CLIFFS

ALUMINIZED STEEL TYPE 2

FABRICATION DATA

Technical Bulletin

WELD SEAMS

Substrate at seams is protected by electrochemical behavior of the Al and Al-Fe coating layers.

RE-ROLLED ENDS

The double corrugation process at pipe ends does not adversely affect the performance of Type 2.

LOCKSEAMS/ SPIRAL RIBS

Coating fissures are plugged as a result of the electrochemical behavior of the coating..

PIPE FABRICATION AND CORROSION BEHAVIOR

In the fabrication of corrugated metal pipe, some mechanical effects of the manufacturing process on the metallic coatings can be expected. The resultant potential impact on corrosion of the substrate must be addressed by the metallic coating. In the case of the Aluminized Steel Type 2 coating, the steel substrate is protected in service over the long term due to the electrochemical behavior of the bi-layer, duplex coating. The aluminum layer of the coating provides low-level galvanic protection that directly retards long-term substrate corrosion. This also modifies the corrosion process to produce a partially protective corrosion-product scale that hinders the advance of corrosion. Additionally, substrate corrosion is further retarded due to insulating films that form naturally on the Al and Al-Fe coating layers and suppress the electrochemical action that powers substrate corrosion. All of these electrochemical mechanisms combine to protect against corrosion problems.

Product Description

PIPE WELD SEAMS AND RE-ROLLED ENDS

The effectiveness of electrochemical corrosion protection for exposed steel substrate was demonstrated in field exposures. Weld seams exhibit good protection by the coating in extended field tests.

Aluminized Galvanized

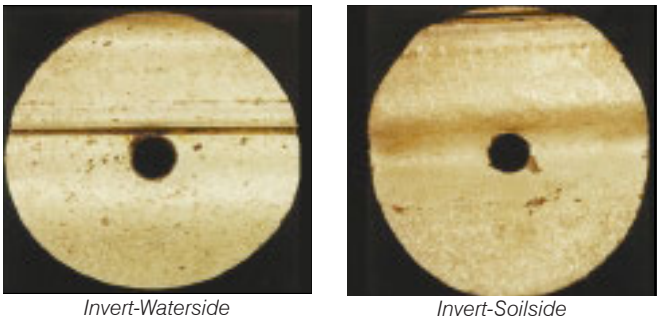
Comparative weld-seam condition in the inverts of aluminized and galvanized pipe in corrosive water. Aluminized shows no deterioration of the weld or the coated surface. Galvanized shows loss of zinc coating and scattered pitting in the substrate.

During pipe manufacturing, re-rolled ends show a few small spots of spalled coating around the pipe circumference. This is due to reverse double bending of pipe material at these spots. Coating electrochemical behavior provides corrosion protection at re-rolled ends, as it does at weld seams. Actually, there is further protection in that the spots retain a skin of protective intermetallic alloy layer. Re-rolled ends can be painted for cosmetic purposes. The full extent of substrate protection was demonstrated by the minimal corrosion at original cut edges on riveted pipe exposed in the field for times up to 50 years.

Thirty-year-old aluminized uncoated edge on a triangular notch cut from an invert handling water corrosive to galvanized. The undeteriorated edge is indicated by the arrow.

LOCKSEAMS AND SPIRAL RIBS

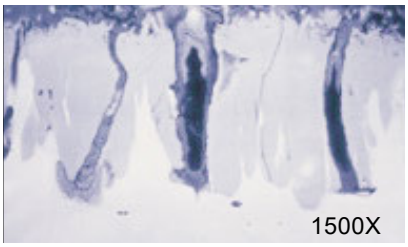
Minor crazing of the coating can occur at lockseams on helically corrugated pipe and also at the ribs of the spiral rib product. The substrate is exposed at coating fissures but is protected by coating galvanic interaction. Additionally, on lockseams and ribs the coating electrochemical factors quickly render the initial substrate corrosion product insoluble and adherent, which causes plugging and sealing of fissures. Thus coating continuity is restored by fissure plugging after a short time in service. Some early, temporary staining accompanies the plugging process. This is simply indicative of the plugging process at work.



Invert-Waterside Invert-Soilside

Undeteriorated lockseam on ten-year-old Aluminized Type 2 Pipe.

The effectiveness of the fissure-plugging tendency was demonstrated in 30 and 50 year field investigations of corrugated and bolted pipe. Plugging is an added benefit of the tendency of the Aluminized Type 2 steel substrate to form protective corrosion product scales under the influence of galvanic interation.



Voids in the corrosion product in fissure cavities are still present after 30 years exposure in the field. This shows that initial substrate corrosion at a fissure base is stifled very early by corrosion product that plugs the fissure, even before the cavity is totally filled. Eventual reactiviation of corrosion at a fissure base occurs, as illustrated by the development of detectable substrate corrosion and cavity filling at one of the fissures in the photo.

ALUMINIZED STEEL TYPE 2 FABRICATION DATA

About Cleveland-Cliffs Inc.

Cleveland-Cliffs is the largest flat-rolled steel producer in North America. Founded in 1847 as a mine operator, Cliffs also is the largest manufacturer of iron ore pellets in North America. The Company is vertically integrated from mined raw materials, direct reduced iron, and ferrous scrap to primary steelmaking and downstream finishing, stamping, tooling, and tubing. The Company serves a diverse range of markets due to its comprehensive offering of flat-rolled steel products and is the largest supplier of steel to the automotive industry in North America. The Company is headquartered in Cleveland, Ohio with mining, steel and downstream manufacturing operations located across the United States and in Canada. For more information, visit www.clevelandcliffs.com.

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