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Application News

Material Testing System DUH

No. SCA_300_040

Evaluation of Hardness of Painted Surface

Painted surfaces are evaluated for properties such as weathering resistance, light resistance, adhesive strength, impact resistance and hardness by instrumental measurement, and for color, gloss, unevenness, rumples etc. by visual inspection. Of these, the hardness test of painted surfaces is most important in evaluating the quality of paint film. Wet paint is dried in order to transform wet paint into rigid paint film. Paint can be dried either by the natural drying method, in which the paint dries completely at room temperature, or by the forced drying method, in which paint is dried under high temperatures of approx. 100 to 250 degrees Celsius. The surface hardness of paint films differs depending on the kind of paint and the drying method. Information for evaluating hardness near the surface of paint film can be obtained by the ultra-micro area measuring technique of the Shimadzu Dynamic Ultra Micro Hardness Tester Model DUH. The following presents the results of hardness tests performed on paint films of paints for general use dried either by the natural or by the forced drying method.

■ Measurement of surface hardness of paint films

TEST MODE	2
CAL. MODE	1 (115° Triangular Pyramid Indenter)
AUTO or MANUAL	AUTO
F.S. DEPTH	2 & 5 μm
MAX LOAD	9,81 mN & 49,03 mN
LOADING SPEED	1 (0,1,4632 [mN/sec]) 5 (13,3240 [mN/sec])
TOUCH SPEED	50 (0,48 [mN/sec]) 50 (0,048 [mN/sec])
AFTER TIME	5 sec.
PRE TIME	5 sec.
LOT	5

Table 1 Test Conditions

■ Paint film of Meramin Resin dried by forced drying

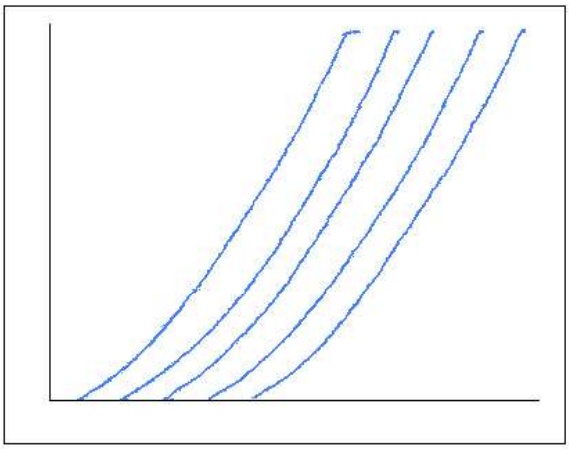

Fig. 1 Indentation depth Load Curves of Painted Films of Meramin Resin

■ Paint film of Urethane Resin dried by natural drying

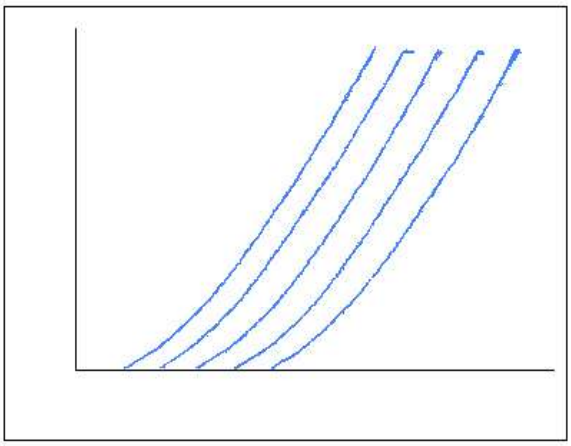

Fig. 2 Indentation Depht Load Curves of Painted Films of Urethane Resin

■ Paint film of acrylic resin dried by natural drying

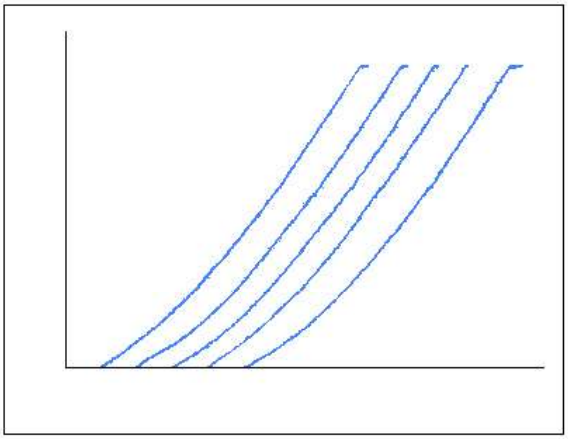

Fig. 3 Indentation Depth Load Curves of Paint Films of Acrylic Resin

Sample Name	LOAD (mN)	DH (mean)
Meramin resin paint film thickness 38 µm - forced drying	9,81 mN	14,60
Overall thickness of paint film 177 µm	49,03 mN	12,00
Urethane resin paint film thickness 48 µm - forced drying	9,81 mN	13,00
Overall thickness of paint film 84 µm	49,03 mN	5,20
Acrylic resin paint film thickness 52 µm - forced drying	9,81 mN	10,50
Overall thickness of paint film 110 µm	49,03 mN	4,90

Table 2 Result of Measurements

Dynamic hardness is obtained based on the load value and indentation depth during the loading process. Since dynamic hardness is calculated from the indentation depth during the loading process, it includes both plastic deformation and elastic deformation.

DH: dynamic hardness

F: test load mN

h: dynamic indentation depth2

DH115 = 3.8584×F／h2

DHT115: Dynamic hardness obtained with the triangular pyramid indenter with 115°tip angle

When LOAD is small, DEPTH is small, allowing the hardness of paint film at the outermost surface to be measured. When LOAD is large, DEPTH is also large, allowing the hardness at the deeper portion of paint film to be measured. In tests on samples dried by natural drying and forced drying, a different trend was observed for the respective samples between the results of 9,81 mN and 49,03 mN LOADs. In other words, the difference between the data for 9,81 mN and 49,03 mN was large in case of natural drying, while significantly smaller in the case of forced drying. This indicates that forced drying creates hardness more evenly distributed throughout the depth of the paint film than natural drying.

* Please be advised that data obtained before the implementation of the current Weights and Measures Law may be presented in terms of gravimetric unit.