BULLETIN
92

The War Against CORROSION

12345

The War Against Corrosion

Corrosion is an ever-present fact of life. It is a relentless natural force of deterioration. Experts estimate the direct financial impact of corrosion in the United States at $50 billion per year. Experts in the chemical-process industry claim this figure to be much higher, estimating costs in their field alone exceeding $80 billion per year. These numbers do not include the costs associated with lost production, poor product quality and customer good will.

The costs associated with corrosion continue to rise. Higher temperatures, harsher service conditions and the use of more aggressive chemicals are among the chief causes. Resolving the problems inherent with corrosion has become more important than ever...

With today's emphasis on quality, hundreds of millions of dollars are being invested to reduce the effects of corrosion. System designers, purchasers, contractors and plant operators have come to realize that careful selection of process equipment is critical to the reduction of corrosion-related expenditures and improved profitability.

Understanding Corrosion

Cor●ro●sion is the deterioration of a material by chemical or electrochemical reaction resulting from exposure to weathering, moisture, chemical or other agents in the environment in which it is placed.

The most basic form of corrosion is wet corrosion. Wet corrosion occurs in the presence of aqueous solutions or electrolytes and is an electrochemical process. The "aqueous" or wet component of this process may be present in trace quantities, such as moisture in the air or as introduced by the mixing of various compounds.

Wet corrosion is the most common because metals, as we use them, are in a highly refined but inherently unstable state. Refined metals want to return to their original form, their natural state as a product mined from the earth. The rusting of carbon steel is a classic example. An analysis of mined iron ore reveals that it is iron oxide, which has basically the same composition as rust. Corrosion could be simply explained as metallurgy in reverse.

Corrosion in Air-Moving Equipment

The rate of corrosion depends on the type of corrosive, its concentration, temperature and the degree of moisture present. These parameters make it extremely difficult to predict the corrosion resistance of any one material or coating in a particular environment.

Air-moving equipment must be designed to meet a variety of operating and environmental conditions. Many are used to exhaust or supply air for particular processes and are exposed to a multitude of different chemicals, temperatures and mild abrasives. Externally, fan structures can be exposed to weathering or severe process environments. While some applications are more aggressive than others, all can result in the degradation of fan wheels, housings, shafts and support structures. Corrosion compromises strength, leading to premature failure, costly downtime and potential safety, environmental and liability problems.

Potentially Corrosive Fan Applications

- Pulp and paper
- Solvent recovery
- Plating exhaust
- Scrubber exhaust
- Mining
- Blast furnaces
- Wastewater treatment
- Odor control/ fume abatement
- Laboratory hood exhaust
- Food processing/washdown
- Rolling mills

Fighting Back

nyb's Solutions to Combat Corrosion

Because each process is different...each application unique...The New York Blower Company offers a variety of solutions to fight corrosion of air-moving equipment including:

Stainless steel
Fiberglass-reinforced-plastic
Hot-dip galvanizing
Aluminum
Corrosion-resistant coatings

Series 20 General Industrial Fan with stainless-steel construction for food-processing-plant dust collection.

Stainless-Steel Construction

Stainless steel is used widely in the air-moving industry in air pollution incineration, fume exhaust, solvent recovery, wash down, steam processes and mining operations.

Often air-handling applications with corrosives also involve high temperatures which are extremely detrimental to the service life of mild steel fans, yet coatings and FRP are not viable alternatives. In these cases, the solution to corrosion may be found through the use of stainless steel.

The availability of stainless-steel alloys for air-moving equipment is selectively limited to those that offer the best corrosion resistance and ductility. For this reason, fan manufacturers use Austenitic stainless steels, as they are the most suitable for welding and fabrication. Of the Austenitic alloys available, types 304, 304L, 316, 316L and 347 are used most frequently. These alloys provide a range of corrosion resistance and the necessary strength characteristics required in fan applications.

