# FILTERS AND FILTRATION HANDBOOK

FIRST EDITION

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# PREFACE

The basic elements of our Earth, air, water and soil, have all been subject to contamination by natural suspended impurities since time began, and nature, taking its own time and course, has evolved a means of purifying most of these natural contaminants, ready for recycling, in order to maintain the balance and keep this "great big world" turning. Modern man has introduced countless artificial impurities into an industrial society, posing problems of contamination for which there is no natural progress of recyclement and no time to spare. The matter is urgent. The problem enormous and still growing. The solution? There is no one solution. The problems are so varied, complicated, changing, and the possible solutions so numerous that the Publishers have produced this 1st Edition, FILTERS AND FILTRATION HANDBOOK for the very purpose of providing most, if not all, the practical answers to contamination in industry as faced by the engineer. The work is comprehensive; incorporating principles, types, media, construction, application, selection, data and purchasing information, with means of easy reference and an adequate subject index. It contrives to combine in one volume, all essential and much useful information and data on filters and filtration.

**The Publishers**

# SECTION 1

## Basics

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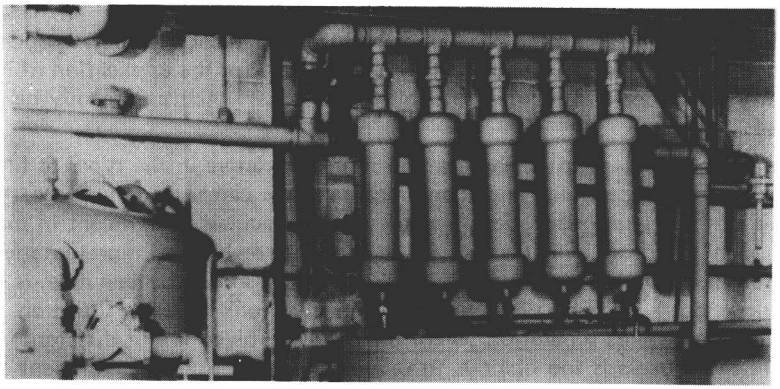
# Filters and Separators

A FILTER is basically a device for separating one substance from another – hence filtration is basically a process of *separation.* Immediately this expands the scope of filtration beyond the use of *filters,* as such. It must equally well include *separating* devices which work on other than pure filtering mechanics.

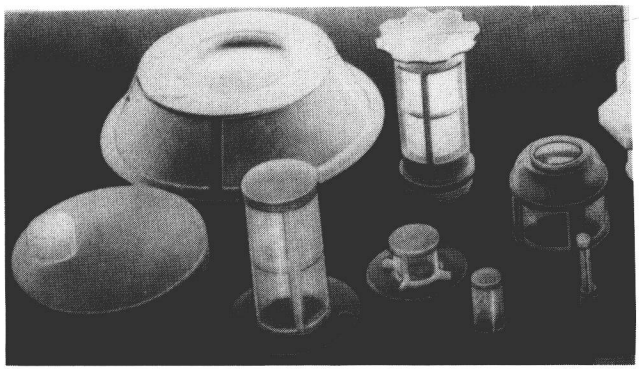
Two immediate problems then arise. Where to stop – and how to group and classify the various types of filters and separators. There is no complete answer to either, except that the various methods and processes of filtration and/or separation fall broadly into four categories:-

i) Solids-gas separation
ii) Solids-liquids separation
iii) Liquids-liquids separation
iv) Solids-solids separation.

