

Jet Vapor Deposition (JVD): The Obvious Future Choice for Zinc Coating of Steel

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The galvanization of steel for the automotive industry or appliances presents certain challenges that are not completely resolved by conventional technologies. The first of these challenges is the galvanization of third-generation advanced high-strength steel up to 290 ksi (2,000 MPa). Such steels chemistries require a high alloying content to obtain the desired mechanical characteristics. The second challenge is to produce exposed panels with the most advanced characteristics in terms of surface aspect, weldability, formability, coating uniformity and corrosion resistance, together with a minimized OPEX. The third challenge is to coat hot-rolled material while reducing energy consumption. With jet vapor deposition (JVD), there is no need to heat the strip up to pot temperature then to cool down to ambient temperature like in hot-dip galvanizing. The strip is heated only to 212°F to avoid humidity. Once again, OPEX is minimized. This article will present how JVD overcomes those challenges and describe the main characteristics of this process.

Introduction

Since 2016, ArcelorMittal Group has been the first steelmaker to industrialize a vacuum deposition technology called Jet Vapor Deposition (JVD) for the continuous deposition of zinc coatings on steel coils. Compared to conventional deposition processes such as electrogalvanizing (EG) and hot-dip galvanizing (HDG), this technology offers the benefits of various steel coating configurations, be it single-sided or double-sided coverage, with different thicknesses of zinc on each side, along with high levels of productivity and a very good coating yield.

The technology enables the coating of steel grades with very high mechanical resistance properties (advanced high-strength steel or AHSS), without the major constraints of conventional processes. First, the JVD technology doesn't cause hydrogen absorption and embrittlement in steel, which is the major drawback of the EG process for AHSS. Second, this technology overcomes the problem of zinc wettability, and so also resolves the coat-ability issues encountered on some AHSS coated with the HDG process

as previously described. After 6 years of continuous production as of the end of 2023, this industrial process has produced over 1 million metric tons of coated steel coil.

JVD is a high-speed process and can exceed 700 feet/minute (approximately 210 m/minute), the present limit of conventional EG and HDG lines. This article will present these developments.

Discussion

JVD uses the deposition of zinc in a vapor state under vacuum. Therefore, one of its innovations is achieving the smallest particle size of metal during coating. If one drew a parallel to different painting technologies, HDG can be compared to brush painting, EG would be roller painting and JVD would be spray painting.

The Process

The zinc ingots are melted in a classical furnace and thanks to the vacuum process — barometric effect for zinc — the evaporators are filled through piping systems. Within these evaporators, zinc is converted to vapor and is sprayed on the strip through ejectors