SRI DEVI LIQUIDS

(A Unit of Sri Devi Group)

Product: CNSL

Rajahmundry Road, Peddapuram-533437, East Godavari District, Andhra Pradesh

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TECHNICAL DATE SHEET (TDS)

Introduction

Cashew nut shell liquid (CNSL) is one of the sources of naturally occurring phenols. It is obtained from the shell of a cashew nut. About 18-22% CNSL is present in the shell, which amounts to approximately 67% of the nut.

CNSL is traditionally obtained as a by-product during the process of removing the cashew kernel from the nut. The processes used are mainly hot-oil and roasting in which the CNSL oozes out from the shell.

Composition

Natural CNSL contains approximately 70% anacardic acid, 18% cardol, and 5% cardanol, with the remainder being made up of other phenols and less polar substances., Anacardic acid, cardanol and cardol consist of mixtures ofcomponents having various degrees of unsaturation in the alkyl side-chain.

In technical (i.e. heat extracted) CNSL, the heating process leads to decarboxylation of the anacardic acid to form cardanol. Typically, the composition of technical CNSL is approximately 52% cardanol,10% cardol, 30% polymeric material, with the remainder being made up of other substances.

The technical CNSL is often further processed by distillation at reduced pressure to remove the Polymeric material. The composition of distilled technical CNSL is approximately 78% cardanol, 8% cardol, 2% polymeric material and the remainder other substances.

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Cashew Nutshell liquid (CNSL), a by-product from cashew industrial processing and one of the richest natural sources of phenolic compounds, emerges as a promising and renewable feedstock for the development of a wide range of functional products. Cashew nut shell liquid (CNSL) is a renewable natural resource obtained from the Cashew Nut Shell. It is a natural and renewable biomaterial.

CNSL is composed of four major phenolic liquids, namely: anacardia acid, cardanol, cardol and traces of 2-methylcardol in varying ratios.

CNSL is primarily used as raw material for Making Cardanol, Paints and Varnishes, Friction Linings, Surfactants, CNSL Liquid Resin, Laminating Resins, Cashew Cements, Polyurethane Based Polymers, PF Resin and Cashew Friction Dust (CFD) for Automobile Brake linings, Epoxy Resins and Oil soluble Resins, Synthetic Rubber & Wax compounding, Foundry Chemicals, Low-cost Phenol.

CNSL end user Industry- Making Cardanol, Coating Industry, Automotive Industry, Fuel Industry, Leather Industry, Tobacco Curing Industry.

CNSL is a potential substitute for petroleum-based raw materials. Furthermore, the potential use of CNSL as a biofuel or additive to biofuel has been demonstrated.

Green Nanotechnology: Exploration of sustainable alternatives to chemicals derived from petro-based industries is the current challenge for maintaining the balance between the needs of a changing world while preserving nature.
The major source for sustainable chemicals is either the natural existing plant sources or waste generated from agro-based industries.

The utility of such resources will supplement new processed materials with different sets of properties and environmental friendliness due to their biodegradability and low toxicity during preparation, usage and disposal.

Cashew nut shell liquid (CNSL) is a renewable natural resource obtained from the Cashew Nut Shell. It is a natural and renewable biomaterial.

At Sri Devi Group , we are taking action to protect our planet as individual and business by promoting the use of sustainable and bio-based product like Cashew Nut Shell Liquid-CNSL .

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CNSL Applications:

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Industrial Coating, Enamel/Paints, Marine Paints, Acid resistant Paints, Varnishes -CNSL based surface coatings possess excellent gloss and surface finish with optimum levels of toughness and elasticity. It is widely known that CNSL resin is added to synthetics by paint/varnish manufacturers to control properties and to reduce cost. Its anti-microbial, acid resistant and rust proof properties are well known and have been utilized in protecting a bottom of the boat hulls. Because of its dark colour, its outlets are restricted to anti corrosion primers, black enamels, marine paints. CNSL is an excellent raw material for the number of anti-corrosive paint formulations CNSL modified by heating 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, gammaxene, etc. to CNSL or chlorinated CNSL, after treatment with formaldehyde, gums and resins and drying or semi-drying oils.