Type 304 offers good atmospheric corrosion resistance at a minimum price.
Type 316 is more resistant to corrosive action by a greater range of chemicals and offers improved strength characteristics over 304 at temperatures from 200°F. to 1000°F.
Type 347 has corrosion-resistant characteristics comparable to the 304 alloy and is used when elevated temperatures and rotating wheel speeds demand strength beyond the capabilities of 316.

Compared to other alternatives, stainless steel performs best against corrosion where temperatures exceed 250°F. or where mild abrasives are present. However, while stainless steel is an all-around corrosion-resistant material, it has limitations. It is susceptible to attack by chlorides and certain acids with resultant physical failure by stress-cracking.

While stainless-steel construction may not have the lowest first cost compared to other alternatives, costs can be tempered depending on the grade of stainless selected

The New York Blower Company offers stainless-steel construction on all of its backwardly inclined and radial-bladed centrifugal fan lines.

RTS Fan Radial Blade Wheel with stainless-steel construction for printing-plant solvent-recovery system.

Fiberglass-Reinforced-Plastic Construction

Fiberglass-reinforced-plastic (FRP) construction of fan equipment is often the best corrosion-resistant alternative and the most economical on a life-cycle cost basis. In many cases, FRP is also less costly on a first-cost basis than metal alloys having comparable corrosion resistance.

FRP Fans are especially well-suited to the handling of acids and inorganic and organic chemical fumes that are highly corrosive to metal. Applications include scrubber systems, odor control in wastewater treatment plants and laboratory exhaust systems. They are also commonly used in the metal-finishing and chemical-process industries.

FRP fans are made from chemical-grade vinyl ester resin and reinforced with glass or fiber. The resin provides the corrosion resistance and rigidity while the glass fibers provide the physical strength.

The corrosion resistance of FRP depends upon the resins used for construction. FRP process-equipment resins are formulated for maximum corrosion resistance and consequently are two or three times as costly as those used in consumer products such as boat hulls, auto body parts or athletic equipment.

FRP high-pressure Fume Exhauster wheel with encapsulated stainless-steel shaft for chemical manufacturing plant venturi scrubber.

FRP General Purpose Fume Exhauster for water-treatment plant-odor control system.

nyb FRP Fans are constructed using vinyl ester resin-based FRP which is more ductile and forms stronger joints. This enables the wheel to withstand the dynamic stress associated with high-speed rotation.

Comparison of FRP Fans to Fans of Other Materials

A comparison of the corrosion resistance and economics of FRP Fans to fans made of other materials leads to these generalizations:

Coated fans, regardless of the inherent corrosion resistance of the coating, have the potential of coating failure and the resultant deterioration of the base metal. However, costs for coated fans run from about one- third that of FRP Fans for the least resistant to approximately three-quarters the cost for a baked-on fluoropolymer system.

Fans made of stainless steel, monel, titanium and high-nickel alloys may or may not be as corrosion-resistant as FRP, depending upon the chemistry and temperature involved. The picture below shows the effect of nitric and hydrochloric acid on coupons of 316L stainless steel and a high-nickel alloy attached to a coupon of FRP (Derakane* 510A).

The entire assembly was placed halfway into the acid solution. Both coupons of metal were nearly destroyed while the FRP coupon was untouched.

Furthermore, the cost of fans made of high-nickel alloys are usually several times the cost of fans made of FRP.

Users of air-moving equipment sometimes face environments where temperature and abrasion are as big a concern as corrosion. FRP is not used in applications exceeding 250°F. nor is it suitable for impact of any kind. Additionally, performance requirements may force the consideration of alloy, coated or galvanized construction as an alternative to the superior corrosion resistance of FRP.

The New York Blower Company manufactures FRP Fans with volumes to 84,000 CFM and static pressures to 40” water gauge in four separate designs.

* Trademark of Ashland Inc.

Series 20 General Industrial Fan with hot-dip galvanized construction for bin-vent exhaust with saltwater exposure.

