NORMAL USE LEVELS
OF RESPIRABLE TALC
PRELIMINARY STUDIES

IRI Project No. 404259

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CONFIDENTIAL

NORMAL USE LEVELS OF RESPIRABLE TALC
PRELIMINARY STUDIES

IRI Project No. 404259

Authors:

R.I. Aylott
J.K. Fawell
J.D. Middleton
M.E. Roberts

To:

Mr. D.M. Bryce
Chairman, Talc Working Party
Toilet Preparations Federation
c/o The Boots Company Ltd.
Consumer Products Development
D10 Building
Nottingham
NG2 3AA

Issued by:

Inveresk Research International
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EH21 7UB
Scotland

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AUTHENTICATION

"We, the undersigned, hereby declare that this work was performed under our supervision, according to the procedures herein described, and that this report represents a true and accurate record of the results obtained".

R.I. Aylott, B.Sc., C.Chem., M.R.I.C.

J.K. Fawell, B.Sc., M.I.Biol., A.I.M.L.S.

J.D. Middleton, B.A.

M.E. Roberts, B.Sc.

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SUMMARY

In this project IRI have designed methods for the collection and analysis of small amounts of respirable talc in air, and have subsequently applied these methods to determine the levels of respirable talc in air during typical in-use talcing studies.

Initially, analytical methods were developed for the determination of both magnesium (by atomic absorption spectroscopy) and silicon (by atomic absorption spectroscopy and colorimetry) after dissolution of the talc in hydrofluoric acid. Analysis of known amounts of talc showed that good recoveries were obtained for both elements. Analysis of talc for total magnesium offered the greatest sensitivity (limit of detection 0.1 mg talc m^{-3} air for a 5 min sampling period) and this method was therefore used for the in-use talcing studies.

In the in-use talcing studies respirable dust in the sampled air was separated from the non-respirable fraction by means of a cyclone device and collected on membrane filters. The collected dust was dissolved in a hydrochloric/hydrofluoric acid medium, excess hydrofluoric acid was complexed with boric acid, and the resulting solution analysed for total magnesium. From the amount of magnesium present and the volume of air sampled, the concentration of talc present in the air was determined.

The respirable concentrations of talc in the air ranged from below the limit of detection up to 1.7, 3.3 and 0.9 mg talc m^{-3} air during use of loose face powder, adult dusting powder and baby dusting powder studies, respectively. Levels were generally higher during the use of micronised talc compared with ~~00000~~ non-micronised grade talcs. Within the limitations of the small number of experiments performed with the non-micronised 00000 grades of talc, there was no evidence that the source of talc (Italian or Chinese) or the addition of perfume affected levels of respirable dust.

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Direct measurement of particle size showed that the particle size of the dust collected fell within the respirable range.

At high humidity the quantity of respirable dust in the air was lower than that found under ambient humidity conditions.

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INTRODUCTION

Background and objectives

In order to define the experimental conditions necessary for tests designed to establish the safety-in-use of talc, information is required on the concentration in the air of respirable talc particles generated during normal use.

Before embarking on an extensive programme of work designed to provide data on respirable talc levels from large numbers of consumers, it was necessary to establish a suitable methodology for the monitoring of in-use levels of respirable talc and to define some of the factors which may affect these levels.

This report gives an account of a preliminary project, the objectives of which were to obtain information which could be used as the basis for designing a more comprehensive project which would provide definitive data on respirable talc levels.

The objectives of the project were:

1. The selection of a suitable method for collecting respirable dust during in-use situations.

2. The development of analytical methods to determine the quantity of respirable talc collected.

3. The determination of the levels of respirable talc using different product types and different particle sizes of talc.

4. An assessment of the influence of added perfume.

5. An assessment of the influence of relative humidity.

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6. A determination of the particle size range of talc particles within the respirable sample.

A further objective specified in the project plan was to compare dust levels generated from baby powders using dolls and real babies. However, problems were encountered in recruiting volunteer mothers with babies and the study has therefore been restricted to the use of dolls.

Practical considerations

The two basic procedures for measuring the concentration of dust in the atmosphere are sample collection and analysis.

Dust particles are normally collected by drawing known volumes of air through filters and collecting the dust on the filter. The smallest particle size collected depends on the pore size of the filter and the largest on its sedimentation behaviour in air. In the present study the objective was to collect only respirable particles, i.e. only those particles which are likely to be retained in the lung. These particles have a diameter in the approximate range of 2 to 7 μm. It was therefore necessary to use apparatus which collects particles in this range. In addition, particles above 7 μm which do not sediment rapidly are present in air so that pre-selection of particle size is necessary before passing the air through the filter. This can be achieved by using a cyclone separator which will remove particles above a certain size (according to the cyclone design) by a process of centrifugation. Particles below this size will pass through the cyclone and be collected on the filter. The collected particles can then be analysed.

A commercially available apparatus which meets the above requirements is the Casella Air Sampler. In conjunction with appropriate filters, this apparatus has been used throughout this study.

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When considering the method of use of talc and some earlier unpublished observations, it was apparent that the quantity of talc likely to be collected on the filters would be extremely low. The only way to increase the amount collected was to increase the total volume of air passed through the collection apparatus during the talcing operation. Unfortunately the air sampling rate in the Casella Air Sampler is fixed and the sampling time depends upon the duration of the talcing operation.

The limit of detection of atmospheric talc therefore depended upon the sensitivity of the analytical method used to determine the quantity of talc on the filter. It was apparent that relatively insensitive methods such as direct weighing or infra-red spectroscopy were not suitable and that a more sensitive method was required. Chemical analysis appeared to be the most promising approach.

Talc is a hydrous magnesium silicate with the general formula $Mg_3Si_4O_{10}(OH)_2$ (Ref. 1). Elemental analysis for magnesium or silicon by atomic absorption spectroscopy (AAS) or colorimetry are suitable methods for the determination of talc, provided that the background levels of these elements in any atmospheric dust are sufficiently low.

Background to analytical method development

Sample preparation

Analysis of talc in terms of its magnesium and silicon content by either AAS or colorimetry requires the dissolution of the sample in a suitable medium. Since silicates, except the alkali metal salts, are insoluble in most acid media (Ref. 2), it was therefore necessary to prepare a solution of the sample by either

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dissolution in hydrofluoric acid or by a fusion decomposition technique.

Fusion decomposition of silicates involves heating the sample with a salt flux in a crucible (usually platinum or graphite); the salt is then dissolved in an acid. Materials frequently used as a salt flux include sodium carbonate, sodium peroxide and lithium metaborate. (Ref. 3).

Fusion techniques, whilst generally satisfactory for relatively large samples, were considered to be unsatisfactory for this exercise where very small samples were expected. Possible sample losses during the fusion process and the presence of significant quantities of magnesium and silicon in the flux made the method unacceptable.

Acid dissolution of talc offers distinct advantages of minimal sample handling and reduced risk of contamination through the use of high purity solvents. In recent years the hydrofluoric acid dissolution method has been applied to a wide range of silaceous materials (Ref. 4) and many specific applications have been developed. The dissolution conditions adopted depended upon the nature of the samples and the elements to be determined.

Losses of silicon as silicon tetrafluoride from certain matrices can be a problem but it is reported that such losses do not occur if the material is dissolved in an excess of hydrofluoric acid and the solutions are not heated (Ref. 5).

Using such dissolution procedures a scheme for the analysis of cement (hydrolysed calcium aluminates and silicates) has been reported (Ref. 6). The method was adapted further by us for the analysis of small amounts of talc.

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Atomic absorption spectroscopy

Talc was analysed for both magnesium and silicon by atomic absorption spectroscopy. The determination of specific elements by AAS is based on the absorption of energy from a sharp spectral line source by the valence electrons of ground state atoms of those elements. Ground state atoms are commonly generated by means of flame or flameless atomisation. In flame atomisation the analytical sample solution is aspirated into a flame in the light path between the source and detector. The flameless technique applied in this project involves the electrothermal atomisation of the sample which is pipetted onto a carbon rod located between 2 electrodes. The rod is electrically heated to a selected temperature at which the element being determined atomises in the instrument's light path.

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EXPERIMENTAL PROCEDURE

1. Analytical Method Development

Apparatus

Atomic absorption spectroscopy was done using a Varian Techtron model 1400 atomic absorption spectrophotometer fitted with a model 80 Automatic Gas Control Unit and a model 63 Carbon Rod Atomiser. The instrument conditions for flame atomisation were as follows:

	Magnesium	Silicon
Source	Varian Techtron Hollow Cathode Lamps	
Wavelength, nm	285.2	251.6
Slit width, nm	0.5	0.2
Lamp current, mA	3	15
Fuel	acetylene	acetylene
Oxidant	air	nitrous oxide
Burner	4 inch air-acetylene	2.5 inch nitrous oxide acetylene

Colorimetry was done using a Pye Unicam SP800 UV/visible spectrophotometer.

Polypropylene volumetric ware (Azlon Products Ltd.) was used wherever the matrix contained hydrofluoric acid, otherwise, standard laboratory glassware was used.

Materials

Standard solutions,

Magnesium chloride, 1 mg $m\ell^{-1}$ magnesium (BDH Chemicals Ltd.). this solution was diluted to produce 100 and 10 $\mu g\ m\ell^{-1}$ working standards.

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Silicon, 1 mg $m\ell^{-1}$ Silicon (BDH Chemicals Ltd.).

Hydrochloric acid, Aristar (BDH Chemicals Ltd.).

Hydrofluoric acid, 42% Aristar (BDH Chemicals Ltd.).

Boric acid, AnalaR (BDH Chemicals Ltd.). Prepared as a 5% (w/v) aqueous solution.

Lanthanum chloride solution, 10% (w/v) Lanthanum (BDH Chemicals Ltd.).

Sulphuric acid, Aristar (BDH Chemicals Ltd.).

Ammonium molybdate (Fisons Ltd.). 19 g Ammonium molybdate was dissolved in 80 mℓ sulphuric acid/water (1/9) and diluted to 250 mℓ with distilled water.

Sodium bisulphite (Sigma Chemical Company). 45 g Sodium bisulphite was dissolved in 400 mℓ distilled water.

Sodium sulphite, hydrated (Fisons Ltd.).

1,2,4-Aminonaphthol sulphonic acid, (Sigma Chemical Company).

Reducing agent. 7 g Hydrated sodium sulphite was dissolved in 50 mℓ distilled water and 0.75 g 1,2,4-aminonaphthol sulphonic acid was added. After stirring, the sodium bisulphite was added and the solution made up to 500 mℓ with distilled water.

Procedure

A. Validation of method of sample preparation

Initially, a range of acid media was examined for the dissolution of known amounts of talc and the following recovery experiment was undertaken using the selected medium.

