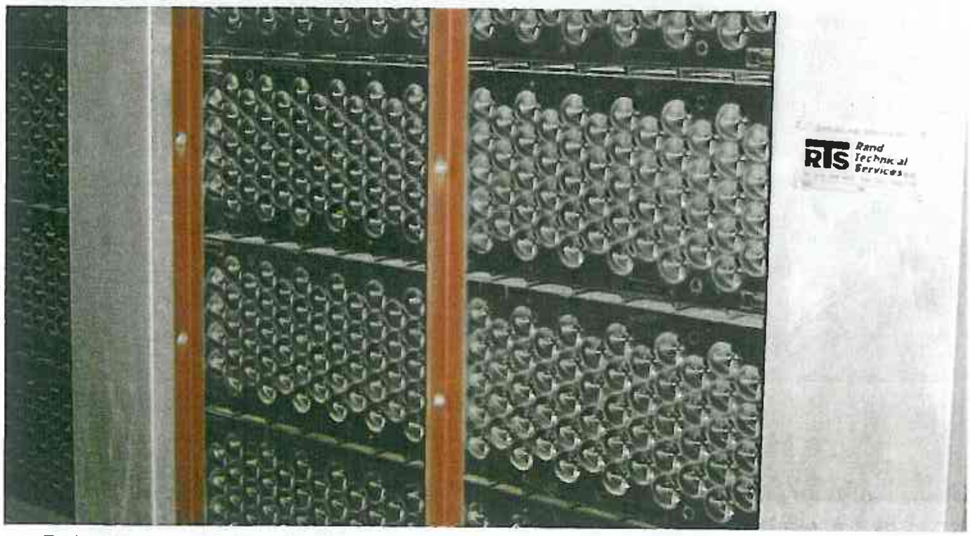
Fine particles of material are generated by a wide variety of processes, from mine crushers and mills; to chemical plant, steel mills, and refineries. Of course, dust is also a familiar natural phenomenon and is lifted and driven by winds. Contaminating material ranges from fine sand (pulverised rock), metal particles in steel mills to carbon and sulphur particulate emitted by furnaces and burners.

Drawn into rotating machinery or circulated in the atmosphere, these particles can and do constitute an often invisible destructive force with an enormous price tag. In rotating machinery, dust combines with lubricating oil to form an effective grinding paste. This can destroy an expensive machine – often within weeks. Fine air-borne particulate – especially in the 0,5 $\mu$m to 1,5 $\mu$m range – is also a serious health hazard if inhaled for any period of time.

Dust particulate finding its way into lubricants such as oil or grease will seriously compromise their performance. Furthermore, delivered by automatic lubrication systems, this kind of contamination can cause injectors to seize, with often catastrophically expensive results.

There is no single or simple answer to these problems. Each contaminant needs to be dealt with, taking into account the particular nature of the contaminant and how it is generated.

As a general rule, contaminants are more effectively dealt with near to the contaminating source. The products of industrial combustion processes, power generation for example, both solid and gaseous, are best dealt with at source, in the stack. Firstly, all combustion processes should be continually optimised to achieve efficient combustion, which also results in the lowest levels of contamination. Then, any further contaminant can be handled in the stack by a variety of technologies that are available today – such as precipitators. This technology is readily available and proven. It is, however, expensive and at the end of the day, the additional cost of the technology has to be passed on to the end user – the electricity consumer for example.




*Typical inertial spin filter installation.*

This is not popular, but refusing to accept this simple fact has serious implications for the very existence of this planet. The process requires not only systems to remove or sequestrate the contaminant, but also suitable monitoring instrumentation to measure and control the levels of contaminant emitted. Instrumentation is available today utilising laser technology that can be used to measure dust, or gases in stacks – even at high temperatures (1 600°C in smelter stacks).

There are many situations where it must be accepted that fine airborne particulate is ubiquitous and unavoidable. In such situations the approach must be to remove or control the contaminant at the point of use, whether in the form of gases, liquids or solids. Solid airborne particulate can be prevented from entering moving machinery such as engines and compressors by correctly designed and applied air-intake filtration. Careful handling of lubricants can reduce the risk of solid contamination, but for total protection, suitable filtration of the lubricant, as near as possible to its application, is the only answer.

The difficulty of dealing with airborne particle contamination is the wide range of particle sizes encountered. A compressor will typically require that 99% of all particles larger that two microns are removed. The problem is that, if a filter with this level of arrestance is installed, it rapidly loads up with coarser particles and is quickly blocked. The compressor is then starved of air or the filter fails under the increased differential pressure and blows through, releasing not only most of the captured contaminant but also some of its own material into the machine.

The solution is to install two, or even three stages of filtration – a primary coarse filter, a secondary intermediate filter; and finally, a high-efficiency particle arrestance (HEPA) filter. This approach works, but the filters do need constant attention, particularly the primaries, and failures continue to occur due to poor maintenance. A useful and cost-effective solution to this problem is to use inertial spin filters, often called Vortex filters. These consist of a number of small vortexes that function as highly efficient cyclones. When correctly specified, designed and installed, this technology can replace both primary and secondary filters. Spin filters require no maintenance and only the final filters need to be monitored and replaced as necessary. The life of the final filter stages has been demonstrated in numerous applications to be extended by up to a factor of ten. Spin filter technology can be applied to a wide variety of dust materials and applications, including space cleaning, conveyor transfer points and compressor intakes.

When we are dealing with liquids, the problems are a little different. While the inertial spin filter principle has been used to some advantage, in centrifuges for example, the technology has limitations when used with liquids. It is virtually useless when we start dealing with highly viscous materials such as grease. Once again, we have to fall back on conventional, well- proven technologies – such as pleated filters. Pleated filters are available in an extraordinary range of sizes, efficiencies and qualities. Many a machine failure has been caused by the replacement of a high quality filter with a cheaper equivalent that 'looks the same'. The primary difference between a cheap filter media, such as paper and high-efficiency synthetic filter media is the open area of the media. This applies equally to air and gas filtration media. Put simply, the open area is the ratio of the 'holes' in the media to the material holding the holes together.

In low quality media this can be as low as 5%. High quality synthetic media can have an open area as high as 80%. The open area percentage of the media affects not only the differential pressure at which the filter will operate in a given application, but also its ability to hold a reasonable quantity of contamination (dirt) before it closes up completely. Remove your 80% open area media and replace it with that cheap alternative, and you may well send the initial (clean) differential pressure up by an order of magnitude, and the filter will clog up and fail very quickly indeed.

Actual selection of a filter configuration and media is subject to a wide variety of possible process conditions. These include: the medium to be filtered (air, acid or grease); flow rate; viscosity; specific gravity; operating pressure; acceptable pressure loss across the filter; and operating temperature.

We should also not forget contamination in the form of gases. Familiar contaminating gases are carbon dioxide ($CO_2$), carbon monoxide (CO), methane (CH), sulphur mixtures (SOx) and nitrate mixtures (NOx) to name but a few. Scrubbing technologies exist that can control these problematic emissions. They are expensive to install and to operate but we cannot afford to ignore them.

It is not within the scope of this article to quantify the costs to humanity of ignoring the destructive potential, both direct and indirect, of contamination. Using the technologies available, however, and paying the upfront costs of taking preventive measures, will be far less costly in the long term than ignoring the problem now. ❑

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