

**A**  
**Report**  
**On**  
**Cashew Nut Shell Oil Distillation**  
**(CNSL):**  
**Cardanol oil Extraction**

## INTRODUCTION

Cashew Nut Shell Liquid (CNSL) or Cashew Oil or Cashew Nut Shell Oil is a dark reddish brown viscous liquid, extracted from a soft honey comb structure inside the cashew shell. It is a natural and renewable biomaterial. Thus, it offers much advantage over synthetics. CNSL is often considered as cost effective and better modern materials for unsaturated phenols.

Moreover, due to its versatility, CNSL has over 200 patents on its industrial applications. Recently, research has also shown that the CNSL constituents contain special structural features, which can be useful for manufacturing of speciality chemicals and high value polymers.

So the main purpose of CNSL extraction is to get Cardanol oil which is widely used in industries.

Physically extracted CNSL contains anacardic acids 70%, cardol 18% and cardanol 5%.

Anacardic acid present inside CNSL is converted to Cardanol which is widely used in Industrial Process like vehicle's brake lining as binder or friction powder and for surface coating, such as in anticorrosive paint, varnish, and lamination, used as brick, concrete, steel, and plywood sealer.

Cardanol is basically a monohydroxyl phenol with a long carbon chain in the metaposition. It has the potential as a substitute for phenol in resin phenolic-base chemical products.

Main Process of Cardanol extraction from Natural CNSL comprises the conversion of natural CNSL into technical CNSL in which anacardic acid is decarboxylated into cardanol.

Technical CNSL is obtained contains mainly cardanol (60-65%), cardol (15-20%), polymeric material (10%), and traces of methyl cardol. Cardanol is sent to distillation for further purification.

## PHYSICAL PROPERTIES

S. No.	Description	Natural CNSL	Cardanol
1	Molecular formula	$C_{22}H_{30}O_3$	$C_{15}H_{31-n}; n = 0,2,4,6$
2	Molecular Mass	342	298
3	Appearance	Dark Brown	Light Pale Brown
4	Density $g/cm^3$	1.009	0.92
5	Boiling Point	-	435 °C @ atm., 225 °C@ 2-3torr
6	Viscosity, cP@30°C	343	45-60



**Natural extracted CNSL**



**CARDANOL**

## PROCESS OVERVIEW: CNSL DISTILLATION

Everest has already made many landmarks in offering the solutions to many complicated processes including CNSL.

Everest offers positive displacement vacuum pumps that are basically meant to handle NC load (within permissible limits as per the HEI standards) + saturated vapor load.

According to the invention Natural CNSL contains anacardic acid which is converted in to cardanol by

decarboxylation process of anacardic acid. In this Process natural CNSL is heating under vacuum

condition up to 170 to 180°C in which anacardic acid get converted into cardanol with release of CO<sub>2</sub>

and H<sub>2</sub>. Anacardic acid Contains carboxylic group which is eliminated by heating, this converted

components is called cardanol,

After this cardanol is further sent for purification step in which cardanol is separated out from rest

components as this process contains highly viscous components so normal distillation is not possible,

that's why Agitated thin film distillation (ATFD) is applied to complete the process.

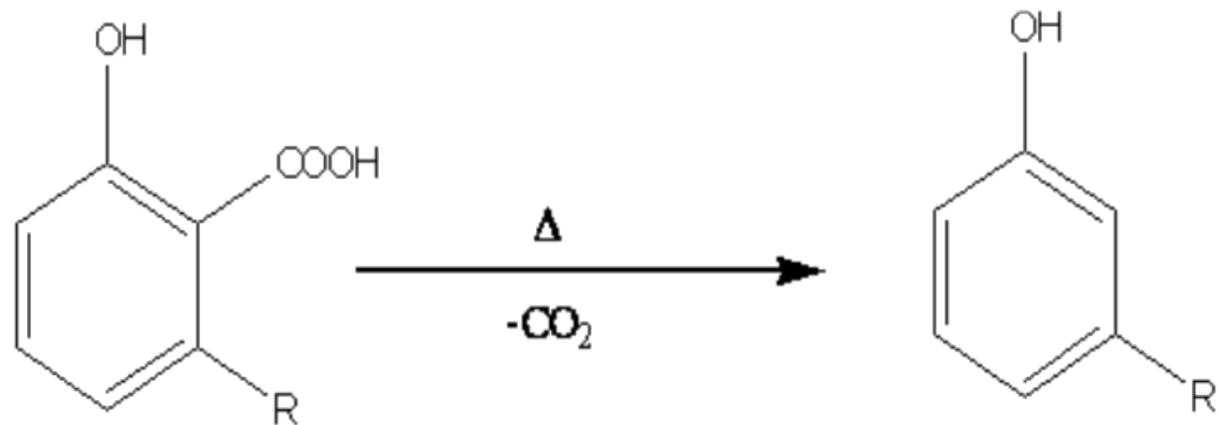
In CNSL distillation, Cardanol is recovered at top of the column and at the bottom of column a tarry matter, high viscous residue remains called 'Resorcinol'.