Ten known amounts of Chinese unperfumed talc ranging from 0 to 50 µg were accurately weighed into 50 mℓ polypropylene screw top bottles and placed in a clean (stainless steel lined) and well ventilated fume cupboard. 2 mℓ hydrochloric acid was pipetted into each bottle followed by 0.25 mℓ hydrofluoric acid using a polypropylene pipette, and then left to stand overnight to ensure complete dissolution of the sample.

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20 mℓ boric acid solution was added to each sample from a dispenser and left to stand 0.5 h. 1.25 mℓ of lanthanum chloride solution was pipetted into each sample, the solutions transferred to a 25 mℓ polyproplyene volumetric flask and made up to volume with distilled water.

These known solutions were then analysed in the following 3 ways.

(i) Determination of magnesium by atomic absorption spectroscopy

Preparation of standards

0, 5, 10, 15 and 20 mℓ aliquots of the 10 μg $mℓ^{-1}$ magnesium working standard were pipetted into 100 mℓ volumetric flasks and diluted to volume with distilled water to produce standards equivalent to 0, 0.5, 1.0, 1.5 and 2.0 μg $mℓ^{-1}$ magnesium.

Preparation of sample solutions

1 mℓ aliquots of the sample solutions were accurately pipetted into 1 ℓ volumetric flasks and diluted to volume with distilled water.

Analysis of standard and sample solutions

Each standard solution was aspirated into the atomic absorption spectrophotometer and the absorption read against a distilled water blank. A calibration curve was constructed with absorbance plotted against concentration of magnesium (Figure 1). Sample solutions were aspirated into the atomic absorption spectrophotometer and their absorbances recorded. The

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concentration of magnesium in each solution was read off from the calibration curve and from this the amount of magnesium in the original talc sample was calculated. A graph was plotted with the amount of magnesium found against amount talc originally taken (Figure 2).

(ii) Determination of silicon by absorption spectroscopy

Preparation of standards

0, 5, 10, 15, 20, 30, 40 and 60 mℓ aliquots of the 1000 μg $mℓ^{-1}$ silicon stock solution were pipetted into 100 mℓ volumetric flasks and diluted to volume with distilled water to produce standards equivalent to 0, 50, 100, 150, 200, 300, 400 and 600 μg $mℓ^{-1}$ silicon.

Analysis of standard and sample solutions

Each solution was aspirated into the atomic absorption spectrophotometer and its absorbance read against a distilled water blank. A calibration curve was constructed with absorbance plotted against concentration of silicon (Figure 3). Distilled water was aspirated between each sample in order to reduce the deposition of boric acid in the burner.

Sample solutions were aspirated into the atomic absorption spectrophotometer and their absorbances recorded. The concentration of silicon in each solution was read off from the calibration curve and from this the amount of silicon in the original talc samples was calculated. A graph was plotted with the amount of silicon found against amount of talc originally taken (Figure 4).

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(iii) Determination of silicon by colorimetry

Silicon was determined colorimetrically as its molybdenum blue complex at 800 nm. The yellow silicomolybdate formed in the reaction with ammonium molybdate was reduced with 1,2,4-aminonaphthol sulphonic acid to form the molybdenum blue complex (Ref. 7).

Preparation of standards and sample solutions

1 mℓ of each standard solution was accurately pipetted into a 500 mℓ volumetric flask containing 50 mℓ distilled water. 5 mℓ ammonium molybdate reagent was added to each solution and then left to stand for 0.5 h. 5 mℓ reducing agent was added to each and after a further 0.5 h each flask was made up to volume with distilled water.

1 mℓ of each standard solution was accurately pipetted into a 500 mℓ volumetric flask and prepared for analysis as described above.

Analysis of standards and sample solutions

The absorbance due to each standard and sample solution against a distilled water reference was recorded at 800 nm. A calibration curve was constructed with absorbance plotted against the concentration of silicon in the original standard solutions (Figure 5). The concentration of silicon in each sample solution was read off from the calibration curve and from this the amount of silicon in the original talc samples was calculated. A graph was plotted with the amount of silicon found against amount of talc originally taken (Figure 6).

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B. Optimisation of sensitivity

Reduced sample volume

The sensitivity of the method for the determination of magnesium by atomic absorption spectroscopy was further optimised by carrying out the complete analysis in a reduced volume (25 mℓ) hydrochloric/hydrofluoric/boric acid matrix.

Standards were prepared by adding 0, 1.25, 2.5, 3.75 and 5.0 mℓ of the 10 μg $mℓ^{-1}$ magnesium working standard into 25 mℓ polypropylene flasks followed by the reagents as described for the known talc samples.

After making up to volume with distilled water, the standards were analysed as described above and a calibration curve plotted (Figure 1). The absorbences due to the individual components of the matrix were examined.

In addition, the above exercise was repeated using 3 polypropylene bottles each containing a single 25 mm diameter membrane filter. These samples were left to stand overnight in hydrochloric/hydrofluoric acid with bottles stoppered before diluting to volume.

Electrothermal atomisation

The analysis of magnesium and silicon by AAS using electrothermal instead of flame atomisation was considered. 5 μℓ solutions were injected onto the carbon rod and the instrumental response to these solutions examined.

C. Precision of analysis and limit of detection

The precision of the determination of magnesium at the 0.05 μg $mℓ^{-1}$ level was calculated from the determination of

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the standard deviation about the mean of the absorbances of 9 solutions in 25 mℓ polypropylene flasks each containing a clean 25 mm diameter membrane filter, 1 mℓ of 1.25 μg $mℓ^{-1}$ magnesium standard and the normal medium as described above. The limit of detection of the analysis was based on the precision at this concentration.

D. Determination of magnesium in talc

Approximately 25 mg quantities of each talc type in triplicate were accurately weighed into 50 mℓ polypropylene bottles and analysed for total magnesium as described in Section A. The amount of magnesium present was expressed as a percentage of total talc.

2. Monitoring of In-Use Levels of Respirable Talc

Apparatus

Atmospheric samples were taken using cyclone filters and pumps made by C.F. Casella & Co. Ltd.

Two types of cyclone elutriator/filter head systems were used for the collection of respirable dust, (models T13043/1 fitted with 37 mm diameter membrane filters; and model A765011 fitted with 25 mm diameter membrane filters). The sampled air was drawn vertically upwards thereby eliminating the majority of particles which would normally settle to the ground. In addition, an open filter i.e. with no form of elutriation (model T13070/1) fitted with 37 mm diameter filters was also used to collect total dust; in this mode of operation the filter was located in the vertical position. The pumps (model T13051/2) were located in static sampler base and collector supports (model T13076/1). Membrane filters (0.8 μm pore size) were supplied by Millipore (UK) Ltd.

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Filters with a grid surface were used for particle size distribution studies.

Relative humidity was measured with a wet and dry bulb whirling hygrometer.

Materials

Chinese 00000 grade, perfumed and unperfumed talcs were supplied by Boots Co. Ltd. (Nottingham). Italian 00000 grade, perfumed and unperfumed talcs and Italian micronised grade, unperfumed talc were supplied by Johnson & Johnson Ltd. (Portsmouth).

The above products were used as loose face powder, adult dusting powder and baby dusting powder.

A. Preparation of apparatus

Each day, prior to use, the Casella pumps were calibrated to draw air through the membrane filters at a rate of 1.9 ℓ min^{-1}. The nickel-cadmium batteries, used in the pumps, were recharged regularly between each sampling occasion. Membrane filters (25 mm or 37 mm diameter) were loaded into their holders using forceps in a clean laboratory away from the sampling sites to which they were transferred immediately prior to sampling.

B. Collection of samples

On each talcing occasion, 4 samplings were made at 1 h intervals over a ½ day period. Two pumps, each fitted with the cyclone device for the collection of respirable particles, were set up next to each other at face height in each location (described in Table 2). One pump was operated for a 5 min period during talcing. The other pump was used successively over 4 talcings (total sampling period of

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20 min) to produce an accumulated sample giving a correspondingly reduced limit of detection over the single samples.

Talcing experiments, each on 2 occasions with 4 talcings in each, were undertaken as follows:

Product use	Product type	Location
1. Loose face powder	Chinese 00000 grade, unperfumed	Washroom
	Italian 00000 grade, unperfumed	
	Italian micronised grade, unperfumed	
2. Adult dusting powder	Chinese 00000 grade, perfumed	Bathroom
—	Chinese 00000 grade, unperfumed	
	Italian 00000 grade, perfumed	
	Italian 00000 grade, unperfumed	
	Italian micronised grade, unperfumed	
3. Baby dusting powder	Chinese 00000 grade, perfumed	Small room
	Chinese 00000 grade, unperfumed	
	Italian 00000 grade, perfumed	
	Italian 00000 grade, unperfumed	

Subjects, alone except at location 3 where an 'observer' was present, were instructed to use the talc in their normal way. In the case of the loose face powder and adult dusting

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powder experiments, subjects were requested to stand with their faces as near as possible to the pumps; approximate distances from the pump to the user's or doll's nose were 0.5 feet (loose face powder), 1 - 3 feet (adult dusting powder) and 0.5 - 1 foot (baby dusting powder). In the case of baby dusting powder, the doll's head was placed alongside the pumps. Both pumps were switched on at the start of the talcing and left running for exactly 5 min. The period during which talc was applied was recorded along with the ambient temperature and relative humidity at the end of each sampling.

At the end of each sample collection the filter holders were returned to the laboratory where the filters were removed from their holders using forceps and placed in 50 mℓ polypropylene bottles which were immediately stoppered. The floors and surfaces of the sampling location were cleaned with a damp cloth after each talcing operation.

Background levels

On one occasion during each of the 3 product use experiments respirable background levels were monitored 0.5 h before each talcing.

Total dust levels

In 2 experiments with Italian 00000 grade, unperfumed and Italian micronised grade, unperfumed talcs, additional samples were collected using filter holders normally used with the cyclone device but with the cyclone device removed (i.e. collection of respirable dust plus other dust normally separated by the cyclone) and using open filters (i.e. collection of total dust).

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C. Particle size analysis

Methods

The filters were cut into quarters, care being taken not to disturb the particles. Each quarter was placed on D.P.X. mounting medium (Refractive Index 1.515) on a clean microscope slide until clear. D.P.X. was then placed around the edge of the filter and allowed to slowly cover the whole area. A microscope cover slip was then placed on top and the preparation was allowed to dry.

The preparations were examined on a research microscope at a magnification of x400. The talc particles which are anisotropic were best visualised using polarised light. Consequently as a result of the low light levels it was not possible to measure the particles using a television image analysing computer and measurements were made manually using a calibrated eyepiece micrometer. The greatest dimension of at least 200 particles per sample was recorded. The measurements were made on all the particles in adjacent fields from the outer edge of the filter to the centre in order to obtain a good sample in case of uneven deposition on the filter during sampling.

Particle size determinations were made on samples of dust collected during the use of Italian 00000 grade, perfumed and Italian 00000 grade, unperfumed talcs. Further samples were taken for size analysis without use of the cyclone filter.

