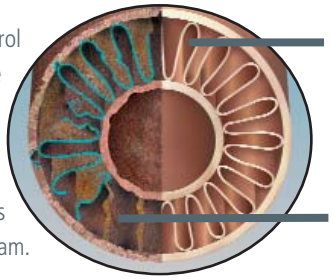
heartfil
HEART FOR FILTRATION

purafil
Filtration Group®

PRODUCT BULLETIN FOR THE COMPRESSOR INTAKE FILTER

THE PROBLEM: CORROSION

Air compressors provide the compressed air essential in operating pneumatic instruments, control valves and processes throughout the industrial plants. Industrial facilities inevitably introduce contaminants into their environment, exposing equipment to the damaging effects of corrosion. Corrosive gases raise the acidity of the compressed air creating aggressive condensate which attacks metal surfaces and leads to vibration and loss of compressor efficiency. To ensure compressors run properly, with a long service life and minimal repairs, it is critical that gaseous contaminants and particulate matter are removed from the intake airstream.



PROTECTED COPPER TUBING IN AN AIR COMPRESSOR

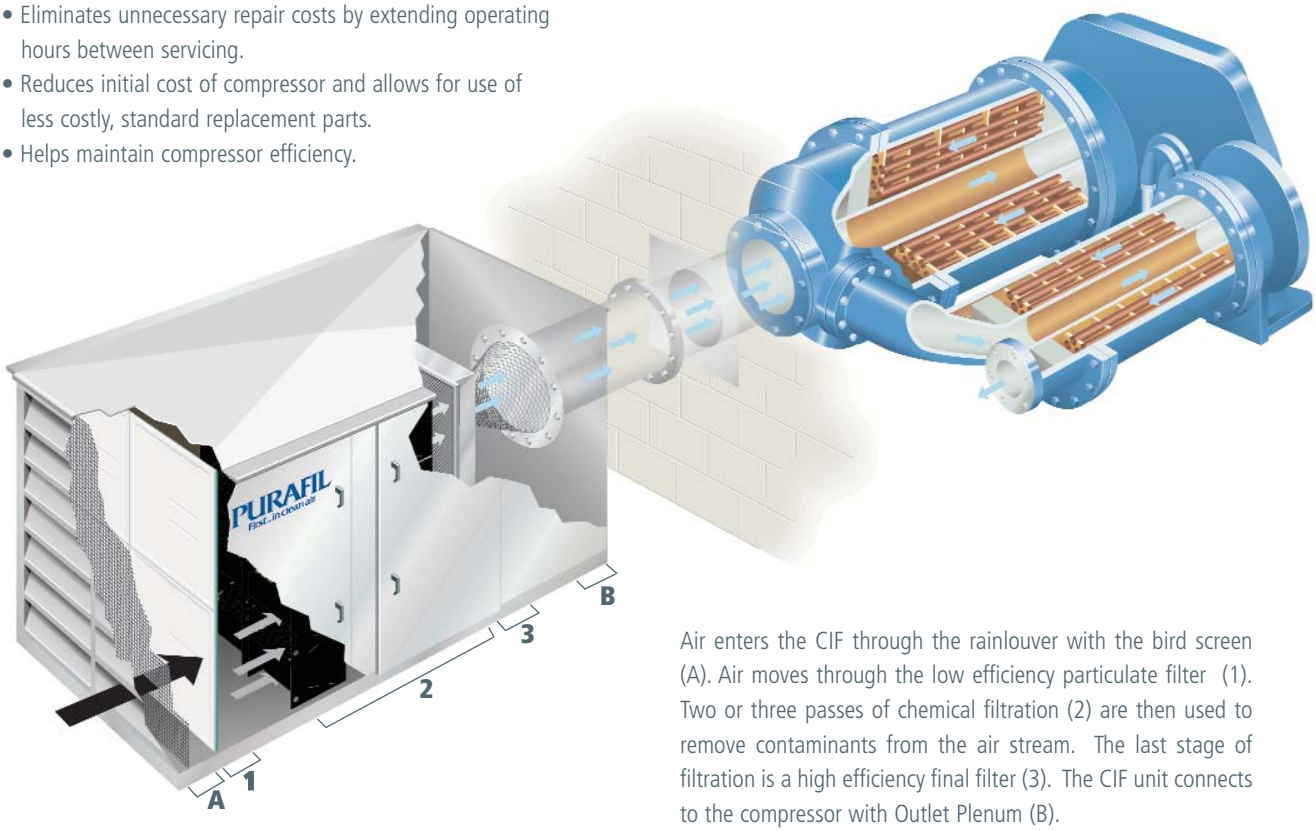
UNPROTECTED COPPER TUBING IN AN AIR COMPRESSOR

Manufacturers cannot afford to neglect air purification. Typical investments for air compressors range from $80,000 to as high as $500,000 with maintenance costs from corrosion at 20% to 50% of the initial purchase price.

THE SOLUTION: PURAFIL'S COMPRESSOR INTAKE FILTER

Purafil, Inc. the industry leader in gas-phase filtration, developed the CIF system to eliminate serious air compressor problems such as vibration and lost efficiency. Benefits of the CIF include:

- Eliminates vibration of impeller caused by build up of corrosion by-products and prevents corrosion damage to intercoolers, diffusers and casings.
- Prevents loss of cooling due to corrosion of intercooler.
- Allows for use of standard copper intercooler tubes even in a contaminated atmosphere.
- Eliminates unnecessary repair costs by extending operating hours between servicing.
- Reduces initial cost of compressor and allows for use of less costly, standard replacement parts.
- Helps maintain compressor efficiency.



Air enters the CIF through the rainlouver with the bird screen (A). Air moves through the low efficiency particulate filter (1). Two or three passes of chemical filtration (2) are then used to remove contaminants from the air stream. The last stage of filtration is a high efficiency final filter (3). The CIF unit connects to the compressor with Outlet Plenum (B).

