

150272
\$
59/12/09

f. 30001

DEGRADATION AND STABILIZATION OF PVC SYSTEMS

BY

W. P. U. SILVA

Thesis submitted to the University of Sri Jayawardenapura in partial
fulfilment of the requirements for the award of Degree of M.Sc. Polymer
Science & Technology.

150272

DEGRADATION AND STABILIZATION OF PVC SYSTEMS

W. P. U. Silva

ABSTRACT

PVC, the most predominant member of the large family of vinyl polymers is among the most versatile and widely used thermoplastics. The unique combination of properties of PVC has been responsible for tremendous potential it possesses both for industrial as well as for domestic applications.

In this research study an effort was made to understand the behaviour of PVC when exposed to weathering characteristics. Theory of degradation and characteristics of stabilizer mechanisms and systems were studied before undertaking the research work.

Research work was carried out on an industrial scale in a PVC leather cloth manufacturing plant, to replace a Pb stabilizer system in the skin white formulation. Pb stabilizer system was replaced for two reasons.

- (1) Yellowing of the material when exposed to environment. Pb stabilizers are prone to sulfide staining. PbS is black in colour and as a result, Pb stabilized systems prone to discolour.
- (2) The greatest deterrent to the use of Pb stabilizer is their toxicity. There is no doubt that Pb stabilizers are toxic and as a result the use of these stabilizers have been restricted in many applications in many countries.

Sn stabilizer system which does not discolour and is non toxic, was introduced to the formula to replace the existing Pb stabilizer system. Several process changes had to be made to incorporate the new stabilizer system to overcome the processing problems associated with the use of Sn stabilizers.

Abbreviations

This new stabilizer system introduced and the new formula developed is currently being used successfully to produce white colour PVC leather cloth in this factory for commercial purposes.

CHAPTER 1.0

This new formula developed by introducing a Sn stabilizer is environmentally friendly and has a significant advantage over Pb stabilized systems in reducing harmful, hazardous and toxic effects.

TABLE OF CONTENTS

	Page No.
Declaration	
Acknowledgements	
Abbreviations	
Abstract	
Table of contents	
Lists of Tables, Figures and Plates, etc	
CHAPTER 1 : INTRODUCTION TO PVC	
1.1. Introduction	1
1.2. Preparations	3
1.3. Properties	5
1.4. General applications	6
1.4.1. Flexible PVC	6
1.4.2. Rigid PVC	7
1.5. Compounding of PVC	8
1.6. Compounding ingredients	9
1.6.1. Plasticizers	9
1.6.2. Extenders	10
1.6.3. Stabilizers	10
1.6.4. Lubricants	11
1.6.5. Fillers	11
1.6.6. Antioxidants	11

1.6.7. Antistatic agents	12
1.6.8. Pigments	13
CHAPTER 2 : THEORY OF DEGRADATION	
2.1. Introduction	14
2.2. Mechanism of degradation	14
2.3. Thermal degradation	17
CHAPTER 3 : ACTIONS AND CHARACTERISTICS OF STABILIZERS	
3.1. Introduction	20
3.1.1. The necessity of stabilization	20
3.1.2. Classification of stabilizers	21
3.1.3. Properties of the ideal stabilizer	21
3.2. PVC heat stabilizer classes	23
3.2.1. Pb stabilizers	24
3.2.2. Metal carboxylate stabilizers	26
3.2.3. Organotin stabilizers	28
CHAPTER 4 : STABILIZER SELECTION CRITERIA	
4.1. Primary stabilizer contribution	31
4.1.1. Process heat stability	31
4.1.2. Processability	32
4.1.3. Long term property retention	32
4.2. Stabilizer side effects	33
4.2.1. Initial colour	33
4.2.2. Ultimate stability	34

4.2.3. Clarity	34
4.2.4. Compatibility	34
4.2.5. Plateout	35
4.2.6. Volatility	36
4.2.7. Moisture resistance	36
4.2.8. Stain resistance	37
4.2.9. Mechanical properties	38
4.2.10. Electrical properties	38
 CHAPTER 5 : RESEARCH STUDY	
5.1. Introduction	39
5.1.1. Skin layer	40
5.1.2. Foam layer	43
5.1.3. Fabric layer	45
5.2. Reasons for yellowing	46
5.3. Selecting suitable stabilizer	47
5.4. Research work carried out	48
5.5. Testing of materials	55
5.5.1. Testing of material for sulfide staining	56
5.5.2. Testing of material for heat stability	57
5.6. Discussion	58
5.7. Suggestions for further work	63
 List of references	 64