CNSL as surfactant: Surfactants are amphiphilic molecules constituted of a hydrophobic tail and a hydrophilic head. They are basically used as detergents, wetting and/or foaming agents, emulsifiers or dispersants, and demulsifies due to their ability to lower the surface tension of a liquid, between two liquids, or between a liquid and a solid

Binders -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.

Rubber -Used as a processing aid, which enhances the vulcanization properties. CNSL enhances the insolubility of natural rubber vulcanizates in petroleum solvents' used to provide oxidative resistance to sulphur-cured natural rubber products. Sulfurated CNSL is added to rubber gum stock or nitrile rubber to improve the processability, mechanical properties and resistance to crack and cut.

Adhesive -Adhesives suitable for plywood are made by oxidizing CNSL with potassium permanganate or manganese dioxide at 100degC reacted with para-formaldehyde and compounded with CuCl2. Also CNSL modified with furfural, aniline, xylol, etc. gives good plywood adhesives

CNSL Based Resins -It is highly suitable for surface coating application, where outstanding film properties and very high resistance to water and chemicals are required. Therefore, CNSL Resin is used commonly as a paint raw material due to its high water and chemical resistant property.

CNSL Formaldehyde Resins (Novolac) -These resins can be used for Surface Coatings with or without oil modification when high chemical resistance is desired.

CNSL Aldehyde Resin -Excellent material for the purposes like Insulating Varnishes, Moulding Powders, Brake Lining Compositions, etc.

Resole type CNSL formaldehyde resin -Resole type CNSL formaldehyde resin is used as adhesive in the preparation of composite wood, medium density particle board etc.

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Foundry Resins – Proven material in the formation of foundry cores

Rubber compounding Resins : Incorporation of CNSL products in rubber improves tensile strength and abrasion resistance, reduces fatigue, enhance self-adhesion, rubber to cord adhesion ,contributes to antioxidant and antiozonant activity . The fast curing cashew modified phenol-formaldehyde resins enhance the resistance of the product to aging, chemical attack and the action of solvents and acids .

Wood Preservative : CNSL Based wood preservative chemicals

Cashew Nutshell liquid and its derivatives in oil field applications.

Cashew Nut Shell Liquid as compression-ignition engine fuel (Biofuel/Biodiesel).

Cashew Nut Shell Liquid as a replacement of furnace oil and Light Diesel Oil (LDO).

Cost Effective Modern Materials

In the search for the cost-effective modern materials, CNSL and its products have a significant role to play. Being renewable, it offers much advantage over synthetics. Its versatility stems from its innumerable applications in many areas. Recent research has shown that the constituents of CNSL possess special structural features for transformation into specialty chemicals and high value polymers. This involves a value addition of many orders of magnitude and the chemical transformation provides 100% chemically pure products. Thus, CNSL offers vast scope and opportunities for the production of speciality chemicals, high value products and polymers.

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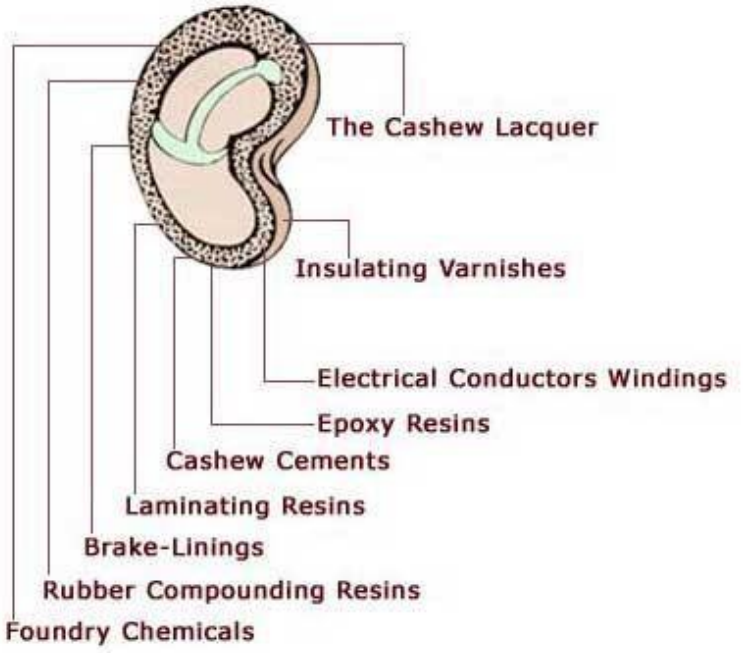

