PROJECT PROFILE

ON

CASHEW NUT SHELL LIQUID

MONTH & YEAR
JULY 2011

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This publication is supported by

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CASHEW NUT SHELL LIQUID

A. INTRODUCTION

Cashew nut Shell Liquid (CNSL) is a reddish brown viscous liquid, having the honey comb structure of the shell of cashew nut obtained from cashew tree.

Cashew Nut Shell Liquid (CNSL) is a versatile by-product of the cashew industry. The nut has a shell of about 1/ 8 inch thickness inside which is a soft honey comb structure containing a dark, reddish brown viscous liquid. It is called cashew nut shell liquid, which is the pericap fluid of the cashew nut. It is often considered as the better and cheaper, material for unsaturated phenols. C.N.S.L. has innumerable applications in polymer based industries such as friction linings, paints and varnishes, laminating resins, rubber compounding ,resins, cashew cements, polyurethane ,based polymers, surfactants, epoxy ,resins, foundry chemicals and ,intermediates for chemical industry. It offers much scope and varied opportunities for the development of other tailor - made polymers.

B. PRODUCT USES AND SPECIFICATIONS

Specifications

Natural CNSL

Anacardic acid	80.9%
Cardiol	10-15%

Small amounts of other materials notably the methyl derivatives of cardiol

CNSL extracted with low boiling petroleum

Anacardic acid	90%
Cardol	10%

i) The revised specifications of the Indian Standards Institution, New Delhi, for untreated cashew nut shell liquid (IS 840:1964) is reproduced below

Specific gravity 30 degree C	0.950 to 0.97
Viscosity at 30 degree C, in centipoises	550
Moisture, % by weight	1.0
Matter insoluble in toluene, % by weight	1.0
Loss in weight on heating, % by weight	2.0
Ash, % by weight	1.0
Iodine value	
a) Wij's method	250
b) Catalytic method	375
Polymerization	
a) Time in minutes	4
b) Viscosity at 30 degree C, in centipoises	30
c) Viscosity after acid washing at 30ºC, in centipoises	200

Colour shall be not deeper than dark brown when viewed by transmitted light.

(ii) Specification for treated Cashew Nut Shell Liquid

The cashew nut shell liquid as extracted has a strong vesicant dramatic action. Before this liquid is utilised for preparation of resins, it requires treatment to get rid of metallic impurities as well as traces of sulphur compounds. The liquid thus treated is known as treated Cashew Nut Shell Liquid. The specification of treated cashew liquid is as follows:

Specific gravity at 25 degree C	0.955-0.975
Viscosity at 25 degree C (Max)	800cps.
Iodine Value (Min)	240.00
Ash (Max)	1%
Moisture (Max)	0.5%
Acid V	14

(iii) Specification for Cold pressed Cashew Nut Shell Liquid

Cashew Nut Shell Liquid is also produced by the 'Cold Pressed' method in solvent extraction plant. The specifications of this liquid are as follows:

Specific gravity at 26 degree C	0.9668-1.0131
Refractive index at 41-50 degree C	1.5158
Saponification number	106-119
Iodine number	170-296
Acid number	94-107

Inspection and Quality Control

Quality Specifications:

Revised IS specifications of CNSL No: IS 840:1964.

APPLICATION OF CNSL RESIN

General Details

Cashewnut Shell oil is extracted from the honey-combed shell of the cashew nut and then sold in its raw or distilled form into two different markets: auto brake linings and industrial and marine coatings. In the coatings arena, cashew nut shell oil is used as a key raw material in the production of curing agents for special epoxy hardeners and epoxy resins.

Coating sector	Industrial and marine coatings. Paint (anti corrosive) and enamels, varnishes rubber industry to enhance the vulcanisate properties. Lacquers developed from CNSL could be used for insulation, protective or decorative coatings for furniture, buildings, automobiles, etc. In the coating arena, cashew nut shell oil is used as a key raw material in the production of curing agents for special epoxy hardeners and epoxy resins.
Construction sector	For cementing floors exposed to chemical attack.
Laminating industry	For reducing brittleness and improving the flexibility of the laminates.
Substitute	As a substitute for linseed oil in the manufacture of foundry core oil, which is used as a binder in the foundry.
Automobile	Auto brake lining

New applications:

Using cash nut shell liquid, novel and cheaper liquid crystalline polyester has been synthesized that can substitute for polymer fibres and films in specialty applications.

