The experiment nobody wants

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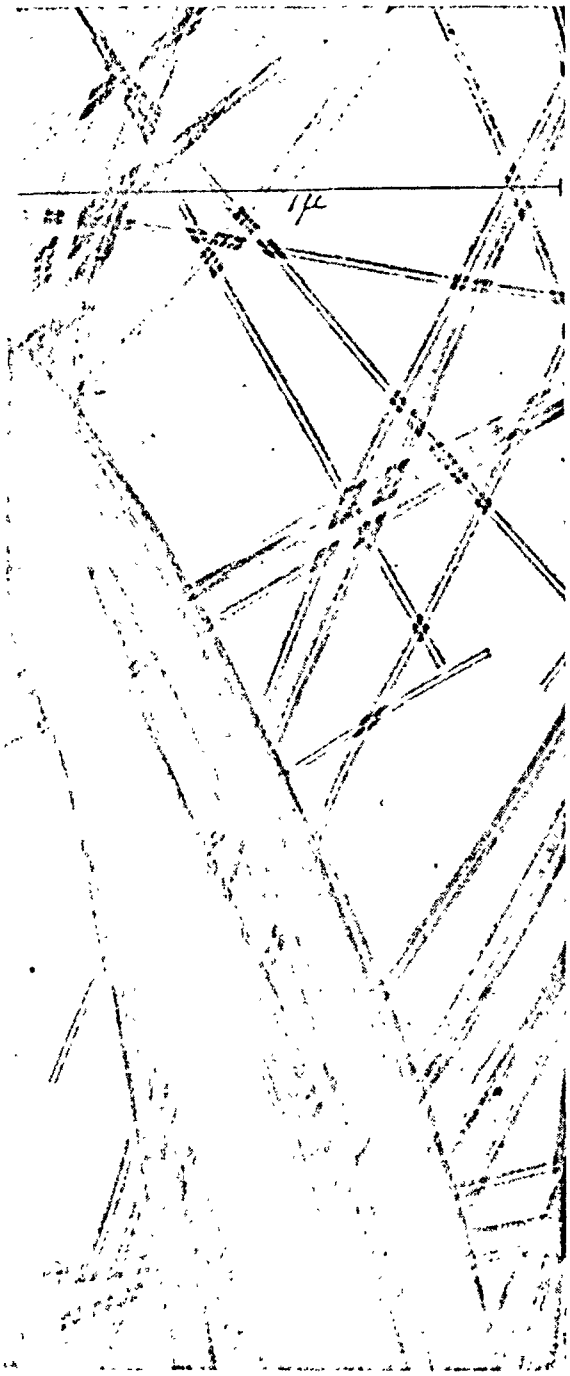


Courtesy Canadian-Johns Manville Co Ltd

Relatively rare photomicrograph shows chrysotile asbestos fibre at 78,000 magnification. Note hollow tube-like structure, thought to be about 250 Angstroms in diameter. Fibres vary from five to 100 microns in length.

WHITE, SILKY, soft and incredibly strong, chrysotile asbestos at first sight looks innocent enough. Yet some authorities say it should be handled with the respect accorded radioactive wastes.

Asbestos is the only "certified" cancer-causing substance we know of; the correlation between exposure to it and development of lung cancer is even stronger than between cancer and cigarettes.

There is some evidence that it is a co-carcinogen, most likely working in conjunction with trace metals and benzpyrene,[1] the latter produced, of course, by almost all combustion.

People who smoke and also work with certain levels of asbestos are 92 times as likely to contract lung cancer as the general populace.[2] Until recently, however, concern with this disease stimulating potential was devoted entirely to occupational groups working with asbestos.

Now, there is increasing speculation that a wider public may be in danger over the long term in the urban environment. While historically it has been mining, construction and textile workers who have been the unwitting guinea pigs, another unwanted experiment may soon begin to show its results in a wider sample of the population.

Since it was first mined commercially — in Canada by the way, in 1878 — the number of products using asbestos has gradually expanded, till there are now more than 3,000. Included are brake linings, floor tiles, water pipe, make-up in cheap talcum powder, stage-curtains, modelling clay, shingles, boards, dozens of different forms of insulation and filtering of soft drinks, beers and pharmaceuticals.[3]

The question arises whether use of the material may not have become too widespread.

