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Foreword

It is perhaps a sign of the times that the neurosis of man about his environment is concerned with the health hazards of minerals rather than the part they play in his adaptation to and enjoyment of his surroundings.

Improvements in the standard of living and sophistication of our society can indirectly be measured by the quantities of the industrial minerals that we consume. Talc is one of the more important industrial minerals which is produced in many parts of the world. It is utilized in every country, either as a primary raw material in manufacturing industries, or in the form of imported finished goods. In the industrial setting and in many consumer products, it is used in the form of a finely ground powder preparation. In this form the dust produced by certain minerals can be a health hazard with the damage being caused by inhalation but rarely by ingestion or ingress into the skin. The toxic effects of the talc dusts are dependent upon dose and the properties of the talc involved. In historically published studies of talc related diseases, no or limited characterisation of the mineralogy and composition of the sample employed was performed, and in particular there has been no information on fibre content or particle size. Incidence of disease amongst talc workers has been closely linked with mineralogical impurities found in raw material, such as asbestos minerals and quartz. In those situations where heavy exposure to pure talc minerals has occurred, no excess mortality has been recorded.

Talc, along with all industrial minerals, is subject to steadily increasing demands for higher purity and better quality control. This is especially true when it is employed in the form of finely divided powders which may contain particles of biologically active minerals of a size which may represent a hazard.

The cosmetic talc industry has recognised these problems and has continuously set itself new and higher standards which have made heavy demands on talc product quality. This document represents the latest effort by the industry to define methods for the evaluation of raw materials to ensure their suitability for safe use both in the manufacture and utilisation of products.

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Preface

The CTPA Cosmetic Talc Guide has been an important industry standard for many years. First issued in the 1960s as the Cosmetic Talc Specification by the Toilet Preparations Federation (TPF), now the CTPA, it was fully revised and reissued in 1977 as a new Specification with accompanying XRD and IR spectra. In 1996 the document was reissued as the CTPA Cosmetic Talc Guide after further revision based on members’ experience, to make significant changes in the specification and methods.

The Guide has now been revised in 2016 in order to ensure it contains the most up-to-date information. An additional section has been added covering the use of talc in finished cosmetic products. In addition to this, the CTPA Talc Guide continues to offer a specification which sets the highest standard for cosmetic talc, as well as guidance to assist companies in ensuring the talc used in their finished cosmetic products are safe for human health. The specification itself has not changed. However, CTPA is aware of discussions currently being held in the US concerning the methodology for asbestos detection provided in the United States Pharmacopoeia. In light of the outcome of these discussions CTPA may revisit the specification methodology in the future.

It is hoped that CTPA members will find the updated Guide helpful in putting in place an effective strategy for identifying and maintaining a high quality source of cosmetic talc. Comments or suggestions for improvements are welcomed by the CTPA Talc Task Force in order to aid with any future revision. These should be addressed to Dr Emma Meredith, Director of Science at the CTPA Secretariat or sent via email to info@ctpa.org.uk.
1. Introduction

The EU Cosmetics Regulation ((EC) No. 1223/2009), like its predecessor the EU Cosmetics Directive (76/768/EEC), requires that “a cosmetic product made available on the market shall be safe for human health when used under normal or reasonably foreseeable conditions of use”. Suppliers have a duty to ensure that cosmetic products will not be harmful to health under all expected conditions of use (1). Additionally, employers are required to protect the health of their employees from the hazards of materials which they may use in the manufacture of products (2).

The purpose of the CTPA talc specification is to define standards which ensure the virtual absence of potentially harmful contaminants from cosmetic talc so that finished cosmetic products containing cosmetic talc do not cause harm to human health. There are additional benefits. The factory worker is assured that the hygiene standards required by the UK Health and Safety Executive for working with talc of this quality will safeguard their health, and the employer does not have to bear the heavier cost of engineering controls which would be required for talc of lower quality.

The purpose of this monograph is to explain the need for a specification for cosmetic talc, and then to advise on the requirements for sources of talc which comply with this specification. A specification for the microbiological quality of talc for certain applications is discussed, a new section highlights the safety of talc in the finished cosmetic product, and finally, advice is given on how to ensure compliance with the requirements for monitoring exposure of factory workers to talc.
2. What is Cosmetic Talc?

Talc, or talcum, is a naturally occurring mineral, hydrated magnesium silicate ($\text{Mg}_6\text{Si}_8\text{O}_{20}(\text{OH})_4$).

‘Cosmetic Talc’ is prepared by milling talc from selected mines, which supply talc of a very high quality and purity (the sourcing of cosmetic talc is reviewed in Section 4). It typically contains about 90% or more of hydrated magnesium silicate and may contain small amounts of associated minerals such as chlorite, magnesite, calcite and dolomite.

It is essential not to confuse cosmetic talc with industrial materials called ‘talc’: these frequently have very low real talc content and may contain many impurities.

Analytical methods have been developed to examine and establish the purity of cosmetic talc and these techniques have been included in the CTPA Specification for Cosmetic Talc. This specification defines the quality and sets the highest standard for cosmetic talc.

In addition to meeting the criteria of this specification, in particular being asbestiform/amphibole free, cosmetic manufacturers also usually choose to conform to the physical, chemical and microbiological criteria of the European Pharmacopeia (Ph. Eur.) or United States Pharmacopeia (USP).
3. Properties and Uses of Cosmetic Talc

Properties

Crude talcs range in colour from white to green or brown. After grinding to powder form, all cosmetic talcs are of varying degrees of whiteness. Pure talc is characterised by its softness (it has the value 1 on the Mohs’ mineral hardness scale), slippery feel, good powers of oil absorption, whiteness and inertness. The refractive index and density (g/cm³) of cosmetic talc lie in the ranges 1.54 - 1.59 and 2.77 - 2.80 respectively. Talc is heat stable to 900°C; above this temperature it loses chemically combined water. Talc is inert to most chemical reagents and exhibits a marked alkaline pH, typically 9.0 - 9.5.

Structurally talc is a layer-lattice mineral in which each layer is composed of a brucite sheet sandwiched between two sheets of silica (see Figure 3.1). Each layer is electrically neutral so that there is no residual (electrical) charge of the sort which gives rise to the cation exchange capacity of clay minerals. As in all layer-lattice minerals, the individual layers are held together not by ionic bonding but by Van der Waals forces. This weak bonding accounts for many of the desirable properties of talc. The ease with which talc can be cleaved to produce platy or foliated particles of high surface area and the slip between the layers when a shearing force is applied, are both due to this weak bonding.

Figure 3.1 Talc Crystal Lattice Structure

Particle size is an important characteristic in determining the suitability of a talc for a particular cosmetic application and the required particle size will vary depending on the proposed end use of the talc. For example, body talcs will need to have a different particle size than talc used in colour cosmetics.