Advantages of CNSL based Polymers

- Improved Flexibility and reduced brittleness.
- Solubility in Organic Solvents.
- Improved Processability.
- Low Fade Characteristics for Friction.
- Resistance to 'Cold Wear'.
- Good Electrical Resistance.
- Better Water Repellence.
- Improved alkali and acid resistance.
- Compatibility with other polymers.
- Antimicrobial Property.
- Termite and Insect Resistance.
- Structural Features for Transformation into High Performance Polymers.

Polymerization Characteristics of CNSL

CNSL can be polymerized by a variety of methods:

- Addition Polymerization through the side chain double bonds using cationic initiators such as sulphuric acid, diethylsulphate etc.
- Condensation Polymerization through the phenolic ring with aldehydic compounds.
- Polymerization after Chemical Modification to introduce specialty properties.
- Oxidative Polymerization.
- Various Combinations of the above.

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Industrial Significance of CNSL

- Low Cost Phenol.
- Versatility in Polymerization and Chemical Modification.
- Possibilities for Development of High Performance Polymers.
- Property advantage over phenolics in certain applications such as impact resistance, flexibility, faster heat dissipation etc.

Reactivity

CNSL undergoes all the conventional reactions of phenols. Cardanol differs from phenol only in the C15 side chain. It undergoes the well known formaldehyde condensation reaction of phenols that gives rise to phenolic polymers. Moreover, it can be polymerised through the unsaturation in the side chain although the bulky nature of the side chain restricts the molecular weight attainable to oligomers. One of the significant advantage of the cardanol is its amenability to chemical modification to effect desirable structural changes so as to get specific properties for making tailor-made polymers of high value. Thus, structural changes could be effected at the hydroxyl group, on the aromatic ring and on the side chain.

Cardanol

Distillation of CNSLunder reduced pressure gives cardanol. The residue will be rich in cardanol and is generally known as residol, which is conveniently used in the preparation of friction dust for brake linings, and also in rubber compounding formulations.

CNSL in oil field applications

Cashew Nutshell liquid and its derivatives in oil field applications.

The oil and gas industry is often challenged with serious problems like high cost of oil field chemicals and environmental toxicity issues of commonly used synthetic oil field chemicals, and this has dragged the attention of researchers to the search for more cost effective and environmentally friendly oil field chemicals. Oil field chemicals formulated from various renewable sources (such as plant extracts) have been recognized as an alternative with great environmental advantages, cost advantage, and availability compared to their synthetic counterparts. Cashew nut shell liquid (CNSL), a byproduct of the cashew industry, stands out as a unique renewable starting material amongst others due to its peculiar structural feature, low cost, and availability. It consists of naturally occurring substituted phenolic compounds that can participate in diverse reactions for the manufacture of numerous useful products. A large number of chemicals and products have been developed starting from CNSL by taking advantage of the reactive sites namely phenolic hydroxyl, aromatic ring, the acid functionality, and unsaturation(s) in the C15 alkyl side chain. This update gives highlights on the composition, extraction, isolation, and reactivity of CNSL. It also focuses on the oil field application of CNSL and its derivatives.