One of these uses that has attracted attention is fireproofing of steel frame buildings by spraying asbestos-based insulation on the beams. It may be no more dangerous than certain other uses, particularly those where looser fibres are involved.

Fireproofing by spraying

Steel will buckle under high temperatures so fire regulations have called for its insulation.

At first, builders safeguarded the steel with a jacket of concrete — a tedious, cumbersome, and expensive process. Resourceful technology came to the rescue, however, and there is little doubt that the solution worked. Between 1955 and 1958 ingenious designers found a sophisticated, practical method of insulating the steel significantly against the effects of fire and heat.

Furthermore, the material they used withstood flame to 500 degrees C, it was easily handled, and could be simply sprayed onto the steel beams and trusses with a bonding agent. It was relatively cheap, and it was abundant, with Canada accounting at the time, for about half the world's production.

The material, of course, was chrysotile asbestos. Yet in the 17 years since its first sprayed application to structural steel it may have turned into a macabre time bomb, attacking the lungs of those who inhale it with millions of tiny fragments ranging from five to 100 μ in length and about 250 Angstroms in diameter.

What really happens when fragment meets lung is not exactly known. However, the consequences of certain types of long exposure are known, through correlations with length of exposure and presence of disease in asbestos workers. And the consequences are sobering.

Still, we don't know what the general public is exposed to from products in general use and from the ambient air, or what people who work in asbestos sprayed buildings are exposed to over the long haul. Our knowledge may soon advance faster than we bargained for.

Time may be running out after 15 ironic years of including a safety factor that might not be so safe after all.

In a typical application of the spraying technique, shown in the photos (page 61) exposed steel is thickly coated with an asbestos vermiculite mixture. Beneath the girders, a suspended ceiling will hang. In the

space formed between the suspended and structural ceilings, there will be electrical services and water pipes — plus ducts to bring cool air from the building's central air conditioner.

But there are no return ducts. Instead, two large central intakes on each floor will draw warmed air from the enclosed space to be re-circulated through the air conditioning system sucking in asbestos particles.

(Most of the major commercial buildings in Canada built since 1958 use this system — including Place Ville Marie in Montreal, the Toronto-Dominion Centre, Commerce Court and the new Manufacturers Life building in Toronto; the Pacific Centre in Vancouver, and Stelco Tower in Hamilton.)

Naturally, the air conditioner is filtered. But you could compare trying to stop the asbestos particles by means of an air conditioner filter to sifting flour on a gravel screen; the particles are just too small to stop, and if they're present will almost certainly re-circulate to the offices and rooms above. Says the U.S. National Academy of Sciences: "There appears to be no published data on the efficiency of air cleaning equipment as related to fibres of different sizes."

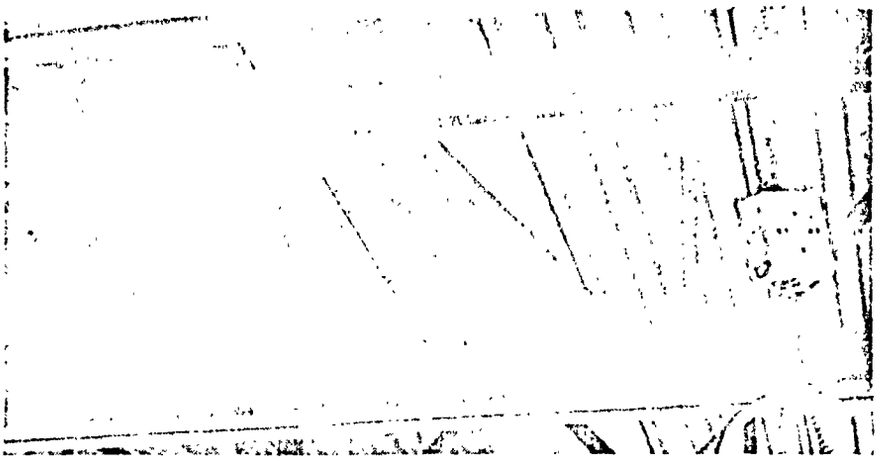
But does it matter? Are there enough fibres of the right size to cause damage? Only an accurate sampling program could tell us for certain. And that, to date, presents a problem.