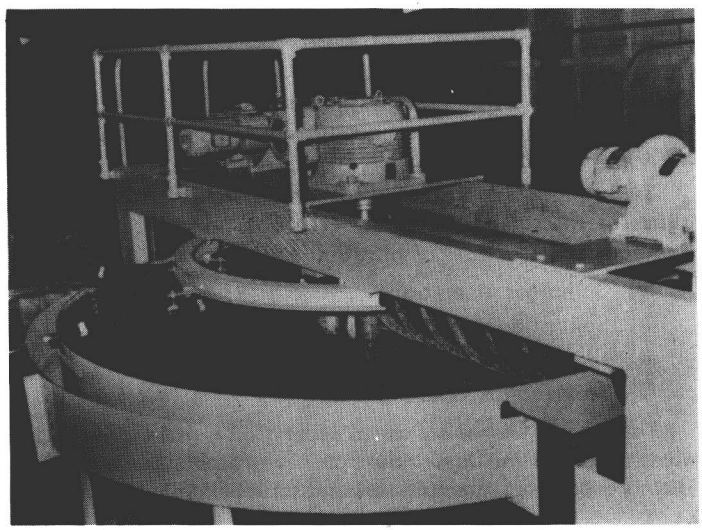
The broad field of solids-gas separation is mainly represented by air filters and air filtration services, but also includes industrial gas processing, *etc.* The former uses mainly filters; the latter mainly separators, precipitators and scrubbers; plus filters as necessary.



*Five Lakos in-line model separators (installed in common manifold), act as a prefilter to a deep-bed sand media ultrafiltration system, reducing the necessary backflushing of the deep-bed system from once an hour to once a day.*



*Moulded nylon filters and strainers. (Plastic Engineers (New Milton) Ltd).*



*Horizontal table filter fitted with scroll discharge offers advantages where coarse crystalline free settling solids must be handled; the drive being protected from splashing by being accommodated above the table.*

Solids-liquids separation is also an obvious field for mechanical filtration as such, but varying widely in volume requirements. Equally, it is a practical field for the application of inertial separation, particularly for process industries, and other methods which can readily be automated or semi-automated.

Liquids-liquids and solids-solids separation are more restrictive in the types of filters or separators which can be used successfully, and economically. These categories, therefore, represent more specialized fields of filtration/separation. Yet they are particularly significant in many industrial processes, although the process involved may be marginal or beyond representative coverage of filtration/separation. A *basic* method of liquids-liquids separation, for example, is distillation or thermal splitting – not a process to be elaborated on in a book covering filtration. Similarly, the *simplest* form of solids-solids separation where the solids involved are of different physical size is by *sieving.* Here the process is too obvious to require more than passing comment on sieve, mesh or screen sizes. Between these two extremes there are, however, specific processes which demand individual coverage for liquids-liquids separation in particular – inertial separators, precipitators, coalescers, *etc,* right up to the fringe subject of homogenization.

This, in fact, has been the main problem in the compilation of this Handbook – coverage of all filter types, related to process applications. Ideally, too, one would like to be positive in stating which type of filter is best for a particular job (or why type A is better than type B), but that is not a completely realistic question. Certain types of filters, or separators, are more or less standard choice for certain applications; but in other cases there are several possible alternatives to consider, offering comparable performance.

The main problems to be answered, in fact, are what you *want* to do, resolved as what you *need* to do, and the efficiency and cost-effectiveness of the possible solutions. There can be a danger in over-simplifying such answers. For example, Fig 1 presents a picture of the range of contaminant