Liquid crystalline (lc) polymers have attracted much attention in recent years because of their potential use as high performance materials.

Paints and Enamels

Because of its dark colour, CNSL is used in the manufacture of dark coloured paints and enamels.

A number of anticorrosive paint formulations for ship bottoms have been made by the Regional Research Laboratory, Hyderabad, the Central Institute of Fisheries Technology, Cochin, Bombay University and the Research, Design and Standards Organisation, Lucknow.

Paints and varnishes made from CNSL have superior properties than those of conventional oils or synthetic resins. Varnishes resistant to water and gasoline have been made by incorporating sulphur in CNSL.

Lacquers developed from CNSL could be used for insulation, protective or decorative coatings for furniture, buildings, automobiles, etc. The films have toughness and elasticity, excellent gloss and superfine adhesive qualities. The dried films are superior to those of ordinary oil paints in respect of resistance to oils, grease moisture and chemicals. Cashew lacquers are cheaper than ordinary oil varnishes.

Electrical Insulating Varnishes

Electrical Insulating varnishes are obtained by treating CNSL with formaldehyde and compounding the resulting material with pure phenolic resin varnish or alkyd resin in suitable proportions. Films of those materials are water and chemical resistant and can be used as insulating varnished with high electrical resistance and as bobbin enamels and laboratory table tops

Polymers

Cashew polymers react with formaldehyde to give a rubbery gel, which can be used as a cement hardening agent that would be immune to acids and alkalis reaction. It can be used for cementing floors exposed to chemical attack.

CNSL modified by heating at 160 deg.C. in the presence of certain accelerators give stoving enamels that are resistant to alkali and acid solutions, mineral and fatty oils and various organic solvents. Coating compositions possessing insecticidal properties are obtained by adding DDT, Gammexane etc., to CNSL or chlorinated CNSL after treatment with Formaldehyde gums and resins and drying or semi-drying oils.

Apart from the polymeric products, CNSL forms the basic raw material for a vast number of industrially important chemicals and chemical intermediates. Chlorinated products of cardanol and hydrogenated cardanol are found to have pesticidal action. The various components of cardanol can be suitably modified to obtain emulsifiers and surface active agents, dyestuffs, antioxidants, plasticizers, stabilizers, accelerators, curatives, reclaiming agents and ion-exchange resins.

Lamination

CNSL or Cardanol derivatives are extensively used in the laminating industry for reducing brittleness and improving the flexibility of the laminates.

A CNSL based adhesive for blending concrete to wooden surface has been developed by the Central Building Research Institute, Roorkee. Adhesives suitable for plywood are made by oxidising CNSL with potassium permanganate or Manganese dioxide at 100 deg. C reacted with Paraformaldehde and compounded with cuprous chloride. Also CNSL modified with furfural, aniline, xylol etc, gives good plywood adhesives.

Rubber Products

The use of CNSL in rubber compositions has been found to improve the performance of rubber products. It helps processing and enhances the vulcanizate properties. CNSL enhances the insolubility of natural rubber vulcanizates in petroleum solvents. It helps in the incorporation of ingredients into rubber and increases its resistance to moisture. Oxides of Cu, Ba, Zn, etc. harden CNSL and give hard products.

Phenoplasts

Cardanol and its derivatives can also be converted to phenoplasts with better processability, hydrocarbon solubility and resistance to acids and alkalies than the conventional phenol-based systems. Moulding powders from CNSL, shellac, and fillers such as wood flour, sawdust, asbestos, etc. are found to give articles with excellent finish, good flexural and tensile strengths and satisfactory water resistance.