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THE COMPRESSOR INTAKE FILTER (CIF)

The CIF is a multi-stage, high efficiency air purification system that removes corrosive gases and particulates from the air. Compressor and process downtime is prevented with the CIF, and thousands of dollars of repair costs are saved. The CIF system guarantees high contaminant removal and maintains compressor efficiency. Other benefits of the CIF include:

POSI-TRACK™ TECHNOLOGY:
For modular systems, the CIF offers Purafil's patented Posi-Track™ technology (shown right), which features slanted tracking to support Purafil's MediaPAK™ modules via a corresponding angled notch in the modules' frame. The Posi-Track™ technology creates self-sealing pressure to create a positive seal, prevent air bypass and enhance filtration efficiency.

As an alternative to granular MediaPAK modules, the CIF is also available with PuraGRID filters containing GridBLOK technology, Purafil's newest gas phase-air filtration medium. This revolutionary new filter is designed to supply a large amount of chemical filtration with minimal pressure drop, increasing operational performance and energy savings

QUALITY ASSURANCE:
Purafil's patented and UL classified chemical media, designed to remove harmful gases, are manufactured under the ISO 9001:2000 quality program.

COMPATIBILITY:
The CIF is compatible with most compressor manufacturer's equipment.

ANALYTICAL SERVICES:
Purafil provides atmospheric monitoring and analytical services to verify that your CIF is providing satisfactory control of contaminants.

FLEXIBLE DESIGN:
The CIF housing is available in wide range of sizes and construction materials. Particulate filters in all efficiencies and dust holding capacities are available as integral design of chemical filter housing. No additional particulate filters are needed to maintain performance.

LOW PRESSURE DROP:
The CIF is designed for low inlet air pressure drop.

