

Epochemick Industries Vs. Collector of Central Excise

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Court : Customs Excise and Service Tax Appellate Tribunal CESTAT Delhi

Decided On : May-08-1985

Reported in : (1986)(6)LC17Tri(Delhi)

Appellant : Epochemick Industries

Respondent : Collector of Central Excise

Judgement :

1. The product is a diglycidal ether of bisphenol A. It is claimed by the manufacturers M/s Epochemick Industries, Madras, that this product is not included in item 15A(1) (i) of the Central Excise Tariff. They informed the Assistant Collector of Central Excise, Madras IV Division that their product was not formed by condensation, polycondensation or polyaddition polymerisation reactions. The Assistant Collector rejected the claim and passed an order C.No. V/15A/30/103/77 VC, dated 13-11-1978 saying that the Chemical Examiner and the Chief Chemist, both said that the product was an epoxy synthetic resin and that it was a synthetic resin poly-condensation product. He, therefore, classified it under Item 15A(1) (i). The appeal before the Appellate Collector of Central Excise, Madras also failed as can be seen from his order No.2316/80, dated 22-12-1980.

2. The appeal before us was heard on 25-3-1985. The counsel for M/s Epochemick reiterated the arguments made before the Assistant Collector and the Appellate Collector that this was not a condensation product and gave the definition of what a condensation product was. It was a reaction in which polymers are formed with resultant by-products like water or alcohol, etc. In the reaction to

produce these goods, no by-product was formed or spilt out.

3. Most authorities agree that separation of water or other byproduct results from the condensation polymerization to form polymers. But there are authorities contrary to Epochemick's assertions which hold that the formation of a side product is not always necessary for condensation polymerisation to take place. This is how condensation is described in GLOSSARY OF CHEMICAL TERMS Second Edition (Clifford A.Hampel & Gessner G. Hawley) A condensation polymer is a linear or three-dimensational macromole-cule resulting from a catalyzed reaction between two organic molecules, often of the aldehyde or ketone type, usually with the formation of water or an alcohol as a byproduct.

Note the word "usually". This is evidence that the formation of a byproduct is not inevitable in every case of condensation polymerisation. The book PLASTICS MATERIALS Fourth Edition (J.A.Brydson) describes condensation polymerization at page 36 thus- In this form of polymerization, initiation and termination stages do not exist and chain growth occurs by random reaction between two reactive groups. Thus in contradistinction to addition polymerization an increase in reaction time will produce a significant increase in average molecular weight. An increase in temperature and the use of appropriate catalysts, by increasing the reactivity, will also increase the degree of polymerization achieved in a given time.

In the case of linear polymer it is often difficult to obtain high molecular weight polymers.

It is to be noted that only one condensation reaction is necessary to convert two molecules with values of $X=100$ to one molecule with $X=200$. A similar reaction between two dimers will produce only tetramers ($X=4$). Thus although the concentration of reactive groups may decrease during reaction, individual reactions at later stages of the reaction will have greater effect.

This book says nothing about separation or elimination of any byproduct during the condensation reaction.

4. PLASTICS CHEMISTRY AND TECHNOLOGY (Walter E. Driver) has this to say on condensation polymerization :- Condensation polymers are formed by a series of chemical reactions.

These reactions involve two active sites which can join to form a chemical bond. Byproducts are given off by many of these reactions.

A clear implication that though byproducts are given off by many reactions, some condensation reactions produce no byproducts. The same book at page 53 on Epoxy Resins says :- Epoxy resins do not give off byproducts during cure. As a result, the cure shrinkage is low. These resins have good adhesion to most materials. A wide selection of resins is available for potting, bonding, laminating, coating, etc. Epoxy resins are identified by the presence of two or more epoxide rings per molecule.

The most common types of epoxy resins are made from bisphenol A. Bisphenol A is derived from phenol and acetone (the A denotes acetone) Epichlorohydrin is reacted with bisphenol A to produce an epoxy-terminated molecule with two epoxide groups.