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D. Chemical analysis of collected talc samples

Atomic absorption spectrophotometric analysis for magnesium was done using the instrumental conditions described earlier under 'Analytical Method Development'.

Preparation of standards

Standards were prepared by adding 0, 1.25, 2.5, 3.75 and 5.0 mℓ of a 10 μg $mℓ^{-1}$ magnesium solution to 25 mℓ volumetric flasks each containing a 25 mm membrane filter followed by 2 mℓ hydrochloric acid and 0.25 mℓ hydrofluoric acid. After standing overnight 20 mℓ of boric acid solution was added from a dispenser and left to stand 0.5 h. 1.25 mℓ of lanthanum chloride solution was pipetted into each flask which was then made up to volume with distilled water.

Preparation of samples for analysis

Prior to analysis all samples were placed in a well ventilated fume cupboard. 2 mℓ hydrochloric acid and 0.25 mℓ hydrofluoric acid was added to each. After standing overnight 20 μℓ of boric acid solution was added from a dispenser and left to stand 0.5 h. 1.25 mℓ of lanthanum chloride solution was pipetted into each sample, the solutions transferred to a 25 mℓ polypropylene volumetric flask and made up to volume with distilled water.

Analysis of standards and sample solutions

Each standard solution was aspirated into the atomic absorption spectrophotometer and its absorbence read against a distilled water blank. A calibration curve was constructed with absorbence plotted against concentration of magnesium (Figure 1). Sample solutions were aspirated into the spectrophotometer and their absorbances recorded. The

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concentration of magnesium in each solution was read off from the calibration curve. This was related to the amount of talc present in the respirable sample as described below.

During the monitoring of in-use levels of respirable talc, samples were analysed approximately twenty at a time and for each set of analyses fresh standards were prepared.

Calculation of results

From the concentration of magnesium in each 25 mℓ sample solution the amount of magnesium and thus the amount of talc present in the collected sample was calculated. (The amount of magnesium in a given type of talc was determined in separate analyses on known quantities of talc.)

Thus, talc collected on filter, μg

$$= \text{concentration of magnesium, } \mu g\ m\ell^{-1} \times 25\ m\ell \times \frac{100}{\text{amount of magnesium in talc, \%}}$$

The concentration of talc in the sampled air was calculated from the amount of talc collected and the volume of air sampled.

Thus, concentration of talc in the sampled air, $mg\ m^{-3} (= \mu g\ \ell^{-1})$

$$= \frac{\text{talc collected on filter, } \mu g}{[\text{pump flow rate, } \ell\ min^{-1}] \times [\text{sampling time, min}]}$$

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RESULTS AND DISCUSSION

1. Analytical Method Development

A. Validation of sample preparation

The optimum medium for the dissolution of talc samples in a minimum volume of acid was found to be a mixture of 2 mℓ hydrochloric acid and 0.25 mℓ hydrofluoric acid. Media containing either smaller volumes of hydrofluoric acid or hydrochloric acid alone were found to give lower recoveries of magnesium and silicon. Lower recoveries were also obtained when hydrochloric acid was replaced by sulphuric acid. The addition of nitric acid to the hydrochloric/ hydrofluoric acid medium made no apparent difference.

The effects of the constituents of the talc solution on the determination of magnesium and silicon were considered. In AAS, absorption due to magnesium is suppressed by the presence of silicon (Ref. 6 and 8); for example, a solution containing 200 μg $mℓ^{-1}$ SiO_3 is reported to suppress by 42% the absorbance due to a 0.4 μg $mℓ^{-1}$ magnesium solution (Ref. 9). Although the concentrations of silicon in the in-use talc samples were likely to be very small, the quantities of silicon and hence the interference due to this element was likely to be variable.

The suppression of absorption of one element by another can be overcome or minimised by the addition of a 'releasing agent' to the analytical solution. Lanthanum (at a concentration of 0.5%) will eliminate the interference of silicon on magnesium absorption (Ref. 6 and 8). However, addition of lanthanum chloride to a solution containing hydrofluoric acid causes precipitation of lanthanum fluoride. Therefore, excess hydrofluoric acid was first complexed with boric acid (Ref. 10) before the addition of lanthanum chloride.

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Aluminium and beryllium compounds are possible alternative complexing agents to boric acid but their use in this analysis was precluded by the fact that aluminium itself suppresses absorption due to magnesium and beryllium compounds are highly toxic.

The experiment in which known amounts of Chinese unperfumed talc were analysed for magnesium and silicon showed mean recoveries of 17.5% (w/w) for magnesium by AAS and 28 and 26.5% (w/w) for silicon by AAS and colorimetry respectively. Recoveries were calculated from the slopes of graphs in which the amounts of magnesium and silicon found were plotted against the amounts of talc originally taken (Figures 2, 4 and 6). Such recoveries are consistent with the amounts of magnesium and silicon normally present in talc.

In the analysis for silicon by AAS the aspiration of the boric acid medium into the hot acetylene-nitrous oxide flame (approx. $3000^{o}K$) led to the deposition of material primarily derived from boric acid in the burner. This led to a reduction in the rate of sample uptake and thus a reduction in absorbance and precision of readout due to that sample. Similar significant problems were not encountered in the analysis of magnesium by AAS where the flame temperature was lower.

The sensitivities (defined as the concentration in the flame (AAS) or in the solution (colorimetry) to give 1% absorption) for each method were as follows:

Magnesium (determined by AAS)	0.043 $\mu g\ m\ell^{-1}$
Silicon (determined by AAS)	22.5 $\mu g\ m\ell^{-1}$
Silicon (determined by colorimetry)	31.4 $\mu g\ m\ell^{-1}$

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Thus, determination of magnesium is the best analytical technique for monitoring low concentrations of talc in the air. The determination of silicon did not offer sufficient sensitivity and the problem of boric acid deposition in the burner reduced further the value of the AAS method. Further improvements in the sensitivity of the colorimetric determination of silicon should be possible by reducing the dilution factor in the sample preparation; but they will be limited by the tendency of the strong acid medium to make the silico molybdate complex unstable and thus increase the reagent blank absorption.

B. Optimisation of sensitivity

The preparation of standards and samples in the 25 mℓ reagent matrix enabled optimum sensitivity to be obtained from the sample preparation. The calibration curve with absorbance plotted against concentration of magnesium (Figure 1) showed a small blank background absorbance (approx. 0.020) and a slight suppression of absorbance at higher concentrations compared with the simple aqueous standards.

The sensitivity for this determination of magnesium was 0.049 $\mu g\ m\ell^{-1}$.

Examination of the absorbances due to individual components showed that boric acid is the major contributor to the blank absorbance. The blank absorbances were further increased (to approx. 0.040) by the presence of single 25 mm membrane filters indicating the presence of low levels of magnesium in the filters. Membrane filter material was reported to contain 17 ppm magnesium (Ref. 11). The polypropylene from which the volumetric flasks were made was reported to contain "no magnesium" (Ref. 12); no other significant sources of contamination were observed.

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Electrothermal atomisation

The sensitivity of magnesium at 285.2 nm using flame atomisation is high. Using the same wavelength with electrothermal atomisation, the sensitivity was raised to the point that even after the carbon rod was suitably cleaned, considerable absorbance was still observed with "blank" distilled water samples. Such sensitivity hinders the application of electrothermal atomisation to this analysis. Use of the less sensitive magnesium absorption line at 202.5 nm using electrothermal atomisation, offered sensitivity of a similar order to that at 285.2 nm using flame atomisation. Conditions examined for the atomisation of silicon resulted in poor sensitivity.

The electrothermal atomisation of magnesium offers the basis for a considerable increase in the sensitivity of this analysis. However, should such an increase be required, further development work would be required to establish conditions of instrument use and sample preparation.

C. Precision of analysis and limit of detection

The precision of the determination for magnesium at the 0.05 ppm (w/v) level (defined as $\pm 2\sigma$ about the mean of the absorbances due to 9 solutions) was found to be 0.005 $\mu g\ m\ell^{-1}$.

The limit of detection of this analysis (defined as the value equivalent to the precision of analysis at the 0.005 ppm level) was therefore 0.005 $\mu g\ m\ell^{-1}$.

D. Determination of magnesium in talc

The results of the determination for magnesium in the talc

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samples are given in Table 1. The mean value, found to be 17.5% (w/w) magnesium in talc (taken to the nearest 0.5%), was applied to the calculation of the amount of talc in a given sample.

2. Monitoring of In-Use Levels of Respirable Talc

The results of the monitoring of concentrations of respirable talc in the air during in-use studies are given in Tables 3 - 22.

Data for the 2 experiments for each talc type and use are described in single tables. The following information is included: subject's panel number, talcing order, ambient temperature and relative humidity, talcing application time and the total talc collected (analysed as total magnesium) and its corresponding atmospheric concentration.

The value of the total talc collected is related to its corresponding atmospheric concentration through the total volume of air sampled. The volume sampled was 9.5 ℓ for single samples (collected over 5 min) and 38 ℓ for accumulated samples (collected over 20 min), unless otherwise stated. Results are given to 2 significant figures.

The limit of detection of talc, based on the limit of detection for magnesium, was set at 1 µg talc. The limit of detection for airborne concentrations was set at 0.1 mg m^{-3}, and 0.05 mg m^{-3} for single and accumulated samples respectively. Amounts and concentrations below these values are given in the tables as "Not Detected".

A. Loose face powder

The following unperfumed samples were investigated and

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the concentration ranges of respirable talc found in air were:

Chinese	00000	< 0.1 - 1.1	mg m^{-3}	(Table 3)
Italian	00000	< 0.1 - 0.8	mg m^{-3}	(Table 4)
Italian micronised		0.3 - 1.7	mg m^{-3}	(Table 5)

Using the Chinese 00000 grade background levels of respirable talc between talcing operations were less than 0.1 mg m^{-3} (Table 18).

The number of observations is too small to draw firm conclusions about differences between product types. However, there appears to be little difference between the Italian and Chinese 00000 grades whereas there is a tendency for the micronised grade to result in higher levels of respirable dust.

There was a wide variation in respirable dust levels generated by the same volunteer using the same product on different occasions.

B. Adult dusting powder

The following samples were investigated and the concentration ranges of respirable talc in air were:

Chinese	00000	perfumed	0.3 - 2.6	mg m^{-3}	(Table 6)
Chinese	00000	unperfumed	0.4 - 1.8	mg m^{-3}	(Table 7)
Italian	00000	perfumed	0.3 - 1.7	mg m^{-3}	(Table 8)
Italian	00000	unperfumed	0.5 - 2.6	mg m^{-3}	(Table 9)
Italian micronised		unperfumed	0.6 - 3.3	mg m^{-3}	(Table 10)

Background levels of talc in the atmosphere were determined between uses of unperfumed Italian 00000 and micronised

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grades. Levels during use of the 00000 grade were <0.1 mg m^{-3} (Table 19) but atmospheric levels of talc were detected before and during use of the micronised talc.