FEATURES & BENEFITS OF THE COMPRESSOR INTAKE FILTER

FEATURES	CORRESPONDING BENEFIT
Eliminates vibration of impeller caused by build up of corrosion by-products and prevents corrosion damage to intercoolers, diffusers and casings.	Eliminates unnecessary repair costs by extending operating hours between servicing.
Prevents loss of cooling due to corrosion of intercooler.	Helps maintain compressor efficiency.
Supported by analytical service for atmospheric contaminant control as well as technical monitoring for performance.	CIF system guarantees high contaminant removal and maintains compressor efficiency.
Allows use of standard copper intercooler tubes even in a contaminated atmosphere.	Reduces initial cost of compressor and allows for use of less costly, standard replacement parts.
Filter housing available in wide range of sizes and construction materials.	Standardization reduces the cost of installation.
Particulate filtration in all efficiencies and dust holding capacities available as integral design of chemical filter	No additional particulate filters are needed to maintain performance.
Designed for low inlet air pressure drop.	Uses less energy.

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POLLUTANTS	SOURCE OF POLLUTANTS	MATERIAL ATTACKED	CHEMICAL REACTIONS
Sulfur Dioxide (SO_2)	Combustion of coal and oil; petrochemical industries; fishing industries; some pulp and paper industries and metal-producing industries.	All metal except noble metals.	$2Cu + SO_2$ 6 $Cu_2S + O_2$ $Fe + SO_2 + 2H_2O$ 6 $FeSO_4 + 2H_2$ See stainless steel note on next page.
Nitrogen Dioxide (NO_2)	Automobile traffic and combustion of oil and coal are the main sources, also power plants and other industries.	Some metals, such as copper and brass. In mixtures with sulfur dioxide, nitrogen dioxide increases the sulfur dioxide attack on many materials. Together with chlorine, nitrogen dioxide even attacks gold.	$Cu + NO_2 + O_2$ 6 CuN_2O_6
Hydrogen Sulfide (H_2S)	Hydrogen sulfide is a main representative of a group of sulfur compounds which react with materials in the same way and which are often found at the same locations: pulp and paper industry, sewage plants, garbage dumps, chemical industries, such as rayon factories and oil factories, animal shelters, some food production plants, geothermal power plants, and natural sources, such as volcanic activities or emission from moss and swamp areas.	Silver and iron at all levels of humidity and all copper based metals.	$4Cu + 2H_2S + O_2$ 6 $2Cu_2S + H_2O$ $Fe + H_2S + 4H_2O$ 6 $FeSO_4 + 5H_2$ See stainless steel note on nextpage.
Chlorine (Cl_2)	Chlorine is a main representative of a group of reactive chlorine compounds which react in the same way and which can be found at the same locations: bleaching plants in pulp and paper industries; magnesium and titanium production, PVC production, PVC cables, and many cleaning detergents.	Most metals, even at low concentrations. Chlorine also accelerates the attack from other pollutants.	$2Cu + Cl_2$62$CuCl$ $Cu + Cl_2$6$CuCl_2$ $2Al + 3Cl_2$62$AlCl_3$ $2Fe + 3Cl_2$62$FeCl_3$ $Fe + Cl_2$6$FeCl_2$ See stainless steel note on next page.
Ammonia and ammonium salts (NH_3 & NH_4+)	Fertilizer production and animal housings; many cleaning detergents and human activities.	All copper-based metals.	$2Cu + 4NH_3 + 9O_2$62$CuN_2O_6 + 6H_2O$ See stainless steel note on next page.
Chloride (Cl^-)	Sea water, aerosols, salt used as a road de-icer or for binding dust, fingerprints (for hydrogen chloride, see mineral acids).	Most metals.	$Cu + Cl$6$CuCl$ $Cu + 2Cl$6$CuCl_2$ $Al + 3Cl$6$AlCl_3$ $Fe + 3Cl$6$FeCl_3$ $Fe + 2Cl$6$FeCl_2$
Soot	Combustion, traffic, steel production.	Promotes adsorption of other pollutants; galvanic corrosion may occur.	
Ozone (O_3)	Among the chemicals known as photochemical oxidants, ozone is the most dominant. Ozone is mainly formed in polluted areas by interaction between oxygen, nitrogen dioxide and sunlight under stagnant climatic conditions and high temperature. The highest concentrations occur under smog conditions.	Ozone as a strong oxidant will react to many organic materials, such as plastics, rubber and textiles. Ozone also increases the reactivity of other gases, such as sulfur dioxide.	$6Cu + O_3$63Cu_2O $4Al + 3O_2$62Al_2O_3 $2Fe + O_3$6Fe_2O_3
Mineral acids (H_2SO_4, HCl, H_3PO_4, HNO_3)	Pickling industries, chemical industries, photo industries. Mineral acids normally used are: sulfuric acid , hydrochloric acid, phosphoric acid and nitric acid. Hydrofluoric acid is the main pollutant in aluminum production.	Mineral acids will stay in the air as aerosols and therefore attack materials even at low levels of humidity. If mineral acids are present in a production room, the environment should be classified as belonging to the highest severity level rating. Hydrofluoric acid will also attack glass and ceramics.	$Cu + H_2SO_4$6$CuSO_4 + 4H_2O + 6O_2$ $4Cu + 2H_2SO_4$62$Cu_2S + 2H_2O + 3O_2$ $2Fe + H_2SO_4 + O_2$6$FeSO_4 + 2H_2O$ $2Cu + HCl + O_2$62$CuCl_2 + 2H_2O$ $4Al + 12HCl + 3O_2$64$AlCl_3 + 6H_2O$ $4Fe + 12HCl + 3O_2$64$FeCl_3 + 6H_2O$ $2Fe + 4HCl + O_2$62$FeCl_2 + 2H_2O$ $3Cu + H_3PO_4$6$Cu_3(PO_4)_2 + 3H_2$ $Cu + 2HNO_3$6$CuN_2O_6 + H_2$
Organic acids (Formic - HCOOH, Acetic - CH_3COOH)	The key organic is formic acid, which is used in large quantities for preserving ensilage. It is also used in food preserving processes and wooden or plywood boxes (packing material).	Not as aggressive as mineral acids, but the effect is of long duration.	$2Cu + 8HCOOH$62$Cu(CH_3COO)_2 + 3O_2 + 2H_2O$ $2Cu + 4CH_3COOH + O_2$ 62$Cu(CH_3COO)_2 + 2H_2O$