While a previous technique for particle size selection was that 98% of talc particles should pass through a BS200 mesh (75µm) sieve to ensure that talc had a smooth feel and was not gritty, this criterion is no longer considered appropriate for a good grade of cosmetic talc. Some talcs with a large particle size (average in excess of 50µm)
are not necessarily gritty and may have superb slip characteristics. These may therefore be preferred for some applications. It is also true that some talcs having a very platy particle, e.g. Italian talcs, have an opposite effect - that is, the finer the particle size, the more likely it is to be gritty.

Generally as the average particle size drops below 3µm grittiness and clumping become apparent.

Manufacturers should be aware that powders with a significant proportion of fine particles (<10µm) may cause dusty conditions in the workplace, and that talc with a larger particle size creates less respirable dust.

Sieve specification is therefore optional and should be agreed between supplier and manufacturer, with the end use in mind. It should be noted that particle size distribution determines bulk density and manufacturers should be aware that changes in specification may cause potential filling problems.

It should also be noted that different methods of measuring particle size, e.g. light scattering or sedimentation, may give very different results for platy minerals such as talc.

**Uses**

In the UK cosmetics industry, talc is used in a wide variety of cosmetic products. Such uses are shown as an indicative list in Figure 3.2. Historically, the principal use of talc has been in body powders, whereas today talc is used principally in colour cosmetics.

![Figure 3.2 Non-exclusive list of talc uses by product category](image)

In body powders, talc acts as a carrier for perfume, gives a smooth feel to the skin and a cooling sensation due to its large surface area. Perfume stability and impact depend on talc pH, surface area and the presence of heavy metal impurities which can vary even with talcs conforming to the CTPA specification. Surface activity, in particular Lewis acid sites, plays an important role in fragrance retention characteristics as well as the purity or ‘top note’ characteristics. Smoothness will be impaired by the presence of hard minerals in talc such as carbonate and silica.

Talc is also used in anhydrous antiperspirant products - in aerosols to give an extra dry feel and in solid sticks and roll-on products where it acts as a filler and gives good skin slip and application.

Talc is a very important ingredient in colour cosmetic products. The intrinsic properties of ‘good quality’ talc, i.e., its inertness, softness, lamellar structure and hydrophobicity contribute to the requirements of many finished products, i.e., stability, texture, skin adhesion, slip and water resistance. Its oil absorption properties and low refractive index extend its applications as an extender/filler particularly in translucent bases.
In colour cosmetics most talc is used in powder products such as eyeshadows, blushers and face powders, where its soft texture and slip properties enhance both the application and wearing properties of the products. Some of these products are marketed as loose powders in bottles, jars and boxes, while a larger number are sold as pressed powders. Platy structures such as talc tend to trap air during compression, which affects the quality of the pressed powder cakes. Control of particle size is critically important in obtaining the ideal talc for compression purposes, and the use of micronised talc (particle sizes below 5 µm) is standard in these applications.

Face powders and blush powders commonly contain over 80% of talc. Lesser quantities are used in eyeshadows, where the talc concentration is often balanced against the quantity of synthetic pearl present, which can have similar platelet structure and slip properties. Pigments extended onto talc usually exhibit improved tone and brightness characteristics, and are easier to process. For this reason, many colour manufacturers use talc to extend their pigment during the manufacturing process.

Treating talc with hydrophobic coatings, such as silicones, can enhance its water repellency, oil dispersibility and compression characteristics. These hydrophobic talcs are particularly popular in the so called 2-way face powder cakes, which can be applied wet or dry and in liquid foundations to give more versatile foundation effects.
4. Sources of Cosmetic Talc

There is variation in the composition of cosmetic talcs within the CTPA specification and so it is not possible to recommend specific sources. Trace minerals may, for example, alter the colour of a batch or impact on fragrance stability. The method of grinding or milling the bulk mineral will result in powders of differing particle sizes resulting in different bulk densities. The purchaser should, therefore, if they are already using talc, ensure that any new source produces the same end product from their manufacturing process. Manufacturers purchasing talc for the first time will look for talc which is of repeatable colour, composition, bulk density etc., for their requirements. The material must also, of course, comply with the CTPA specification for cosmetic talc. Ideally the talc should be from a single mine and subject to control by the mining company and importer.

Choosing a Talc

Experience with talc from a range of suppliers will have enabled those regularly using talcs over the years, to select materials suitable for their purpose. However, this is not the case for the new purchaser nor perhaps for the regular purchaser who finds themselves deprived of their normal source of supply for any reason. The purchaser must then satisfy themselves by obtaining satisfactory answers to the following questions:

1. Has the geology of the deposit been sufficiently studied in order to preclude the working of, for example, areas containing tremolite or that are rich in quartz?
2. Has the mining company the will and ability to exclude minor inclusions of undesirable minerals? (Refer to Section 5)
3. Are the physical and chemical properties of the talc reasonably constant throughout the deposit?
4. Are the mine control procedures adequate to prevent contamination of the product during mining and subsequent processing?
5. Serious cross contamination can occur where the milling process is used to process other minerals. Are there adequate safeguards? Is the bulk shipped for milling at another location? If so, what guarantees are there that the supplier has undertaken appropriate risk management, for example to ensure that no cross contamination will occur?
6. How is the milled talc shipped - bagged or in bulk? Bulk shipments can be contaminated.
7. What tests against the CTPA specification are carried out by the supplier?; by the mine?
8. Does this talc meet the requirements of the CTPA specification for cosmetic talc?

Remember that 1-7 above are at least as important as 8.

It is recommended to obtain written confirmation from the supplier on the points above for the purpose of record keeping and traceability.

Once the purchaser has satisfied themselves on these and any other points which may concern them, it is recommended that for the purpose of ensuring Good Manufacturing Practices, regular auditing within the whole supply chain is maintained. The frequency and points within the supply chain when quality checking is necessary will need to be established.

Routine in-house monitoring of the mineralogical composition of the talc is also recommended. The frequency of testing will depend on the user’s knowledge of the talc and on their confidence in the supplier of the material.
Where in-house testing is not possible, the information should be sought from the supplier or an analytical organisation with experience in evaluating talc.

Whether a product is being manufactured in-house or by a contract manufacturer, it is ultimately the responsibility of the company placing the product on the market (Responsible Person) to ensure that the right quality talc is being used. If a contract manufacturer is being used, the Responsible Person must be satisfied by all of the information provided with regard to sourcing and traceability, as detailed above.

**Major Talc Deposits**

Countries from which high grade cosmetic talcs are available include:

- Australia
- India
- China
- Spain
- France
- United States of America
- Italy

The inclusion in or omission of a country from this list does not mean that any talc from such a place is acceptable or unacceptable. Each country has more than one deposit and produces both high grade and low grade talcs. Acceptability can only be confirmed by the user considering the points mentioned above and following analytical and formulation testing.

In the event of difficulty, Members are urged to seek advice from the CTPA.