5. There are certain significant passages in the TEXTBOOK OF POLYMER SCIENCE Second Edition (Fred W. Billmeyer, Jr.) which presents this reaction thus- The epoxy resin used most widely is made by condensing epichloro-hydrin with bisphenol A, diphenylol propane. An excess of epichlorohydrin is used to leave epoxy groups on each end of the low-molecular-weight (900-3000) polymer : Depending on molecular weight, the polymer is a viscous liquid or a brittle high-melting solid.

6. MODERN PLASTICS TECHNOLOGY (Raymond B. Seymour) explains epoxy resin by saying that glycidyl ethers are prepared by the condensation of epichlorohydrin and monofunctional phenol. The book says that the curing of the epoxy resin intermediate is sometimes called a condensation reaction, but this is also incorrect since the resinous product is produced exclusively in the absence of any byproducts. The term step reaction polymerization is preferred.

7. There is an argument by M/s Epochemick that their product diglycidal ether of bisphenol A is not a resin. They prepare a resin out of this by addition of a curing agent. The reaction process by which the diglycidal ether of bisphenol A is prepared is described by M/s Epochemick as follows :- The first step is the formation of the sodium salt of bisphenol A. Here it is formally represented as a disodium salt. The reaction is classified as neutralisation. The second and most important step is a nucleophilic substitution on the epoxy carbon in which the C-O bond of the epoxide ring is broken and a new C-O bond between the oxygen of bisphenol and the epoxy carbon is formed. The resultant product is a chlorohydrin in equilibrium with its sodium salt. The latter is shown in the representation. The last step is the removal of a molecule of sodium chloride with the concomitant formation of the epoxy ring. This is a nucleophilic substitution in which the terminal C-C1 bond is replaced by a C-O bond leading to the formation of an epoxide ring.

Thus, say M/s Epochemick, it can be easily seen that none of the reactions involved in the synthesis of the glycidyl ethers can be called a condensation reaction. The reactions involved are neutralization and nucleophilic substitution at a saturated carbon.

8. Mrs. Zutshi who appeared on behalf of the department pointed out to the order of the Assistant Collector which explains the matter in sufficient detail. The party relied on the June, 1977 amendment of the tariff item to deduce that before its specific inclusion, epoxy resin would not fall in item 15A(1) (i). The party forgets that an epoxy resin is a product of condensation reaction and was, therefore, included in this item even before June, 1977. The chief chemist has given his opinion that this reaction was a condensation reaction and that the products were epoxy resins.

9. In TEXTBOOK OF POLYMER SCIENCE (Fred W. Billmeyer, Jr.) second edition there is an article on epoxy resins which are described as fundamentally polyethers, but retained their name on the basis of their starting material and the presence of epoxide group in the polymer before cross-linking.

10. The epoxy resin used most widely is made by a condensing epichlorohydrin with bisphenol A, diphenylol propane.

11. In MODERN PLASTICS TECHNOLOGY (Raymond B. Seymour) epoxy resins are described at pages 154-155. The article says that- Glycidyl ethers were prepared by the condensation of epichlorohydrin and monofunctional phenol by Lindermann in the last part of the nineteenth century.

12. These authorities prove that the reaction that produced Gebriez 500 involved condensation. Therefore, M/s Epochemick were in error when they say their goods was not a condensation product. The chief chemist also gave his opinion after testing the sample that the product was an epoxy resin.

13. The reference to the styrene monomer by the factory is irrelevant because this is not styrene ; the trade notice would not help in the assessment of this product. The party admits that it is an epoxide. The public notice concerning Polyol issued by the Madras Custom House has no relevance because the product here has a fixed chemical composition.

Certain opinion of experts had been produced ; one is written by Dr.

S.R. Ramadas, Professor of Chemistry Indian Institute of Technology and the other by Dr. V. Thiagarajan, Professor and Head of the department of Chemistry, Ramakrishna Mission College but these are new evidences and cannot be accepted. However, she pointed out that in Dr. Ramadas's written opinion the last sentence runs thus- These compounds are classified simply as epoxy ethers or epoxides. This sentence completely contradicts the party's claim. The reaction is not a nucleophilic substitution but a polymerization.

