Research and Industry
Vol. 27, June 1982, pp. 178-180

Effect of Adhesion Promoters on the Adhesive Property of Shellac Over Metal-to-Metal Surfaces: Part II

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Received 27 *August* 1981; *accepted* 2 *April* 1982

The effect of few adhesion promoters on the adhesive property of shellac over metal surfaces, viz. iron, copper and brass, has been investigated. It has been observed that maleic acid behaves better than other promoters and it imparts a bond strength of 0.3 ton/in^2, whereas plain shellac gave only 0.08 ton/in^2 when bonded at 150°C and 2000 lb/in^2 pressure on steel surface.

In an earlier communication[1], the adhesive strengths of three grades of plain shellac, viz. *rangeeni*, *kusmi* and dewaxed shellac on iron, brass and copper substrates were reported under different combinations of the three main parameters involved, viz. temperature, pressure and time. It was found that among the two grades of shellac, dewaxed shellac possessed better adhesive properties irrespective of the nature of the substrate and among the different substrate used, iron was found to be the best surface for adhesion.

The present article reports the results of the systematic studies of adhesive properties of *rangeeni* shellac in presence of adhesion promoters, such as succinic, tartaric, malic, citric, maleic and phthalic acid. Among the promoters hydroxy acids and unsaturated acid (maleic) have been found to increase the adhesion by two to four times over plain shellac which are critically discussed.

Experimental procedure

In all the experiments *rangeeni* shellac, having life, flow and acid value 34 minutes, 38.6 mm and 68.88 respectively, was used. Ten per cent alcoholic solution of the same shellac was prepared and di and tri carboxylic acids were incorporated in varying proportion (0.5 to 7 per cent on the weight of shellac). Panels of iron, brass and copper of size 7.5 × 2.5 cm having cleaned and polished surfaces were used. The panels were finally cleaned with trichloroethylene in order to remove oil and grease from the surface. One ml of the prepared solution was spread over the surface of the panel to cover 1 sq inch area and allowed to dry overnight at room temperature. The panel was then baked at 94°-95°C in a steam oven for 1 hr. Two panels were placed one upon the other, overlapping the coated area (1 sq inch) and then they were hot pressed for 1 hr in a carver press at 150°C and 2000 lb pressure, allowed to cool to room temperature and the bond strength of each pair was determined by Hounsfield Tensometer. Five pairs of bonded panels were tested for each experiment and the mean value was taken.

Results and discussion

From the results given in Table 1 it will be found that incorporation of small quantity of acids decreases the adhesive strength of shellac. On increasing the proportion of acid, there is, however, a gradual rise in bond strength and on further increase there is a fall.

Table 1—Adhesive Strength of Shellac in Presence of Adhesion Promoters

Type of acid (%)	Bond strength (ton/in²)			Type of acid (%)	Bond strength (ton/in²)		
	Iron	Copper	Brass		Iron	Copper	Brass
1 *Tartaric acid*				4 *Malic acid*			
0.00	0.080	0.130	0.120	0.0	0.08	0.12	0.13
0.50	0.033	0.090	0.070	0.5	0.10	0.13	0.12
1.00	0.090	0.014	0.130	1.0	0.12	0.13	0.12
2.00	0.110	0.135	0.140	1.5	0.13	0.14	0.13
2.50	0.160	0.145	0.140	2.0	0.15	0.13	0.14
3.00	0.170	0.146	0.150	2.5	0.14	0.13	0.13
3.50	0.180	0.146	0.158	3.0	0.15	0.14	0.12
4.00	0.190	0.150	0.160	4.0	0.15	0.14	0.13
5.00	0.190	0.150	0.120	5.0	0.16	0.12	0.12
6.00	0.140	0.130	0.116	6.0	0.15	0.11	0.11
7.00	0.130	0.120	0.110	7.0	0.12	0.10	0.10
8.00	0.120	0.100	0.100				
				5 *Citric acid*			
2 *Phthalic acid*				0.0	0.08	0.14	0.13
0.0	0.08	0.12	0.12	0.5	0.07	0.13	0.12
0.5	0.09	0.10	0.10	1.0	0.14	0.14	0.13
1.0	0.08	0.06	0.06	1.5	0.15	0.16	0.14
1.5	0.09	0.08	0.08	2.0	0.17	0.16	0.14
2.0	0.10	0.09	0.08	2.5	0.16	0.15	0.15
2.5	0.10	0.10	0.10	3.0	0.14	0.15	0.16
3.0	0.08	0.10	0.10	4.0	0.12	0.13	0.13
4.0	0.10	0.12	0.11	5.0	0.10	0.11	0.12
5.0	0.12	0.13	0.12	6.0	0.10	0.10	0.11
6.0	0.10	0.10	0.09	7.0	0.09	0.08	0.09
3 *Succinic acid*				6 *Maleic acid*			
0.0	0.08	0.12	0.12	0.0	0.08	0.13	0.12
0.5	0.06	0.10	0.10	0.5	0.07	0.10	0.10
1.0	0.06	0.10	0.10	1.0	0.05	0.08	0.07
1.5	0.08	0.10	0.10	1.5	0.08	0.15	0.14
2.0	0.08	0.10	0.10	2.0	0.10	0.20	0.19
2.5	0.09	0.10	0.00	2.5	0.15	0.21	0.21
3.0	0.10	0.11	0.12	3.0	0.20	0.25	0.23
4.0	0.10	0.12	0.12	4.0	0.30	0.35	0.34
5.0	0.09	0.10	0.10	5.0	0.14	0.25	0.26
6.0	0.08	0.10	0.10	6.0	0.16	0.21	0.22
7.0	0.08	0.09	0.08	7.0	0.11	0.20	0.19

Incorporation of succinic acid and phthalic acid hardly affects the bond strength, whereas malic acid, citric acid and tartaric acid increase the bond strength from 0.08 ton to 0.16 ton, 0.17 ton and 0.19 ton respectively. In case of citric acid, maximum bond strength was achieved by incorporation of 2 per cent of promoter and for malic acid and tartaric acid, 4 per cent of the acid is essential for achieving maximum bond strength. It thus appears that hydroxy acid plays an important role in increasing the bond strength and the increase in value can be ascribed to the number of hydroxyl group present in the molecule as could be seen from the fact that malic and citric acids are monohydroxy, whereas tartaric acid is dihydroxy. Non-hydroxy

acids like succinic and phthalic acids had hardly any effect on the bond strength. However, the best performance was observed in case of maleic acid which gave a bond strength equal to 0.3 ton/in^2 as against 0.08 ton/in^2 when plain shellac was used. This higher value could be ascribed to the fact that maleic acid could go under adduct formation with terpenes present in the shellac molecule. Such reactions of maleic acid or anhydride with a terpene, such as terpinene, terpineol, dipentene, pinane, etc. are well known[2].

Acknowledgement

The authors are thankful to Dr T P S Teotia, Director, Indian Lac Research Institute, for his keen interest in the work.

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