**Sustainability**

It is becoming more and more commonplace, as part of a company’s Corporate Social Responsibility programme, to ensure a balance is met between the economic, environmental and social aspects of their business.

To put sustainability into practice, cosmetic manufacturers may have in place a Sustainability Plan for the natural resources they use. Companies may work with their suppliers to create local sustainable sources wherever possible.

Information on sustainability in the talc industry can be found on the website of the Scientific Association of European Talc Producers, EUROTALC.

**Suggested reading**

Editorial and ‘Talc, Destiny and Diversity’ by Clarke G.M.

Industrial Minerals Sept 1979

5. Minerology

5.1 Introduction

Talc deposits were formed in the Earth’s crust by the alteration of certain rocks under the influence of heat, pressure and water or carbon dioxide. For example, talc may be formed from magnesium oxide (periclase), silica (quartz) and water under pressure as follows:

\[
6 \text{MgO} + 8 \text{SiO}_2 + 2 \text{H}_2\text{O} \rightarrow \text{Mg}_6\text{Si}_8\text{O}_{20}(\text{OH})_4
\]

\[\text{periclase} \quad \text{quartz} \quad \text{6000 - 30,000 psi} \quad \text{talc}\]

The periclase may be a decomposition product of dolomite:

\[
\text{CaMg(CO}_3)_2 \rightarrow \text{CaCO}_3 + \text{MgO} + \text{CO}_2
\]

\[\text{dolomite} \quad \text{calcite} \quad \text{periclase}\]

Dolomite may however also give rise to tremolite:

\[
5 \text{CaMg(CO}_3)_2 + 8 \text{SiO}_2 + \text{H}_2\text{O} \rightarrow 3 \text{CaCO}_3 + 7 \text{CO}_2 + \text{Ca}_2\text{Mg}_5\text{Si}_8\text{O}_{22}(\text{OH})_2
\]

\[\text{dolomite} \quad \text{quartz} \quad \text{tremolite} \quad \text{calcite}\]

Talc may also be formed from so-called ultrabasic silicates such as pyroxenes and amphiboles (3).

\[
4 \text{Mg}_3\text{Si}_2\text{O}_5(\text{OH})_4 + 6 \text{CO}_2 \rightarrow \text{Mg}_6\text{Si}_8\text{O}_{20}(\text{OH})_4 + 6 \text{MgCO}_3 + 6 \text{H}_2\text{O}
\]

\[\text{serpentine} \quad \text{talc} \quad \text{magnesite}\]

Tremolite is also an amphibole and may form talc.

Thus talc often contains other minerals such as quartz or dolomite which were present in the parent rock, magnesite, calcite and amphiboles such as tremolite. The term ‘accessory mineral’ is used to describe minerals such as quartz (silica) which were present in an igneous parent rock and which become liberated into the secondary rock when the parent rock is converted by geological processes to a metamorphic or sedimentary rock. They are not strictly ‘contaminants’ since they are present in the mineral when it is mined, as compared with contaminants which are introduced afterwards e.g. in milling or transport. However, for convenience accessory minerals are often referred to as contaminants. The purpose of the CTPA specification is to define standards which ensure the virtual absence of potentially harmful contaminants from cosmetic talc.

The following sections expand on the possible contaminants of talc and why they should be limited or excluded from cosmetic talc.

5.2 Fibrous Minerals: Amphiboles

Amphiboles, including asbestos, are fibrous minerals that can be present in some talc. However, cosmetic talc must not contain fibrous minerals.

The inhalation hazards of fibrous minerals have long been recognised (4, 5, and 6). The CTPA view is that fibrous minerals should not be detectable in a cosmetic talc by ‘state of the art’ methods.
As the description of the mineralogical processes involved in the formation of talc may have shown, amphiboles are possible contaminants: these include tremolite, anthophyllite, actinolite, etc. Tremolite, the most common amphibole contaminant, occurs only rarely as the fibrous form, and the varieties of massive tremolite which under the microscope appear to contain fibres, commonly comprise mainly thick fibres or cleavage fragments which do not present the same hazard as asbestos. However, in order to eliminate any hazard to the consumer which might arise from the need to interpret fibre shape and dimensions, and to facilitate routine screening, the CTPA view is that if an amphibole is detected by X-ray diffraction, that batch of talc is unacceptable for cosmetic use, whether or not subsequent examination by optical or electron microscopy shows that the contaminant is not fibrous. In this respect the CTPA Specification is even more stringent than others which refer only to fibrous amphiboles.

Chrysotile is classed with the asbestos minerals but is not one of the amphiboles, which have a chain silicate structure; it is a sheet silicate, as are talc and chlorite. Chrysotile has been reported to occur in certain talc deposits, notably in New York State (7), but it has not been found in talc from sources used in the UK.

5.3 Quartz (Silica)

The presence of quartz (silica) is generally considered as unacceptable in cosmetic talc for optimum skin feel and should therefore be avoided.

Workers exposed to quartz dust over a period of years may develop silicosis, but the risk can be minimised if the daily exposure to respirable particles of quartz is not allowed to exceed a certain value. That value is determined by the average concentration of respirable quartz dust and is currently set at 0.1 mg. m³ (8).

See Section 8 for legal obligations for protecting workers.

Good mining and manufacturing processes should ensure that silica is kept to a minimum to make certain that consumers are not exposed to harmful levels.

5.4 Chlorite

To a mineralogist, ‘chlorite’ is not one mineral but a family, varying considerably in composition but all having a layered structure which gives some chlorites a ‘slip’ similar to talc. Chlorites are widely distributed and are often the consequence of the hydrothermal alteration of parent rocks related to those which give rise to talcs by similar processes, so they would be expected to be common contaminants of talc.

Structurally they have much in common with talc, the crystal lattice comprising regular layers of a talc like structure \((\text{Mg}_6\text{Si}_8\text{O}_{20} \text{(OH)}_4)\) alternating with layers of a brucite-like structure \(-\text{Mg}_6(\text{OH})_{12}\). However, in the chlorite family both the magnesium and the silicon may be to varying degrees substituted by aluminium and/or iron. As a result therefore they may be green in colour, and technically undesirable in a cosmetic talc, for example due to potential issues with fragrance stability.

Some deposits corresponding to the form of chlorite known as ‘clinochlore’ may contain only a trace of iron and yield a white powder with a good ‘slip’.

5.5 Other Minerals

Carbonates such as dolomite, magnesite and calcite are undesirable major contaminants of talc because they do not have a platy structure and therefore reduce the quality of the talc: they do not present a health hazard in this context. However, because of their potential reactivity they can impair product performance e.g., by affecting fragrance integrity.
Similar remarks apply to apatites, a group of calcium phosphates, $\text{Ca}_5(\text{PO}_4)_3X$, in which $X$ may be OH, F or Cl. Fluorapatite, $\text{Ca}_5(\text{PO}_4)_3\text{F}$, is the commonest member of the group. Apatites occur in almost all igneous rocks and are also found in metamorphic and sedimentary rocks, so it would be difficult to find a talc deposit which did not contain at least a trace of apatite.