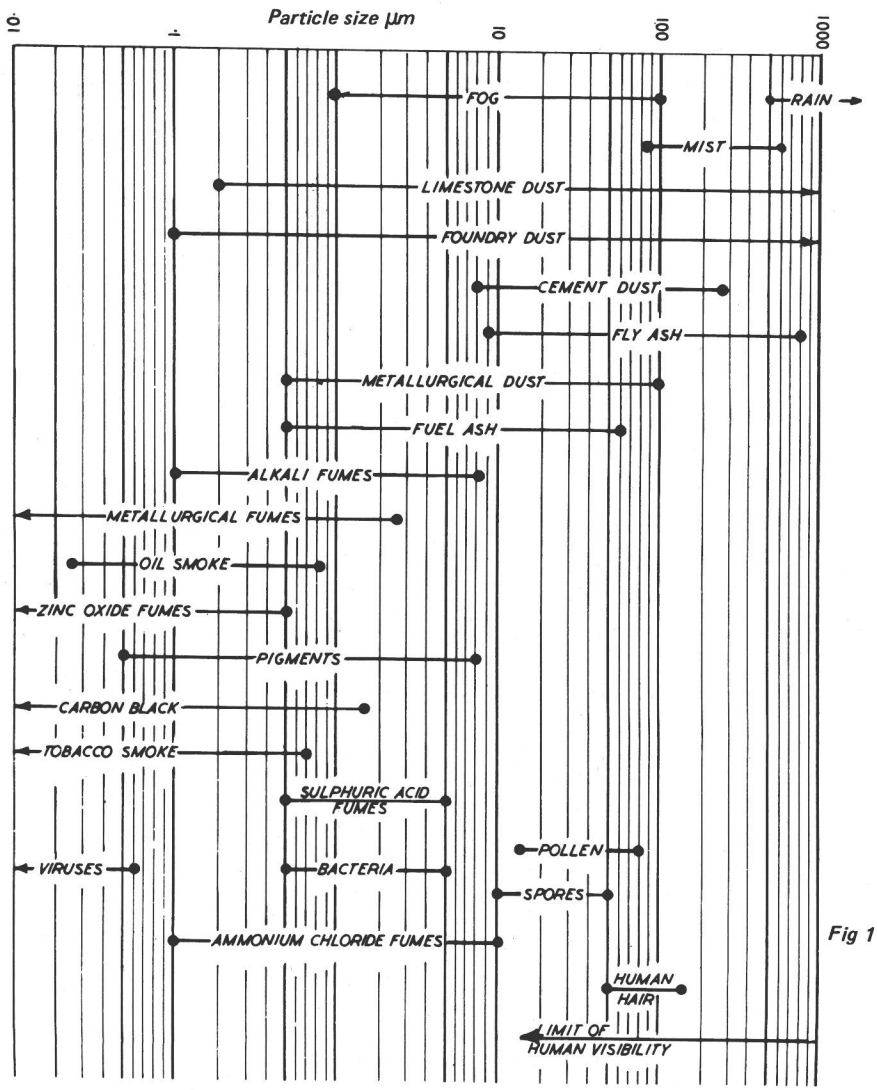


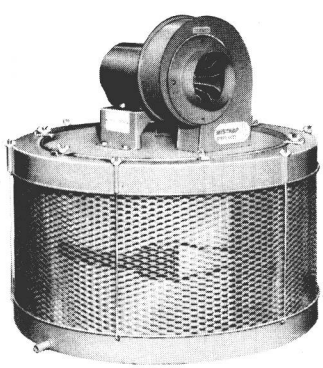

*Fig 1 Contaminants in air.*

particles which may be present in air. (These are further delineated in more specific detail in the chapter on *Contaminants*). The type of contaminants present, and their concentration, will obviously depend on the environment. A fabric dust collector is capable of filtering out contaminants ranging from the largest size down to about 0.1 μm – or the complete range illustrated, but would only be justified in particular circumstances (*eg* treating a heavily contaminated industrial atmosphere). Simple panel filters would be more than adequate for most other applications.

The filtering *range* of a particular type of filter or separator can also be misleading in terms of both efficiency and cost-effectiveness. The finer the filter the more readily it becomes clogged in the presence of coarser contaminants. In many cases, therefore, where fine or ultra-fine filtering is required, it becomes both more efficient and more cost-effective to filter in stages, using two or more separate filters with progressively decreasing cut-off ratings. And these filters may be of different types. Screens and strainers, for example, still have their place as primary filters in an era where particle removal (by filtration or separation) is possible down to 0.001 μm (*eg* with membrane filters and possibly with electrostatic precipitators).

In the case of filters, too, the media material must also be considered for compatibility (and other possible side effects).

The size range of sulphuric acid fumes and bacteria, for example, is about the same. An ultra-fine filter with a cut-off rating of the order of 0.2–0.3 μm would be capable of removing both from air – provided the filter medium and its housing is not attacked by acid. Equally, it is improbable that the need for removing both bacteria *and* sulphuric acid would be the particular requirement.



*'Mistkop' filter drum as used for dust extraction from precision tap girders (right). (Belisle Filtration Ltd).*