

PROTOBIND 1075 - An Indigenous Economical and Eco-friendly Renewable Raw Material for the Plywood Industry

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Background

In a country like India, which is experiencing widespread accelerated economic growth, the demand for wood panels has increased in recent years and is expected to continue increasing for the foreseeable future. The wood panels industry depends on adhesives derived from petroleum such as phenol formaldehyde resins for the preparation of boards of high durability and strength. India is a net importer of oil. Furthermore, oil is an exhaustible feedstock and an oil-based economy potentially increases emissions of greenhouse gases with damaging environmental effects. As the world moves towards a sustainable economic model, it is necessary to rely on alternative renewable raw materials.

Our planet has abundant plant life, which is a source of food, feed, energy, chemicals and materials. Plants represent massive quantities of renewable resources, mostly constituted by lignocellulosic biomass. Among the components of biomass, lignin is second in abundance to cellulose, constituting 20-40% of the weight of wood and other biomass. Lignin is a complex phenolic biopolymer that acts as the binding agent that holds the fibers in wood and other biomass together, generating a high-stiffness composite structure with outstanding resistance to impact, compression and bending. In addition, lignin provides the plant with protection against weather, insects, pathogenic microorganisms and environmental stress among others.

Extensive development activities have been conducted worldwide focused on the use of lignin as a co-reactant in Phenol formaldehyde (PF) adhesives for use in the panel industry¹⁻⁶. These have included activities by experts in the Indian panel industry⁷⁻¹². Up to recently the technical success had not resulted in widespread industrial use due to non-availability of consistent quality of lignin in sufficient quantity. This situation has fortunately changed for India, as Asian Lignin Manufacturing Pvt. Ltd. (ALM) a new company devoted to the domestic production of this renewable material in consistent high-quality recently started commercial operations in Punjab. This Chandigarh-based company is associated with a Swiss group focused on production and marketing of renewable chemicals, such as sulphur-free lignin and its derivatives. Swiss patented know-how has been implemented now in Northern India with the installation of a computer-controlled, state-of-the-art plant for the production of high-purity sulphur-free lignin from wheat straw and other agrofibres. This plant is the largest of its type in the world. Besides production of lignin, ALM is involved in product development and marketing in several application areas. The

company has a technical centre in Mumbai and availability of technical experts and commercial representatives in various parts of the country.

Given its geographical situation and operational organization, the company offers a unique logistic advantage by making the product locally available from ready stocks at stable prices thus enabling the industry to save upon inventory costs.



Protobind 1075

Protobind 1075 is a high-purity natural polyphenolic material developed by ALM and especially formulated for use as a partial replacement of phenol in phenol-formaldehyde (PF) resins.

Protobind 1075 is a renewable product obtained from agricultural fibrous feedstocks. Since the product is obtained from biomass, its production cost is to a great extent independent from the ever-increasing price of oil, which has caused severe price escalation in petroleum derivatives such as phenol and other raw materials used in the plywood industry. Typical properties of Protobind 1075 are summarized in Table 1;

Table 1: Typical properties of Protobind 1075

% Solids	> 95
% Ash	< 3
pH (10% aqueous suspension)	~ 4
Solubility in water (acid or neutral)	Nil
Solubility in aqueous alkali	Very high

The use of Protobind 1075 is 100% compatible with Indian industrial practices and results in comparable performance to phenol formaldehyde resin. Furthermore, using Protobind 1075 also leads to favorable environmental impacts

ALM with the collaboration of the renowned Indian Plywood Industries Research & Training Institute (IPIRTI), Bangalore, has worked extensively on the development of plywood PF resins based on Protobind 1075 that are suitable for Industrial plywood production as per Indian Standard. The collaboration activities were executed in phase-wise manner with the studies moving from laboratory to pilot plant and finally to successful demonstrations at the industrial level. These studies involved an investigation of resin preparation as well as panel preparation parameters using a variety of veneer species representative of those available across the country. More detailed account of the ALM-Ipirti collaborative work is published elsewhere¹³.

Although various substitution levels are possible, 20 - 30% phenol replacement is recommended as a starting point that offers significant savings as compared to the use of phenol. Typical properties of the resins prepared are shown in Table 2. As can be seen the formulations developed are similar in properties to those of conventional phenol-formaldehyde resins.

