Most existing methods of defining solid contaminant quantities are based on the supposition that all such contaminants have a similar distribution of particle size. This may be true of natural contaminants such as airborne dust. It is not necessarily true for contaminants which have been circulated in a system, subjected to crushing in pumps and to separation in filters.

To allow for such changes in distribution, the profile is defined by two numbers indicating, respectively, the number of solid particles above 5 micrometre and 15 micrometre per 100 ml sample of fluid.

In order to keep the number of ranges to a reasonable minimum and still ensure that each step is meaningful, a step ratio of two has been used and Fig. 37 shows how each quantity has been allocated to a range number.

The procedure used is as follows:

Using a 100 ml sample, first count all the particles above 5 micrometre and allocate a range number from the right hand column.

Next, sum all particles above 15 micrometre and again allocate a range number as with the 5 micrometre count.

For example, Fig. 38 shows the results of a typical millipore particle count.

In this case the number of particles above 5 micrometres is 200,668 and hence would have a range number of 18; similarly, the number of particles above 15 micrometres is 5,468 and hence would have a range number of 13. By combining the two numbers with a solid line we get an 18/13 profile (Fig. 39).

There are two ways in which this system can be used. The first is by adhering rigidly to the rules just stated, and the second is by comparing the results of actual measurements plotted on a graphical background.

Fig. 40 gives 34 examples of contaminant profiles which can be created easily from the table in Fig. 37.

The ISO S.C. CODE is based on the fact that hard abrasive particles sized around 5 micrometres have an apparent aspect (length to width) ratio approaching unity, and that sizes above 15 micrometres do not generally exceed an aspect ratio of 3.

Thus, additional information is needed to describe the fibrous content, the abrasiveness of the contaminant or any special contaminants. In some cases it may be essential to specify the method of measurement, e.g. microscope or type of automatic counter.

The advantages claimed for the ISO S.C. CODE system can be summarized as follows:

The prime number of the class, i.e. the quantity of particles above 15 micrometre, is produced relatively accurately by all current systems of counting, both manual and automatic.

It classifies the contaminant levels in the two most

Fig. 37: Allocation of range of numbers in the ISO S.C. CODE system to particle counts.

No. of particles per 100 millilitres More than	& up to	Range Number	No. of particles per 100 millilitres More than	& up to	Range Number
8M	16M	24	2k	4k	12
4M	8M	23	1k	2k	11
2M	4M	22	500	1k	10
1M	2M	21	250	500	9
500k	1M	20	130	250	8
250k	500k	19	64	130	7
130k	250k	18	32	64	6
64k	130k	17	16	32	5
32k	64k	16	8	16	4
16k	32k	15	4	8	3
8k	16k	14	2	4	2
4k	8k	13	1	2	1

M = million; k = thousand

Fig. 38: Results of a typical particle count.

Particle size range	No. of particles per 100 ml of oil
5 — 15 micrometres	195,200
15 — 25 micrometres	3,880
25 — 50 micrometres	1,280
50 — 100 micrometres	232
Above 100 micrometres	76

Fig. 39: The contaminant code is constructed by allocating a range number to the total number of particles above 5 micrometres, allocating a second range number to the number of particles above 15 micrometres, and then combining these range numbers with a diagonal thus: 18/13.

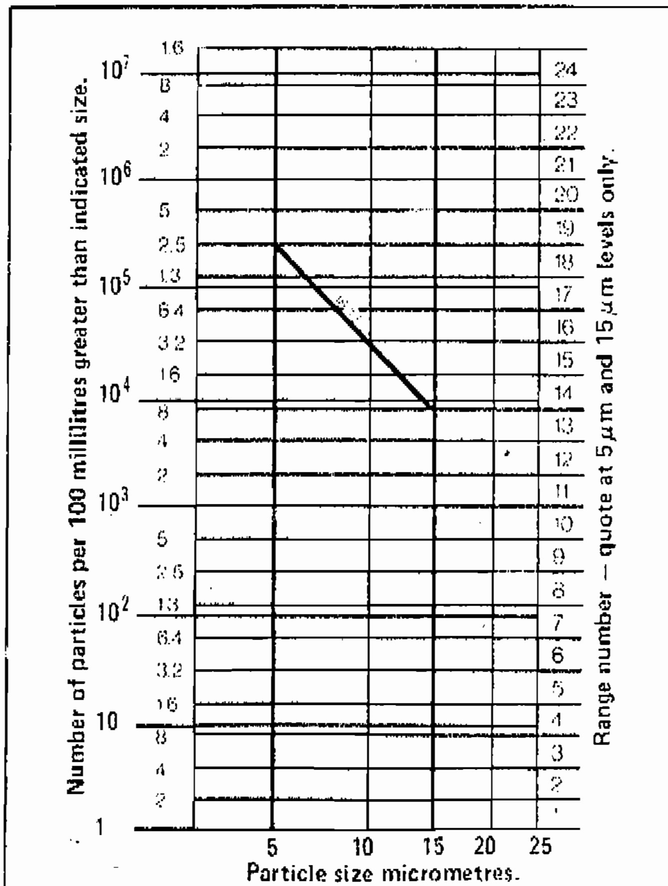

Fig. 40: Tabular presentation of contamination levels and corresponding codes.