There appeared to be no difference between the levels of respirable talc obtained during use of Italian and Chinese 00000 grade talcs. Similarly the addition of perfume to the talc did not affect the levels of respirable dust.

As with the loose face powders the levels of respirable dust generated during the use of the micronised powder appeared to be higher than those generated during use of the 00000 powders. The background levels observed during the use of micronised adult dusting powder may account for this difference but there is insufficient data to draw meaningful conclusions on this point.

C. Baby dusting powder

The following samples were investigated and the concentration ranges of respirable talc in air were:

Chinese	00000	perfumed	<0.1 - 0.9 mg m^{-3}	(Table 11)
Chinese	00000	unperfumed	<0.1 - 0.7 mg m^{-3}	(Table 12)
Italian	00000	perfumed	<0.1 - 0.3 mg m^{-3}	(Table 13)
Italian	00000	unperfumed	<0.1 - 0.5 mg m^{-3}	(Table 14)

No background levels of talc were detected before and between uses of the Italian 00000 grade (Table 21).

Although with both perfumed and unperfumed talcs the maximum levels found were higher with Chinese than with Italian talc, this arises largely because of single observations and it would be unjustified to draw conclusions about possible

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differences. As with the adult dusting powders the presence of perfume did not appear to influence the level of respirable talc.

D. Comparison of product types

Excluding the micronised talc, the experimental data do not indicate any differences between the levels of dust generated during use of the different varieties of talc (Chinese or Italian, perfumed or unperfumed). In order to have sufficient data to compare mean values it may therefore be justified to average all the data for 00000 talc for each product type. This calculation gives the following results, taking non-detectable readings as 0.1 mg m^{-3} (number of observation in brackets):

Product type	Mean level (mg m^{-3})
loose face	0.48 (16)
adult dusting	1.13 (32)
baby	0.22 (32)

These figures suggest that the greatest quantity of respirable talc dust is generated during adult dusting operations and that the quantity likely to be inhaled by a baby during a talcing operation is considerably less.

E. Effect of relative humidity

Examination of the individual data in Tables 3 - 14 does not show any consistent effect of humidity. No attempt was made to control humidity in these experiments. In some experiments, e.g. Nos. 16, 1 and 8, it remained fairly constant throughout whereas in others, e.g. Nos. 3, 2 and 6, it changed markedly with successive samplings.

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In one series of experiments with Italian 00000 perfumed adult dusting powder (Table 15) the humidity was deliberately raised to between 92 and 100% R.H. by generating steam. When the same talc was used under normal conditions (Table 8) at relative humidity varying between 56 and 74% there was a greater concentration of respirable talc in the atmosphere. The single high figure in Table 15 results from a suspected contamination.

It appears, therefore, that at very high humidity, above 90% R.H. concentration of talc in the air may be reduced because of an increased tendency of particles to aggregate under these conditions. Under more normal conditions there is no evidence that relative humidity is an important factor.

F. Determination of particle size

The majority of the particles measured were between 0.96 and 6.7 μm (Figures 7 and 8 and Tables 23 and 24). The majority of particles were needle shaped though there was a higher proportion of plate-like particles in the Italian 00000 grade unperfumed talc. The total number of particles on the filter was also very much reduced with this latter grade.

After removal of the cyclone filter there was little change in the size distribution of the micronised material. However a second peak of particles greater than 19.2 μm appeared in the Italian 00000 unperfumed sample. This demonstrates the efficiency of the cyclone filter. The equivalent sample of micronised talc showed many large clumps of particles not present in samples taken in presence of the cyclone filter.

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G. Determination of the total quantity of atmospheric talc

As expected, removal of the cyclone filter from the collection apparatus resulted in an increase in dust collected. This was true both for the 00000 and the micronised talc samples (Tables 16 and 17). An extra experiment in which an open filter was used showed that even greater quantities could be collected by maximising the conditions of collection.

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CONCLUSIONS

The study has developed a satisfactory technique for measuring the concentration of respirable talc in air at concentrations down to 0.1 mg talc m^{-3} air.

Determination of the concentration of respirable talc during talcing operations gave values between <0.1 and 3.3 mg talc m^{-3} air.

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TABLE 1

Results of the Determination of Magnesium in Talc

Talc type	Magnesium, % (w/w)
Chinese 00000 grade, perfumed	17.0, 18.0, 17.5
Chinese 00000 grade, unperfumed	17.7, 17.2, 17.1, 17.3
Italian 00000 grade, perfumed	18.0, 19.0, 16.4, 15.9
Italian 00000 grade, unperfumed	17.4, 17.2, -
Italian micronised grade, unperfumed	17.4, 18.5, 18.9

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TABLE 2

In-Use Atmospheric Sampling Locations

Location	Product used	Description of room	Location of pumps
1. Washroom	Loose face powder	Small wash room (6' x 3') adjacent to toilets fitted with wash hand basin and mirror above. Small window open during sampling, no other ventilation.	On shelf adjusted to face height in front of mirror.
2. Bathroom	Adult dusting powder	Bathroom (7'6" x 7') fitted with bath and wash hand basin. Window closed during sampling.	On shelf (5' high) next to wash hand basin.
3. Small room	Baby dusting powder	Small room (9' x 12') fitted with table and 2 chairs. Window closed during sampling.	On table (2'9" high) covered with towel and next to doll's head.

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TABLE 3

Use Levels of Respirable Talc

Product use: Loose face powder

Talc type: Chinese 00000 grade, unperfumed

Sampling location: 1 (Washroom)

Panel Number	Talcing order	Ambient temperature, °C	Ambient relative humidity, %	Talcing application time, secs	Respirable talc collected, µg	Respirable talc, mg m^{-3} air
Occasion number 1 (Experiment number 14)						
F 21	1	18.5	68	15	ND	ND
F183	2	18.5	68	15	4.3	0.5
F 30	3	18.5	68	25	ND	ND
F 31	4	18.5	68	15	ND	ND
-	(Accumulated)	-	-	-	3.6	0.1
Occasion number 2 (Experiment number 17)						
F 21	1	17	68	20	7.1	0.8
F 30	2	17	65	20	10	1.1
F183	3	16	68	15	7.9	0.8
F 31	4	17	64	26	7.9	0.8
-	(Accumulated)	-	-	-	7.9	0.2

ND = Not detected

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TABLE 4

Use Levels of Respirable Talc

Product use: Loose face powder

Talc type: Italian 00000 grade, unperfumed

Sampling location: 1 (Washroom)

Panel Number	Talcing order	Ambient temperature, °C	Ambient relative humidity, %	Talcing application time, secs	Respirable talc collected, µg	Respirable talc, mg m^{-3} air
Occasion number 1 (Experiment number 15)						
F 21	1	20	66	10	5.7	0.6
F183	2	20	66	15	2.9	0.3
F 31	3	19	66	25	4.3	0.5
F 30	4	19	66	20	ND	ND
-	(Accumulated)	-	-	-	2.9	0.1
Occasion number 2 (Experiment number 18)						
F 21	1	14	71	15	1.4	0.2
F183	2	17	64	10	2.9	0.3
F 30	3	17	68	25	5	0.5
F 31	4	18	65	20	7.9	0.8
-	(Accumulated)	-	-	-	4.3	0.1

ND = Not detected

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TABLE 5

Use Levels of Respirable Talc

Product use: Loose face powder

Talc type: Italian micronised grade, unperfumed

Sampling location: 1 (Washroom)

Panel Number	Talcing order	Ambient temperature, °C	Ambient relative humidity, %	Talcing application time, secs	Respirable talc collected, µg	Respirable talc, mg m^{-3} air
Occasion number 1 (Experiment number 16)						
F 21	1	16	68	10	7.1	0.8
F 31	2	16	68	20	8.6	0.9
F 30	3	17	68	20	9.3	1.0
F194	4	17	68	20	12	1.3
-	(Accumulated)	-	-	-	15	0.4
Occasion number 2 (Experiment number 19)						
F183	1	17	68	15	6.4	0.7
F 21	2	17	68	10	14	1.5
F 31	3	16	68	15	16	1.7
F 30	4	16	68	20	2.9	0.3
-	(Accumulated)	-	-	-	14	0.4

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TABLE 6

Use Levels of Respirable Talc

Product use: Adult dusting powder

Talc type: Chinese 00000 grade, perfumed

Sampling location: 2 (Bathroom)

Panel Number	Talcing order	Ambient temperature, °C	Ambient relative humidity, %	Talcing application time, secs	Respirable talc collected, µg	Respirable talc, mg m^{-3} air
Occasion number 1 (Experiment number 1)						
F155	1	20.5	70	45	13	1.4
F144	2	20.5	72	48	24	2.6
F 4	3	20.5	74	61	8.6	0.9
F 35	4	20.5	74	33	5.7	0.6
-	(Accumulated)	-	-	-	12	0.3
Occasion number 2 (Experiment number 6)						
F155	1	20	62	48	19	2.0
F 4	2	20	62	74	14	1.5
F151	3	21	64	31	8.6	0.9
F 35	4	20	74	35	11	1.2
-	(Accumulated)	-	-	-	37	1.0

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TABLE 7

Use Levels of Respirable Talc

Product use: Adult dusting powder

Talc type: Chinese 00000 grade, unperfumed

Sampling location: 2 (Bathroom)

Panel Number	Talcing order	Ambient temperature, °C	Ambient relative humidity, %	Talcing application time, secs	Respirable talc collected, µg	Respirable talc, mg m^{-3} air
Occasion number 1 (Experiment number 2)						
F144	1	20.5	60	47	4.3	0.5
F155	2	22	61	45	5.7	0.6
F 35	3	20	72	33	5.7	0.6
F 4	4	20.5	74	57	5.7	0.6
	(Accumulated)	-	-	-	16	0.4
Occasion number 2 (Experiment number 7)						
F151	1	17.5	66	39	17	1.8
F 21	2	18.5	69	15	11	1.2
F 35	3	19	74	30	14	1.5
F151	4	19.5	70	26	16	1.7
	(Accumulated)	-	-	-	19	0.5

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TABLE 8

Use Levels of Respirable Talc

Product use: Adult dusting powder

Talc type: Italian 00000 grade, perfumed

Sampling location: 2 (Bathroom)

Panel Number	Talcing order	Ambient temperature, °C	Ambient relative humidity, %	Talcing application time, secs	Respirable talc collected, µg	Respirable talc, mg m^{-3} air
Occasion number 1 (Experiment number 3)						
F155	1	16.5	69	36	9.3	1.0
F 4	2	18	61	80	11	1.2
F144	3	17.5	59	48	11	1.2
F 35	4	19	56	34	16	1.7
	(Accumulated)	-	-	-	24	0.6
Occasion number 2 (Experiment number 8)						
F 21	1	19.5	74	15	5	0.5
F 4	2	19	74	60	7.9	0.8
F194	3	19	74	46	6.4	0.7
F 35	4	19	74	27	3.6	0.4
-	(Accumulated)	-	-	-	11	0.3

