Corrosion protection by means of dehumidification

Corrosion Protection by Means of Dehumidification

Matthew L. BLOOMSTINE
Project Manager
COWI AS
Lyngby, Denmark

Matthew L. Bloomstine, born 1955, received his engineering degree from the Technical Univ. of Denmark in 1987. He has specialised in inspection, maintenance and rehabilitation of major bridges.

Frank RUBIN
Civil Engineer
Danish Road Directorate
Copenhagen, Denmark

Frank Rubin, born 1942, received his civil engineering degree from the Technical Univ. of Denmark in 1966. He is Area Manager for Operation and Maintenance in the Bridge Department.

Ejgil VEJE
Department Head
COWI AS
Lyngby, Denmark

Ejgil Veje, born 1954, received his engineering degree from the Technical Univ. of Denmark in 1981. He is the Head of Department for Maintenance and Rehabilitation of Major Bridges.

Summary

Painting has traditionally been used to protect steel structures from corrosion. Over the last 30 years dehumidification has been adapted and implemented as a means of corrosion protection for enclosed steel surfaces in bridge structures. For this use dehumidification has been proven to be superior in all respects, i.e. technically, economically and environmentally. It has been chosen as the sole means of corrosion protection for the internal surfaces of steel box girders and other components on many major bridges in countries over the entire world.

The paper presents descriptions and examples of dehumidification systems, the advantages of dehumidification, key technical and economical figures, as well as experience from operation and maintenance.

Abstract

Many of the main components of major bridges are steel structures. In order ensure a long service life and provide an appropriate level of safety, these structures must be protected from corrosion.

Corrosion protection has traditionally been provided by means of surface treatment, i.e. blasting and painting. In the course of the last 30 years an alternative method of corrosion protection for the internal surfaces of steel structures has been developed, implemented and proven. This method is dehumidification and is based on the fact that steel does not corrode when the relative humidity is below 60%. Dehumidification has been proven to be superior to painting in all respects, i.e. technically, economically and environmentally.

The most widespread application for bridges is the protection of the internal surfaces of closed box bridge girders. However, there are many different applications on bridges and one of the most recent developments is dehumidification of the main cables on suspension bridges. Dehumidification systems are implemented in new bridges and in existing bridges, which may have insufficient protection or need renewal of corrosion protection.

The following concerning dehumidification is presented in the paper:

- Corrosion problems
- Principles of dehumidification and typical equipment
- Advantages of dehumidification - technical, economical and environmental
- Experience from major bridges including bridge girders and other bridge structures

- Key technical, economical and service figures
- Operation and maintenance experience

Corrosion is mainly dangerous in the following two ways:

- Severe corrosion can lead to an appreciable loss of the thickness of the plates in the cross section and reduce the load carrying capacity. If the corrosion is extreme enough or occurs at especially critical areas it can lead to collapse of the structure.
- Lighter corrosion on fatigue affected areas, such as the deck of a bridge girder, can significantly reduce the fatigue resistance leading to premature cracking and a reduced service life.

The concept of dehumidification has been known for many years and it has been successfully applied to a wide range of applications. A dehumidification plant, such as used in bridge structures, is a well know and reliable means of keeping the relative humidity in a closed room under an acceptable level. The use of dehumidification for the corrosion protection of enclosed steel surfaces in bridges has been pioneered by COWI over the last 30 years. During this time the dehumidification concept for bridges has won international acceptance and is well on the way to becoming a world-wide standard.

The sorption method of dehumidification is to the best of our knowledge the only method used for bridge structures. A sorption system contains a rotor which is built up of many small pipes, which are coated with a sorbent, most commonly lithium chloride. The process air is forced through the rotor and its moisture is absorbed under this process, resulting in dry air. The rotor turns very slowly, allowing time for the process. On the opposite side of the rotor heated intake air is blown through, which dries out the sorbent coating. This air becomes moisture laden and is subsequently discharged. The other method of dehumidification is condensation. This method has a number of limitations and drawbacks, which make it unsuitable for use on bridge structures.

Dehumidification is technically superior to traditional painting, as it provides 100% protection and does not have the many weaknesses and execution requirements that painting does. Dehumidification provides great initial savings as compared to painting and the operation and maintenance costs are also much lower. Dehumidification is also more environmentally friendly, as it does not have the short term and long term effects that painting does.

The use of dehumidification as corrosion protection for enclosed steel surfaces in major bridges was first applied to the box girder of the Little Belt Suspension Bridge, Denmark, which opened in 1970. Since then dehumidification of steel box girders on bridges has become the standard method of corrosion protection in Scandinavia. During the last 30 years the dehumidification concept for bridges has won international acceptance. Outside of Scandinavia it has also been applied in England, France, Germany, Japan and other countries.

The dehumidification systems of the Little Belt Suspension Bridge and the Faroe Bridges, both in Denmark, have been in operation respectively for 29 and 14 years. The Little Belt Suspension Bridge has dehumidification plants in the 1,080 m long box girder as well as both anchor houses. The Faroe Bridges have plants in the 1,596 and 1,726 m long box girders, in all four abutment rooms and in the two cable anchor boxes on top of the pylons. The individual dehumidification plants are serviced once a year, which entails a check of the individual components and control of effectiveness. As of yet only wearing parts have been repaired or replaced. No entire plants have been replaced and this is not expected to be necessary.