**Rutile** is the most common naturally occurring form of titanium dioxide, $\text{TiO}_2$. It occurs in igneous and metamorphic rocks and may be present as small particles scattered throughout the deposit. Pure titanium dioxide is white, but natural rutile is frequently coloured by impurities such as iron and thus would be undesirable in a cosmetic talc. It does not present any health hazard.

**Iron Oxide.** There is a link between rutile and magnetite, $\text{Fe}_3\text{O}_4$, in that titanium is often present in the crystal lattice of magnetite. Magnetite is one of the most abundant and ubiquitous accessory minerals in igneous and metamorphic rocks. The crystals are almost always dark coloured and gritty and thus would be undesirable in a cosmetic talc. It does not present any health hazard. Other oxides of iron derived from magnetite by oxidation and hydration are orange to brown in colour and are even more detrimental than magnetite for colour contamination and grit.

**Toxic metals (Cr, Ni, Pb, As).** When present in talc, these metals would probably not be as discrete minerals, but as substituents in the crystal lattice of the major or accessory minerals. Exchange of one atom by another of similar size and charge is not uncommon in geological processes.

Although chromium and nickel can produce coloured compounds their presence in a talc at levels generally considered to be toxic would probably not discolour the talc to render it aesthetically unacceptable to the cosmetic scientists. In addition, the compounds of lead and arsenic are often light in colour. Colour alone cannot therefore be used as a discriminant for the presence of heavy metals.

It should be borne in mind that when considering toxic metals, finished products containing talc must conform to the requirements of the EU Cosmetics Regulation, especially in relation to the general safety clause (Article 3) and Annex II, the list of substances prohibited in cosmetics.
6. CTPA Cosmetic Talc Specification

Definition
Cosmetic Talc must be carefully distinguished from material commonly or traditionally known as talc in other industries, which may contain high levels of minerals other than talc. Cosmetic talc typically contains about 90% or more of hydrated magnesium silicate, Mg₆Si₈O₂₈(OH)₄ and may contain small amounts of associated minerals such as chlorite, magnesite, calcite and dolomite.

The following table presents the criteria for the CTPA Cosmetic Talc Specification. (In addition to meeting the criteria of this specification, cosmetic manufacturers also usually choose to conform to the physical, chemical and microbiological criteria of the European Pharmacopeia (Ph. Eur.) or United States Pharmacopeia (USP)).

<table>
<thead>
<tr>
<th>Property</th>
<th>METHOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macroscopic Appearance</td>
<td>A powder free from visible extraneous matter</td>
</tr>
<tr>
<td>Microscopic Appearance</td>
<td>Cosmetic talc is composed predominantly of translucent, laminar, irregular but substantially isodiametric particles not normally exceeding 60µm in maximum dimension.</td>
</tr>
<tr>
<td>Colour</td>
<td>White or ‘off-white’. Shade criteria to be agreed between buyer and supplier.</td>
</tr>
<tr>
<td>Odour</td>
<td>Virtually odourless</td>
</tr>
<tr>
<td>Texture &amp; Slip</td>
<td>Free from gritty particles by palpation.</td>
</tr>
<tr>
<td>Sieve Test*</td>
<td>100% passes through a BSS 100 mesh sieve and 98% minimum through a BSS 200 mesh sieve. CTPA Method 1</td>
</tr>
<tr>
<td>Bulk Density</td>
<td>Must meet buyer’s requirements.</td>
</tr>
<tr>
<td>Loss on Drying</td>
<td>Loses not more than 0.6% when dried at 105°C to constant mass. CTPA Method 2</td>
</tr>
<tr>
<td>Loss on Ignition</td>
<td>5% maximum</td>
</tr>
<tr>
<td>Acid-Soluble Matter</td>
<td>6% maximum. There must be no odour of H₂S. CTPA Method 4</td>
</tr>
<tr>
<td>Iron</td>
<td>Must meet buyer’s requirements</td>
</tr>
<tr>
<td>Identification</td>
<td>By X-Ray Diffractometry</td>
</tr>
<tr>
<td>Amphibole Minerals</td>
<td>Not detected by the techniques described. CTPA Method 6 or 7, or other method of equivalent accuracy and sensitivity.</td>
</tr>
<tr>
<td>Ethylene Oxide Residues</td>
<td>No residues harmful to health. CTPA Method 8</td>
</tr>
</tbody>
</table>

* Optional. See page 8. Deviations from this specification are acceptable if agreed between the customer and the supplier.
7. Microbiological Specification

Talc is imported into the UK from many countries throughout the world and may vary considerably in microbial population. The source of contamination of raw talc may be through direct faecal contamination from animal sources and soil and indirectly from contaminated water. Levels of contamination greater than 10,000 microorganisms per gram have been found in raw talc. In addition to the normal background microflora of Bacillus sp., micrococci, streptomycetes and moulds, potentially pathogenic microorganisms that are regularly isolated include species of clostridia e.g., Cl. perfringens, Cl. chauveoi and Cl. bifermantans. Other microorganisms isolated from some sources include Enterobacteriaceae and faecal streptococci. The presence of Cl. tetani has also been recorded: in 1946 the death of several babies in New Zealand from tetanus followed the use of contaminated baby powders.

Talc Treatment

For general use in cosmetic products some form of treatment is essential to reduce the total microbial population to levels that will meet CTPA limits. These limits, which can be found in the CTPA Guide on Microbial Quality Management (MQM), are no more that 100 colony forming units per gram or ml (cfu/g or ml) for products intended specifically for use in the eye area or for use on babies, and no more than 1000 cfu/g or ml for products for general use. These limits are also stated in the European Commission’s Scientific Committee on Consumer Safety Notes of Guidance (9th Revision). However, the Notes of Guidance also give a limit of 100 cfu/g or ml for products specifically intended for use on the mucous membranes. The latest issues of the CTPA MQM Guide and SCCS Notes of Guidance must be consulted to confirm current limits.

A variety of methods for talc treatment have been used e.g., dry heat, steam, ethylene oxide and gamma irradiation. Dry heat has the disadvantage that the delicate, platy character of some talcs can be destroyed when heated to temperatures of 320°F (160°C). Steam is preferable but may not be practicable for talc in bulk. The efficacy of treatment processes may be monitored routinely by parametric methods.

Talc may be decontaminated by total flotation in chlorinated water, which has the added benefit that chlorite, quartz, black specks and tremolite all separate out. The chlorine is easily driven off after treatment but the surfactants used in the flotation process must also be thoroughly removed by washing. This procedure has the potential to give a much more consistent, purified and microbially secure product than dry processing. However, although this process avoids the need to use ethylene oxide, it must be licensed due to environmental concerns from the gaseous and liquid effluents. It is not extensively used in Europe.

