

Spotlight on talc

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TALC

Talcum powder is widely used but the properties of talc are not so widely known or understood, nor is it an easy material to analyse. Allegations about 'asbestos contaminated talc' may lead to legislation covering the processing of talc for use in toiletry products. The author discusses the problems and some possible consequences

The first commandment for the production of goods intended for personal use is that they must not harm the user. Safety must therefore be a prerequisite to any quality considerations.

Ethics apart, the awareness of that fact is now being rather forcibly brought home to the cosmetics industry, which is increasingly under fire from a 'consumerist movement' growing in strength and influence—especially since the mass-media have espoused its cause. Cosmetic manufacturers are also feeling the force of mounting legislative pressures.

The approach of the consumer to the 'problem' tends to be emotional. This is hardly surprising as the movement has originated as a backlash—a reaction of people who felt, rightly or wrongly, that they had been reduced from a status of those 'who were always right' to mere purveyors of money. Unfortunately, when power falls into hands of people with grievances—witness all revolutions—a lot of foolish, and unjust deeds are usually perpetrated. Indeed, the manner of summarily disposing of hexachlorophene, branded as a villain by the underinformed and sensation-seeking press ('The killer drug strikes again!'), bore all the signs of unreason and blind fury of a lynching mob.

The approach of the authorities, on the other hand, tends to be more doctrinaire, and the favourite approach is to take a well-established blueprint from one industry, and try to impose it on another. This may be convenient but is methodologically wrong, since it is tantamount to administering a remedy before diagnosing the complaint in the individual patient. Thus, when microbiology was making its painful entry into the cosmetics industry, it was obvious that the zeal of the well meaning specialist advisers greatly exceeded their knowledge of the problems peculiar to cosmetics. However, much of the blame for the difficulties then encountered was due to the cosmetics industry itself since it did not fully understand its own prob-

lems either. So now when the industry has acquired a new examining magistrate—Toxicology—and unnerving questions are being asked: 'Is your product toxic?' (1) it would be more appropriate to try and meet the challenge from the position of knowledge.

First, one must establish definitions and terms of reference. The US National Research Council defines toxicity as 'the capacity of a substance to produce injury', an inherent ability to bring about undesirable alterations in biological tissue.

If that is the case, the answer to the question would simply be: no! But does it automatically mean that our products are safe? Again: no! It merely means that a wrong question is being asked. It is common knowledge that any product for personal use represents a certain hazard. Although the cosmetics industry is reluctant to admit it, this applies to cosmetics as well, simply because two factors are always involved: the product, as well as the user—the latter being beyond the industry's control. And a situation which may arise is summed up succinctly in that old adage about one man's meat and another's poison.

This ever present hazard is defined by the US National Research Council as 'the probability that injury will result from the use of the substance in the quantity and manner proposed'. The key question should thus be: 'What hazard may be incurred by the use of your product?' The answer to that question, however, involves not only the inherent toxicity of the ingredients, but also their level, their possible physicochemical interaction which may potentiate or attenuate the effect as well as a possibility of secondary toxicity due to the deterioration of the product, as a result of microbial spoilage or rancidity, for example. Furthermore it will also depend on the mode of the application of the product, the frequency and duration of usage, on the site of application, and on whether the product is left on the body surface or is removed etc.

It may also be added that the assessment of hazard should include the possible misuse or abuse of the product because, to quote Dr Schaffner of the FDA, 'It falls upon all of us to protect the fools, the damn fools, and even the goddamn fools.' (2)

From all this it is obvious that the industry's own scientific personnel—assuming their knowledge and integrity—are better equipped to assess

the overall hazard of a cosmetic product than specialists in any single discipline, be it microbiology or toxicology, who are likely to be conscious only of one aspect of the product.

The case in point was illustrated when the author's company submitted a new product to a consultant for a dermatological evaluation, enclosing the formula, and samples of all the ingredients. In his assessment, the dermatologist condemned one of the ingredients, namely di-isopropanolamine as being a primary irritant, and recommended removing it from the formulation. He was right, of course, from the toxicity point of view; the misunderstanding rested however in his not appreciating the fact that DIPA was used in the formula for stoichiometric neutralisation of an acid component, did not appear in a free state in the finished product, and therefore did not represent any hazard.