Stable rigid or flexible covering materials in the form of tiles sheets, etc., are made from compositions containing CNSL, formalin, natural rubber and synthetic rubber and other conventional ingredients.

Light weight, sandwich type plastics, composite panels suitable for partitions, claddings, flush doors etc. Have been developed using resins based on CNSL. Foam plastics based on CNSL and its derivatives have also been made.

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CNSL enhances the insolubility of natural rubber vulcanisates in petroleum solvents. It helps in the incorporation of moisture. Oxides of Cu, Ba, Zn, etc. Harden CNSL and give hard products.

CNSL also finds use in making floor tile laminate resins, oil-cloth finish compositions and as a rubefacient and vessicant in treating skin diseases and in tropical medicine. CNSL, is a unique monomer source for unsaturated phenols which can be polymerized to get various polymeric products can be suitably modified to chemical intermediates for industrial uses.

Modified CNSL

The various components of cardanol can be suitably modified to obtain emulsifiers and surface active agents, dyestuffs, antioxidants, plasticizers, stabilizers, accelerators, curatives, reclaiming agents and ion-exchange resins.

CNSL modified by heating at 160-300 deg.C in the presence of certain accelerators give stoving enamels resistant to alkali and acid solutions, mineral and fatty oils and various organic solvents.

Coating compositions possessing insecticidal properties are obtained by adding DDT, gammexane, etc. to CNSL or chlorinated CNSL, after treatment with formaldehyde, gums and resins and drying or semi-drying oils.

Derivatives of CNSL

CNSL or Cardanol derivatives are extensively used in the laminating industry for reducing brittleness and improving the flexibility of the laminates.

Adhesive

A CNSL-based adhesive for blending concrete to wooden surface was developed by the Central Building Research Institute, Roorkee. Adhesives suitable for plywood are made by oxidising CNSL with potassium permanganate or

manganese dioxide at 100degC reacted with paraformaldehyde and compounded with $CuCl_2$. Also CNSL modified with furfural, aniline, xylol, etc. gives good plywood adhesives.

Binder in the foundry

CNSL is also used as a substitute for linseed oil in the manufacture of foundry core oil, which is used as a binder in the foundry.

Basic raw material

Apart from the polymeric products, CNSL forms the basic raw material for a vast number of industrially important chemicals and chemical intermediates.

Pesticidal action

Chlorinated products of cardanol and hydrogenated cardanol are found to have pesticidal action.

New polyester from cashew nut shell liquid

Using cashew nut shell liquid, a group of scientists have synthesised a novel and cheaper liquid crystalline polyester that can substitute for polymer fibres and films in specialty applications.

The team includes a scientist (RRL), Trivandrum, who is on a fellowship at the University of Strathclyde, Glasgow, United Kingdom, and D.C.Sherrington and A. Sneddon from Strathclyde. Their work was reported in the journal Polymer.

Liquid crystalline (LC) polymers have attracted much attention in recent years because of their potential use as high-performance materials. Earlier attempts to prepare the motropic LC polymers have met with varied success as they yielded products that were insoluble and could not be easily processed.

Since then, scientists have been attempting to lower the melting point of these polyesters by various chemical methods to make them easy to process. The Glasgow team developed a new method using a natural material cardanol obtained from cashewnut shell liquid (from the plant Anacardium polymer poly (1,4-benzoate-1,3-phenyl octanoate).

Cardanol is similar to phenol except that it has an additional 15-carbon unsaturated sidechain. Like phenol, cardanol can be polymerised with formaldehyde. It can undergo a variety of polymerisation reactions and chemical modifications because of the additional side-chain Earlier studies by Pillai have shown that high-performance and speciality polymers could be produced from cardanol.

The significance of the new copolyester obtained by Pillai and his Strathclyde colleagues is that its transition temperature-256degC-is lower than that of two commercially available LC co-polyesters in the United States. These two polyesters-known in the market as Vectra and Xyder-have melting points near 300degC and are, therefore, difficult to process. The cost that of other similar products.