14. These glycidyl ethers marketed by M/s Epochemick are used to prepare resins by addition reactions with curing agents. It appears also that these ethers have very low molecular weight of about 1,000 or less. The book PLASTICS CHEMISTRY AND TECHNOLOGY (Walter E. Driver) gives the molecular weight of the simplest form of bisphenol A epoxy at 340 (page 54). Certain other solid bisphenol A epoxies have molecular weight of 2,009 to 3,000. This resin has to be hardened, usually with an amine hardner to form a hard high polymer plastic. The form in which it is presented for assessment would not appear to be one to qualify for it the name of artificial resin under the central excise tariff. An artificial resin has

been defined as a man-made high polymer resulting from a chemical reaction between two or more substances. A high polymer is defined as an organic macromolecule composed of a large number of monomers. The molecular weight may range from about 5,000 into the millions. The reaction that has taken place in this product is the reaction of bisphenol A and epichlorohydrin. The book PLASTICS MATERIALS (J.A. Brydson) page 669 records that diglycidyl ether has a molecular weight of 340. Many of the well-known commercial liquid glycidyl ether resins have average molecular weights in the range 340-400. Higher molecular weight products may be obtained by reducing the amount of excess epichlorohydrin and reacting under more strongly alkaline conditions which favour reaction of the epoxide groups with bisphenol A. The book further reports that since commercial resins seldom have average molecular weights exceeding 4,000, it will be realised that in the uncured stage the epoxy resins are polymers with a low degree of polymerisation. It is evident from this that the diglycidyl ether bisphenol A product does not become a true high polymer until it is cured with a hardner.

15. The goods were described by the party as diglycidyl ether of bisphenol A. The party has given a description and the reaction leading to this product. We have seen the steps and chemical equations. The party says that it is not a condensation reaction that produced the product but that the reaction involved is a neutralization and nucleophilic substitution of a saturated carbon. At the relevant time, the central excise tariff item 15A did not list epoxide resins as it does now. Before 18-6-1977, the item covered- ARTIFICIAL OR SYNTHETIC RESINS AND PLASTIC MATERIALS AND ARTICLES THEREOF (1) Artificial or synthetic resins and plastic materials in any form, whether solid, liquid or pasty, or as powder, granules or flakes, or in the form of moulding powders, the following namely- (i) Condensation, polycondensation and polyaddition products, whether or not modified or polymerized, including pheno-plasts, aminoplasts, alkyds, polyamides, polyurethane, polyallyl esters and other unsaturated polyester. (The rest of the item is not reproduced, as it is not relevant).

16. From 18-6-1979, item 15A underwent a change although the essential contents remained the same. For our purpose, the most important change was

inclusion of "epoxide resins" in 15A(1) (i). The appellants argued that the goods fell outside 15A because under the old tariff item only condensation, polycondensation and polyaddition products could be included and since epoxy resins are not condensation nor addition polymerization products, they would not fall in this item. The counsel said that the Chief Chemist did not say very much in his test report.

He wrote- It is seen from the party's letter that the sample under reference is diglycidal ether of bisphenol A, a condensation product of bisphenol A with epichlorohydrin.

The Chief Chemist went on to say that the sample was in the form of a pale yellow coloured brittle solid. It was epoxy synthetic resin and had thermoplastic properties.

17. What was required from the Chief Chemist was to state if this was a condensation polymerization, a reaction in which a byproduct like water or alcohol, etc., is eliminated to form the polymer. There has been no such elimination of water or any other product in this reaction. Such a reaction is not known in polymer science and technology as a condensation reaction.

18. The appellants' counsel said that as reproduced in the Assistant Collector's order, the reaction has three stages, one of which is the removal of sodium chloride in the second stage. This cannot mean that there has been a condensation reaction. There has been no suppression or evasion of any kind. The Assistant Collector does not say that there has been a condensation. Even if it is held that the product is a synthetic resin, it will not fall under 15A of the period because it is not a condensation product. The Assistant Collector banks on the inclusion of epoxide resin after June, 1977, as if this would change the coverage before that date. This is not possible and cannot be the interpretation. He prayed that the Appellate Collector's order be set aside.

