CHAPTER I

INTRODUCTION

1.1 The Statement of Problem

Natural rubber (NR) contains 93–95 wt% of *cis*-1,4-polyisoprene (Morton, 1973). It has excellent properties such as high strength, outstanding resilience and high elongation at break (Hofman, 1989). However, it has poor resistance to oil and hydrocarbon solvents and it also deteriorates to oxygen and ozone because of the carbon-carbon double bonds in its chain (Thavornyutikarn, 1999). These disadvantages of NR limit its applications in industries. Various methods have been used to improve those properties of NR. One is the blend of NR with other polymers. For example, blend of NR with nitrile rubber (NBR) is one of the solutions to produce the blend with higher oil resistance and good mechanical properties resulting from unique property of NBR and NR, respectively. However, the mechanical properties of NR/NBR blends are very poor. Generally, the properties of blends are controlled by many factors such as the nature of polymers, blend compositions and blend morphology (Sirisinha, Limcharoen, and Thunyarittikorn, 2001). Since the structure of NR is non-polar, the blend of NR with polar rubbers is quite difficult resulting from the incompatibility effect. Therefore, the compatibilization between each component in the polymer blends is necessary to obtain the better interfacial adhesion. It is well known that graft copolymers can be employed as compatibilizers for promoting the interaction between immiscible phases in the blends.

Graft copolymerization is a technique to combine desirable properties of diene-based polymers with vinyl monomers such as methyl methacrylate (MMA) (Thiraphattaraphun et al., 2001; Kochthongrasamee, Prasassarakich, and Kiatkamjornwong, 2006), styrene (ST)-*co*-MMA (Arayapranee, Prasassarakich, and Rempel, 2002, 2004), ST-*co*-acrylonitrile (ACN) (Prasassarakich, Sintoorahat, and Wongwisetsirikul, 2001), ACN-*co*-MMA (Okieimen, and Urhoghide, 2002) and glycidyl methacrylate (GMA)-*co*-ST (Suriyachai, Kiatkamjornwong, and

Prasassarakich, 2004) to obtain graft products having some properties better than those of the inherent ones. Graft copolymer of GMA and ST onto NR latex could act as a compatibilizer for NR/poly(methyl methacrylate) (PMMA) blends because GMA contained methacrylate groups which were compatible to PMMA phase in the polymer blends (Suriyachai et al., 2004). The graft polymerization of PMMA onto NR initiated by potassium persulfate was used as an impact modifier and compatibilizer for NR/PMMA thermoplasticelastomer (Thiraphattaraphun et.al, 2001). For blends of poly(styrene-*co*-acylonitrile) (SAN) with ethylene–propylene–diene monomer (EPDM), it was reported that the toughness–stiffness balance of the SAN/EPDM blend was improved when an appropriate amount of ACN–EPDM–ST (AES) graft copolymer was employed (Qu et al., 2004).

In this research, an attempt was made to prepare graft copolymers of styrene (ST) and acrylonitrile (ACN) onto NR in both solution and emulsion method. The effects of the initiator systems, initiator concentrations, reaction temperature and nitrogen pressure on the grafting properties were evaluated. The resulting graft natural rubber (GNR) was also used as a compatibilizer for NR/NBR blends. The mechanical properties, oil resistance and morphology of the blends were also investigated.

1.2 Objectives of the Research Work

The objectives of this research were stated as followed:

1. To prepare the graft copolymer of ST and ACN on NR via solution and emulsion method. The effect of initiator systems, initiator concentration, and reaction temperature and nitrogen pressure was examined.

2. To characterize the grafting properties of the obtained GNR.

3. To prepare the blends of NR and NBR by using GNR as the compatibilizer and also investigate the vulcanization characteristics, mechanical properties, oil resistance and morphology of the NR/NBR vulcanizates.

1.3 Scope of the Research Work

The graft copolymer of ST and ACN onto NR was prepared. The suitable GNR content in NR/NBR blend to yield the good mechanical properties, oil resistance and morphology was investigated. The details of experimental procedure for this research were presented as followed:

1. Surveyed the previous literatures and related research works.
2. Prepared the graft copolymer of ST and ACN onto NR latex in emulsion method using redox and persulfate initiator systems.
3. Prepared the graft copolymer of ST and ACN onto dry NR in solution method using peroxide and azo-compound initiator systems.
4. Characterized the structure of (NR-*g*-(ST-*co*-ACN)) using Fourier Transform Infrared Spectroscopy (FT-IR) and Nuclear Magnetic Resonance Spectroscopy (NMR).
5. Studied the morphological properties of GNR latex using Transmission Electron Microscope (TEM) technique.
6. Prepared the NR/NBR compounds containing GNR as a compatibilizer on a two-roll mixing mill at room temperature and then vulcanized the rubber compounds using a hydraulic compression mould at 150°C and optimum cure time obtained from Oscillating Disk Rheometer (ODR) at the same curing temperature.
7. Investigated the mechanical properties and oil resistance of the NR/NBR vulcanizates.
8. Determined the thermal properties of the vulcanizates using Dynamic Mechanical Analysis (DMA).
9. Studied the morphological properties of the vulcanizates using Scanning Electron Microscope (SEM).
10. Summarized and concluded the results.