Medicinal applications

Cashew, the king of dry fruits, is not merely the best topping for a delicious last course, it is also an aphrodisiac that can boast of many curative properties. The latent and benign medicinal properties of cashew, of which India is the largest producer worldwide, are enormous, according to research data published by the Cashew Export Promotion Council of India, at Kochi.

Laden with 21% protein and an equally high percentage of poly unsaturated fatty acids, cashew helps in reducing the blood cholesterol level considerably preventing possibilities of heart attacks. With an exceedingly low content of saturated fat and soluble sugar, cashew could slim down one's waistline.

Besides, cashew kernels, rich in calcium, phosphorous and iron, can help prevent anagemia and nervous system ailments, the research found. In fact, the vegetable proteins contained in cashew kernels stand at par with milk, eggs and meat. Besides, it also contains a high concentration of much needed acids in right proportions, generally very rare in nuts.

A cashew kernel contains 47% fat, 82% of this fat is unsaturated fatty acids. This unsaturated fatty acids helps in lowering blood's cholesterol level. The most prominent vitamins in cashew are vitamin A, D and E. These vitamins help in assimilating the fats and increase the immunity level. Being a rich source of minerals like calcium, phosphorus and iron, consumption of cashew kernels can help protect the nervous system as well.

According to the Indian Cashew Journal, an official publication of the Cashew Export Promotion Council, cashew kernel is very low on carbohydrates-as low as one per cent of soluble sugar-which means that one is privileged to a sweet taste without worrying about excess calories. One big property of cashew is that it helps in controlling diabetes, says the journal.

The recently discovered vitamin-PP also develops when a cashew is roasted, the journal says, adding that these vitamins exert a sparing action on the B group vitamins and assist in metabolism of lactose and thiamine. The presence of vitamin E in cashew takes care of all reproductive problems and prevents the development of oxidative rancidity in fats.

According to experts, at the council, high content of linoleic acid in cashew kernel makes it an ideal digestive assimilative stimuli since linoleic acid has a structure best suited to the synthesis of prostaglandins, the wonder substance found in many body organs and having a profound influence on various body functions. The process roasting and toasting kernels assists in increasing these properties.

Cashew kernel oil is also considered a good mechanical and chemical antidote for irritant poisons, and it is a vehicle for liniments and other external applications, experts point out. The kernel is also used as a substitute for almond mixture, and is a good food for patients suffering from incessant and chronic vomiting.

One of the most popular systems of Indian medicine, Ayurveda also lists quite a few unique curative properties of Indian cashew nut and prescribes it as a good stimulant, rejuvenator, appetiser, excellent hair tonic aphrodisiac and restorative. Experts say raw cashew fruit was used as an anaesthetic in leprosy, and also for curing warts, corns and ulcers.

The juice of the nut is used as a substitute for iodine while the oil obtained from the shell is good for cracks in feet. The cashew apple contains 10.44 per cent of fermentable sugars and 261.5 mg per 100gm of vitamins C, giving both the fruit and the wine made of it very good antiscorbutic properties. The liquor is also valued as a diuretic with healthy effect on kidneys and advanced cases of cholera.

Apart from its commercial importance as an intoxicant liquor, cashew feni, very popular in Goa, is said to have high medicinal value and has for centuries been used by the Goans as a cure for ailments ranging from worm sickness in children to diahrroea and even cholera.

C. MARKET POTENTIAL

Currently, 60,000 tonnes of CNSL is produced in the country as against the potential of 160,000 tonnes (about 15 per cent of the nut weight is liquid).
While Karnataka produces one-third of the total output at 20,000 tonnes per annum, Kerala, Tamil Nadu, Goa, Andhra Pradesh and Orissa contribute the rest.

The shell liquid, which is extracted out of the outer shell of the nut, also has industrial applications in the automotive industry, leather, and tobacco curing.

Recently, this has found application in the energy sector too. CNSL-based derivatives have been used as substitute for phenol.

CNSL is also used in the making of resins for paints and foundry core oils, insulating varnishes and the like.