Hot-Dip Galvanizing

Hot-dip galvanizing is a corrosion-control system used to protect fan housings, pedestals, guards and structurals. It is often favored for protection of these components because of its lower cost and the maintenance free service it provides compared to other forms of corrosion protection.

Hot-dip galvanizing forms a physical barrier by providing a tough, metallurgically bonded zinc coating which completely covers the steel surface and seals it. In addition, the sacrificial action of zinc protects steel, even where damage or a minor discontinuity appears in the coating.

Hot-dip galvanizing of fan components for corrosion protection has advantages over alternatives. Its metallurgical bond ensures that no underfilm corrosion occurs that could lead to widespread corrosion and component failure. Galvanizing goes on thickest at corners and edges where corrosion usually begins, as a natural result of the galvanizing process.

Galvanized steel performs well at temperatures to 400°F. Applications higher than this can cause the zinc layer to peel from the underlying zinc-iron alloy layer. In addition, fan wheels and shafts cannot withstand the required dipping temperatures without incurring significant distortion and, therefore, cannot be galvanized. In applications where temperatures are in excess of 400°F. or where the fan wheel is subject to corrosives, stainless steel and high-temperature-performance coatings, such as a cold spray galvanize, may provide better protection.

Aluminum Construction

Because of aluminum's dual ability to resist corrosion and its spark-resistant nature, aluminum alloys are often selected as the material of construction for air-moving equipment. Since many fans are required to handle air laden with combustible dry gas or fumes, system designers must not only consider corrosion protection but safety as well. Aluminum satisfies both of these requirements in addition to having a lower first cost compared to high-nickel alloys.

There are many varieties of aluminum alloys on the market today. The New York Blower Company fabricates fan components using the 5052 and 6061 aluminum alloys, both of which have excellent corrosion resistance.

Aluminum alloys are very resistant to corrosion caused by a variety of waters, including saltwater and steam, making them an excellent material for high moisture or outdoor environments. Aluminum is also highly resistant to corrosive attack by certain acids and alkaline solutions.

The use of aluminum for fan construction is not without some limitations. Airstream temperatures are restricted to 200°F., due to limited strength at elevated temperatures. It can also be susceptible to corrosion caused by specific chemicals.

The New York Blower Company provides aluminum construction as an alternative to mild steel on virtually all of its fan lines.

Tubular AcoustaFoil Fan with all-aluminum construction for outdoor laboratory exhaust.

Corrosion-Resistant Coatings

The application of special finishes for corrosion prevention has been the source of study in the air-handling industry for a long time. Today, many coating manufacturers have formulated coatings designed specifically for fume-laden environments rather than actual aqueous exposures such as tank linings. Careful selection and specification of a coating system can provide good corrosion protection in a cost-effective manner with limited maintenance problems.

Pressure Blower with stainless-steel airstream and high-build epoxy-coated structure for landfill-methane evacuation.

Selection of a corrosion-resistant coating system consists of identifying the type of corrosive, surface preparation and service-life requirements. Determining these parameters is essential in the selection of a coating since certain finishes have been formulated to be more resistant to given environments. In fan applications, there are additional factors that limit options in selecting the optimal coating system. Typical limitations include temperature, thickness on moving parts and content for a given application such as in food-handling applications.

The following are brief descriptions of the most popular coating systems along with an overview of their chemical resistance and temperature limitations:

Phenolic Resin Coatings are available in baked and air-dry formulations and are known for their extremely hard finish. Phenolic coatings possess excellent resistance to moisture, solvents and a wide variety of concentrated acids at temperatures up to 150°F. (air dry) and to 400°F. (baked).

Epoxy Resin Coatings are normally provided in a catalyzed formulation. Epoxies are characterized by their excellent resistance to a variety of corrosive chemicals including acids, alkalis and salts. Most have a temperature limitation of 200°F. to 300°F.

Epoxy-Phenolic Resin Coatings are used mainly for alkali-resistance in moderate temperatures up to 350°F. and are baked or catalyzed.