It has been found that there are certain difficulties of operation with regard to single-stage fractional distillation method, as long term exposure of CNSL to heating cause the CNSL self polymerised which affects the Product properties therefore distillation is carried out in short period of time.

When CNSL distillation is done at about 200°C to 240°C under reduced pressure of about 2 to 2.5 mm mercury in short possible time gives distillate containing cardanol and cardol and residue tarry material. To make the purity and color of cardanol of high level, firstly distilled cardanol is then subjected to a second distillation under the same identical conditions of temperature and pressure where the cardanol distils over at a temperature of 230°C to 235°C and other impurities remains which has high boiling point than Cardanol that is why cardanol extraction is high temperature sensitive

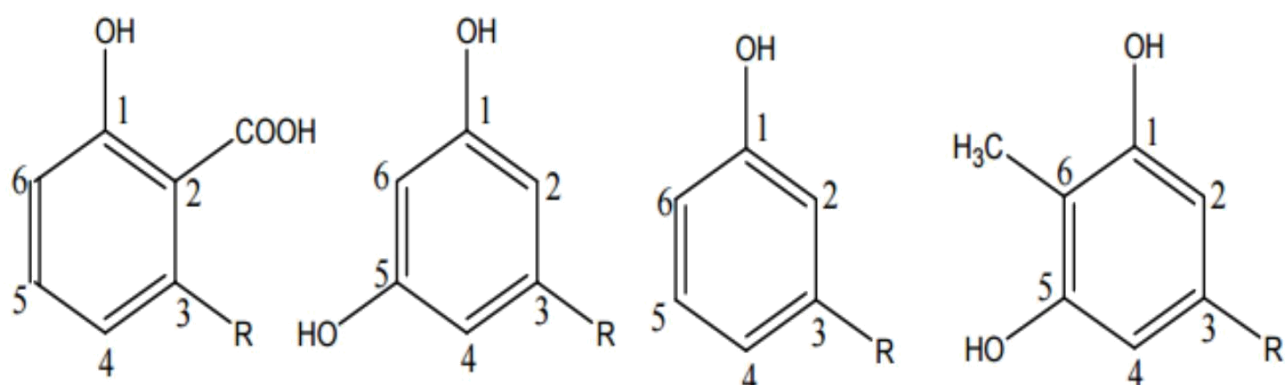
process, if there is drop in vacuum then temperature will rise suddenly which cause the impurities to carry with distilled cardanol and will cause the discoloration of Cardanol. In practice it has been found that the preliminary decarboxylation of the oil is essential, since there will be excessive frothing, which renders the distillation procedure unproductive and uneconomical.