**Table 2: Properties of Protobind 1075 based
plywood PF resins
(20- 30% phenol substitution)**

Solids Content	42 – 50 %
Viscosity B-4 cup at 25 ± 2°C (freshly prepared resin)	18–25 sec
pH	9 – 10
Gel Time at 150±1°C	50-100 sec
Water Tolerance	8 to Infinity

Plywood PF resins based on Protobind 1075 may be employed according to conventional procedures used for plywood manufacture. The product is compatible with traditional extenders such as coconut shell powder, groundnut shell powder, maida (wheat flour), etc. The recommended glue spread rate is within the ranges of conventional Indian practice. Depending on the type of veneer used, open assembly time may be adjusted for optimum results. Pressing conditions are standard, according to panel construction and thickness, as shown in Table 3.

**Table3: Typical Glue Formulation and
Panel Manufacturing Parameters for use of
Protobind 1075 based plywood PF resin**

<u>Glue Formulation</u>	
Protobind 1075 resin	100 parts per weight
Coconut Shell powder	6 - 8 parts per weight
Veneer Moisture	6 - 8 %
Spread Rate	3- 3.5 m ² /kg
Open Assembly Time	30 - 60 minutes
Pressing Temperature	145 ± 5 °C
Specific Pressure	14 - 16 Kg / cm ²
Pressing Time*	7 - 25 minutes

** Depending upon panel thickness*

Based on the successful results of the joint activities with Ipirti, ALM has conducted a series of industrial trials jointly with various innovative industries across the country. Depending on the availability and suitability of resin kettle at customer end, varying batch size of Protobind 1075 based PF resin has been prepared by partial replacement of phenol in the range of 20- 30%. In such trials veneers of various thickness have been used. The types of veneer include poplar, eucalyptus, gurjan, and silver oak, among others. Panels in the thickness range of 6 mm to 19 mm have been produced using Protobind-based PF glue with different types and varying percentage of extenders which include coconut shell powder, groundnut shell powder, maida (wheat flour) and some of their combinations etc. The panels obtained have been evaluated with respect to glue shear strength and boil water proof as per Indian standard. Representative results obtained in such industrial trials are shown in Table 4.

Table 4- Industrial panel results obtained at customer end using Protobind 1075 based PF resin

S. No.	Trial code	Batch Size Kgs.	Protobind 1075 Replacement %	Construction	PANEL		GSS	
					Ply Nos.	Thickness mm	Dry Kgs.	Wet, BWR (8 Hrs Boiling) Kgs.
1	051109	2200	30	GPEPEPEPG	9	12	133	110
2	051129	200	30	GGGGGGGGG	9	12	126	110
3	051129	200	30	GGGGG	5	6	122	96
4	060214	350	30	GEGEGEGEG	9	12	139	90
5	060201	600	25	GPEPEPEPG	9	12	128	112
6	060216	330	20	GEGEGEGEG	9	12	132	96
7	060227	370	20	GPPPPPG	7	9	113	109
8	060418	625	20	GPEPEPEPG	9	12	131	90
9	060503	1500	20	GPEEEEEPG	9	12	147	140
10	060214	330	20	GGGGGGGGG	9	12	150	100
11	060413	330	20	GGGGGGG	7	9	134	122
12	060202	330	20	GSGSGSGSG	9	12	110	80
13	060209	1056	30	GPEPEPEPEPEPG	13	19	136	106

G: Gurjan; P: Poplar; E: Eucalyptus; S: Silver oak; GSS: Glue shear strength; BWR: Boil water resistant

Based on the above industrial trial, it is inferred that the resulting panels using PPF resin gives consistent satisfactory results in terms of dry and wet GSS strength till 8 hrs boiling. Furthermore, no delamination was observed till 72 hrs boiling for boil water proof grade panels.

Many of the leading plywood producers in the country have already started using Protobind 1075 in their plywood resin formulations and are pleased to get consistent quality at reduced manufacturing cost. ALM's team of technical experts is prepared to work with other customers for customized formulation development and demonstration of resin preparation schedule for further introduction of this product.

Conclusions

- ❖ The consistent availability of sulphur- free lignin as a high purity product in industrial quantities is a reality in India through ALM, who is exclusively promoting and marketing Protobind 1075 to the plywood industry across the country. .
- ❖ ALM with the collaboration of Ipiri successfully demonstrated the manufacture of Protobind 1075 based PF resin at 20-30 % phenol replacement level. And its use for industrial production boil water resistant and boil water proof plywood panel products as per Indian standard
- ❖ The use of Protobind 1075 reduces dependence on petrochemical-based raw materials and offers significant cost reduction with respect to conventional PF resin
- ❖ The method of preparation of Protobind based resin is similar to that of conventional PF resin and its use does not require any additional equipment or process deviation while making plywood.
- ❖ ALM's team of technical experts is prepared to work with individual customers to customize formulations as required in order to achieve an optimum balance of performance and economics

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