Certain types of talc undergo a drying process in the final stages of manufacture. This cannot be considered in any way as a decontamination process. However, if properly controlled, it may achieve considerable reductions in the total microbial population. Nevertheless, it is known that spores, including clostridial spores, may survive.

Treatment may be carried out by the talc supplier as part of his production process. A well controlled drying process generally produces talc which will meet CTPA limits for normal cosmetic use. The cosmetic manufacturer should be aware that fluctuations in the efficiency of this type of process may occur and adequate tests should be carried out on talc deliveries to ensure that they meet the CTPA limits.

Experience has shown that it is unlikely that talc prepared in this way will consistently meet the CTPA limits for eye and baby products and it is therefore recommended that talc used for these products should undergo a validated decontamination treatment. For the majority of talc sources however, a controlled drying process is not carried out by the supplier and these talcs may be heavily contaminated or show sporadic high microbial.
counts. Such sources of talc will require a validated decontamination treatment by the cosmetic manufacturer to meet the CTPA limits for cosmetic products.

The recommendation of the Association therefore is to ensure that all talc for cosmetic purposes is subjected to a validated decontamination procedure. This can form part of the specification/contract with the supplier of the raw material, carried out by the manufacturer itself if the facilities are available, or contracted out to a third party.

For detailed procedures for sampling and microbiological examination of finished products refer to the CTPA Guide on Microbial Quality Management (MQM). This document also gives guidance on the avoidance of microbiological contamination during manufacture and packaging of cosmetic products.

Residues

Treatment with ethylene oxide may result in residues of the gas or its by-products being present in bags, packaging or bulk. Care should therefore be taken to ensure that if such treatment has been carried out by the supplier or a third party there are no residues at levels which could be harmful to health and that duties under the Health and Safety at Work Act are satisfied (cf Specification, Section 6, and Health and Safety Aspects, Section 9).
8. Talc in the Finished Cosmetic Product

All cosmetic products in the EU and EEA, whether or not they contain talc, are subject to the requirements of the Cosmetic Product Regulation (EC) No. 1223/2009 (the Regulation). In order to ensure a high level of protection of human health, the Regulation requires that all cosmetic products made available on the market must be safe under normal or reasonably foreseeable conditions of use. In order to demonstrate this, each product must undergo a safety assessment performed by an appropriately qualified safety assessor. In addition, a more detailed safety assessment is required for cosmetic products intended for children under three years old.

When talc is used in powdery products intended to be used for children under 3 years of age, the Regulation requires the following wording to be included on the pack: “Keep powder away from children’s nose and mouth”. This is to warn against the powder being accidentally inhaled by small children.

Cosmetic talc has been in use for over 120 years. Whereas the value of historical studies on talc toxicity are limited in that they lack the characterisation of impurities, the cosmetic talc industry has actively supported major scientific studies into the properties, use and safety of cosmetic talc, providing evidence of its quality and purity.

The overall body of scientific evidence satisfies medical opinion that the normal use of cosmetic talc meeting quality and microbial standards represents no hazard to health (13-18).

More information on the safety of cosmetic talc is available on the CTPA consumer website http://www.thefactsabout.co.uk/talc---in-depth/content/245.
9. Health and Safety Aspects

Whilst talc in finished cosmetic products must be safe for human health when used under normal and reasonably foreseeable conditions of use, its presence in the workplace as an airborne particulate can, if uncontrolled, present a health hazard to those workers regularly exposed (9). The Health and Safety Executive in its Guidance Note, EH40/2005 (4) gives a recommended limit for talc respirable* talc dust of 1 mg. m⁻³. The latest issue of EH40 must be consulted for the current limits.

The prudent employer will be aware of their duties under the Health and Safety at Work etc. Act 1974 and the UK Control of Substances Hazardous to Health Regulations (10) and many will already be measuring and controlling any exposure of their workforce to talc, by the following means.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Acquiring knowledge of the composition of the talcs, particularly in respect of quartz and amphibole content by regular analysis either by the supplier or ‘in-house’.</td>
</tr>
<tr>
<td>2</td>
<td>An assessment of worker exposure by routine personal sampling using the techniques recommended in HSE publications MDHS14 (11) and HSG173 (12). This must be by true personal sampling, that is by collection of ‘breathing zone’ samples using a suitable filter holder (MDHS14) worn at the operator’s lapel and connected to a pump worn at his or her waist. Suitable sampling equipment are described in MDHS14. An occupational hygiene consultancy may be contracted to undertake the work. The sampling should be representative of whole shift exposure and it may be necessary to sample for the whole shift. A sampling programme should be designed to cover a representative section of the workforce and cover such points as variation in the height of workers and differing work practices.</td>
</tr>
<tr>
<td>3</td>
<td>The measurements resulting from such a monitoring exercise may show that exposure levels are well below the values listed in the current issue of EH40. In that case all that is required is measurement at intervals sufficiently close together to detect changes in concentration resulting from machine wear and changes in operator working practices. Reassessment should also be made whenever there are planned changes in methods of work, changes in plant and handling technique and whenever a talc from a fresh source or different specification is used. If measurements indicate exposure levels are above 50% of the limits listed in EH40 there should be an immediate investigation to discover the causes of these high concentrations. Steps should then be taken to remedy any plant defects or implement improved control measures. Whilst such remedial work is in progress it may be necessary to enforce the wearing of suitable respiratory protection until such time as subsequent personal sampling shows a satisfactory state of affairs exists. Records of all measurements must be kept for at least 40 years and linked to employees’ health and medical records.</td>
</tr>
</tbody>
</table>

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The most common causes of high concentrations of airborne dust, apart from plant failure are:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>The arrival of split, torn and dirty bags on site - dirty bags should be cleaned by vacuum cleaning, never by brushing, and damaged bags should be returned to the supplier because the contents may have been contaminated.</td>
</tr>
<tr>
<td>b</td>
<td>The emptying of bagged talc during transfer to hoppers.</td>
</tr>
<tr>
<td>c</td>
<td>The folding and disposal of empty talc bags arising from both a) and b) can give rise to high concentrations of dust. Consideration should be given to mechanical handling at this point, particularly for the disposal of the empty bags, with adequate air extraction.</td>
</tr>
<tr>
<td>d</td>
<td>Spillage of talc - this must be removed by vacuum cleaning, never brushing. Vacuum cleaners for this purpose must be fitted with filters capable of retaining fine particles. Such filtration should conform to the Type H amendment to the BS 5415. Note: Empty bags and vacuum cleaner filters should be sealed into impermeable sacks and containers for disposal.</td>
</tr>
<tr>
<td>e</td>
<td>The filling of small containers - emission from this source can be controlled by properly designed air extraction.</td>
</tr>
<tr>
<td>f</td>
<td>General maintenance work, cleaning and the emptying of filter bags in dust control equipment. The wearing of respiratory protection may be necessary for these tasks and an assessment should be made to ascertain whether this is necessary, for example, by the use of a dust lamp.</td>
</tr>
</tbody>
</table>

* Definitions for the term ‘ respirable’ can be found in MDHS14.

