CHAPTER I

INTRODUCTION

1.1 Anacardium Occidentale

1.1.1 The Cashew Tree [1,2]

The cashew tree, Anacardium occidentale Linn., is a native of Brazil and was introduced into Asia and Africa by the portuguese in the 1600's. It is now found widely in other part of tropical South and Central America, Mexico and West Indies. The generic name, Anarcadium, was bestowed upon it because it described the heart-like shape of the nut. The specific name, occidentale, was used because the nut came from the Western Americas (Bailey, 1935).

The cashew plant is a jungle or semi-jungle tree by nature. The tree, which is an evergreen, naturally grows up to 12 metres high and has a spread of 25 metres. They are readily recognized by their ligh colored foliage. The yellow-green leaves, revealing distinct veins, are elliptic in shape and approximately 4 to 6 inch in length and 2 to 3 inch in width. They feel leathery to the touch (Raphael,1963).

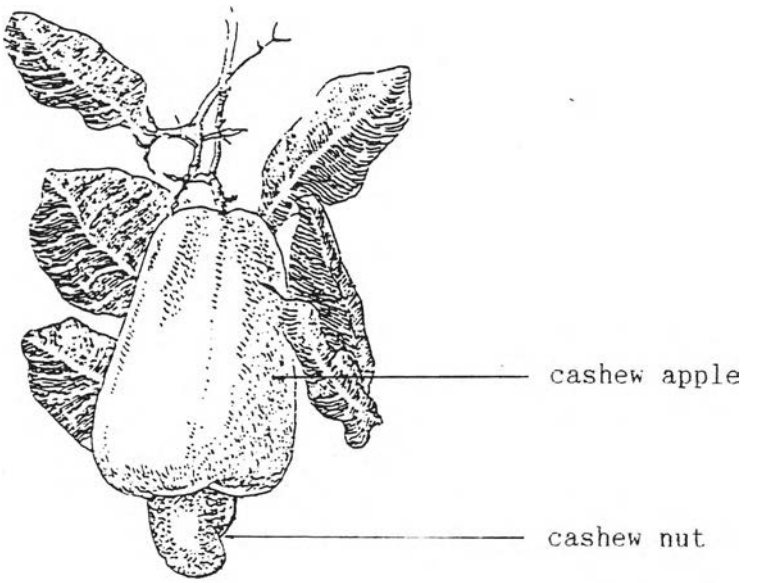
1.1.2 Cashew Apple and Cashew Nut [1-3]

The cashew nut is attached to the bottom of the cashew apple, false fruit, developed from the receptical. The

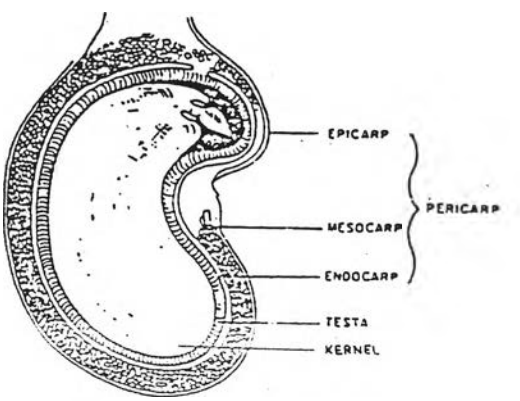
Figure 1.1 The cashew tree.

cashew apple varies in size from 2 to 4 inch in length and 1.5 to 2 inch in width. It is yellowish-red in color and possess a thin waxy skin. Broadly conical or pear-likes in shape, it is called a cashew "pear" or cashew "apple" (figure 1.2 a).

The whole cashew nut is from 2.5 to 3.2 cm long; 1.9 to 2.2 cm broad at the base; and 1.3 to 1.6 cm thick at the steam-end. It is gray brown in color and shaped more like the kidney than the heart from which its generic name is derived. The shell of the nut is hard, about an eight of an inch thick. It consists of two layers. The outer layer, which is smooth surfaced, thin and tough. The inner layer is hard. Between the two layers is a honeycomb structure, which contains a



(a)



(b)

Figure 1.2 (a) Cashew apple and cashew nut.

(b) Section of a cashew nut.

phenolic material known as "Cashew Nut Shell Liquid (CNSL)". IT is commercially and is growing in economic importance. Inside the shell is the kernel, wrapped in a thin brown skin, know as the "testa" (figure 1.2 b).

1.2 Cashew Nut Shell Liquid

1.2.1 Introduction

Cashew nut shell liquid is contained in the honeycomb structure between the soft outer skin of the nut and the harder inner shell. It is a dark brown viscous liquid and is reported to occur in the fresh shell to the extent 15 to 20 and 20 to 30 per cent by weight for African nuts and Indian nuts, respectively. CNSL is extremely caustic and is a strong vesicating agent. Table 1.1 shows the Indian and Irvington specification [2,4].

1.2.2 Production of CNSL [1,2,5]

In the production of cashew kernels for edible purposes, CNSL is extracted from the cashew nuts before they are decorticated in order that the kernels may be removed without becoming contaminated by the liquid. There are four main methods which have been suggested for obtaining this liquid :

1. Roasting the shells of the whole cashew nuts and collecting the expelled liquid. This is the Indian native method and only about half the liquid is extracted by this process.

Table 1.1 Specifications for Cashew Nut Shell Liquid

Properties	Indian 840-1964	Irvington Specification[a]
Spec.gr. 30 /30°C	0.950-0.970	-
50 /60°F	-	0.95-0.97
Viscosity at 25°C, cps	-	max 600
30°C, cps	max 550	-
Moisture, w/w, per cent	max 1.0	max 1.00
Matter insoluble in toluene, w/w, per cent	max 1.0	-
Dirt and foreign matter w/w, per cent	-	max 1.00
Loss in weight on heating, w/w, per cent	max 2.0	
Colour	-	Brown
Iodine Value (Wij's method), per cent	min 250	min 250
Ash, w/w, per cent	max 1.0	-
Polymerization		
(a) Time, min	max 4	max 19
(b) Vis, at 30°C, cps	min 30	min 30

[a]Irvington Varnish and Insulator Co., Irvington, New Jersey, USA.

