ENVIRONMENTALLY COMPATIBLE RECYCLING OF HIGH PERFORMANCE FUSE LINKS

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Everyone knows how important the environment is to us all and how we must all do whatever we can to help protect it. Industry too has an important role to play, not only by employing manufacturing processes that cause as little harm as possible to the environment in the first place but also by ensuring that when its products come to the end of their lives they can be disposed of safely and efficiently.

The task of the Verein zur Förderung des umweltgerechten Recycling von abgeschalteten NH/HH-Sicherungseinsätzen e.V., a non-profit association established by German fuse manufacturers, is to process the various materials of which fuse links are made so that they can be returned to the cycle of manufacture for further use. In 1998, for example, the association collected and recycled more than 140 tonnes of materials. It is currently estimated that, in Germany alone, this figure could be increased to around 600 tonnes. Other manufacturers and users are being encouraged to participate in the project.

The practice of simply disposing of old products at the refuse tip without a moment's thought for their recycling potential is not only frowned upon these days from the point of view of social responsibility for future generations but, in many cases, it is actually illegal too.

The law demands environmentally-compatible recycling and disposal

Article 1 § 22 of the German legislation on environmentally-compatible recycling and waste disposal states that products must be designed in a way which, at the end of their service life, allows the materials which they are made of to be recycled and any waste disposed of in an environmentally-compatible manner. Another requirement of the legislation is that products must be returnable and any recyclable waste must be used again.

Since most products are made of a very wide variety of different materials it is no easy task to take them apart and recycle each raw material separately. Plastics, for example, are often joined by thermowelding processes whereas other parts are either screwed, bolted, soldered, welded or bonded. This means, of course, that disassembly is very labor-intensive and therefore costly. In addition, the process of disassembly also has its dangerous side, such as when asbestos gaskets, glass-fiber-reinforced plastic parts, solders containing harmful substances, etc. have been used in the original items.

Recycling symbols clarify matters for users

Environmental protection and waste disposal do not come free-of-charge so a thorough fundamental analysis must be carried out first in order to determine whether recycling, disposal or separation is the most appropriate course of action as far as the environment and safety are concerned. For example, if the process of recycling consumes more energy than the manufacture of a new product it is obvious that an alternative solution will have to be found. Also, the environmental legislation in Western Europe is stricter than elsewhere so inevitably it becomes a factor in the commercial market-place involving, say, our competitors in Asia. This means that it is important for the customer to be made aware of the reason for any higher price that might be involved. Consequently, it is necessary to identify the products as having been manufactured by environmentally-compatible processes and being suitable for disposal by environmentally-compatible means - "recycling symbols" are used.

As far as the electrical industry is concerned, a ground-breaking initiative has been taken by the German manufacturers of low-voltage and high-voltage high-breaking-capacity fuse links. Even before the most recent German legislation on recycling came into force customers had begun asking the manufacturers of fuse links if they could set up a methodical system which would allow used fuse links to be returned for environmentally-compatible disposal. As a result, several fuse manufacturers began offering and charging

for a disposal service for used fuse links. Then, in 1995, with the aim of putting the subject of environmentally-compatible disposal on a regular footing, a number of the manufacturers involved (Fritz Driescher KG, Efen GmbH, M. Schneider-Annaberg GmbH, Jean Müller GmbH, Siba GmbH and Siemens AG) joined forces with the ZVEI (Zentralverband Elektrotechnik- und Elektronikindustrie) and, through an initial working party, established the non-profit-making "Verein zur Förderung des umweltgerechten Recycling von abgeschalteten NH/HH-Sicherungseinsätzen", otherwise known as "NH/HH-Recycling", registered in Regensburg and with its Head Office in Frankfurt.