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TABLE 9

Use Levels of Respirable Talc

Product use: Adult dusting powder

Talc type: Italian 00000 grade, unperfumed

Sampling location: 1 (Bathroom)

Panel Number	Talcing order	Ambient temperature, °C	Ambient relative humidity, %	Talcing application time, secs	Respirable talc collected, µg	Respirable talc, mg m^{-3} air
Occasion number 1 (Experiment number 4)						
F155	1	16	55	48	8.6	0.9
F144	2	17	58	51	11	1.2
F 4	3	17	64	58	8.6	0.9
F 35	4	17	62	30	7.1	0.8
-	(Accumulated)	-	-	-	26	0.7
Occasion number 2 (Experiment number 9)						
F155	1	17	64	41	25	2.6
F 35	2	19	64	27	17	1.8
F 4	3	18.5	70	71	5	0.5
F194	4	18.5	70	43	5	0.5
-	(Accumulated)	-	-	-	26	0.7

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TABLE 11

Use Levels of Respirable Talc

Product use: Baby dusting powder
Talc type: Chinese 00000 grade, perfumed
Sampling location: 3 (Small room)

Panel Number	Talcing order	Ambient temperature, °C	Ambient relative humidity, %	Talcing application time, secs	Respirable talc collected, µg	Respirable talc, mg m^{-3} air
Occasion number 1 (Experiment number 20)						
F 4	1	20.5	66	60	8.6	0.9
F145	2	21	63	40	4.3	0.5
F 85	3	20.5	70	25	4.3	0.5
F142	4	22	63	30	1.4	0.2
-	(Accumulated)	-	-	-	10	0.3
Occasion number 2 (Experiment number 24)						
F 4	1	19	66	35	ND	ND
F 85	2	19.5	66	15	ND	ND
F 4	3	20	66	30	ND	ND
F142	4	20.5	63	23	ND	ND
-	(Accumulated)	-	-	-	2.9	0.1

ND = Not detected

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TABLE 12

Use Levels of Respirable Talc

Product use: Baby dusting powder

Talc type: Chinese 00000 grade, unperfumed

Sampling location: 3 (Small room)

Panel Number	Talcing order	Ambient temperature, °C	Ambient relative humidity, %	Talcing application time, secs	Respirable talc collected, µg	Respirable talc, mg m^{-3} air
Occasion number 1 (Experiment number 21)						
F145	1	18	68	40	1.4	0.2
F 4	2	18.5	69	45	ND	ND
F142	3	19	70	25	6.4	0.7
F 85	4	19.5	70	15	1.4	0.2
-	(Accumulated)	-	-	-	7.9	0.2
Occasion number 2 (Experiment number 25)						
F 4	1	13	69	30	ND	ND
F145	2	19.5	70	30	ND	ND
F 85	3	23.5	72	15	ND	ND
F142	4	22.5	67	20	ND	ND
-	(Accumulated)	-	-	-	1.4	0.05

ND = Not detected

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TABLE 10

Use Levels of Respirable Talc

Product use: Adult dusting powder

Talc type: Italian micronised grade, unperfumed

Sampling location: 2 (Bathroom)

Panel Number	Talcing order	Ambient temperature, °C	Ambient relative humidity, %	Talcing application time, secs	Respirable talc collected, µg	Respirable talc, mg m^{-3} air
Occasion number 1 (Experiment number 5)						
F155	1	19.5	58	46	31	3.3
F 4	2	20	60	75	26	2.7
F151	3	21	54	31	26	2.7
F 35	4	21	54	40	19	2.0
-	(Accumulated)	-	-	-	93	2.5
Occasion number 2 (Experiment number 10)						
F155	1	19	66	50	21	2.3
F144	2	19	66	55	8.6	0.9
F151	3	19.5	68	78	10	1.1
F 35	4	20	68	30	5.7	0.6
-	(Accumulated)	-	-	-	49	1.3

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TABLE 13

Use Levels of Respirable Talc

Product use: Baby dusting powder

Talc type: Italian 00000 grade, perfumed

Sampling location: 3 (Small room)

Panel Number	Talcing order	Ambient temperature, °C	Ambient relative humidity, %	Talcing application time, secs	Respirable talc collected, µg	Respirable talc, mg m^{-3} air
Occasion number 1 (Experiment number 22)						
F 4	1	20	66	40	1.4	0.2
F145	2	21	63	40	1.4	0.2
F142	3	21	63	25	ND	ND
F 85	4	21	60	15	ND	ND
-	(Accumulated)	-	-	-	2.9	0.1
Occasion number 2 (Experiment number 26)						
F 4	1	21	67	33	2.9	0.3
F145	2	21	67	36	ND	ND
F 85	3	21.5	67	15	ND	ND
F142	4	20	70	20	ND	ND
-	(Accumulated)	-	-	-	1.4	0.05

ND = Not detected

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TABLE 14

Use Levels of Respirable Talc

Product use: Baby dusting powder

Talc type: Italian 00000 grade, unperfumed

Sampling location: 3 (Small room)

Panel Number	Talcing order	Ambient temperature, °C	Ambient relative humidity, %	Talcing application time, secs	Respirable talc collected, µg	Respirable talc mg m^{-3} air
Occasion number 1 (Experiment number 23)						
F 4	1	12	68	35	1.4	0.2
F145	2	18.5	62	35	ND	ND
F 85	3	22	64	15	4.3	0.5
F142	4	19	66	21	2.9	0.3
-	(Accumulated)	-	-	-	3.6	0.1
Occasion number 2 (Experiment number 27)						
F145	1	14	66	34	1.4	0.2
F 4	2	19.5	58	28	ND	ND
F 85	3	17.5	60	16	ND	ND
F142	4	18	65	20	ND	ND
-	(Accumulated)	-	-	-	1.4	0.05

ND = Not detected

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TABLE 15

Use Levels of Respirable Talc
Humid Conditions

Product use: Adult dusting powder
Talc type: Italian 00000 grade, perfumed
Sampling location: 2 (Bathroom)

Panel Number	Talcing order	Ambient temperature, °C	Ambient relative humidity, %	Talcing application time, secs	Respirable talc collected, µg	Respirable talc, mg m^{-3} air
Occasion number 1 (Experiment number 12)						
F155	1	24	92	40	39 *	4.1 *
F194	2	22	100	54	4.3	0.5
F 4	3	24	95	65	7.1	0.8
F 35	4	23	100	32	1.4	0.2
-	(Accumulated)	-	-	-	14	0.4

* Contamination of sample suspected

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TABLE 16

Use Levels of Respirable and Total Talc

Product use: Adult dusting powder

Talc type: Italian micronised grade, unperfumed

Sampling location: 2 (Bathroom)

Panel Number	Talcing Order	Ambient temperature, °C	Ambient relative humidity, %	Talcing application time, secs	Respirable talc collected, µg	Respirable talc, mg m^{-3}	Total talc (cyclone filter), µg	Total talc (cyclone filter), mg m^{-3}	Total talc (open filter), µg	Total talc (open filter), mg m^{-3}
(Experiment number 28)										
F 4	1 *	17	68	78	1.4	0.2	31	3.3	160	17
F151	2	19	62	28	14	1.5	57	6.0	91	9.6

* An additional respirable sample was collected during this sampling and examined for particle size distribution

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TABLE 17

Use Levels of Respirable and Total Talc

Product use: Adult dusting powder

Talc type: Italian 00000 grade, unperfumed

Sampling location: 2 (Bathroom)

Panel Number	Talcing Order	Ambient temperature °C	Ambient relative humidity, %	Talcing application time, secs	Respirable talc collected, µg	Respirable talc, mg m^{-3}	Total talc (cyclone filter, cyclone removed) µg	Total talc (cyclone filter, cyclone removed) mg m^{-3}	Total talc (open filter), µg	Total talc (open filter), mg m^{-3}
(Experiment number 29)										
F151	1	18.5	54	32	14	1.5	44	4.7	240	26
F155	2 *	19	54	48	7.1	0.8	39	4.1	260	27
F194	3	18.5	57	45	4.3	0.5	26	2.7	76	8.0
F 35	4	19	-	32	5.7	0.6	46	4.8	240	26

* An additional respirable sample was collected during this sampling and examined for particle size distribution

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TABLE 18

Background Levels of Respirable Talc during Experiment 14*

Product use: Loose face powder

Talc type: Chinese 00000 grade, unperfumed

Sampling location: 1 (Washroom)

Sample	Sampling Order *	Respirable talc collected, µg	Respirable talc, mg m^{-3} air
A	before talcing 1	ND	ND
B	between 1 and 2	ND	ND
C	between 2 and 3	ND	ND
D	between 3 and 4	ND	ND

* See Table 3

ND = Not detected

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TABLE 19

Background Levels of Respirable Talc during Experiment 29*

Product use: Adult dusting powder
Talc type: Italian 00000 grade, unperfumed
Sampling location: 2 (Bathroom)

Sample	Sampling Order *	Respirable talc collected, µg	Respirable talc, mg m^{-3} air
A	before talcing 1	ND	ND
B	between 1 and 2	ND	ND
C	between 2 and 3	ND	ND
D	between 3 and 4	ND	ND
E	after talcing 4	ND	ND

* See Table 17 ND = Not detected

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TABLE 20

Background Levels of Respirable Talc during Experiment 5*

Product use: Adult dusting powder

Talc type: Italian micronised grade, unperfumed

Sampling location: 2 (Bathroom)

Sample	Sampling Order *	Respirable talc collected, µg	Respirable talc, mg m^{-3} air
(Experiment number 5)			
A	before talcing 1	7.9	0.8
B	between 1 and 2	5.7[1]	0.5
C	between 2 and 3	5.7	0.6
D	between 3 and 4	14	1.6
E	after talcing 4	5.7	0.6

* See Table 10

[1] Sampled over 5.5 min

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TABLE 21

Background Levels of Respirable Talc during Experiment 23*

Product use: Baby dusting powder

Talc type: Italian 00000 grade, unperfumed

Sampling location: 3 (Smallroom)

Sample	Sampling Order *	Respirable talc collected, µg	Respirable talc, mg m^{-3} air
A	before talcing 1	ND	ND
B	between 1 and 2	ND	ND
C	between 2 and 3	ND	ND
D	between 3 and 4	ND	ND

* See Table 14

ND = Not detected

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TABLE 22

Background Levels of Respirable Talc during Experiment 12*

Humid Conditions

Product use: Adult dusting powder

Talc type: Italian 00000 grade, perfumed

Sampling location: 2 (Bathroom)