HSE Guidance Notes EH40, HSG173 and MDHS 14 are available from HSE approved agents and:

HSE Books  
PO Box 1999  
Sudbury  
Suffolk  CO10 2WA  
Tel: 01787 881165  
Fax: 01787 313995  
Email: hsebooks@prolog.uk.com  
https://books.hse.gov.uk
10. References

1. EU Cosmetics Regulation (EC) No. 1223/2009
11. Health and Safety Executive. MDHS14/4 General methods for sampling and gravimetric analysis of respirable, thoracic and inhalable aerosols. Published June 2014.
# 11. Appendix

## CTPA METHOD NO 1

**METHOD FOR THE DETERMINATION OF THE SIEVE FRACTION OF TALC**

<table>
<thead>
<tr>
<th>Summary</th>
<th>A weighed sample of talc is wet-sieved. The residue in the sieve is dried and weighed. The weight of residue is expressed as a percentage of the weight of original sample.</th>
</tr>
</thead>
</table>
| **Apparatus** | BSS sieves, 8 inch (200mm) diameter of 100 and 200 mesh  
Brush, camel hair  
Drying oven  
Balance |
| **Procedure** | 1. Weigh 19.9 - 20.1g (+/- 0.0001g) sample and place in sieve.  
2. Thoroughly wet the sample and sieve with 95% alcohol.  
3. Hold the sieve under a jet of water from a mains tap, directing the water vertically onto the surface of the sieve, adjusting the flow so that the water does not overflow and the depth of the water in the sieve is about 1 inch (25mm). When the residue in the sieve appears to be constant, continue to wash for a further three minutes.  
4. Dry the sieve in an oven at 105°C, then brush through as much of the residue as possible. The residue should be free from grit and other foreign matter.  
5. Carefully transfer the residue to a weighed watch glass and determine the weight of residue. |
| **Calculation** | % Passing sieve = \( \frac{(Ws - Wr)}{Ws} \times 100 \)  
% Retained on sieve = \( \frac{Wr}{Ws} \times 100 \)  
Where  
Ws = original weight of sample (g)  
Wr = weight of residue retained on sieve (g) |
### Method for the Determination of Loss on Drying of Talc

#### Summary
A weighed sample of talc is dried at 105°C, at which temperature moisture is lost but talc and the accessory minerals are heat stable. The weight lost on drying is expressed as a percentage of the weight of original sample.

#### Apparatus
- Moisture dish (nickel)
- Drying oven, fan assisted
- Vacuum desiccator
- Analytical balance

#### Procedure
1. Turn on the oven and allow the temperature to reach a steady 105°C.
2. Prepare the moisture dish by heating in the oven for 30 minutes at 105°C.
3. Transfer the crucible to the vacuum desiccator, close the tap on the desiccator after about 30 seconds, and allow the dish to cool over a bed of self-indicating silica gel (6-20 mesh).
4. Weigh the dish to the nearest 0.0001g.
5. Weigh 1.9 to 2.1 grams (+/- 0.0001g) of the talc sample into the dish and spread evenly over the base of the dish.
6. Transfer the dish to the oven: if the oven shelves are not perforated, stand the dish on a silica triangle in order to allow free flow of air. Fit the lid loosely on the dish so that it covers only about 3/4 of the contents.
7. Remove the dish and place in vacuum desiccator. After about 30 seconds, close the tap. Do not evacuate with a pump. Allow to cool to room temperature and re-weigh the dish to the nearest 0.0001g.
8. Repeat 6 and 7 until a constant weight is recorded.

#### Calculation
\[
\text{% Loss on drying} = \left( \frac{W_s - W_d}{W_s} \right) \times 100
\]

Where
- \(W_s\) = original weight of sample (g)
- \(W_d\) = weight after drying (g)
# CTPA METHOD NO 3

## METHOD FOR THE DETERMINATION OF LOSS ON IGNITION OF TALC

### Summary

A weighed sample of talc is heated to constant weight at 600 °C, at which temperature water is lost and carbonates decompose but talc is not affected. The loss in weight, expressed as a percentage of the weight of original sample, is the loss on ignition.

### Apparatus

- Crucible (porcelain or silica)
- Muffle furnace
- Vacuum desiccator
- Analytical balance

### Procedure

1. Turn on the muffle furnace and allow the temperature to reach a constant 600°C.
2. Prepare the crucible (porcelain or silica) by heating in the muffle furnace for 30 minutes at 600°C.
3. Transfer the crucible to a vacuum desiccator and allow to cool over a bed of self-indicating silica gel (6-20 mesh).
4. Weigh the crucible to the nearest 0.0001g.
5. Weigh 1.9 - 2.1g (+/- 0.0001g) of the talc sample into the crucible.
6. Transfer the crucible to the muffle furnace and heat at 600°C for 2 hours.
7. Remove the crucible and place in vacuum desiccator. Allow to cool to room temperature and re-weigh to the nearest 0.0001g.
8. Repeat 6 and 7 until a constant weight is recorded.

### Calculation

\[
\text{% Loss on ignition} = \left( \frac{W_s - W_i}{W_s} \right) \times 100
\]

Where

- \( W_s \) = original weight of sample (g)
- \( W_i \) = weight after ignition (g)
## CTPA METHOD NO 4

**METHOD FOR THE DETERMINATION OF ACID-SOLUBLE MATTER IN TALC**

### Summary

A weighed dried sample of talc is digested with dilute hydrochloric acid, which decomposes carbonates and sulphides. The residue is washed, dried and weighed. The loss in weight, expressed as a percentage of the weight of original sample, is the percentage of acid-soluble matter.

### Apparatus

- Glass beaker, 100ml
- Glass stirring rod
- Water bath
- Sintered glass filter crucible porosity grade 3 (27mm diameter is convenient but other sizes may be suitable)
- Whatman GF/A filters to fit crucible (25mm diameter fits the 27mm crucible)
- Drying oven, fan assisted
- Vacuum desiccator
- Analytical balance
- Hydrochloric acid, dilute (approximately 5N), 20ml
- Lead acetate paper
- Litmus paper
- Distilled water in wash bottle

### Procedure

1. Dry a sample of the talc at 105°C as in Method 2.
2. Weigh 0.9 to 1.1g (+/- 0.0001g) of the talc sample into the beaker.
3. Add 20ml dilute hydrochloric acid. Record any evolution of hydrogen sulphide (which may be confirmed by use of lead acetate paper) indicating the presence of sulphides.
4. Digest the sample by placing the beaker in a boiling water bath for 15 minutes, stirring the contents intermittently.
5. Filter the contents through the glass fibre filter which is contained in the sintered glass crucible.
6. Wash the residue thoroughly with distilled water until the washings are acid-free to litmus.
7. Dry at 105°C to constant weight, as in Method 2.

