WHITE PAPER

CABLE MANAGEMENT SYSTEMS FOR THE PETROCHEMICAL INDUSTRY:

Choose the Right Combination of Weight, Strength, Durability and Protection

By Bob Crain

> These innovative systems are quick and easy to install, requiring less labor and equipment than traditional systems.

OVERVIEW

Cable management systems are used in petrochemical facilities at each stage of the extracting and manufacturing process, from upstream exploration and drilling, through midstream pumping and pipelines, to downstream refineries and storage facilities. The various locations in which these facilities are situated – including the North Sea and Europe, the Gulf of Mexico, and the Middle East – offer a wide range of environmental challenges from extremes of heat and cold to various combinations of wet, salt, and caustic conditions.

Traditionally, these facilities have relied on stainless steel, hot-dipped galvanized carbon steel or fiberglass cable manager infrastructure to support industrial power and control cable networks. But each of these materials have disadvantages not found in newer aluminum ladder and wire mesh cable tray systems.

This paper reviews various cable tray materials by weight, strength, durability, and protection against corrosion when used in both off-shore and land-based petrochemical facilities. Even across a wide range of harsh and hazardous environments, we find the best performance to be offered by aluminum ladder tray for main circuits paired with wire mesh tray for branch circuits. This proven cable management system combines weight reduction, stable load performance at both high and low temperature extremes, corrosion resistance, vibration and shock resistance, and ease of installation.

CABLE TRAY MANAGEMENT SYSTEMS

A unit or assembly of units or sections and associated fittings forming a structural system used to securely fasten or support cables and raceways.

ENVIRONMENTAL CHALLENGES FOR CABLE MANAGEMENT SYSTEMS

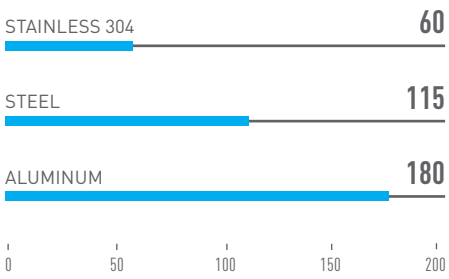
NORTHERN CLIMATES

Off-shore drilling platforms in locations such as the North Sea and northern Europe face environmental challenges of extreme cold, as well as wet and salt conditions. They are also subject to hazards from high-frequency vibrations caused by engines and gears, and very low-frequency shock caused by constant wave action. Land-based processing and manufacturing plants located in northern climates also face many of these same challenges, particularly extremes of cold, wet and corrosive conditions.

In these environments, traditional cable management systems have relied heavily on stainless steel ladder and/or hot-dipped galvanized carbon steel ladder and trough tray. These materials offer good corrosion resistance, but both have the disadvantage of low strength-to-weight ratios when compared to aluminum.

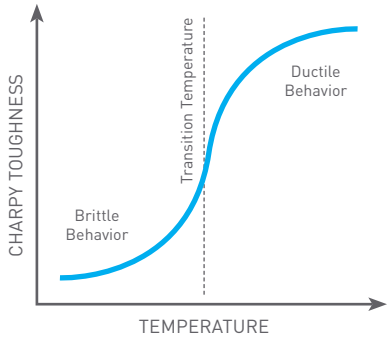
SPECIFIC STRENGTH

(STRENGTH TO WEIGHT KG.M/KG)



FOR STEEL

TOUGHNESS VS. TEMPERATURE



In addition, galvanized carbon steel may pose risks in terms of durability and safety. While hot-dipped galvanization offers good corrosion resistance when applied to carbon steel, at low temperatures this material loses toughness and becomes brittle. The temperature at which this material transitions from ductile to brittle depends on several factors, including the grain size of the steel microstructure (with smaller grains giving a lower transition temperature) and the type of alloying elements used (silicon and nickel content tends to lower transition temperature).

In many modern steels, the transition temperature is about -60 degrees Celsius. Older, less refined grades of steel may transition at 0 or -10 degrees C, impacts durability of older structures and often leads to significant over design.

Stainless steel offers good corrosion resistance and performs well at very low temperatures, but its weight is twice that of the aluminum equivalent. Since each pound of tray weight requires three to five pounds of support structure in floating platforms, aluminum is a much more efficient and cost effective option for these applications.

Aluminum tray offers corrosion resistance equal to stainless steel and hot-dipped galvanized carbon steel in cold coastal environments, so protection against wet and harsh conditions is not compromised. In addition, standard aluminum cable trays (copper-free) dramatically improves corrosive resistance in salt water environments.

Wire mesh tray with a stainless steel finish is even lighter than aluminum ladder tray. This is especially true for narrow width. This innovative system meets the rigorous DNV (Det Norske Veritas) certification requirements for use in applications onboard ships and mobile offshore units. It has demonstrated proven performance in a broad range of conditions including tests for short circuit, cold, vibration, impact, temperature rise, and metallic protection. Unique mesh design distributes cable loads across hundreds of welds, limiting stress concentrations and improving reliability.