Sample	Sampling Order *	Respirable talc collected, µg	Respirable talc, mg m^{-3} air
A	before talcing 1	ND	ND
B	between 1 and 2	ND	ND
C	between 2 and 3	ND	ND
D	between 3 and 4	9.3	1.0
E	after talcing 4	12.9[1]	0.4

* See Table 15 ND = Not detected

[1] Sampled over 18 min

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TABLE 23

Particle Size Distribution of Italian 00000 Grade Unperfumed Talc

Size Class μm	.96	1.92	2.88	3.84	4.80	5.76	6.72	7.68	8.64	9.60	10.56	11.52	12.48	13.44	14.40	15.36	16.32	17.28	18.24	19.20	>19.20
Number of particles with cyclone filter	21	36	37	24	22	10	12	6	7	9	3	4	2	0	2	3	0	1	1	0	0
Number of particles without cyclone filter	15	33	20	18	9	14	8	10	4	4	4	5	9	5	1	5	3	0	2	3	28

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TABLE 24

Particle Size Distribution of Italian Unperfumed Micronised Talc

Size Class µm	.96	1.92	2.88	3.84	4.80	5.76	6.72	7.68	8.64	9.60	10.56	11.52	12.48	13.44	14.40	15.36	16.32	17.28	18.24	19.20	>19.20
Number of particles with cyclone filter	19	44	41	28	29	16	11	4	4	0	1	0	2	0	0	0	1	0	0	0	0
Number of particles without cyclone filter	14	35	36	32	25	16	13	7	6	7	0	2	0	2	1	1	0	1	0	0	1

