Application Note

Surface Carbon on Metal Sheets

Introduction

Concentration of surface carbon on steel directly affects performance of coating process on steel surface. Source of carbon on the surface might be contamination or lubrication during the process of production [1,2]. Carbon on the surface of steel sheets, to be coated by any material like paint, enamels, primers, etc. is very critical quality control parameter [3]. Therefore, surface carbon needs to be determined and controlled to achieve successful coating.

The same is applicable from hygiene point of view on aluminum sheet materials to be used in food industry for packaging. Source of carbon on the surface might be the same however control requirement is not for coating but health and safety this time.

It is possible to determine specifically surface carbon concentration on metal sheets by using TRL-SC analyzer. It has patented "Two Zone Furnace" design easily converting carbon into CO2 for further measurement by an NDIR detector. The same feature also provides extended catalyst service life. Calculated value of CO_2 is converted into carbon concentration per area of the material. It is possible to diffrentiate surface carbon concentration by its nature, total organic carbon and amorphous carbon.

Principle of operation

Table 1: Analysis Parameters for Surface organic carbon

Parameters	Surface Organic Carbon (SOC)
Decomposition furnace temperature	450 °C
Catalyst furnace temperature	500 °C
Carrier gas	Oxygen
Carrier gas pressure	2 bar
Total Carrier gas flow	100 mL/min
NDIR gas flow	100 mL/min

Table 2: Analysis Parameters For amorphous carbon

Parameters	Amorphous Carbon (AC)
Decomposition furnace temperature	600 °C
Catalyst furnace temperature	500 °C
Carrier gas	Oxygen
Carrier gas pressure	2 bar
Total Carrier gas flow	100 mL/min
NDIR gas flow	100 mL/min

Surface organic carbon: Sample is inserted in the sample loading car and it automatically drives the samples into the furnace at 450 ^{o}C. Combustion gases coming through the decompostion furnace go through the catalyst furnace at 500 °C to further oxidize any incomplete combustion products to CO_2. After conditioning of combustion products, it is analyzed for CO_2 concentration in a NDIR detector.

Amorphous Carbon: After TOC analysis, the same samples were analyzed for its amorphous carbon by ramping decomposition furnace temperature up to 600 ^{o}C.

Results

TC results and RSD values are shown in table 2.

Table 1: Metal sheet samples analysis result

Sample	SOC (mg/m2)	AC (mg/m2)	Total Surface Carbon (mg/m2)
A	26.36	6.45	32.81
B	19.90	1.99	21.90
C	27.24	7.37	34.62
D	21.50	0.05	21.55

Conclusions

TRL-SC with its flexible configuration options for automation is proven to analyze surface carbon parameters like amorphous and surface organic carbon on metal surfaces whichs helps assuring quality surface coating process of metal sheets.

References

1. King, Arthur E. “Direct Determination of Carbon on Metal Surfaces.” AFP/SME Technical Paper FC78-584. Dearborn, MI: Association for Finishing Processes / Society of Manufacturing Engineers. 1978.

2. Devries, J. E., Haack, L. P., & Coduti, P. L. (1994). Measurement of Carbon on Cold-Rolled Steel: A Comparative Study Using Surface Analytical and Coulometric Methodologies. Industrial & Engineering Chemistry Research Ind. Eng. Chem. Res., 33(11), 2618-2630. doi:10.1021/ie00035a013

3. Coduti, Phillip L. “Effects of Steel Processing on the surface Carbon of Cold-Rolled Steel.” Technical paper presented at the American Society for Metals / American Deep Drawing Research Group Conference: Technological Impact of Surfaces: Relationship to forming, welding, and painting. April 14, 1981.