19. This problem has been complicated by the fact that the Chief Chemist did not give a clear finding as to whether the diglycidal ether of bisphenol A was a condensation polymerisation product. But there are sentences in his report which

support the assessee. One goes thus- The following information are available in the books available here.

Epoxy resins are generally based on the reaction between epichlorohydrin and bisphenol A. The combination of the above initially results in an intermediate diglycidyl ether of bisphenol A which is thermoplastic in nature and is also called as 'epoxy resins'. These intermediates vary in molecular weight from 890 to 2900 and are either honey coloured liquid or amber coloured solids requiring hardening agents i.e. diamines or dibasic anhydrides for further reaction to form the finished product, thermosetting resins.

20. The Chief Chemist confirms what we thought about this product, namely, that the diglycidyl ether of bisphenol A is only an intermediate in the production of the epoxy resin. This intermediate has molecular weight from 890 to 2900, too low for a high polymer which is understood to be the basis for all artificial and synthetic resins of the type covered by item 15A of the central excise tariff. The CONDENSED CHEMICAL DICTIONARY (Gessner G. Hawley) describes a synthetic resin as a man-made high polymer resulting from the chemical reaction between two or more substances. It describes high polymer as an organic macromolecule composed of a large number of monomers. The molecular weight may range from about 5000 into the millions. It gives the dividing line between low and high polymers as being in the neighbourhood of 5000 to 6000 molecular weight. The GLOSSARY OF CHEMICAL TERMS (Clifford A. Hampel and Gessner G. Hawley) defines a high polymer as a natural or synthetic polymer of high molecular weight i.e. 5000 or more. The book PLASTICS CHEMISTRY AND TECHNOLOGY (Walter E. Driver) explains in Chapter 2 that a molecular weight is customarily used to represent the molecular size. Thus, if a polymer of ethylene contained 1,000 molecules of ethylene per molecule, the polymer's molecular weight can be computed as Polymerization takes place when a large number of monomers link together to form very large molecules-the polymer ; and as the size of the molecule changes so do the properties of the product. Ethane, with number of carbon atoms of 2 is gaseous and weak. With the number of atoms between 3,000 to 350,000 after polymerization it becomes a high molecular weight polyethylene, stiff, strong and solid.

21. These products have molecular weight of 890 to 2900. The Chief Chemist himself calls them intermediates requiring hardening agents like diamines and anhydrides to form the finished products i.e.

thermosetting resin. In this he is unquestionably correct. This is further confirmation for the view that the diglycidal ether of bisphenol A is not a high polymer resin classifiable under 15A. In the book quoted by the learned counsel for the department TEXT BOOK OF POLYMER SCIENCE, page 262 contains the following formula reaction on nucleophilic substitution reactions- These reactions are important from the standpoint of commercial organic polymers primarily because of their use in the polymerisation of epoxides. The most common epoxide monomer is epichlorohydrin, which reacts with a nucleophile. Typically, the nucleophile is a bifunctional hydroxy compound such as bisphenol A.²² The GLOSSARY OF CHEMICAL TERMS Second Edition (Hampel and Hawley) describes a high polymer as a natural or synthetic polymer of high molecular weight (i.e. 5,000 or more). Such polymers may contain as many as several thousand monomer units, the molecular weight sometimes running into the millions.

23. The ENCYCLOPAEDIA OF CHEMICAL TECHNOLOGY (Kirk-Othmer) third edition describes POLYMERS (page 745 first three paragraphs).

24. It is clear that the stage to which the reaction progressed to produce the products before us was to produce the monomer/prepolymer from which the thermosetting epoxy resin is to be produced. The monomer is an epoxide. Epoxy resins are identified by the presence of two or more epoxide rings per molecule.