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Figure 1

Typical calibration curves for magnesium

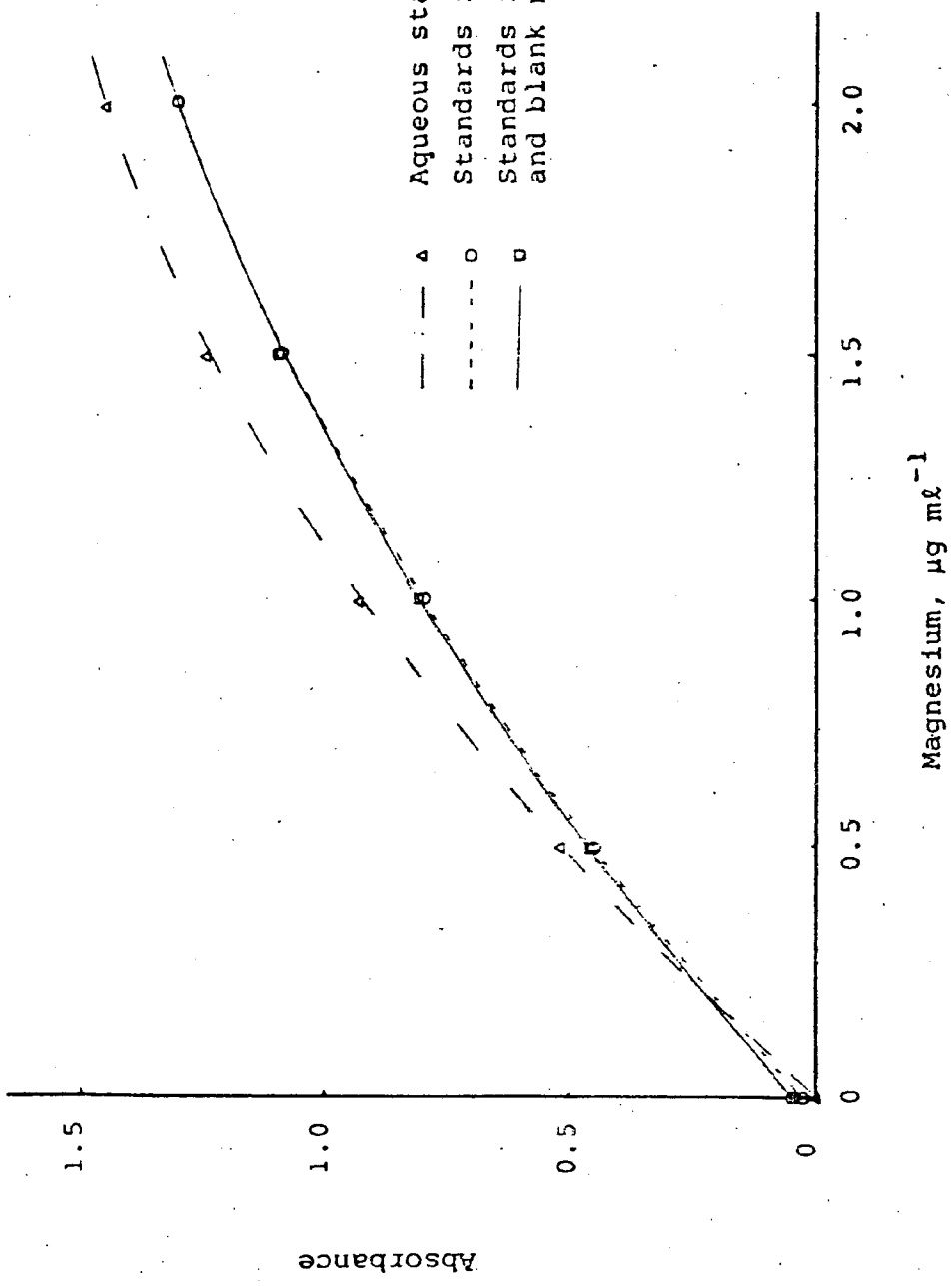

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Figure 2

Recovery of magnesium from talc

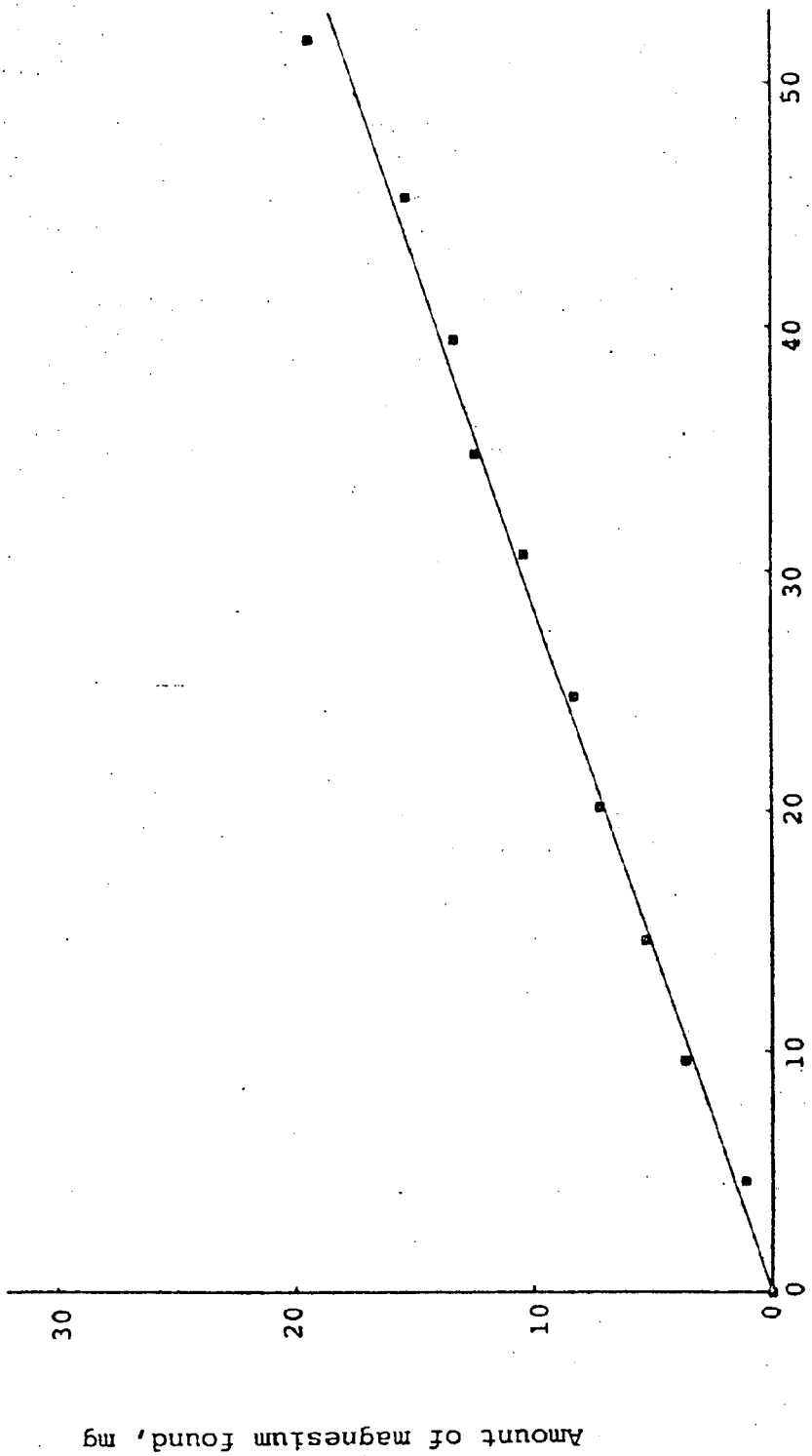

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Figure 3

Calibration curve for silicon determined by AAS

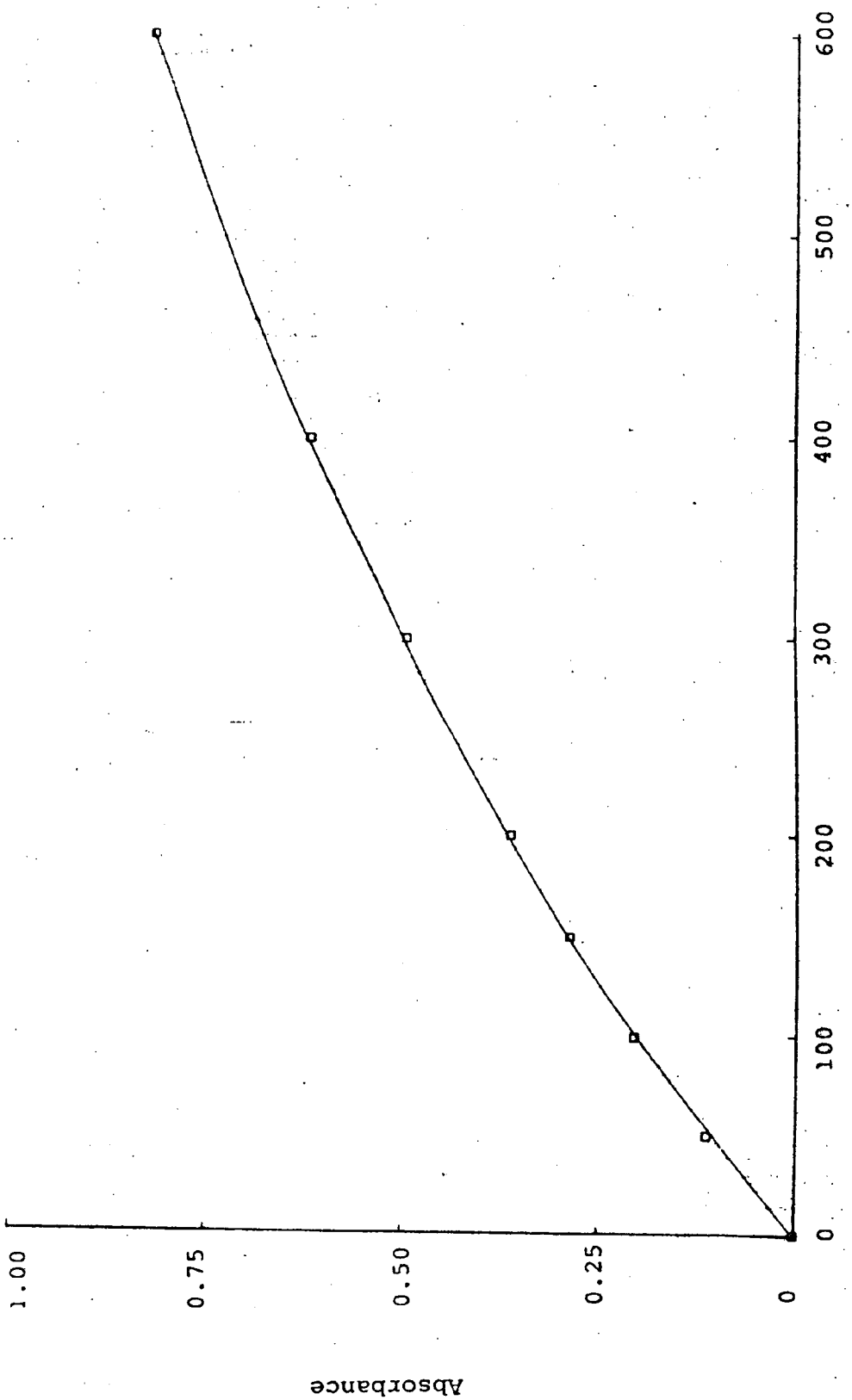

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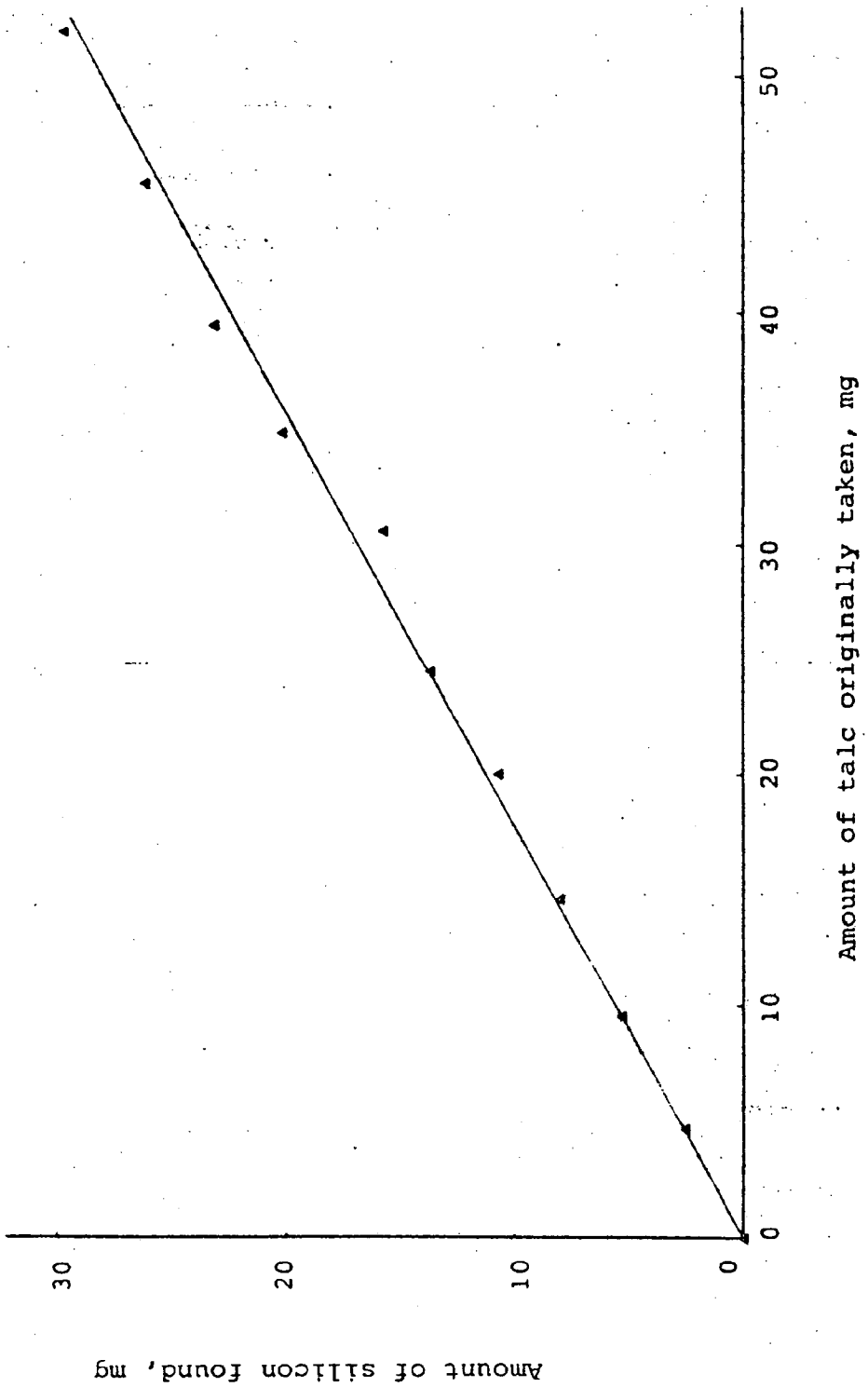
Figure 4

Recovery of silicon from talc
(Silicon determined by AAS)



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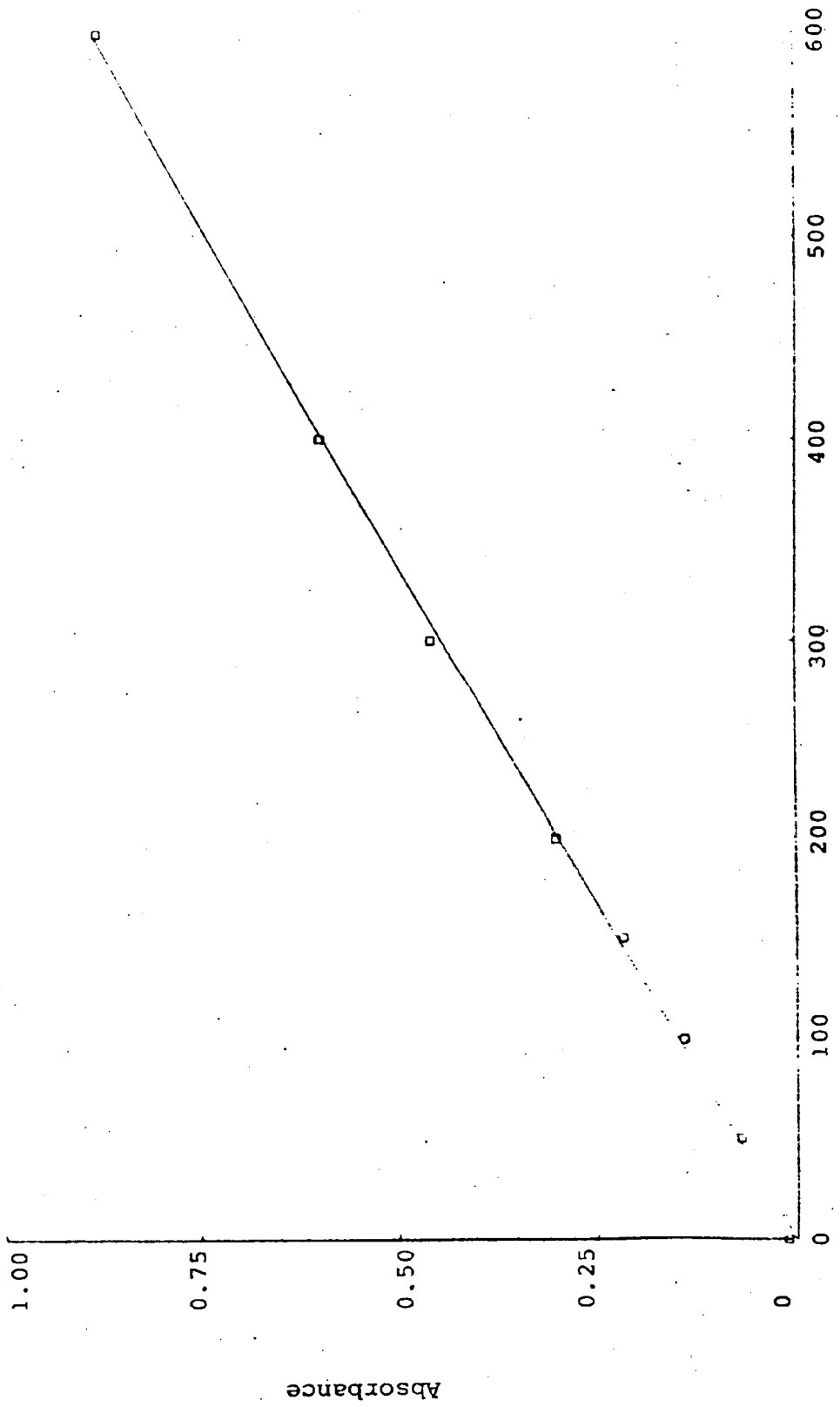

Figure 5

Calibration curve for silicon determined by colorimetry

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Figure 6

Recovery of silicon from talc
(Silicon determined by colorimetry)

