CHAPTER I

INTRODUCTION

1.1 Scientific Rationale

The advanced printing industry has been developed instead of the conventional printing. On the part of printing ink technology, the water-based inks have come to play a more important role in place of the solvent-based inks because environmental concerns have required the reduction of volatile organic emissions [1]. Therefore, the water-based ink formulations have been improved. However, satisfactory printing is most problematic when developing water-based inks for printing on nonporous, low surface energy substrates such as polymeric films.

According to previous research, Arayamaythalert [2] prepared acrylic acid-cassava starch graft copolymers as thickeners that were used for an ingredient in cotton fabric printing inks, the results showed that the printing inks with these synthetic thickeners gave as good print qualities on cotton fabrics as the ones with sodium alginate, which is one of commonly used thickeners; therefore, these synthetic thickeners can be used instead of sodium alginate. In addition, these acrylic acid-cassava starch graft copolymers were also applied in water-based screen inks printing on plastic film. The results obtained were unsatisfactory since the ink film adhesion was difficult to overcome surface energy of plastic films because of high water content in water-based inks. Proper wetting and adhesion, in particular, were necessary because these substrates frequently exhibit low surface energy and polarity.

Wetting and adhesion usually occur readily with inks supplied in solvent base. On the other hand, the high surface energy and high polarity of water provide a challenge in the development of water-based inks for surface printing on films.

In this thesis, effects of appropriate concentration of *N,Ń*-methylenebisacrylamide, which is the crosslinker on acrylic acid-cassava starch graft copolymer used as thickeners for water-based screen inks printing on polypropylene films, was carried out. The improvement of the thickener properties and the water-based ink formulations were achieved in order to promote ink film adhesion on plastic film surface and provide satisfactory print qualities.

1.2 Objectives

The objectives of this research are the following:

1. To determine the optimum concentration of crosslinking agent for synthesis acrylic acid-cassava graft copolymer used as thickener in water-based screen inks for printing on plastic films.

2. To study the rheological properties of the synthetic thickeners and the water-based screen inks made of these synthetic thickeners.

3. To study the correlation of surface tension of these water-based screen inks and surface energy of treated plastic films in order to search for optimum ink adhesion on treated plastic film surface.

4. To analyze the plastic film print qualities printed via screen printing process using the water-based inks with these synthetic thickeners as binders.

1.3 Expected Benefits Obtainable for Future Development of the Research

The benefits for the development can be:

1. To obtain the optimum properties of acrylic acid-cassava starch graft copolymer, which can be used as a thickener for water-based screen inks printing on treated plastic film.

2. To obtain acceptable plastic film print qualities, which printed from the improved water-based screen inks.

1.4 Scope of the Investigation

In this research, the plan for graft copolymerization of acrylic acid onto cassava starch via the hydrogen peroxide-ascorbic acid initiation and crosslinking by *N,N'*-methylenebisacrylamide to achieve the suitable products for use as a thickener for water-based screen inks printing on plastic films is as follows:

1. Literature survey and in-depth study of this research work

2. Preparing graft copolymerization of acrylic acid onto cassava starch via the hydrogen peroxide-ascorbic acid initiation, and crosslinking by *N,N'*-methylenebisacrylamide, by studying the following parameters so as to select the suitable conditions and to attain the appropriate thickeners for water-based screen inks:

2.1 Constant Parameters

a) The quantity of cassava starch of 60 grams,

b) The quantity of ascorbic acid of 0.4 grams,

c) The quantity of acrylic acid of 80 cm^3,

d) The quantity of hydrogen peroxide of 4 cm^3,

e) The reaction time of 2 hours,

f) The reaction temperature of 35°C,

g) The adding rate of monomer-initiator mixture of 1 cm^3 min^{-1}.

2.2 Variable Parameter

The crosslinking agent (*N,N*´-methylenebisacrylamide, *N,N*´-MBA) concentration of 0.1-0.3 wt% based on the quantity of acrylic acid.

3. Bringing the graft copolymer obtained from Section 2 to the saponification of starch graft copolymer.

4. Measuring water absorption capacities of the saponified starch-g-poly (acrylic acid) in distilled water.

5. Measuring rheological properties of thickener solutions of the product obtained from Section 3.

6. Bringing the optimum thickener solution to prepare water-based screen inks and investigating their properties as follows:

a) Rheology,

b) Dispersion,

c) Surface tension.

7. Corona treatment on plastic film surfaces and measurement of the contact angles of water, methyl alcohol-water mixtures, and 2-ethoxyethanol droplets on the corona treated plastic film surfaces in order to investigate the treated plastic film properties as follows:

a) Wetting tension,

b) Surface energy,

c) Polar and dispersion components of surface energy.

8. Determination of adhesion work between the water-based screen inks and the treated plastic film surface.

9. Analysis of the results obtained from Sections 7 and 8 via Student's t distribution order.

10. Examination of film morphology.

11. Printing of the water-based screen inks obtained from Section 6 on the optimum treated plastic films.

12. Investigating the print qualities of printed plastic films as follows:

a) % Dot area and % dot gain,

b) Tone reproduction,

c) Dot characteristic,

d) Print contrast,

e) Gloss,

f) Adhesion.

13. Summarizing the results and writing up the report.