ENVIRONMENTAL CHALLENGES FOR CABLE MANAGEMENT SYSTEMS

SOUTHERN CLIMATES

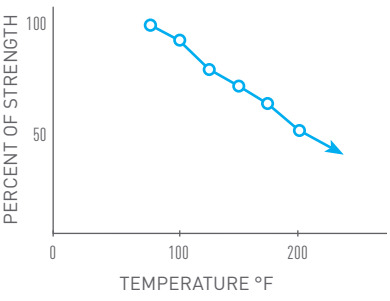
Offshore and land-based facilities in locations such as the Gulf of Mexico face many of the same corrosive and hazardous conditions as those in northern climates, but instead of freezing temperatures, the challenge for cable management systems in these locations is the extremes of high temperature.

Hot-dipped galvanized carbon steel ladder tray has been a traditional choice in many warm-climate environments, since corrosion resistance is good and the threat of failure due to low temperature is not a factor.

Reinforced fiberglass cable management systems have also been widely used. Fiberglass offers superior corrosion resistance, but this is less of an advantage in most modern plants. Newer facilities are more efficient, which means less loss and fewer emissions, which results in a less corrosive environment.

NEMA CHART

EFFECT OF TEMPERATURE



Environmental heat, however, poses a significant risk to fiberglass tray since it loses strength when continuously exposed to elevated temperatures. According to NEMA, the working load of reinforced fiberglass should be reduced by 10% when exposed to a temperature of 100 degrees F. The reduction is 50% at 200 degrees.

In contrast, load performance of aluminum cable tray system is stable at all normal operating temperatures. Aluminum ladder and wire mesh systems also provide excellent corrosion resistance and protection against wet, salt and other hazards. These systems have demonstrated proven performance in challenging environments in the US, and have met all requirements for the rigorous ABS Rules for Marine and Offshore Applications.

In southern climates such as the Middle East, hot-dipped galvanized carbon steel ladder and trough tray has been widely used as the material of choice in cable management systems. Fiberglass performs poorly at high temperatures and stainless steel, which is more expensive than galvanized carbon steel, is not required to guard against freezing temperatures.

The disadvantage of galvanized carbon steel, however, is its weight. While a 20-foot section of steel tray weighs approximately 100 to 120 pounds, the same length of aluminum tray weighs 50 to 60 pounds, making installation much easier, faster, and more efficient. Fewer installers with less equipment is required for aluminum systems, which results in significant cost savings versus steel.

ADVANTAGES OF NEW MATERIALS AND DESIGN INNOVATIONS

ALUMINUM LADDER TRAY

Although not yet commonly used in globally petrochemical facilities, aluminum tray cable management systems are increasingly found in natural gas fields being built in the U.S. These aluminum tray systems are very well suited to meet the challenging environments these facilities face, offering the added benefit of 50% less weight (as compared to steel) for roughly the same cost. Less weight means less supporting structure (in floating platforms), and fewer installers with less installation equipment, which results in more efficiency and less cost.

Unlike galvanized steel and fiberglass tray, load performance of aluminum tray is stable at all temperatures. Aluminum offers the same corrosion resistance as stainless steel and hot-dipped galvanized steel, and is available in marine grade (copper-free), which is non-corrosive in salt conditions.

INNOVATIVE ITRAY

The newest design in aluminum ladder tray features a revolutionary mid-span splicing system that maintains full NEMA load class with no special splice plates, hardware or field fabrication required. Reduction in total supports required dramatically reduce weight, installation times and costs are kept under control.

WIRE MESH TRAY

Even lighter than aluminum ladder tray, wire mesh tray with stainless steel finish also meets the petrochemical industry's demanding requirements for non-corrosion and stable performance at all temperatures. It is DNV certified, meets military spec MIL-S-901D for vibration and shock resistance in oceangoing vessels and has a successful history of performance in offshore drilling operations in the North Sea and Europe.

COMBINED SYSTEM OFFERS BEST PERFORMANCE

Cable management systems that utilize aluminum ladder tray for main circuit runs paired with stainless steel wire mesh for branch circuits offer the ideal combination of stable load performance across all temperatures, effective corrosion resistance, and unprecedented weight reduction. These innovative systems are quick and easy to install, requiring less labor and equipment than traditional systems. They meet rigorous ABS, DNV and NEMA certification requirements and are currently being used by leaders in the petrochemical industry across the globe.

BOB CRAIN | DIRECTOR MARKETING / PRODUCT DEVELOPMENT
ELECTRICAL WIRING SYSTEMS, LEGRAND CABLOFIL

Bob Crain, P.E. is a registered electrical engineer in the state of Illinois with 25 years of experience working for several leading US cable tray manufacturers. Bob is a leading expert on industry standards for the cable tray market. For the past 15 years he has been a member of the NEMA Technical Committee (5CT) and is currently a representative for the North American IEC, focusing on Standard 61537 for cable tray. Over his career, he has lent his expertise to numerous NEC code changes, written articles for industry trade magazines and published many white papers.

For the past 10 years, Bob has worked for Legrand/Cablofil in Mascoutah, IL, and currently holds the position of Director of Marketing/Product Development.

RISK SUMMARY OF TRADITIONAL MATERIALS

HOT-DIPPED GALVANIZED CARBON STEEL TRAY

- Susceptible to Failure at Low Temperatures
- Low Strength-to-Weight Ratio

STAINLESS STEEL TRAY

- Low Strength-to-Weight Ratio

FIBERGLASS TRAY

- Susceptible to Failure at High Temperatures

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