There are, however, other, unpredictable, sources of hazard. The cosmetics industry uses ingredients of predominantly GRAS (generally recognised as safe) status, but occasionally the results of research, or simply accumulated evidence, bring to life some hitherto unknown harmful properties of an ingredient. This is quite a common occurrence in the pharmaceutical industry which, in the first place, uses materials which are physiologically active (and thus toxic by definition) and where possible long term untoward side effects are routinely watched. Should such a situation arise, the matter is assessed on a basis of the facts, reappraisals are made, and suitable steps taken—usually consisting of one of the following courses of action:

- (a) When the findings prove to be too harmful, and the risk too great, the ingredient is dropped altogether, or replaced.
- (b) When benefits outweigh the hazard, and no suitable alternative is available, a 'calculated risk' solution is adopted, moderated by increased watchfulness.
- (c) The ingredient is used as in (b) but attempts are made to abolish or minimize the risk by, for instance, adjustments in posology, using some additives, etc.

We witnessed such a situation only a few months ago when phenacetin, a drug with a long record of safety, had been found to be—on

prolonged use—damaging to the kidneys. The outcome of that was completely matter of fact; without much fuss, sensation-mongering or publicity, phenacetin lost its OTC drug status, and was put on prescription whereby it could be more closely controlled.

The same approach applies, or at least should apply, to the cosmetics industry, although—as mentioned before—the industry is psychologically handicapped to admit any faults of a toxicological nature. Thriving on imponderables it is, by the same token, extremely prone to rumours and panics. Nevertheless, we have such a situation on our hands at the moment.

Talc, which is one of the oldest, most important and most commonly used ingredients of cosmetics and toiletries, has come under fire as being — allegedly — contaminated with asbestos, a material tainted with sinister carcinogenic connotations.

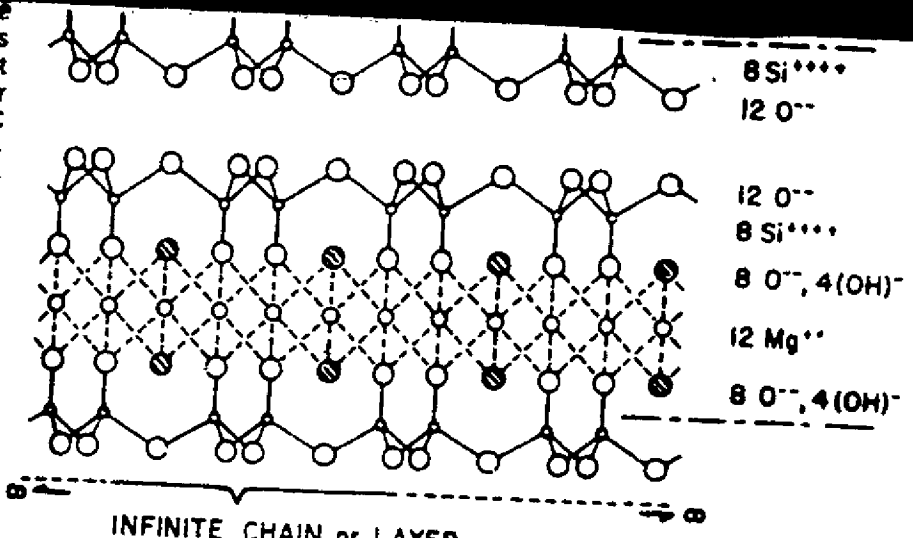
An ominous phrase 'asbestos in talc' begins to crop up in various publications, scientific and lay ones alike—and whether we like it or not—we have to face the issue and take appropriate decisions, before another 'Casus Hexachloropheni' takes place. However, decisions arise from judgement, and this can only be as good as the knowledge backing it. Therefore we must get acquainted with all the facts available, starting with definitions and terms of reference.

We—of course—all know what talc is. But do we? For a start it appears that 'talc' can mean three different things — depending on whether we have in mind talc as a chemical compound, a mineral, or a commercial product.