Of late, the shell liquid has been extensively distilled to produce Cardanol, which is used in the preparation of friction dust for brake linings and also in rubber compounding formulations.

Recently, there have been enquiries for CNSL as an energy input. CNSL has qualities replicating furnace oil. The potential as fuel gives it additional value.

As a bio-fuel, it can compete with costlier petroleum products. This development augurs well for the cashew value chain and eventually assists the growth of large-scale cultivation in India in non-traditional areas. At the same time, traditional users will have to adjust to newer prices.

The demand is increasing in usage sectors. There is export potential also. As the user sectors of Cashew nut shell liquid is growing faster the demand for CNSL is also going up .If adequate quantity of raw material is available the unit can be started.

D. TECHNICAL ASPECTS

1. INSTALLED CAPACITY

The installed capacity of the unit is 300 Tonnes of Cashew nut shell liquid per annum on three shift basis,8 hours per day, for 300 days.

2. PLANT AND MACHINERY

The following items of equipment are required.

Items	Qty nos
2 HP Motor for Filter Press	1
Miscellaneous Equipments	
Filter press-22 plates 22'×22' with plunger pump	1
4. Lab. glass equipment balance, etc	
M.S. 2500 lt. cap	3
Oil expeller 4.5MT cap hrs mounted on steel fabricated channel fitted with oil tray. Thrust bearings single helical generator with 20 HP motor, starter and all other accessories	1
Installation and Electrification	

The above-mentioned machines are available at an estimated cost of Rs.30.00 lakhs

3. MANUFACTURING PROCESS

The process of manufacturing Cashew nut shell liquid involves the following sequence of operations. Cashew nut is processed by two methods i.e.

(a) Roasting process, and

(b) Oil extraction process.

Some manufacturers use the first method while some others prefer the second method from which the oil is obtained as a by-product.

Raw Cashew nut shell contains over 20% CNSL. In the oil bath process about 10% of oil is recovered as a by-product. By using expellers for extraction, it is possible to extract a further quantity of about 10% more from the shells. Thus from 1 tonne of shells using oil bath process, upto 100 Kg of good quality of CNSL could be extracted by using oil expellers. It is advisable that a small unit of the size given below for extraction and recovery of CNSL is set up adjacent to each good cashew processing unit in view of the economic importance and ready foreign as well as internal demand of the product

4. RAW MATERIAL

The raw material required for cashew shell liquid is the cashew shell .Any cashew processing areas of Tamilnadu and Kerala are suitable for starting the industry. The raw material requirement is 300 MTs of cashew nut shells and the cost is estimated at Rs.500 per MT.

Major Cashew producing states

States	Area in hectares	Production in tonnes
Kerala	120000	100000
Maharashtra	103500	60000
Andhra Pradesh	124100	500000
Orissa	108600	45000
Karnataka	87000	35000
Tamil Nadu	80500	30000
Goa	52000	25000

5. LAND & BUILDING

Land required – Half an acre Cost Rs.7.50 lakhs

Building area 2000 sq.ft –Cost Rs.16.00 lakhs

6. UTILITIES

Power:

The total power requirement of the unit will be 30 HP .Fuel required10 litres per day.

Water:

Water is required only for human consumption.

***Man power*:**

Category	Nos.	Monthly Salary	Total monthly Salary
Supervisor	1	9000	9000
Skilled	2	7000	14000
Helpers	4	5000	20000
Clerk	2	6000	12000
			55000
Add : Benefits	20%		11000
Total			66000

Total wages per annum [Rs.lakhs] Rs.7.92 lakhs

7. IMPLEMENTATION SCHEDULE

If financing arrangement is made available the project can be implemented with in three month's period.