25. In the paragraphs below we shall discuss epoxides briefly to illustrate the significance of this.

26. In MODERN PLASTICS TECHNOLOGY another book cited by the learned Mrs. Zutshi, there is a paragraph at page 155 thus- The Classical intermediate, and the one accounting for 85% of all production of epoxy resins, is a diglycidyl ether produced by the gradual addition of sodium hydroxide to promote the condensation of more than 2 moles of epichlorohydrin and 1 mole of bisphenol A

[2, 2'-bis (4-hydroxyphenyl) propane] at 60C.27. This paragraph is significant for more reasons than one. The condensation that it speaks of here is not the condensation of polymerization, but the condensation to produce the (diglycidyl) ether (of bisphenol A). The author regards this diglycidyl ether as the intermediate, accounting for 58% of all production of epoxy resins.

28. PLASTICS AND TECHNOLOGY by Walter E. Driver reports that epoxy resins give off no byproducts during cure. The most common types of an epoxy resins are made from bisphenol A reacted with epichloro-hydrin to produce an epoxy terminated molecule with two epoxide groups. The simplest form of bisphenol A epoxy has a molecular weight of 340. Since there are two epoxide groups, equivalent weight is 170.

29. PLASTICS MATERIALS (Brydson) tells us that the first and still most important commercial epoxide resins are reaction products from bisphenol A and epichlorohydrin. It reports at page 668 that most epoxide resins are of low molecular weights. Many of the commercial liquid resins consist essentially of low molecular weight diglycidyl ether of bisphenol A together with small quantities of higher molecular weight polymers. The formation of the diglycidyl ether is said to result in hydrochloric acid reacting with caustic soda to form sodium chloride. In the next page (669), we read that diglycidyl ether has a molecular weight of 340. Many of the well-known commercial liquid diglycidyl ether resins have average molecular weight in the range of 340 to 400 ; it is, therefore, obvious that these materials are composed largely of the diglycidyl ether.

30. From their nature, epoxides, although resinuous and in many ways behaving like resins, are not high polymers. Kirk-Othmer's ENCYCLOPAEDIA OF CHEMICAL TECHNOLOGY tells us that the fact that epoxides polymerized under thermal ionic and free-radical catalysis has encouraged considerable research on epoxy homopolymers and copolymers for industrial applications, and speaks of the commercial usefulness of epoxies, particularly as chemical intermediates. Epoxidation is the formation of cyclic three-membered ethers (oxiranes) by the reaction of peracids and hydrogen peroxide with olefinic and aromatic double bonds.

Oxiranes may also be formed by an internal S_N2 reaction of a chlorohydrin. The three membered ethers formed are also designated as 1, 2 epoxides.

31. There can be no further doubt now that the products whose assessment we have to decide is an epoxide, an ether. The very name of the product viz. diglycidyl ether of bisphenol A shows that it is an ether.

32. Ethers are compounds of the general formula Ar-O-Ar', Ar-O- R', and R-O-R' whether A(sic) is any aryl group and R is any alkyl group. If the two R or Ar groups are identical, the compound is a symmetrical ether. Examples of symmetrical ethers are methyl ether, CH₃OCH₃, and phenyl ether, C₆H₅OC₆H₅; examples of unsymmetrical ethers are methyl ethyl ether, CH₃OCH₂CH₃, and methyl tertbutyl ether, CH₃OC(CH₃)₂.

Cyclic ethers are oxygen heterocycles such as tetrahydrofuran, OCH₂CH₂CH₂CH₂, p-dioxane, OCH₂CH₂CH₂CH₂CH₂CH₂O, and 1, 2-propylene oxide, CH₃CHCH₂O.

33. The CONDENSED CHEMICAL DICTIONARY (Gessner G. Havvley) gives the manufacture of polymer as one of the uses to which an ether is put.

34. Having seen the above, we can now appreciate better the opinions given by the experts, Dr. Ramadas and Dr. Thiagarajan. Dr. Ramadas gives as his opinion that diglycidyl ether of bisphenol A (Gebirex 500) is not produced by condensation or polycondensation or addition polymerization and that it is useful as a monomer in the production of polymers or resins. These compounds should be classified simply as epoxy ethers or epoxides. Dr. Thiagarajan also says that in his opinion the reaction was a typical nucleophilic substitution reaction and that it produced diglycidyl ether of bisphenol A which is not formed by condensation reaction. He opined further that diglycidyl ether of bisphenol A was only an epoxy ether and was not a polymer formed by condensation reaction.