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**Anacardic acid**

**Cardanol**



Anacardic acid

Cardol

Cardanol

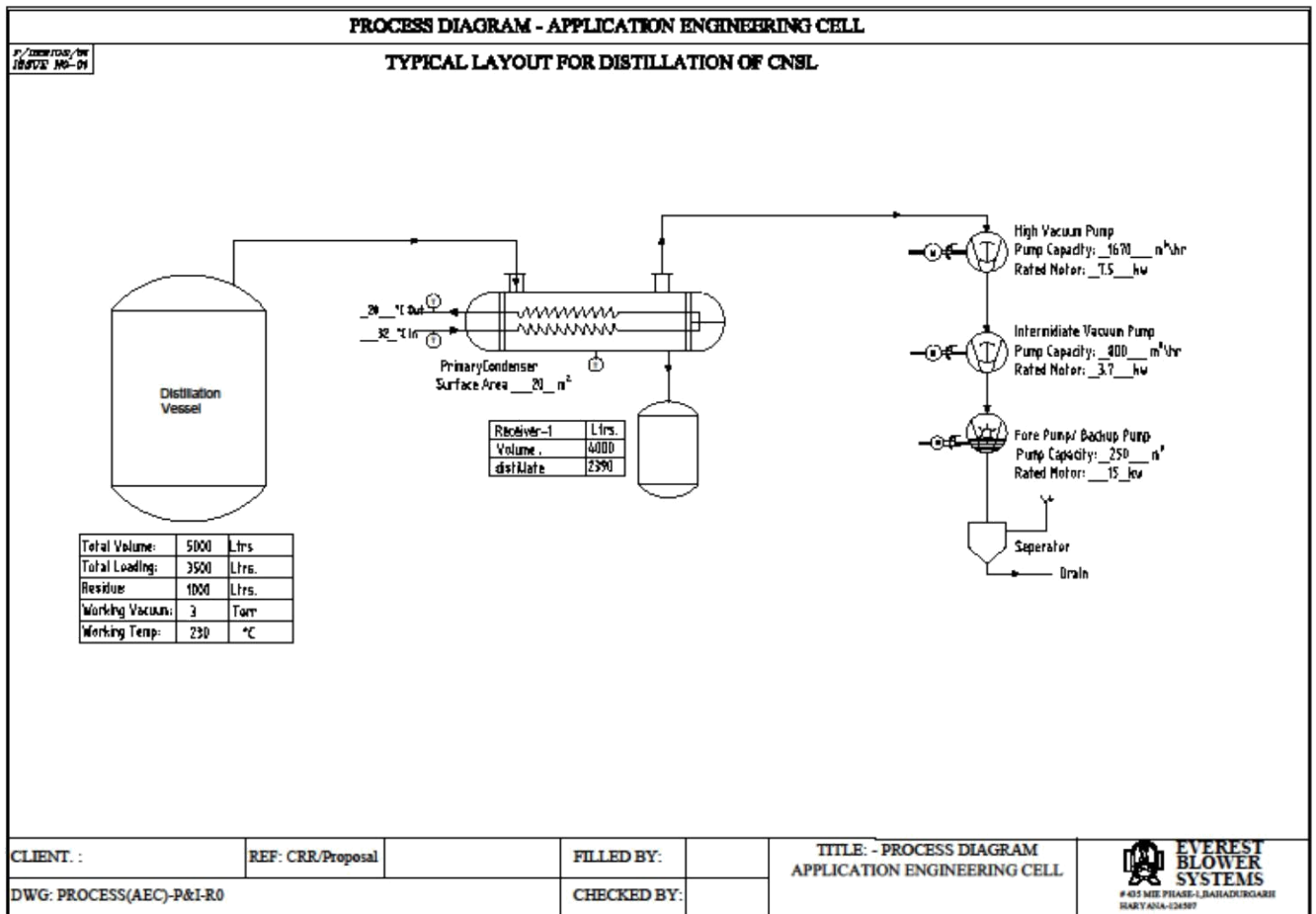
2-Methyl-cardol

## EVEREST SHARES PRACTICAL DATA TAKEN AT ONE OF THE SITES WITH SETUP FOR CNSL DISTILLATION:-

- Kettle Capacity:- 5000 litres
- Total Loading:- 3500 litres
- Main Product:- 1000 litres
- Total distilled:- 2390 litres
- Working Temperature: 170 -235 °C
- Pump Capacity: - 1670.800.250M3/Hr
- Loss %:- 3 - 4%
- Pre-condenser recovery: - 2930 litres
- Process Time:- 14Hrs 30 Min
- Average distil rate: 140-150 lt/hr

## OBSERVED DATA DURING PROCESS:

S. No	TIME	KETTLE VACUUM	KETTLE TEMP.	REMARKS
UOM	HH:MM	TORR	°C	
1	00:00	760		HEATING START
2	03:00	45	180	DECARBOXILATED OIL COMES
3	04:00	5	210	ANACARDOL DISTILATE
4	14:30	3	235	CARDANOL DISTILLATION COMPLETES