Recycling the products and materials of 20 years ago

For many applications, fuse links represent a relatively cheap and safe way of providing protection for electrical systems and equipment. L.v. h.b.c. (NH) fuse links (low-voltage high-breaking-capacity) are used in low-voltage installations and h.v. h.b.c. (HH) (high-voltage high-breaking-capacity) fuse links in medium-voltage installations. The volume of the l.v. h.b.c. fuses varies between 45 and 900 cm^3 (5 to 15 cm long and 3 to 10 cm wide). The h.v. h.b.c. fuses, on the other hand, are substantially larger: 20 to 65 cm long and 5 to 8.5 cm in diameter. The service life of these fuses, provided they are not called upon to blow, is approximately 20 years, which is well above the average life of most other types of electrical equipment. This means that, with these long-life products, recyclers are having to deal with materials that were in common use 20 years ago. In "old" fuse links, for example, asbestos was still being used as a jointing material. Fig. 1 shows a cross section through an l.v. h.b.c. fuse link and lists the other materials used in its construction; similarly Fig. 2 illustrates an h.v. h.b.c. fuse link.

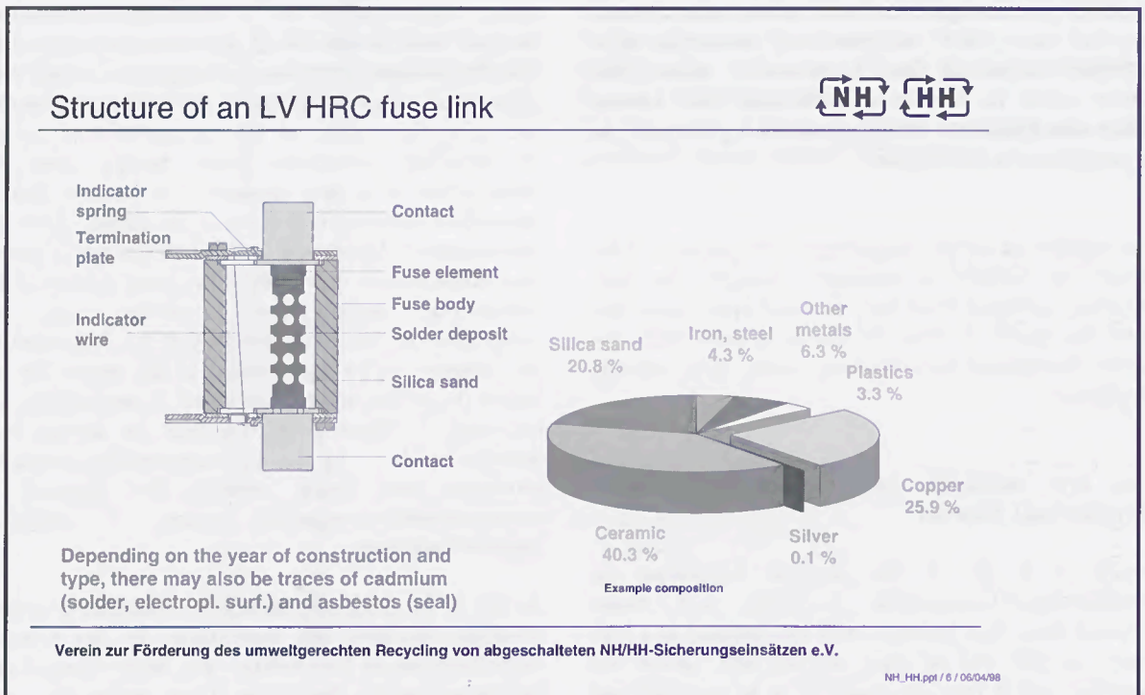

Figure 1: The constituent materials of and a section through an l.v. h.b.c. fuse link