Talc, as a pure chemical compound, is defined as hydrous magnesium silicate, with the formula, first suggested by Pauling(3) as $Mg_3(Si_2O_5)_2(OH)_2$ or $3MgO \cdot 4SiO_2 \cdot H_2O$. The latter mode of presentation of the formula may be convenient—inasmuch as it indicates ratios of the components in the compound but it must be considered unlikely that a normal molecule of water exists in the crystals. Differential thermal analysis studies carried out by Pask and Warner(4) showed that purer talc samples exhibited one, predominant endothermic peak at about 975°C—apparently indicative of the breakdown of the talc molecule with evolution of the chemically combined H_2O . In view of that, perhaps more correct nomenclature would be 'basic', instead of 'hydrous'.

Its theoretical chemical composition expressed in terms of oxides is thus:
 MgO 31.90%, SiO_2 63.40%, combined H_2O 4.70%.

The suggested formula was ultimately confirmed experimentally by Bowen and Tuttle(5) who succeeded in producing synthetic talc as a



INFINITE CHAIN or LAYER
 $(OH)_2Mg_3Si_4O_{10}$ or $(OH)_2Mg_3(Si_2O_5)_2$ - TALC

Fig 1 Atomic structure formula of pure talc compound

crystalline solid solution—only at the equivalent ratio of MgO to SiO_2 of 3:4.

Apart from establishing the chemical composition, Pauling also suggested for talc its crystal atomic structure formula as being a layer lattice mineral. This initial suggestion was later proved correct by Gruner(6) who used X-ray diffraction techniques, and furthermore, substantiated on a ground of theoretical considerations by Hendricks.(7)

The idealised diagram of talc structure illustrating the above mentioned concept is shown in fig 1.

The diagram represents an edge view of a 'layer' of talc extending indefinitely in all directions in a plane perpendicular to paper. The picture is a projection of a three-dimensional lattice. Thus, looking along the axes of SiO_4 chains it must be realised that alternate Si ions are situated underneath and above the plane of paper, forming a sort of 'zig-zag'. The two outer parts of the 'layer' composed of Si^{++++} and O^{--} in a form of a hexagonal network are called 'silica sheets'. The middle part, composed of Mg^{++} ions bordered on both sides by O^{--} and $(OH)^-$ ions is called 'brucite sheet'. Thus a talc 'layer' or infinite chain, consists of a 'brucite sheet' sandwiched between two 'silica sheets', the constituent sheets being held primarily by ionic bonds whose relative strength determines such properties of the compound as its specific gravity (2.6-2.8) and hardness. (About 1 on Mohs' scale). The layers, however, being electrically neutral, are held together only by, relatively weak, residual, or van der Waal's forces. As a result of that, adjacent layers subjected to even a slight shear, easily get detached, and slide across one another which accounts for the familiar unctuous feel of talc, usually referred to as 'slip'. This, together with its intrinsic and subjective softness, chemical

inertness, good colour and attractive, pearly lustre, makes talc a raw material of choice for powder based products.

Needless to say, however, that monoclinic crystals of such pure hydrous magnesium silicate are extremely rare.

Not so with the Talc—mineral; it is of widespread occurrence and known and exploited since antiquity. Its massive, crystalline, orthorhombic form, being soft and sectile, was used for carving by the ancient Egyptians, Assyrians and Chinese. The mineral was described by Theophrastus and Pliny, who conferred upon it its present mineralogical name 'steatite' while its commercial name has been contributed by the Arabs ('talq'). Various folk lores referring to the mineral's tactile properties provided its other semi-official names like 'soapstone' or 'lardstone', while its silvery lustre was responsible for the poetic Roman description of 'stella terrae' or the mocking German phrase 'Katzensilber'.(8)

Apart from its compact form, talc most often occurs in foliated to fibrous masses, which are easily separated into thin, very flexible, non-elastic laminae. However, depending on the deposits from which they originate, these particles may also be tabular, granular, fibrous, or variegated, as well as the most desirable 'lamellar' or 'platy' types.

Those physical differences, as well as widely differing chemical analyses even of samples freed from extraneous impurities, and accessory minerals, and appearing homogeneous by petrographic examination, made talc something of a riddle and many apparently conflicting theories have been put forward as to its origin(9) (10). The key, however, to understanding the problem of talc—provided by geological studies—is to realise in the first place that talc is a