Introduction

Film thickness gages are among the most essential instruments used in the coatings industry. The generally accepted ratio of dry film to wet film thickness of most coatings is:

$$\text{Dry Film} = \frac{\text{Wet Film x \% Vol. Solids of Coating}}{100}$$

Errors in film thickness estimates result in a needless expenditure of time, material, and money. If a film is too thin, its hiding power and protective capabilities may be inadequate and time will be lost in recoating the surface. If a coating application results in a dry film being excessively thick, failures such as cracking, flaking, or excessive drying time may result. Also, there is the cost factor of applying too much coating.

Wet Film Thickness

In order to control the process variables when applying a coating to a surface, it is often desirable that measurements are made to determine thickness while the coating is still wet. Wet film measurement is done by devices based upon the shape of the surface area, and the expected range of thickness. In addition, wet film measurements are also very useful for coating systems where the dry film thickness can only be measured destructively.

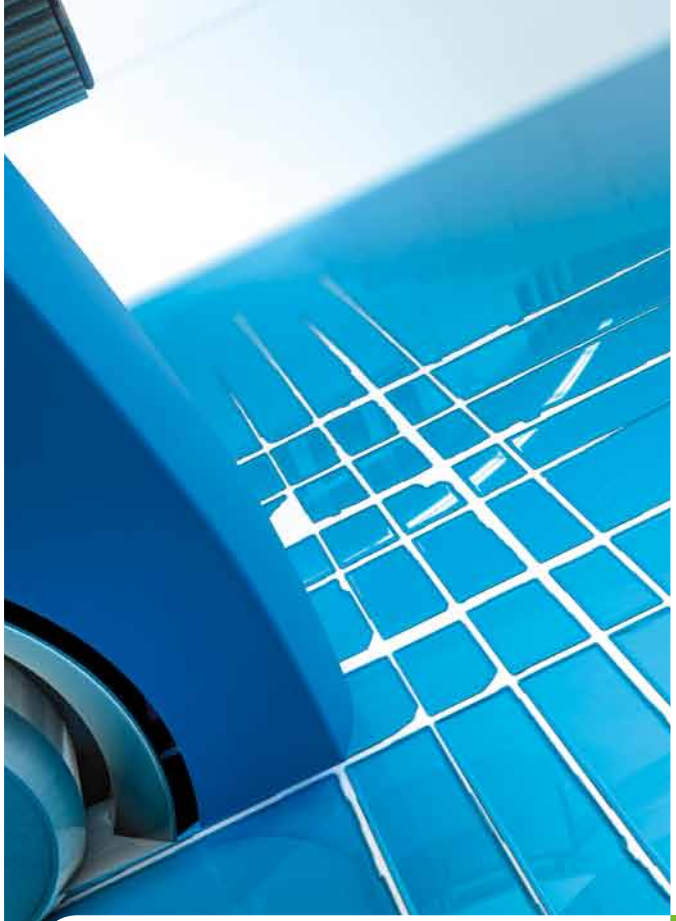
Dry Film Thickness

Measuring coating thickness accurately maximizes quality and minimizes material costs. Dry film checking can be carried out non-destructively or destructively, for e.g. multi-layer applications.

Non-Destructive Tests

Electronic type gages with digital display are used. These instruments measure the thickness of insulating coatings on non-magnetic, metal substrates (NFe) and of non-magnetic coatings on steel or iron (Fe). Two different measurement principles are being used:

- Magnetic inductive measurement on Fe-substrates
- Eddy-current measurement on NFe-substates
- Examples for insulating and non-magnetic coatings: paint, plastic, enamel, chrome, copper, zinc, powder coatings, electro-plating, galvanizing, rubber, hard chrome, sprayed metal, ceramics
- Examples for NFe substrates: aluminum, copper, brass, non-magnetic steel, bronze, magnesium, zinc
- Examples for Fe substrates: steel, cast iron



Measurement Techniques

Magnetic Induction (Fe):
This method uses two magnet coils where the magnetic field changes if brought near a ferromagnetic substrate. The change of the magnetic field is related to the distance between the probe and the substrate – thus to film thickness. The second of the two coils takes up the magnetic current. This magnetic coupling between both magnetic poles is the measure used for film thickness. In addition, electromagnetic induction uses alternating magnetic fields, generated by a ferromagnetic coil. Today, highly precise Hall-effect semiconductors are integrated in modern ferrous probes.

Eddy-Current Measurements (NFe):
This method is required when measuring non-conductive coatings (NFe) on non-ferromagnetic substates (NFe) such as e.g. aluminum. The eddy-current measurement method is based on the principles of the electromagnetic induction technique. A coil of fine wire conducting a high frequency alternating current sets up a magnetic field which changes its direction according to the alternating current connected. When the NFe probe is brought near a conductive substrate, eddy currents are generated, which affect the magnetic field of the coil. The effect depends on the characteristics of the substrate and the distance between the probe and substrate – i.e. film thickness.

Choosing the Right Probe
It is important to choose the appropriate test method for each application. The following table shows the recommended test methods for different combinations of substrate and coating. The type of substrate is very easily established with a magnet. In case the magnet adheres to the substrate, an Fe substrate is concerned.

	Substrate								
Coating	**Aluminium**	**Brass**	**Bronze**	**Copper**	**Steel**	**Magnesium**	**Stainless**	**Titanium**	**Zinc**
Aluminium	--	--	--	--	F	--	--	--	--
Anodizing	N	--	--	--	F	N	--	--	--
Brass	--	--	--	--	F	--	--	--	--
Bronze	--	--	--	--	F	--	--	--	--
Cadmium	--	--	--	--	F	--	--	--	--
Chrome-hard	--	--	--	--	F	--	--	--	--
Copper	--	--	--	--	F	--	--	--	--
Eloxal	N	--	--	--	--	--	--	--	--
Epoxy	N	N	N	N	F	--	N	--	N
Galvanizing	--	--	--	--	F	--	--	--	--
Lacquer	--	--	--	--	F	--	N	--	N
Molybdenum disulphide	--	--	--	--	F	--	N	--	--
Nickel-electroless	--	--	--	--	F*	--	--	--	--
Paint	N	N	N	N	F	N	N	N	N
Plastic	N	N	N	N	F	N	N	N	N
Rubber	N				F				
Tin					F				
Varnish	N	N	N	N	F	--	--	--	--

N = non-ferromagnetic; F = ferromagnetic
* only if nickel content is 8% or greater