Essential problem: sampling

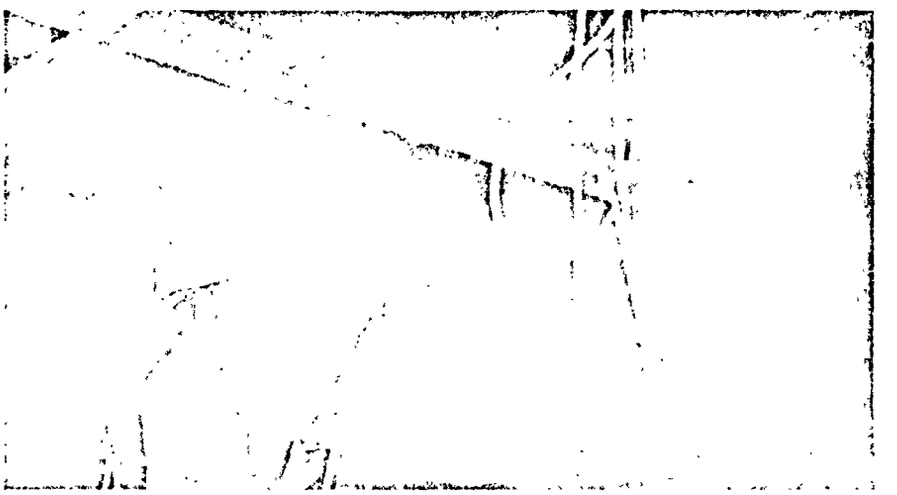
In fact, the only type of filter known to trap the sub-micron wisps of asbestos is an *HEPA* (High efficiency particulate) filter (it feels like the finest suede), capable of withstanding only very low flow rates without tearing. The *HEPA* filter technique was actually developed by the Atomic Energy Commission to sample very fine particles; even so, many pitfalls can distort the findings of investigators.

Both collection and later identification of the fibres are difficult and uncertain. For that reason, responsible researchers have expressed their findings in minima — that it, they say that at least as much asbestos as they found was present — but that there might be more. This is true of sampling dusts at job sites where spraying or wrapping of insulation has taken place; it is true of ambient air sampling.

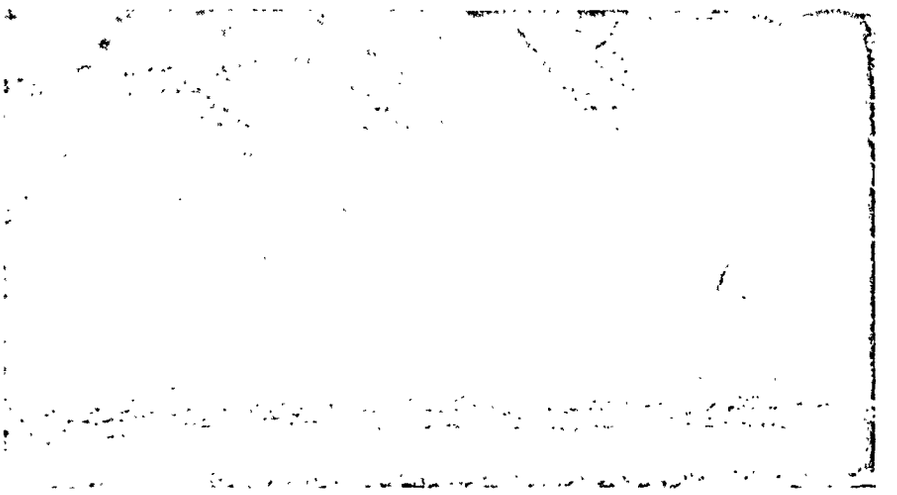
Accurate, complete counts are so hard to obtain that in December last year, the U.S. Environmental Protection Agency, instead of the asbestos-limiting regulation that was expected, published this account to explain why none was forthcoming:



Exposed steel truss (above) vulnerable to fire . . .

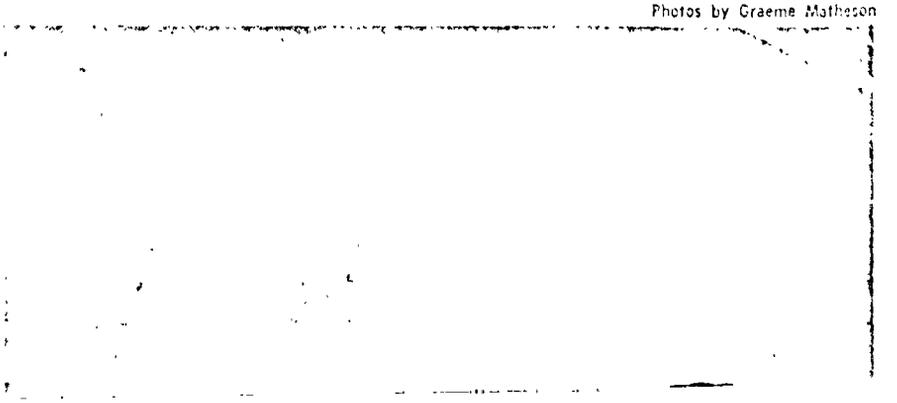


. . . is sprayed with an asbestos-mineral fibre mixture . . .



