WASC 612

Materials Research at Explosives R and D Establishment

Electrical Equipment

July 1968.

ELECTRICAL EQUIPMENT

Vol. 8 No. 1 July 1968

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IN its early days the Explosives Research and Development Establishment was concerned exclusively with work on liquid and solid propellant and explosives. Over the years, however, activities at the Waltham Abbey Establishment have been extended to cover non-explosive materials and its R & D programme now embraces numerous projects of general industrial interest. One of the main objectives of the Open Days held last month, therefore, was to ensure that industrial undertakings are informed of the facilities and knowledge that is available at ERDE for the solution of technological problems.

Present Structure of ERDE

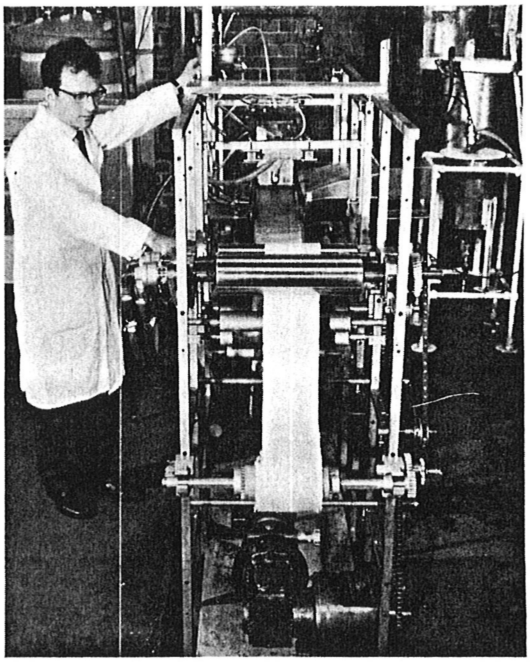
There are currently seven technical branches within ERDE. Two of these are concerned with research and development on propellants, one dealing with those based on nitrocellulose while the other is responsible for work on composite propellants using plastic or rubbery binder systems. An explosives branch is primarily concerned with the development of high explosives and initiating compounds and with carrying out tests on explosives and propellants to provide information for users on safety requirements.

The first materials laboratory was established on the North Site in 1956 and there are now two materials branches. One of these undertakes basic and applied research and development on the chemistry and physics of polymers while the other is engaged on research and development on fibre-reinforced materials and the growth of ceramic whiskers. The remaining two branches—Analysis and Ingredients, and Chemical Engineering—exist essentially to provide services for the other branches.

Fibre-Reinforced Materials

In the continuing search for engineering materials with improved physical properties, metals and plastics reinforced with whiskers (needle crystals) and other fibres are now the focus of attention at a number of research centres.

In the Materials 1 laboratory the incorporation of graded asbestos fibres, silicon nitride and silicon carbide 'whiskers', potassium titanate 'whiskers', and chopped carbon fibre into a wide range of thermoplastics, from polyethylene to nylon, has been in hand since 1966. Graded asbestos-fibre reinforced thermoplastics have shown the greatest promise, and as the fibre is cheap and readily available these materials should prove competitors to the comparable glass-filled grades.



A machine developed at ERDE for the production of continuously aligned fibre sheet.

The Chemical Engineering Branch have also made composites from asbestos, chopped carbon fibres and whiskers with epoxy, phenolic and polyester resins. Best mechanical properties are achieved at the high volume packings gained by orienting the fibres, which should preferably be straight and stiff. The table below lists some basic properties of the composites.

Material	Flexural Strength $\times 10^3$ lb/in.^{2}	Flexural Modulus $\times 10^6$ lb/in.^{2}	Specific Gravity
Asbestos/resin	up to 125	up to 14·5	1·8 to 2
Carbon (type)/ resin	up to 100	up to 25	9·I
Silicone carbide/resin	200–300*	30 to 40	1·9 to 2

* Silicon carbide is in the early stages of development and only a fraction of its potential has yet been realised.

There are two wet processes for aligning the fibres, after cleaning and sieving into lengths. In one they are extruded in a filament of alginic acid carrier

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which is wound into a mat and then burned-off to remove the alginic acid. In the other they are extruded in viscous suspension (glycerine) direct on to a moving filter and form an aligned sheet, which can be handled. The mat or sheet is then built up to the shape required, sheets can be crossed or laid in the direction strength is required, resin is added and the article moulded in a heated press or autoclave to the finished form. Up to 1000 lb/in.^{2} pressure is necessary to get a high enough packing density of fibre. The sheeting process is also being developed to produce continuous rolls of tape and composite filament which can be used for filament-winding.

Fibre reinforced plastics have recently made outstanding advances as readily fabricated materials with excellent but highly directional properties. However, structures are seldom stressed uniquely in one direction and designers are accustomed and equipped to use metallic materials which have virtually isotropic properties. By elaborate laboratory methods, research workers have already attained remarkable properties from simple metal matrices reinforced with whiskers. Now, using near-conventional metal forming techniques and tools, aluminium alloys reinforced with whiskers of silicon carbide show good prospects of development into hard-wearing, highly efficient materials.

Polymer Development

Much work on the development of rubber proofed fabrics for use in flexible storage containers for liquid, hovercraft skirts and aircraft arrester tapes has been carried out by the Polymer Development and Applications Group. The design and strength of the joints between the proofed fabric sections of Dracone flexible barges and large pillow tanks is one of the subjects under investigation. The evaluation of new plastics and rubbers is another important part of the group's work. Special purpose moulds have been designed to produce the test specimens required for the assessment of the engineering properties of these materials and an investigation is in progress into the production of low-cost injection moulds made from metal-filled thermosetting resins.

The group is also frequently called upon to look into the causes of failure of components and to suggest remedies. As an illustration of the valuable results that can be obtained from these trouble-shooting exercises, visitors were able to see samples of highly conductive rubbers developed to prevent the build-up of static electricity on the solid rubber tyres of tracked vehicles.

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