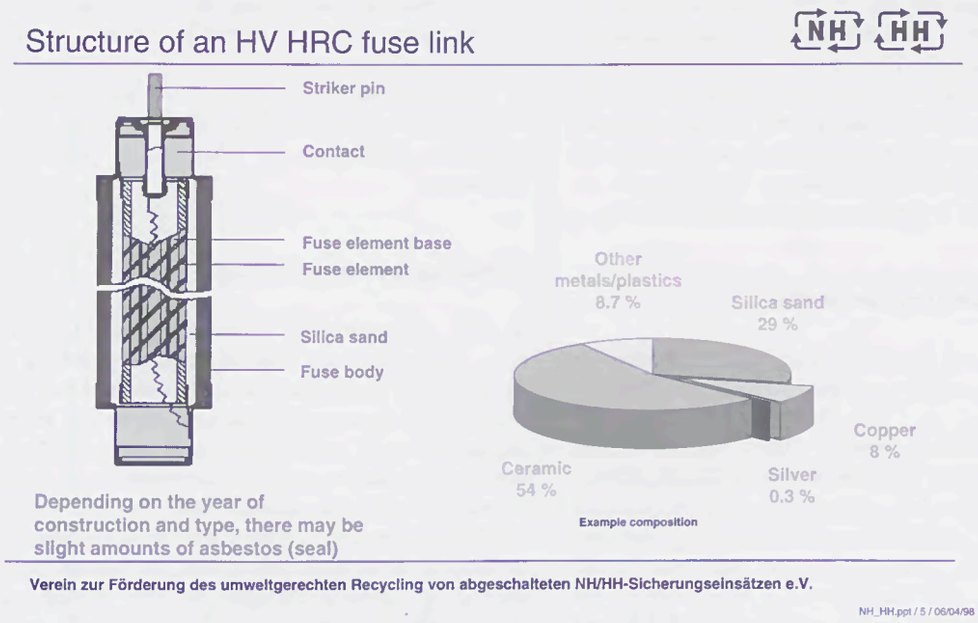

Figure 2: The constituent materials of and a section through an h.v. h.b.c. fuse link

The result: copper, silver and materials for the building trade and the chemical industry

The percentages of different materials also listed in Fig. 1 show that the recycling and re-use of copper and silver is thoroughly worthwhile and, as "valuables", do not deserve to be included amongst the residual waste or dumped on the refuse tip. The classic alternatives of disassembly or shredding offer the possible means by which the materials can be recovered.

Although disassembling these fuse links is a labor-intensive process, some successful projects have been set up, e.g. with power utilities and disabled people's organizations working together, in which the fuses are disassembled and the valuable materials they contain recovered so that they can be returned to the manufacturing cycle. The actual cost of disassembly is not covered by the profit obtained from the raw materials so the disabled people's organizations have to make a small charge for each fuse. The asbestos joint gaskets mentioned previously also cause some problems with disassembly.

The strict rules that apply when working with asbestos make disassembly a complex and costly process - as also is shredding or processing by pan grinder (a crushing process producing coarser results than a shredder) with subsequent melting down in the blast furnace. This situation has led to further tests being carried out in conjunction with a copper smeltery which have demonstrated that fuse links can be processed directly in a converter without any pre-processing at all. Under normal circumstances it is necessary to add quartz sand during the process in order to produce slag and promote the precipitation of iron. Since the fuse links that are being melted down already contain around 30% quartz sand, however, this "waste product" actually helps in the process.

Following an inquiry among various copper smelters and recycling companies throughout the country, the Norddeutsche Affinerie in Hamburg was eventually chosen because of its capacity and environmental capabilities.

For direct processing in copper converters the fuse links must normally satisfy the following specification:

- Plastics content less than 3.5%
- Asbestos content less than 0.05%
- Cadmium content less than 0.005%

The plastics are utilized to produce heat with continuous monitoring of the flue gas. During the melting, any zinc that originates from, say, brass

contact blades is converted into zinc dust and collects in the plant filters. However, this is not a problem provided the total amount of zinc remains below 50 tonnes per annum - as it will given the total amount of recycling anticipated. The ceramic body of the fuses and the quartz sand are converted to slag that can be used again for road building and in the concrete industry. Another end-product, sulfuric acid, can be re-utilized by the chemical industry. The asbestos is rendered harmless by being incorporated into the slag.