. . . leaving a thick layer near a future air intake duct.

Photos by Graeme Matheson



(Courtesy Canadian-Johns Manville Co Ltd

Wiry beauty of asbestos fibres gives no hint of potential dangers in using the material carelessly. Note variation in length.

atmosphere. Because there is no suitable technique for sampling and analyzing asbestos in the air or in emission gases, the standards are expressed as requirements for the operation of specific control equipment (or other equipment of comparable effectiveness), or in situations where no control system is available, as prohibitions on the use of asbestos. When acceptable source sampling and analytical methods are available and it is possible to delineate hazardous levels, these standards may be revised. . ."[4]

An expensive solution

Faced with these facts about sampling, Ontario's Air Management Branch approached Dr. E. J. Chadfield of the Ontario Research Foundation. Branch personnel, using *Millipore* membrane filters took four samples, each of 150 cubic feet of air, near the processing plant of a large asbestos products' manufacturer.

At this stage, said chief lab technician for the branch, Art Rayner, the problem was to assure sufficient flow through the filter. He is not sure it was obtained. Sampling completed, the filters were turned over to Dr. Chadfield. To remove particles from them, they were subjected to ultrasonic vibration, the collected particles going, it was hoped, into a aqueous solution, which was then centrifuged (probably at about 16,000 g) and examined under the electron microscope.

The apparent asbestos fibres were counted, but as Dr. Chadfield pointed out, the figure arrived at must be looked at as a minimum. What portion were actually caught by the filter? How many were released for counting in the lab? And what exactly do you count as an asbestos fibre — they can appear in clumps, fibres of 100 μ can break into discreet segments down to 5 μ, and there is the possibility of entraining other material of similar appearance.

Currently, many authorities accept two fibres per cc as allowable occupational exposure, a figure established by the British Occupational Hygiene Society and proclaimed in Britain in May 1970[5]. But what do you count as "two" fibres per cc?

Tom Cross, director of the Air Management Branch, passed on some figures from Dr. Chadfield: one out of three (0.057) was 40 per cent over Ontario's highly tentative ambient air standard of 0.04 fibres per cc. Of course, this is a good deal lower than the British Industrial Hygiene Society standard aforementioned; in fact, it is only about one fiftieth of two fibres per cc.

Mr. Cross explains why: "The British standard is too high for ambient exposure. Their TLVs (Threshhold Limit Values) are for eight hours for a healthy man; we're talking about the general populace." He cautions that what constitutes a truly safe level is not known, so Ontario's working standard is set very low. He foresees further sampling in other urban areas in the province, but adds: "Sampling one location once a week would cost $40,000 a year. By comparison, you can constantly monitor sulphur dioxide for $4,000 a year."

With Dr. Chadfield's study "we have made a break-through, but we haven't gone far enough."

What are we to make of this? A single sampling station, far from any construction site, produces values, one of which exceeds tentative, though admittedly stringent standards. And even this exacting, difficult and costly technique cannot be guaranteed to include all the fibres in the sampled air.

And when we mention the British Industrial Hygiene Society standard of fewer than two fibres per cc, we are talking of their "low" risk category: there is another they designate as "negligible," by which they mean that a worker exposed over a 50 year period to fewer than 0.4 fibres per cc of air would stand less than one per cent chance of contracting a disease caused by asbestos.[6] If we take this category, by the way, Ontario's working standard of 0.04 fibres per cc is a tenth, rather than a fiftieth the most strict industrial level.

Now how does all this relate to the conditions inside buildings sprayed with asbestos, and in which insulation of asbestos is wrapped around pipes and ducts?

Researchers in Britain, doubting there might be danger to occupants of buildings where the insulation and spraying had been made of asbestos, took air samples to approximate the methods of the Hygiene group.