CODE	Number of particles per 100 millilitres			
	Over 5 µm		Over 15 µm	
	More than	& up to	More than	& up to
20/17	500k	1M	64k	130k
20/16	500k	1M	32k	64k
20/15	500k	1M	16k	32k
20/14	500k	1M	8k	16k
19/16	250k	500k	32k	64k
19/15	250k	500k	16k	32k
19/14	250k	500k	8k	16k
19/13	250k	500k	4k	8k
18/15	130k	250k	16k	32k
18/14	130k	250k	8k	16k
18/13	130k	250k	4k	8k
18/12	130k	250k	2k	4k
17/14	64k	130k	8k	16k
17/13	64k	130k	4k	8k
17/12	64k	130k	2k	4k
17/11	64k	130k	1k	2k
16/13	32k	64k	4k	8k
16/12	32k	64k	2k	4k
16/11	32k	64k	1k	2k
16/10	32k	64k	500	1k
15/12	16k	32k	2k	4k
15/11	16k	32k	1k	2k
15/10	16k	32k	500	1k
15/9	16k	32k	250	500
14/11	8k	16k	1k	2k
14/10	8k	16k	500	1k
14/9	8k	16k	250	500
14/8	8k	16k	130	250
13/10	4k	8k	500	1k
13/9	4k	8k	250	500
13/8	4k	8k	130	250
12/9	2k	4k	250	500
12/8	2k	4k	130	250
11/8	1k	2k	130	250

The above tables cover the most usual series of codes between ranges 8 and 20. Other codes which are not shown above can be constructed from Fig. 39.

important zones describing the relationship of coarse and fine particle quantities.

It allows for and indicates differing slopes between the 5 and 15 micrometre counts.

A classification can be made direct from counts without the need to compare with a graph, although the latter will show benefits in certain cases.

It does not greatly conflict with any existing system.

The ratios chosen allow the most common contaminant ranges to be described with two figures, yet the ranges are adequately spaced to have useful significance.

Fig. 41 shows a commonly used format for displaying particle count data.

CHAPTER 9
Conclusion

Any examination of the subject of contamination involves four groups of people:

1. The fluid manufacturer or supplier.
2. The hydraulic equipment and filter manufacturers.
3. The manufacturer of the machinery which uses the hydraulic equipment.
4. The end user of the machinery.

Each of these has a commercial responsibility to supply equipment which will perform its duty satisfactorily at a reasonable price, and each must have some knowledge of the cleanliness of the working fluid.

The fluid supplier will supply fluid as clean as required and will charge accordingly.

The hydraulic equipment manufacturer should recommend the types of fluids, and their degree of cleanliness, best suited to the hydraulic equipment recommended for a specific application.

The machinery manufacturer must be aware of all the conditions to be met, including availability of fluids, maintenance practices and the machine reliability required. It is the manufacturer's job to offer customers the best value. This could mean, for example, providing either an inexpensive throwaway filter which must be replaced relatively frequently, or a more expensive one for which the only service needed is the occasional exchange of a relatively inexpensive component, such as a filter cartridge.

The end user has to make the final judgement, by comparing the real value of each machine offered; each user will place different emphasis on the values of the equipment offered, depending on the job to be done. To the end user, the value of a machine is its fitness for the purpose, how long it will satisfactorily perform, and what the cost of servicing will be. He is not interested in how many 10 micrometre particles are contained in 100 ml of hydraulic fluid.

The user's interest is in the least-expensive filter that will provide the required degree of cleanliness. In making this assessment, the original cost of the equipment has to be balanced against the cost of service. For example, the advantages offered by a very expensive pump that will operate on 'dirty' oil may have to be compared with those of a low-cost pump plus filter.

If it is to maintain its present high integrity, the hydraulic equipment industry needs to establish more meaningful specifications for filtration. The specifications must allow the end user to buy performance without necessarily having to know how this performance is achieved. The responsibility for establishing specifications must be divided between manufacturers of filter elements, who know what is possible, and the manufacturers of hydraulic equipment, who know what is needed. These two groups should be able to communicate in meaningful terms.

At present there are no adequate techniques covering all aspects of contamination measurement in