CURE PREDICTION OF EPDM RUBBER COMPOUND USING AUTOCATALYTIC KINETIC MODEL

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Received: 09 February 2021 Accepted: 06 April 2021

Tejasvi, K. (2021). Cure prediction of EPDM rubber compound using autocatalytic kinetic model. *Rubber Science*, **34**(1): 101-110.

Ethylene propylene diene (EPDM) rubber-based insulation is an integral part of solid propellant rocket motor and it plays a key role in ensuring desired propellant performance. EPDM rubber having sulphur cure system was characterized using a moving die rheometer under isothermal conditions at 130°C, 140°C, 150°C and 160°C. It was found that the cure kinetics depended upon both compound formulation and the temperature. Rheology was used to predict the cure time. Nature of cure was represented using vulcanization curves. Cure kinetics were described with an autocatalytic model and the experimental data was found to fit well by this model. The optimum cure time decreased with increase in the temperature.

Key words: Autocatalytic, EPDM rubber, Cure kinetics, Propellant, Rheometer, Vulcanization

Ethylene propylene diene (EPDM) consists of ethylene, propylene, and diene monomers. EPDM is ozone resistant because of its saturated polymer backbone and the "skeleton" chain pattern at higher ethylene content causes lower entanglement molecular weight and contribute to high plateau modulus and can accommodate high filler loading (VerStrate, 1986). The intrinsic properties of EPDM make it suitable for various applications such as automotive sealing systems, building profiles, roof sheeting, insulation for rocket motor casings and under-the-hood applications.

The above-mentioned factors make EPDM unique among other synthetic rubbers. On vulcanization, EPDM undergoes chemical cross-linking which enables EPDM to achieve mechanical strength. Vulcanizing agents other than sulphur, like peroxides, resins, and metal oxides are also used to increase the rate of curing (Eirich and Coran, 1994). To obtain desired physical properties, the cure system should be designed properly (Long, 1985). Rubber changes its morphology on compression instead of changing its volume. It also has a property to convert into hard elastic from soft plastic (Mortan, 1987), which can be influenced by the vulcanization reaction between sulphur and the rubber backbone (Faith, 1993; Coran, 1995). The crosslinking reaction that takes place during the vulcanization process is proportional to the change in the stiffness of rubber, which is monitored by the equipment called moving die Rheometer (Nampitch and Buakaew, 2006). Vulcanization reaction kinetics was monitored by researchers using techniques such as short-wave infrared radiation (Le Bideau *et al*., 2009), online ultrasonic (Jaunich *et al*., 2009), ultrasound

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