Research benefits from the profits

Most of the l.v. and h.v. h.b.c. fuse links come from the country's power utilities and general industry. They are usually collected in "egg box" pallets placed at specified collecting points. The various sales organizations, which also function as collecting points, provide information for smaller users, such as electrical contractors and installers, on the recycling facilities that are available. Nedlloyd Unitrans, with branches all over Germany, has been awarded the contract for collecting the egg-box pallets when they are full and transporting them to the company's own buffer store. When a collecting point has full pallets to be collected it notifies the transport company by fax and the pallets are then collected within three days and replaced with new empty pallets.

When a sufficient quantity of fuse links has accumulated in the buffer store, the haulier delivers them to the copper smeltery and invoices "NH/HH-Recycling" for its work. There are no charges to users for any aspect of the logistics involved or the recycling process.

The costs incurred by "NH/HH-Recycling", e.g. for transporting the egg-box pallets, for processing and refining the copper and silver and for the production of information brochures and advertising, are offset by the income obtained from selling the copper and silver. At current price levels, "NH/HH-Recycling" is able to achieve a modest surplus, which, in conformance with its memorandum and articles, is spent on further research into the recycling of fuse links - the Technical University of Ilmenau is one of the recipients.

Spreading throughout Europe

In 1997, approximately 125 tonnes of used l.v. and h.v. h.b.c. fuse links were collected and recycled; in 1998, by the end of December, the collected total had already reached 145 tonnes. For Germany alone the estimated annual figure of used fuse links is approximately 600 tonnes so it can be seen that the potential of recycling is very considerable indeed. Over the next few years "NH/HH-Recycling" expects the collected total figure to increase to around 300 tonnes per annum, which it regards as perfectly feasible in view of the rate of increase that has been achieved so far (Fig. 3).

"NH/HH-Recycling" intends to also enable foreign customers of the member companies to have their old fuse links disposed of by environmentally-compatible means. The organization's trade-marks have already been registered in more than 28 countries and inquiries about the concept of the recycling process have been received from Austria and Sweden.