PVC Coatings have excellent adhesion qualities to steel. They are available in powder form and are cured via baking. PVC coatings possess superior corrosion-resistant performance over a broad range of corrosive combinations such as an acid and an alkali. However, they are not recommended in solvent-laden environments. PVC coatings offer satisfactory results for most corrosive-fume applications below 200°F.

Zinc Coatings are designed to protect steel with a single coat. They will not undercut or peel back even if abraded to bare metal, making them an excellent source of protection against weathering. Zinc coatings have good solvent resistance but should not be used for acid or alkali resistance unless accompanied by an appropriate top coat. Generally, temperature capabilities range up to 350°F. (maximum) with organic zinc and up to 750°F. with inorganic zinc coatings.

Polyester Resin Coatings cure at room temperature after being catalyzed. They are resistant to mild traces of acid, alkalis and solvents. Temperature limitations vary according to each specific coating manufacturer's formulation.

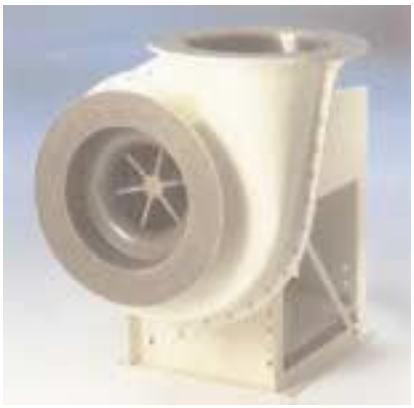
Silicone Coatings are baked and formulated for medium to high-temperature service where temperatures seldom fall below 200°F. to 300°F. These coatings normally exhibit good fume resistance from acids, alkalis, solvents, salts and water but are not recommended for splash, spillage or immersion service.

Although these coatings cover a broad range of generic types, many more specific types exist in today's ever-changing coatings environment.

Series 20 General Industrial Fan with all-surface phenolic coating for plating-process hood exhaust.

Protective coatings play an important role in corrosion-resistant construction. While special alloy and fiberglass-reinforced-plastic construction are able to handle a wider range of corrosives and are far superior in terms of corrosion resistance, protective coatings are generally available at a lower first cost and provide an alternative to FRP in applications above 250°F.

The New York Blower Company offers a wide variety of corrosion-resistant coatings on virtually all of its products.



FRP Radial Fume Exhauster with baked-phenolic coated-steel structure for pulp-and-paper-plant bleach processing.

CORROSION SOLUTION ALTERNATIVES

STAINLESS STEEL
- Very good corrosion resistance
- Best choice with abrasives
- Temperatures to 1000°F.
- Available in three grades; 304, 316, 347
- Susceptible to attack by chlorides

ALUMINUM
- Very good corrosion protection
- Spark-resistant
- Lower first cost than stainless steel or FRP
- Temperatures to 200°F.

FIBERGLASS-REINFORCED PLASTIC
- Best corrosion protection
- Most economical life cycle cost
- Four specially designed fan lines
- Temperature to 250°F.

HOT-DIP GALVANIZING
- Good corrosion resistance
- Low first cost
- Temperatures to 400°F.
- Limited to non-rotating components

CORROSION-RESISTANT COATINGS
- Numerous formulation choices. Generally, lowest first cost
- Wide range of corrosion protection and limitations
- Can be used with other alternatives for added protection

SUMMARY

The New York Blower Company has over 100 years of experience in the design and fabrication of fan equipment for industrial and commercial air-moving industries. We have the technology and the capabilities to build quality fans for corrosive environments with a variety of materials and coatings as noted in the preceding pages. This brochure is a summation of our capabilities but is not all-inclusive. The New York Blower Company has a nationwide network of trained and experienced sales representatives who can help you determine the best corrosion-resistant solution for your application. For further information on corrosion-resistant fighters in air-moving applications, contact your New York Blower sales representative.