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Cashew Nut Shell Liquid as compression-ignition engine fuel (Biofuel/Biodiesel)..

Cashew Nut Shell Liquid (CNSL) being used as an alternative fuel for diesel engine. The viscosity of CNSL is 30 - 35 times higher than diesel; hence different blends of CNSL would have different properties and application. Also, modification of the oil and its application condition such as, injection pressure, injection timing and preheating the oil also optimizes the performance of the engine. There were indications that preheating of CNSL25 blends at 200 kg/cm2 injection pressure and 28° injection timing gives encouraging results suitable for commercial purposes . CNSL as a bioadditive in engines increases the durability of the equipment. Hence, the application of CNSL as a bioadditive will reduce the dependency on petroleum products besides preserving the environment by lowering pollutant residues from fuel combustion products. Some of the properties of diesel, biofuel and ethanol are presented against CNSL . CNSL has higher density than diesel. It can be reduced by degumming and trans esterification. Cetane for CNSL is expected to be poor due to the presence of aromatic compounds. The usual C:H:O ratio for vegetable oils is 78:12:10 whereas for CNSL it is 80:12:8; hence, it justifies the higher calorific value of CNSL (47 MJ/kg), whereas for diesel it is 42 MJ/kg. Also, ash content is well within the limits for CNSL. The water content of CNSL is quite high. The sulphur content does not exceed 0.006% for any vegetable oil. Thus it is anticipated that CNSL has no sulphur content. The flash point for CNSL is 164°C; this is higher than the flash point for diesel and represents the higher starting ignition temperatures and compression of CNSL.

Cashew Nut Shell Liquid as a replacement of furnace oil and Light Diesel Oil (LDO)

Light Diesel oil (LDO) and furnace oil mainly belong to the intermediate boiling range products of crude oil distillation. As a result, LDO and furnace oil have a high metallic content along with other impurities which is detrimental to our daily usage and additionally the petroleum reserves are stiffly exhausting. Prices of petrochemical derivatives are rising. So, an urgent replacement is needed in order to maintain the stability of our economy.

In an experiment, the properties of both LDO, furnace oil and CNSL were tested and the results were compared. According to obtained results, CNSL was found to have a higher ash content as compared to both LDP and furnace oil, but that is only more by 1%. So, this little amount of difference can be tolerated in our industrial heating applications. The Gross Calorific Value (GCV) and relative density of the LDO, furnace oil and CNSL are the same. Moisture content is same for CNSL and furnace oil but is lower for LDO. So, the moisture of CNSL needs to be removed to some extent before being used in replacement of LDO. The moisture content can easily be removed.

The most notable point of difference is that the flash point for CNSL (170°C) is much higher than that for LDO (66°C) and furnace oil(66°C). The pour point of CNSL (2°C for both summer and winter) is much lower than LDO (120 °C for winter and 20 °C in summer). The comparatively higher flash point and lower pour point indicate that the CNSL in much safer to use and will be much more commercial if used in place of LDO and furnace oil.

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PROPERTIES OF CNSL

S.N	Characteristic	Specification
1	Appearance	Reddish Brown liquid
2	Specific Gravity @ 30°C	0.950 – 0.970
3	Viscosity @ 30°C(cps) Flow cup no.4 (seconds)	550(max) 40-200
4	Moisture content	1% (max)
5	Ash content	2% (max)
6	Insolubles in Toluene (%)	1% (Max)
7	Acid Value (mgKOH/gm)	<10
8	Iodine Value (WIJS)	240 – 290
9	Loss in Weight on heating, % by Weight, Max	2.0
10	Polymerisation Time in minutes,	4(max)

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Certificate of Components

Product Name : Natural CNSL

Chemical Name(IUPAC or CA Index Name)	CAS No	Content(%)
Anacardic acid	16611-84-0	70%
Cardol	57486-25-6	18%
Cardanol	37330-39-5	5%
2-Methly-Cardol	8007-24-7	7%