8. ASSUMPTIONS

Installed capacity per annum	Cashew nut shellLiquid-300 MT
Capacity utilization-Year -1	60%
Year-2	70%
Year-3	80%
Selling price per unit	Cashew nut shell liquid-Rs.38000 /MT
Raw material	Cashew nut shells Rs.45.00 lakhs per annum
Consumables /Packing materials	Rs.2200 per MT
Power and Fuel-100% (Rs.lakhs)	Rs.7.17lakhs
Wages & salaries -100% (Rs.lakhs)	Rs.7.92 lakhs
Repairs & Maintenance- p.m.	Rs.20000/-
Depreciation	Written down value Method
General & administration Expenses per month	Rs.50000/-
Selling expenses	3% on Sales
Interest on term loan and Working capital finance	14% p.a.
Income tax provision	34% on profit

LIST OF MACHINERY SUPPLIERS

1. ABC Agro foods Machines (India) Pvt ltd
284, Dr. Ambedkar Road,
Velandipalayam,
Coimbatore, - 641 025

2. Kumar Industrial Works
43-45, Sidco Industrial Estate,
Five Roads, Salem,- 636 004,

3 .Dhanalakshmi Industries
201-204, Suramangalam Road,
Salem - 636009,

4. Mavinchandra and Co.,
180,Linghi Chetty Street,
Chennai-110001

LIST OF RAW MATERIAL SUPPLIERS

Local cashew nut factories in Panruti and Marthandam in Tamilnadu and other Cashew processing areas in Kerala Karnataka and Goa.

FINANCIAL ASPECTS

1. COST OF PROJECT

	[Rs.lakhs]
Land	7.50
Building	16.00
Plant & Machinery	30.00
Technical know how fees	1.00
Other Misc. assets	5.00
Pre-Operative expenses	15.00
Margin for WC	3.03
	77.53

2. MEANS OF FINANCE

Capital	37.53
Term Loan	40.00
	77.53

3. COST OF PRODUCTION & PROFITABILITY STATEMENT

[Rs.lakhs]

Years	1	2	3
Installed Capacity (MT)	300	300	300
Utilisation	60%	70%	80%
Production/Sales (MT)	180	210	240
Selling Price per MT	Rs.38,000		
Sales Value (Rs.lakhs)	**68.40**	**79.80**	**91.20**
Raw Materials	27.00	31.50	36.00
Packing materials	3.96	4.62	5.28
Power & fuel	4.30	5.02	5.74
Wages & Salaries	7.92	8.32	8.74
Repairs & Maintenance	2.40	2.64	2.90
Depreciation	5.15	4.40	3.77

Cost of Production	50.73	56.50	62.43
Admin. & General expenses	6.00	6.30	6.62
Selling expenses	2.05	2.39	2.74
Interest on Term Loan	5.60	4.90	3.50
Interest on Working Capital	1.54	1.54	1.54
Total	65.92	71.63	76.83
Profit Before Tax	2.48	8.17	14.37
Provision for tax	0.84	2.78	4.89
Profit After Tax	**1.64**	**5.39**	**9.49**
Add: Depreciation	5.15	4.40	3.77
Cash Accruals	6.79	9.79	13.26

4. WORKING CAPITAL:

	Months Consumptions	Values	%	Margin Amount	Bank Finance
Raw Materials	3.00	6.75	25%	1.69	5.06
Finished goods	0.25	1.06	25%	0.27	0.79
Debtors	1.00	5.70	10%	0.57	5.13
Expenses	1.00	0.50	100%	0.50	0.00
		14.01		3.03	10.98

5. PROFITABILITY RATIOS BASED ON 80% UTILISATION

Profit after Tax / Sales	=	9.49 / 91.20	10%
Profit before Interest and Tax / Total Investment	=	19.41 / 88.51	22%
Profit after Tax / Promoters Capital	=	9.49 / 37.53	25%

6. BREAK EVEN LEVEL

Fixed Cost (FC):

	[Rs.lakhs]
Wages & Salaries	8.74
Repairs & Maintenance	2.90
Depreciation	3.77
Admin. & General expenses	6.62
Interest on TL	3.50
	25.53
Profit Before Tax (P)	14.37

$$BEL = \frac{FC \times 100}{FC + P} = \frac{25.53}{39.90} \times \frac{80}{100} \times 100$$

51% of installed capacity