They sampled 60 buildings in 74 test locations and in 13 instances found fibres equaling or exceeding the 0.04 fibres per cc that Ontario has adopted — pro tempore — as its ambient air safety level.[7]

Be it noted that six of these were in locations where insultation board was the material apparently responsible and in only one instance sprayed asbestos; be it further noted that insulation board consistently registered at all levels; nevertheless, sprayed asbestos was also present at all lower levels (from .005 to .03).

Furthermore, the British office buildings in the survey were shown in four instances to exceed Ontario's ambient air standard, whereas they were a small minority of the buildings surveyed. The study failed to mention whether these buildings had an air conditioning system. A number of tests were taken in buildings which did not incorporate asbestos in their construction. There, the figures were under 0.004 fibres per cc — a tenth of the prevalence in the buildings that gave readings over the danger level and incorporating asbestos. The study concluded that there was no hazard to occupants of the asbestotic buildings. But it is difficult to accept this conclusion with entire peace of mind.

Unfortunately, no such tests have been made in Canada, and we can only speculate what might be present in our buildings. A U.S. study[8] commissioned by the Sprayed Mineral Fibre Manufacturers Association, Inc. concluded that there "is no exposure to asbestos fibres of respirable size in the work environment in the new

Federal Building" which had been spray-fireproofed; but these results are in such blatant contrast to both the British series and to the erosion characteristics of the sprayed material that they must be regarded with some skepticism.

Erosion tests in typical flows

One manufacturer graciously allowed us to see the results of air erosion tests of his product.

Since the flow rates of the air in the tests are roughly comparable to those in the area immediately surrounding the return intakes in a high rise building, they are of some interest, although the methods used in testing do not make for comparison with the ambient air standards used by Ontario nor with the British Occupational Hygiene Society methods.

Glass slides were coated on the unwarranted assumption they would retain all flying particles. A sample of sprayed asbestos material of about two square feet was played on by a stream of air at various rates of flow.

At 265 fpm for half an hour, (about the rate you'd find in perhaps a five foot radius from the opening of a typical intake, an engineer told me) less than one particle per square centimetre was found. At 430 fpm (or roughly two and a half feet radius from an opening, in practice), two particles were noted after an hour. At 810 fpm (in practice still closer to the intake) three fibres per square centimeter were sighted, falling off to less than one after seven and a half hours testing.

So we are back to the questions raised by Dr. Chadfield: what do you count as a fibre? How can you be sure you got them all onto the coated glass and off again?

Particle size was of the average of 100 microns, wrote the laboratory manager.[9] As we have seen, this is a rather high average size for chrysotile fibres, which in any case would not likely be caught or observed much below 100 microns by the methods used.[13*] Thus the amounts detected were minimal indeed.

In a multi-storey building using a pair of air intakes on each floor, there will be many square feet of asbestos based insulation exposed to erosion by the flow to the air conditioner. These intakes typically work at rates between 700 and 1200 fpm, with the radius around their openings exposed to flows that drop by half about every two feet.

The degree to which fibres thus flaked off in a building might be concentrated to levels intolerable under the tentative ambient air standards is another imponderable: obviously not all the air put through the air

Asbestos fibres in half city dwellers

conditioner comes from inside the building; some is make-up air from outside. How many of the fibres may remain in large enough state to be caught by the air conditioning filter is an unknown, though probably not many. How long air erosion persists on the insulation isn't known either, although the manufacturer's tests seemed to show it falling off somewhat as time goes by.

The researcher most responsible for current concern about possible effects of asbestos on the general population is Dr. Irving Selikoff, division of environmental medicine, Mt. Sinai Hospital, New York.

He investigated 632 individuals whose careers as asbestos workers spanned at least 20 years. The study began in 1962. By 1971, 425 of the men had died, whereas only 285 deaths would be expected in such a group outside the industry. The deaths included 47 from asbestosis and 161 from cancer — eight times the expected rate. One in ten of these cancers was mesothelioma, a tumour of the pleura (lung sac) at one time thought so rare that some pathologists even doubted its existence.

Dr. Selikoff and his colleagues performed 3,000 autopsies on urban residents and confirmed by electron microscope the presence of asbestos fibres in 48.3 per cent of them. This means at least that urbanites are getting some asbestos from the air, though how much and with what hazard remains unknown.