2. Extracting the liquid from the whole nuts with hot CNSL maintained at 370-380°F which will not char the kernels. This method enables 85 to 90 per cent of the CNSL to be recovered.

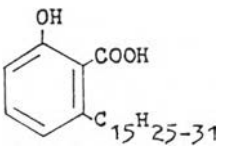
3. Treatment of the shell with super-heated steam and collecting the condensate. This process claims to produce a better grade of CNSL and is sometimes used in conjunction with extracting by hot CNSL to improve yield.

4. Solvent extraction of the shells (G.T.B. 1946)

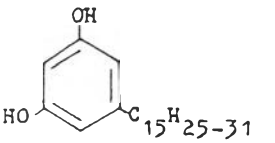
1.2.3 Compositions of CNSL [1,2,5,6]

CNSL, is mixtures of phenolic compounds, consists of two principal constitutents, anacardic acid and cardol. Both bolong to the group of chemicals classified as higher phenols. In it natural state, the composition of CNSL is shown in scheme 1.1 (Tyman, 1976). In each fraction, it have a side chain of 15 carbon atoms with different degree of unsaturation (scheme 1.1).

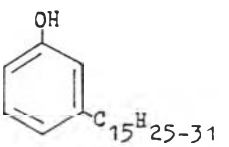
Anacardic acid readily loses carbon dioxide to yield a meta-substituted phenol, "cardanol" on heating. For commercial usage the CNSL is obtained from the cashew nut shell by a process that involves heating the shells to a high temperature for several minutes in a vat of previously obtained the liquid. During this process the liquid is held at the high temperature for several hours. Considerable decarboxylation of the anacardic acid takes place, as well as some polymerization of the phenolic bodies to yield a commercial CNSL, which is mainly monophenolic in character, but contains a small amount (approximately 16%) of ancardic acid, cardol and polymerized material.



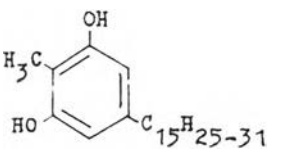
anacardic acid (82%)



cardol (13.8%)



cardanol (1.6%)



2-methylcardol (2.6%)

$-(C_{15}H_{25-31})$ = $-(CH_2)_{14}CH_3$

$-(CH_2)_7CH=CH(CH_2)_5CH_3$

$-(CH_2)_7CH=CHCH_2CH=CH(CH_2)_2CH_3$

$-(CH_2)_7CH=CHCH_2CH=CHCH_2CH=CH_2$

Scheme 1.1 Composition of naturally occuring CNSL [2].

1.2.4 Resins from CNSL [7]

CNSL has a dual functionality in resin-forming reactions, because it is both phenolic and olefinic in character. It can therefore be :

(a) Condensed with formaldehyde through the phenolic nuclei with acid or base catalyst that give straight chain polymer.

(b) Polymerized through the unsaturated side-chains ($-C_{15}H_{25-31}$) by addition polymerization.

$$-C{=}C- \quad + \quad -C{=}C- \longrightarrow -C-C-C-C- \qquad (1.1)$$

Both reactions are use in making commercial products from CNSL and its derivatives.

1.2.5 The Advantages of Resin from CNSL [7]

The principal features of all resinous products based on CNSL arise from the presence of the long unsaturated carbon-chain substituent. These can be summarised as:

1. Internal plasticity of the cured aldehyde condensation products, i.e., the resin have more flexibility, especilly at elevated temperatures, than straight phenolic resins.

2. Solubility or compatibility with substances of a hydrocarbon nature, e.g., aromatic and aliphatic solvents, natural and synthetic rubbers, and drying oils, similar to resins based on p-alkylphenols.

3. Resistance to alkalis and acids, probably because of the strongly hydrophobic nature of the hydrocarbon chain.

1.2.6 Uses and Application [1-3,8]

Liquid from the shell of the cashew nut, CNSL, once an undesirable by-product of the cashew kernel industry, has

become a valuable raw material in the manufacture of numerous industrial products.

The CNSL is second only to the cashew kernel or nutmeat in economic importance. In its natural state, it serves as a protection to the kernel against insect attack. If used in combination with kerosene or diesel oil, it is an effective insecticide against mosquito larvae. Made into a varnish it is a preservation of wooden floors and fine carved woods, protecting them from insect destruction. For many years, fishermen have used the liquid to waterproof and preserve their fishnets, fishing lines and boats.

With recent advances in chemical technology, the CNSL is finding many new industrial applications. It is used commercially as a phenolic raw material for the manufacture of certain resins and plastics. In particular, it is used as a friction modifier in the manufacture of brake-linings, industrial belting and clutches. IT is claimed to possess excellent frictional properties and low friction "fade", i.e., the fall in coefficient of friction with increase in temperature, and long wear. It is also used in rubber compounds, where it acts as reinforcing fillers, which tensile strength, hardness and abrasion-resistance [9] are improved. The resins from CNSL are used in laminating for papers, cloths and glass fibers, or impregnating materials where oil or acid resistance is required. Other uses include the manufacture of lacquers, paints, printing inks, electrical insulation material, an anti-corrosive for metals, water proofing compounds and adhesives.

The objective of this work is to investigate the proper ratio between CNSL and formalin and optimum condition to produce the adhesive, give a good adhesion strength for wood to wood and nylon-6 fabric to natural rubber compound.