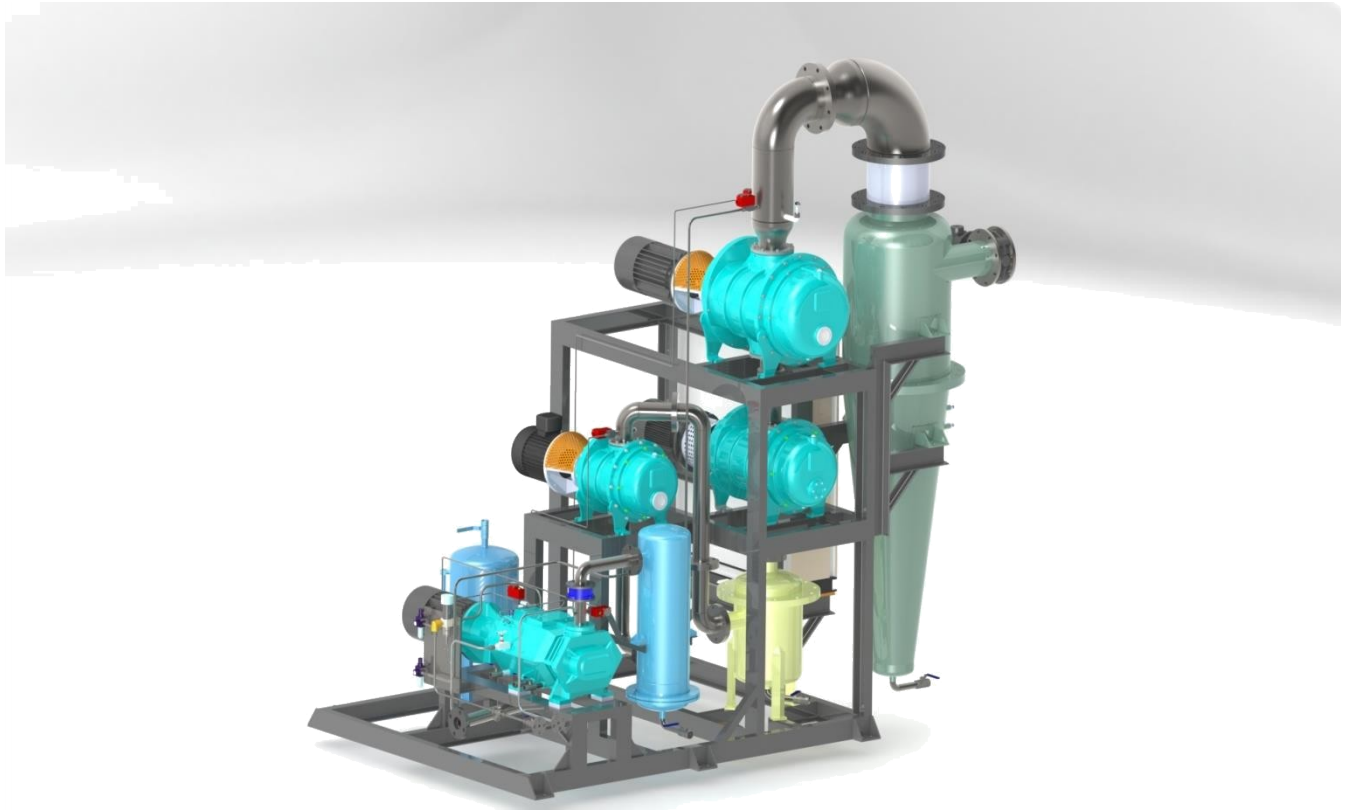
**Cardanol has many industrial applications described below:**

**Application:**

- Oil Soluble Resins
- Lamination
- Surface coating & paints
- Electrical Insulating
- Varnishes
- Brake lining, clutch facings
- Lacquers
- Pesticides
- Rubber compounding
- Adhesives
- Wax substitutes
- Mineral oil additives
- Azo Dyes



**TYPICAL EVEREST VACCUM PUMPING SYSTEM FOR CNSL DISTILLATION  
PROCESS:**



**EVEREST VACUUM PUMPING SYSTEM**