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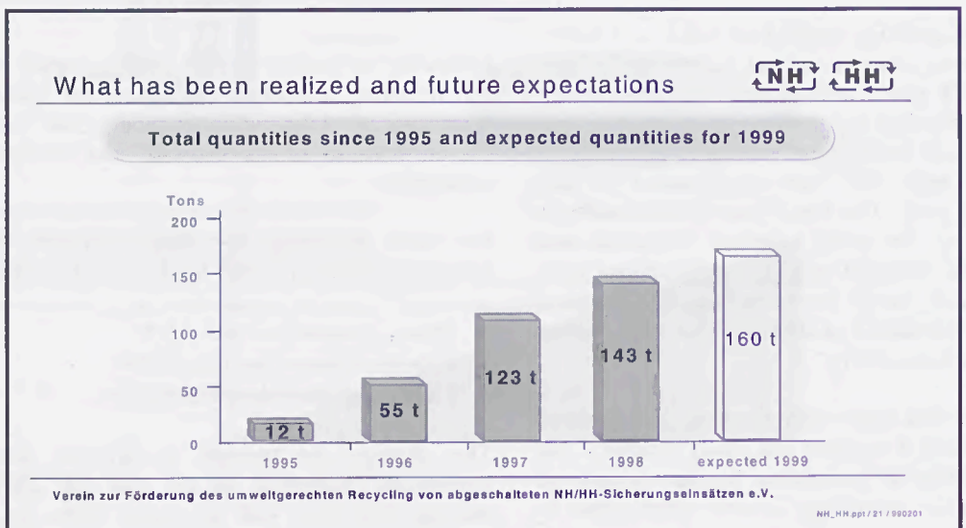
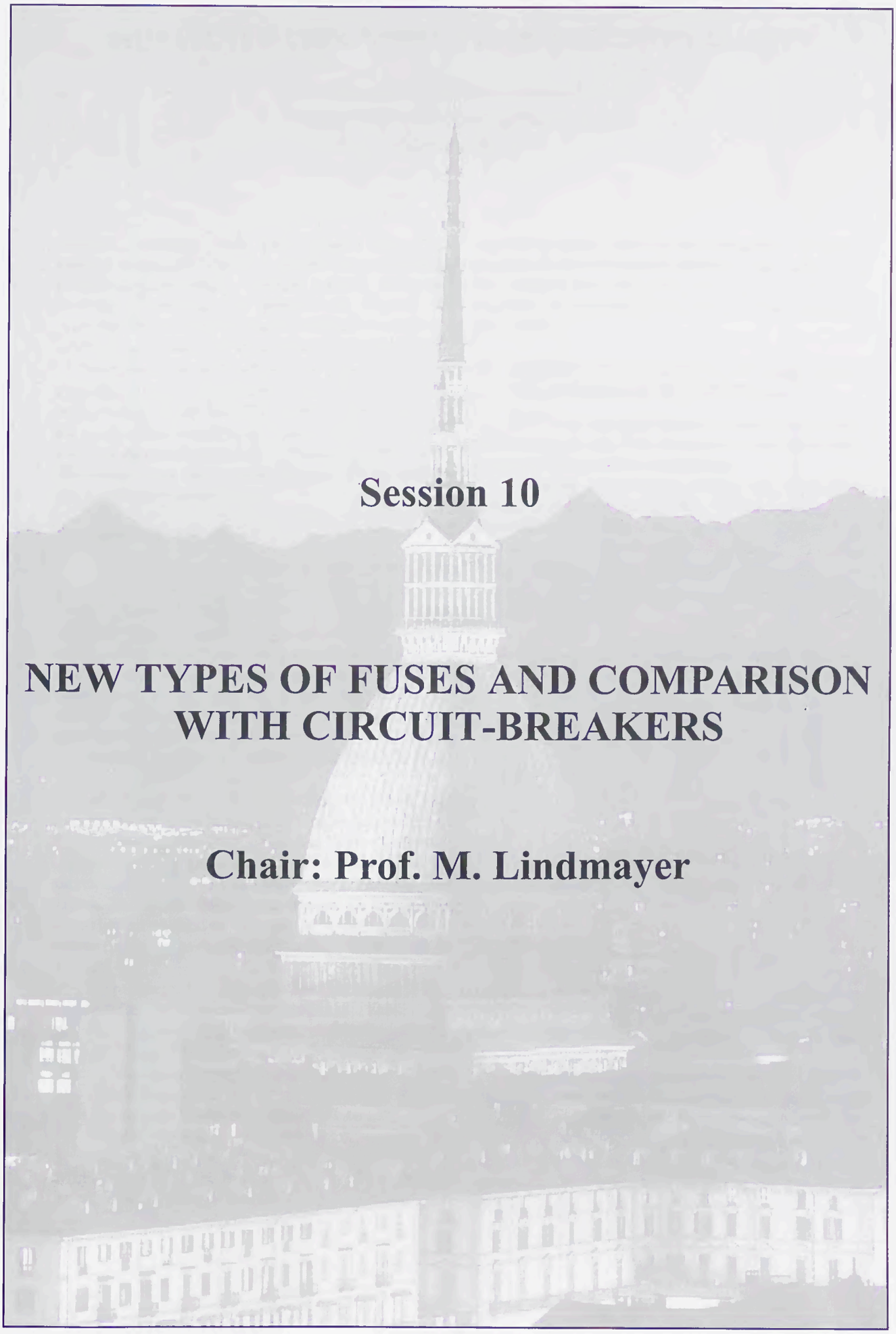


Figure 3: Actual and anticipated collected totals



Session 10

NEW TYPES OF FUSES AND COMPARISON WITH CIRCUIT-BREAKERS

Chair: Prof. M. Lindmayer