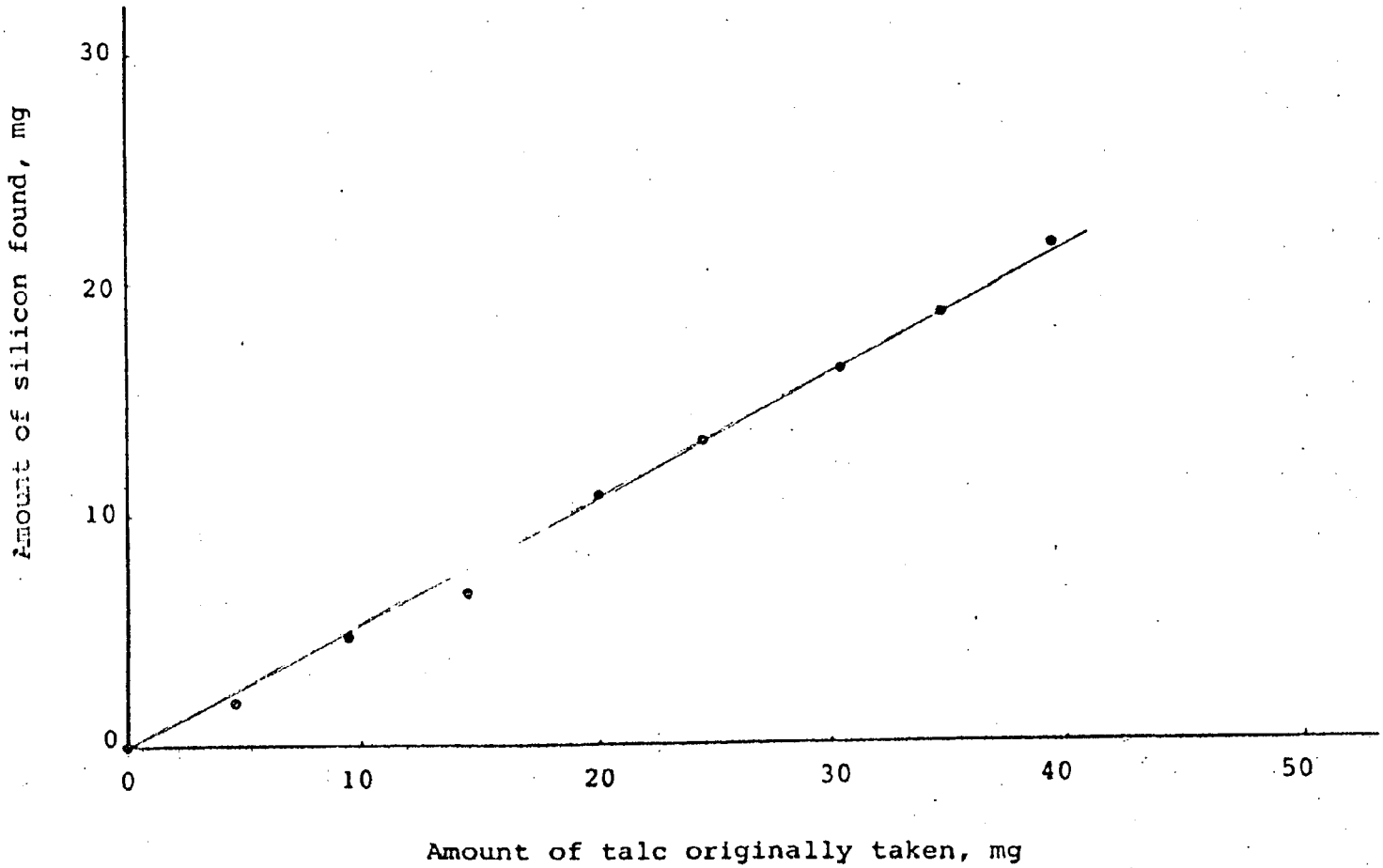

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Figure 7

Particle Size Distribution
(Italian 00000 unperfumed)

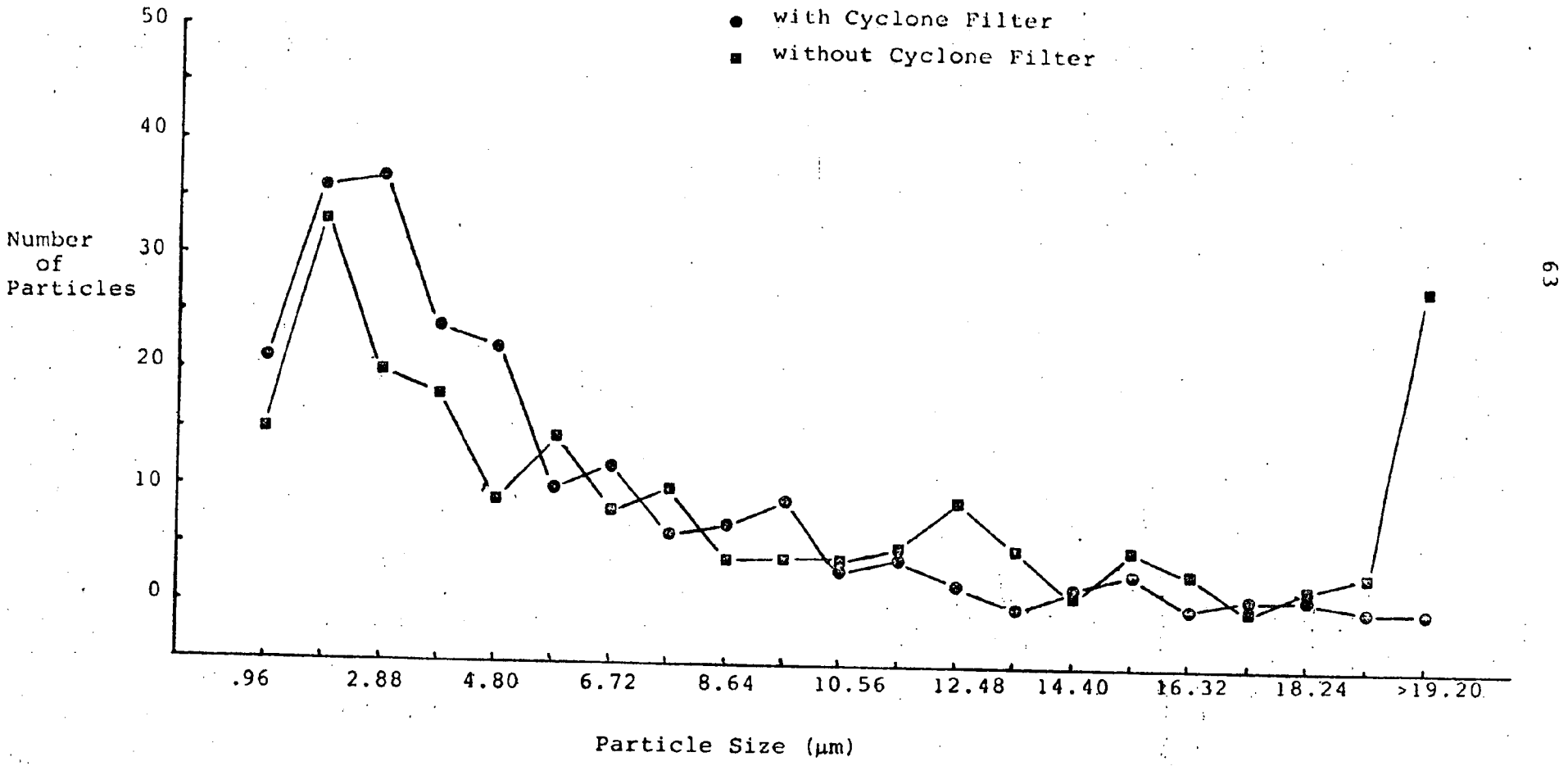

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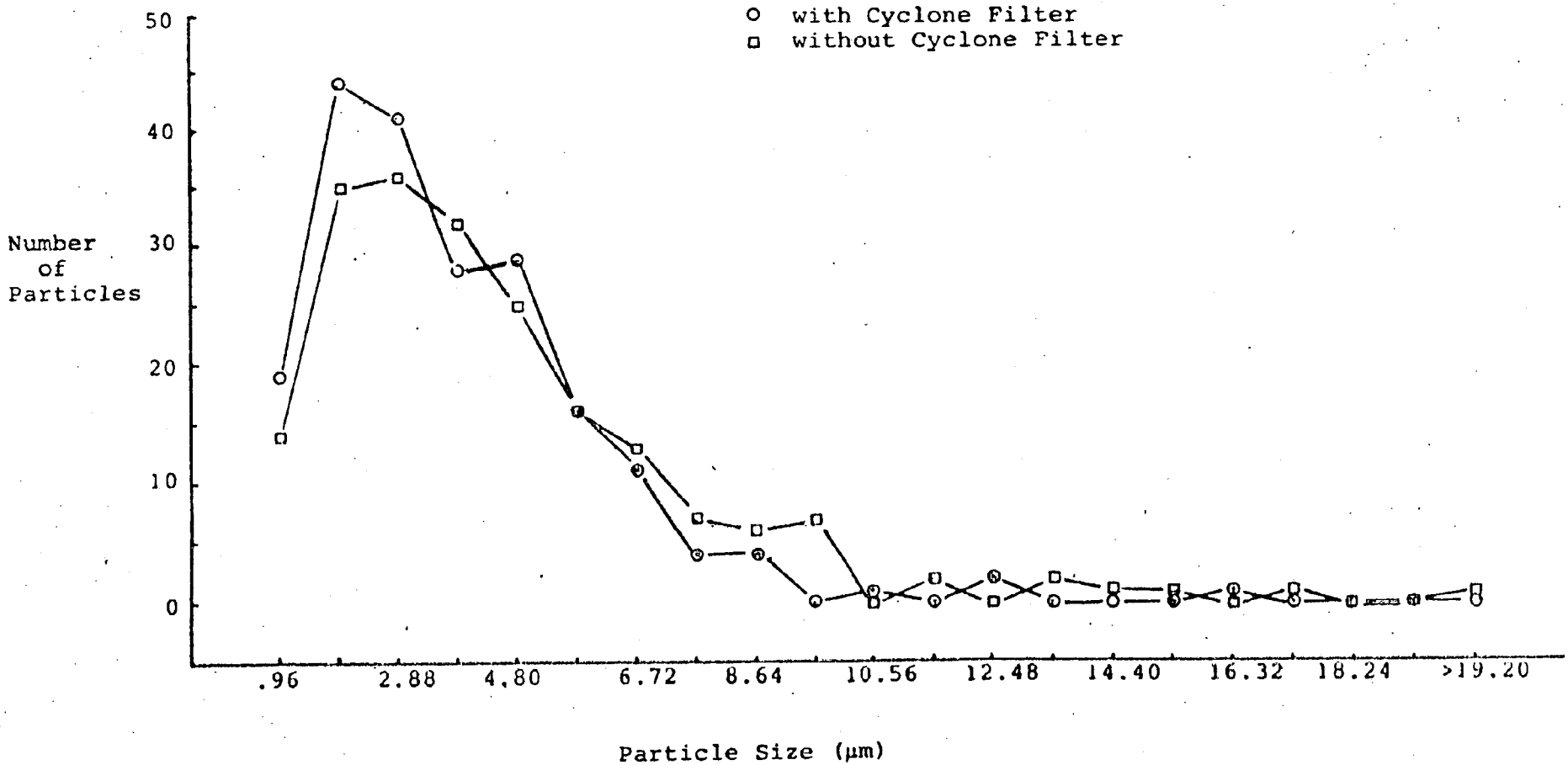
Figure 8

Particle Size Distribution
(Italian unperfumed Micronised)



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