### Calculation

\[
\text{% Acid soluble matter} = \frac{(W_s - W_a)}{W_s} \times 100
\]

Where
- \(W_s\) = original weight of sample (g)
- \(W_a\) = weight of residue after acid digestion (g)
# CTPA METHOD NO 5

**METHOD FOR THE IDENTIFICATION OF TALC BY X-RAY DIFFRACTOMETRY**

<table>
<thead>
<tr>
<th>Summary</th>
<th>Talc is identified by comparison of the major peaks in the X-ray diffraction pattern of the sample with those of the CTPA reference pattern or with those in a published file. A modern instrument should be used. The increased sensitivity and resolution of modern instruments is critical for the high standards which the industry requires.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procedure</td>
<td>A representative sample of the talc is obtained and sufficient is pressed into the sample holder to present a flat surface. Some users recommend the use of a surface abrasion method in order to avoid orientation of the talc minerals. Others use a spinning sample holder. A major supplier, however, finds that these procedures are unnecessary and that preferred orientation of talc crystals may be used to generate a crystallinity ratio which is of value in characterising a talc. Users should use whichever method they find most appropriate for the purpose and which gives the required sensitivity. The sample is scanned on the diffractometer from 5° to 60° 2θ. The pattern is compared with that of the relevant CTPA reference pattern. Some examples are shown in Appendix XRD patterns 1, 2, 4 and 5. The major talc reflections together with those of associated impurities should resemble the appropriate CTPA reference pattern. For the identification of crystal patterns refer to the Index (Inorganic) to the Powder Diffraction File 1972, published by the International Centre for Diffraction Data, 12 Campus Blvd., Newtown Square, PA 19073-3273 USA.</td>
</tr>
</tbody>
</table>
CTPA METHOD NO 6

METHOD FOR THE DETECTION OF AMPHIBOLE MINERALS IN TALC BY X-RAY DIFFRACTOMETRY

Summary

Amphibole minerals are identified by comparison of the characteristic major peaks in the X-ray diffraction pattern of the sample with those of the CTPA reference pattern or with those in a published file.

A modern instrument should be used. The increased sensitivity and resolution of modern instruments is critical for the high standards which the industry requires.

Procedure

A representative sample of the talc is obtained and sufficient is pressed into the sample holder to present a flat surface. Some users recommend the use of a surface abrasion method in order to avoid orientation of the talc minerals. Others use a spinning sample holder. A major supplier, however, finds that these procedures are unnecessary and that preferred orientation of talc crystals may be used to generate a crystallinity ratio which is of value in characterising a talc. Users should use whichever method they find most appropriate for the purpose and which gives the required sensitivity of the detection of amphiboles.

No time period is specified for scanning the critical region of the pattern. Scanning for 3 minutes over the range 10.2-10.9° 2θ is similar to the CTFA method, J4-1, which is sensitive to 0.5% amphibole. By lengthening the time to 30 minutes using the same interval, sensitivity is increased to 0.1% amphibole. The increased sensitivity is critical for better detection of amphiboles which otherwise, using XRD procedures alone, would go undetected. Members are urged strongly to use this increased sensitivity if at all possible, particularly in the light of the various new foreign talcs that are emerging in the market place. If the raw material suppliers as well as users adopt this changed procedure, our industry will achieve better control of the quality of the currently available talcs. However, this procedure significantly reduces the throughput and a dedicated XRD instrument will be required if many samples must be scanned.

The sample is scanned on the diffractometer from 10.2-10.9° 2θ. The pattern is examined for peaks which may indicate the presence of amphiboles. The assumption that any peak present in this interval indicates an amphibole is not necessarily correct. Some talcs may contain interfering minerals such asapatites which have peaks within this range (e.g. chlorapatite at 10.81° 2θ). Before a talc is reported to contain amphiboles, the presence of amphiboles suggested by XRD should be verified by polarised light microscopy (PLM) and by transmission electron microscopy with energy dispersion scanning (TEM/EDS) if the PLM results are inconclusive. An indirect, and therefore, less preferred method of verification would be to discount the presence of interfering minerals by running an XRD scan for total mineralogy that is sensitive enough (i.e. by use of a slower scan) to detect elsewhere in the pattern those peaks which are characteristic of a mineral whose peaks may show up in the region scanned for amphibole.

An example of a talc which contains amphibole and therefore does not comply with the CTPA specification for cosmetic talc is shown in Appendix XRD pattern no. 8.

For the identification of crystal patterns refer to the Index (Inorganic) to the Powder Diffraction File 1972, published by the International Centre for Diffraction Data, 12 Campus Blvd., Newtown Square, PA 19073-3273 USA.
Optical methods may be used by experienced workers, but should not be used as the only method of identification. For example, errors of interpretation can occur due to the presence of talc ‘ribbons’.

The presence of amphibole minerals (tremolite, anthophyllite and actinolite) in talc may be detected by ‘Dispersion Staining’ with polarised light microscopy. ‘Dispersion Staining’ is a colour effect produced when a transparent colourless particle or fibre, immersed in a liquid having a refractive index near to that of the particle, is viewed under a microscope by transmitted white light. The use of liquid of specified refractive index enables identification of particles of refractive indices corresponding to those of certain amphiboles, which may be examined further for other optical characteristics and morphology.

The procedure has been modified to take account of user experience. The method of slide preparation described here allows for a more representative sampling and a better dispersing of the sample over the area of the slide to be viewed. A third common amphibole is included and the interpretation takes account of some problems which may be experienced.

Small concentrations of coarse amphiboles may go undetected in coarse (+200 mesh) samples, which should be ground before analysis. Carbonates which may interfere are removed from the sample by pre-treatment with hydrochloric acid.

### Apparatus
- Polarizing microscope
- Dispersion staining objective
- Cargille fluid RI 1.605 and 1.680
- Water bath
- Glass beaker
- Glass stirring rod
- Vacuum filter fitted with sintered glass filter porosity No.4.
- Hydrochloric acid, 10% v/v
- Isopropyl alcohol (IPA) 70% in distilled water
- Distilled water in wash bottle
- Drying oven, fan assisted
- Vacuum desiccator

### Procedure
1. Coarse (+200 mesh) samples should be ground to a finer size prior to analysis.

2. The sample is digested with acid essentially as in CTPA Method No. 4. Weigh 1.9 - 2.1g of the talc sample into the beaker. Add 25ml hydrochloric acid and heat on the steam bath for 30 minutes with occasional stirring. Allow to cool, filter, wash with water until free from acid and dry.

3. 0.2g of sample is dispersed in 15ml of 70% IPA/30% water. Six drops of the suspension are spaced onto a glass slide and allowed to dry, then one drop of the appropriate Cargille liquid is added, mixed with the residue and covered with a clean microscope cover slip. Two slides should be prepared, one with Cargille RI 1.605 liquid for tremolite and actinolite and the other RI 1.680 liquid for anthophyllite.