35. This opinion agrees with what we learn in TEXT BOOK OF -POLYMER SCIENCE (Billmeyer, Jr.) that the most common epoxide monomer is epichlorohydrins which reacts with a bifunctional hydroxy compound such as

bisphenol A, and finds further confirmation in MODERN PLASTICS TECHNOLOGY (Seymour) which reveals that glycidyl ethers were prepared by the condensation of epichlorohydrin and monofunctional phenol by Linderman in the 19th century to produce a difunctional phenol. The book says in the same Section (7'6 Epoxy Resins) that the classical intermediate and the one accounting for 85% of all production of epoxy resins is a diglycidyl ether produced by the gradual addition of sodium hydroxide to promote the condensation of more than 2 moles of epichlorohydrins and 1 mole of bisphenol A at 60C. Whether the intermediate is liquid or solid depends on the extent of the reaction.

36. The ENCYCLOPAEDIA OF CHEMICAL TECHNOLOGY (Kirk-Othmer) Vol. 9 gives this account at page 274. Liquid epoxy resins may be synthesized by a two step reaction of an excess of epichlorohydrin to bisphenol A in the presence of an alkaline catalyst. The reaction consists initially in the formation of the dichlorohydrin of bisphenol A, and further reaction via dehydrohalogenation of the intermediate product with a stoichio-metric quantity of alkali. (The words "initially" and "intermediate" in the preceding sentences clearly indicate that what is formed initially in the reaction is the intermediate. This is the substance we are dealing with).

The use of a large excess of epichlorohydrin minimizes the formation of higher molecular weight species i.e. further reaction of the diglycidyl ether of bisphenol A with bisphenol A results in the formation of polymeric species.

37. The factory itself told the Assistant Collector and other central excise authorities that the product had a molecular weight of about 1,000 or even less. This alone would have been sufficient indication that it was not a polymer. The Chief Chemist says the intermediates had molecular weight of less than 2900, a figure too low for a high polymer. There has not been any effective answer by the department to the arguments given by the factory that its product was not a resin assessable under item 15A ; but after what we have seen above, we have to conclude that this product is not a resin polymer classifiable under 15A of the Central Excise Tariff. We need not go too much into whether it was a condensation product. There appears to have been a condensation in the

formation of the epoxide ether, but in order to be a product attracted into item 15A, it must be a condensation to form the polymer, i.e. a condensation polymerization. This was not the reaction.

38. But we do not agree with M/s Epochemick that condensation polymerization much result in splitting out or in the elimination of a byproduct (water, alcohol, etc). There are sufficient authorities to indicate that splitting out or elimination of byproducts does not always accompany or result from condensation polymerization, though such is frequently the case. We have already reproduced at the beginning of this discussion what several authorities say on this subject. Besides these, we have the *ENCYCLOPAEDIA OF CHEMICAL TECHNOLOGY* (Kirk-Othmer) Vol. 18. At page 747 it writes condensation or step-reaction polymerisation, is entirely analogous to condensation of low molecular weight compounds in polymer formation, the condensation takes place between two polyfunctional molecules to produce a larger polyfunctional molecule, with the possible elimination of a small molecule such as water. The reaction continues until almost all of one of the reagents is used up ; an equilibrium is established, which can be shifted at high temperatures by controlling the amounts of the reactants and products.

39. We find here a clear proposition that elimination of a byproduct such as water is by no means a certainty ; only a possibility.

40. The learned Mrs. Zutshi said that the two written expert advices preferred before the Bench should not be accepted as they were new evidences. But she herself relied on one of them to buttress her arguments. Furthermore, these are only the opinions of experts on a highly technological and difficult subject. As a matter of fact, we cannot have too much expert opinions in a case like this. At any rate, the Tribunal is at liberty to reject an advice, but these two experts' opinion is confirmed as we have found, by good and authoritative written works of high repute. They say no more than is said by texts of scientific publications.

41. We accordingly adjudge M/s Epochemick's goods not assessable under item 15A. We set aside the orders of the Appellate Collector and the Assistant Collector.