Other researchers, particlarly Dr. George Wright,[10] have pointed out ambiguities and inconclusiveness in some of the findings and fears of Selikoff's group. Still, to the city of New York, the hazard seemed sufficient to ban spraying in February of this year; Chicago and Philadelphia followed suit. The EPA regulations seem to imply that a spraying ban across the U.S. is imminent.

Occupational exposures in Canada

In Canada, all studies have concentrated on occupationally exposed groups. In Quebec, McDonald et al.[11] gathered information on more than 10,000 asbestos mining and milling workers born between 1891 and 1920, including cause of death of the 23 per cent dead. In the highest dust exposure category there were five per cent more deaths than the general population of Quebec experienced. It is claimed that since the time these men were exposed, many years ago, conditions have been altered to exclude such conditions. Mortality rates in future are expected to parallel those in the general population.

When low levels of exposure have not been considered to pose a threat, it is not surprising that the provinces have done little to regulate the use of asbestos material.

But some attitudes remain shocking. In B.C., only the usual levels of dustfall for any dust are a legal restraint on mines or construction sites. Enforcement seems minimal — to the point that workmen on the Pacific Centre building in Vancouver made high incidence of asbestos dust from spraying the cause for a strike. When tarps were hung and masks provided, however, for some reason the men failed to wear them. Others left bags of the material opened and exposed. Asbestos dust did leave the worksite, since guests at a nearby hotel complained of it.

Also in B.C., witnesses said of the Cassiar mine site: ". . . our automobile was left parked within a hundred yards of the mill for a period of three hours. We discovered upon return that the car was completely covered with a heavy layer of asbestos fibres which in places had accumulated to a depth of half an inch. . ."[12] The Cassiar mine has operated for 15 years; it would be interesting to review the health of long-term employees.

In Ontario, the Construction Safety Branch draws on the mining act, the industrial safety act and the construction act. Asbestos is not named in any of them, but can be covered under general provisions to control hazardous substances. Despite attempts to enforce the wearing of masks and the sealing off of work areas with tarpaulins, the branch makes no claim to have succeeded.

Construction Safety Branch director Ken Cleverdon recalled a published photo of an unmasked man spraying asbestos in a new subway tunnel although the workers had been masked when the inspector had toured the worksite.

The only solution, in Mr. Cleverdon's mind, is a kind of war of attrition against the use of sprayed asbestos: "The real answer is that if we push hard enough on the regulations — the masks and tarps — it will force the use of non-asbestos materials. The answer in the construction industry is not to use the product."

In Alberta, workers are required to have chest X-rays every two years under the general dusty-industries regulations. In Manitoba, they must have a "license", requiring a chest X-ray, each year. Saskatchewan unofficially

follows the British Occupational Hygiene Society standard; Nova Scotia covers the matter under the Industrial Safety Act; New Brunswick uses a section on hazardous materials; Newfoundland and Prince Edward Island have no specific legislation.

Yet none of this deals directly with the problem of release into the air around job sites, or the long-term effect on the people inside sprayed structures. It is apparent that much investigation followed by legislation and above all enforcement remains to be done.

It is still possible that sprayed asbestos might get a clean bill of health. A sealer might defuse this potential danger by making erosion impossible. The good will of the suppliers is not lacking: in Ontario, they have recently lowered the asbestos content of their spray from 60 to 10 per cent.

Mr. Vince Struther, of the Donalco, spraying firm, while discounting much of the danger others have perceived, nevertheless says: "We think regulations on dust should be much more stringent—and not just on ours."

If we do not religiously enforce present rules, there's little point in keeping the sanctimonious safety measures now on the books.

If we do not find out what levels of exposure can really be expected in high rise buildings — and continue investigation of the ambient air in urban environments near construction sites and other sources — we may soon see the results of an experiment nobody volunteered for. □

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13 Inertia of particles below 50 microns is insufficient to carry them onto a coated glass plate, or any other structure that in itself interrupts the air flow. That's why accurate samples can be taken only at low flow rates, as with the *Millipore* filter, for example.

Chemical chart

Five-page fold-out chart list chemicals used in water and waste water treatment. Includes data on chemicals' name and formula, common or trade name, shipping containers, suitable materials for handling, available forms, weight, solubility, commercial strength appearance, properties—and precautions. 50 cents apiece, payable to *Water and Pollution Control*, **Southam Business Publications, 1450 Don Mills Rd, Don Mills, Ont.**