The prepared slide is mounted on the stage of a polarizing microscope equipped with a McCrone centre stopped objective lens and the polarizer in position.
|   | Tremolite and actinolite will, with rotation of the stage and sample, exhibit a yellow/brown colour, changing to blue. Anthophyllite appears orange. However reference should be made to HSG248 for details (19). A platelet of talc ideally orientated will appear blue and will not change significantly upon stage rotation, but many grains of talc are not ideally orientated and may yield higher order colours. However, dispersion staining colours are only one of the features by which amphibole grains are easily distinguished from talcs.

If the presence of amphiboles is indicated by this technique, then confirmation should be sought by using an alternative method.

|   | NB: It is recommended that this method is not used unless the microscopist has been trained in the technique. |
## CTPA METHOD NO 8

**METHOD FOR THE DETERMINATION OF ETHYLENE OXIDE, ETHYLENE CHLOROHYDRIN AND ETHYLENE GLYCOL IN TALC**

<table>
<thead>
<tr>
<th>Summary</th>
<th>Ethylene oxide residues are extracted from the sample by treatment with carbon disulphide and the solution is analysed by use of gas liquid chromatography.</th>
</tr>
</thead>
</table>
| **Apparatus** | Gas chromatograph  
Vials with septum closures  
Hamilton syringe  
Fume cupboard  
Balance  
Carbon disulphide for GLC |
| **Procedure** | 5g of talc are weighed into a stoppered container and 10ml of carbon disulphide are added. The mixture is shaken for 20 minutes and then centrifuged to produce a clear supernatant liquor. An aliquot of the clear supernatant is transferred to a vial with a septum closure and 10 microlitres are then drawn from the vial and injected into the column of a gas chromatograph.  
The suggested chromatograph conditions are: |
| Column: | 2m glass, 2mm id, packing Chromosorb 101  
Oven Temperature: | 190°C  
Carrier Gas: | FID Detector  
Nitrogen at 30ml per minute  
The three compounds have also been determined on single samples by aqueous extraction using the technique outlined above.  
The chromatograph conditions were: |
| Column: | Glass 2m x 4mm id, packing Chromosorb 101  
Oven Temperature: | 190°C  
Carrier Gas: | FID Detector  
Nitrogen at 40ml per minute |
INTRODUCTION TO THE XRD REFERENCE PATTERNS

A new set of reference patterns was prepared for this edition of the monograph. They were prepared as follows. The instrument used was the Phillips model PW3710 diffractometer. (This was the instrument used by the CTPA member-company concerned, and does not imply CTPA endorsement of this instrument nor the exclusion of any other instrument of similar specification.)

The samples were prepared by back filling, the standard technique used by the laboratory concerned, not by surface abrasion as recommended in the monograph, but this should not make any significant differences to these patterns. A sample spinner was not available.

The operating conditions were as follows:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tube anode:</td>
<td>copper</td>
</tr>
<tr>
<td>Generator tension:</td>
<td>40 kV.</td>
</tr>
<tr>
<td>Divergence slit:</td>
<td>1°</td>
</tr>
<tr>
<td>Thin film collimator:</td>
<td>no</td>
</tr>
<tr>
<td>Lower level:</td>
<td>35%</td>
</tr>
<tr>
<td>Maximum 2θ:</td>
<td>154.000°</td>
</tr>
</tbody>
</table>

**Example of settings and data for identification of talc**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wavelength alpha 1:</td>
<td>1.52060A</td>
</tr>
<tr>
<td>Intensity ratio (α2/α1):</td>
<td>0.5</td>
</tr>
<tr>
<td>Start angle (°2θ):</td>
<td>5.000</td>
</tr>
<tr>
<td>End angle (°2θ):</td>
<td>59.980</td>
</tr>
<tr>
<td>Step size (°2θ):</td>
<td>0.020</td>
</tr>
<tr>
<td>Type of scan:</td>
<td>continuous</td>
</tr>
<tr>
<td>Scan speed (°2θ/s):</td>
<td>0.04</td>
</tr>
<tr>
<td>Scan duration (h:m:s):</td>
<td>0:22:55</td>
</tr>
</tbody>
</table>

**Example of settings and data for detection of amphiboles**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wavelength alpha 1:</td>
<td>1.52060A</td>
</tr>
<tr>
<td>Intensity ratio (α2/α1):</td>
<td>0.5</td>
</tr>
<tr>
<td>Start angle (°2θ):</td>
<td>9.600</td>
</tr>
<tr>
<td>End angle (°2θ):</td>
<td>13.200</td>
</tr>
<tr>
<td>Step size (°2θ):</td>
<td>0.020</td>
</tr>
<tr>
<td>Type of scan:</td>
<td>continuous</td>
</tr>
<tr>
<td>Scan speed (°2θ/s):</td>
<td>0.004</td>
</tr>
<tr>
<td>Scan duration (h:m:s):</td>
<td>0:15:00</td>
</tr>
</tbody>
</table>

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X-ray diffraction reference patterns

The talcs were selected to illustrate the following patterns:

1/1a. Talc complying with the CTPA specification. A trace of chlorite is present, otherwise no accessory minerals or contaminants.

2/2a. As (1) but slight differences in pattern.

3/3a. Talc complying with the CTPA specification. Chlorite and dolomite are present, and a trace of magnesite.

4/4a. As (3) but slight differences in pattern.

5/5a. Talc complying with the CTPA specification. Chlorite and quartz are present, also traces of dolomite and magnesite.

6/6a. As (5) but slight differences in pattern.

7/7a. Talc complying with the CTPA specification. Chlorite, dolomite, magnesite and quartz are present.

8/8a. Talc which does not comply with the CTPA specification. Chlorite, dolomite and amphibole are present.

For each talc, the first pattern is that obtained at normal scanning speed, the second is a slow scan over the amphibole region (see previous page.)
TRACE OF CHLORITE PRESENT
TALC COMPLYING WITH THE CTCA SPECIFICATION
REFERENCE XRD PATTERN 1.
Pattern 3 from No. 3
Chlorite & Dolomite Present, slight differences in
talc complying with the CTPA specification.
Reference XRD Pattern 4.
MAGNESITE. SLIGHT DIFFERENCES IN PATTERNS FROM NO. 5
CHLORITE AND QUARTZ PRESENT. TRACES OF DOLOMITE AND
TALC COMPLYING WITH THE CPA SPECIFICATION
REFERENCE XRD PATTERN 6.
REFERENCE XRD PATTERN 6a.
Chlorite, Dolomite, Magnesite and Quartz Present
Talc Complying with the CPA Specification
Reference XRD Pattern 7.
CHLORITE, DOLomite AND AMPHIBOLE PRESENT
TALC WHICH DOES NOT COMPLY WITH THE CPA SPECIFICATION
REFERENCE XRD PATTERN 8.