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STAINLESS STEEL RESISTANCE TO CORROSION ATTACK

Stainless steel is sometimes used as an alternative to copper for the intercoolers in an effort to reduce the possibility of corrosion attack. The following statement is from the METALogic N.V. web page, found at http://www.metalogic.be, "Stainless steel will remain bright in uncontaminated atmospheres. Even the austenitic grades, however, can rust and pit if chloride contamination is prevalent or if dirt or deposits are allowed to accumulate on the metal surface. Also, reduced sulfur species [sulfide, ...] or, for example, diesel engine exhausts may cause attack."

ADMIRALTY METAL RESISTANCE TO CORROSION ATTACK

Admiralty metal is sometimes used for intercoolers in an attempt to reduce the severity of corrosion attack. Admiralty metal does offer some resistance to dilute acids and alkalies. As a copper based alloy (70-73% copper, 0.75-1.2% tin, remainder zinc), however, it is still susceptible to corrosion attack. (Hawley's Condensed Chemical Dictionary, Twelfth Edition.)

CORROSION & ENVIRONMENT ISSUES

SYMPTOM	CAUSE	COMPONENT AFFECTED
Decreased compressor efficiency	-insulating properties of corrosion film impedes heat dissipation	intercooler
	-thickness of corrosion film reduces the air flow area	intercooler
	-corroded and leaking copper tubing	intercooler
Vibration of compressor	-dislodged corrosion by-products which pass through the intercooler attaching itself to the diffuser, therefore inhibiting air flow	diffuser
	-dislodged corrosion by-products from the intercooler attaching itself to the nose bolt	nose bolt
	-dislodged corrosion by-products from the intercooler attaching itself to the impeller	impeller
	-dislodged corrosion by-products from the intercooler blocking the passage of air/water which can create a hammering effect	impeller
Reduction in compressor efficiency & vibration of compressor	-corrosion on intercasing section	intercooler, impeller, diffuser & casings

CASE STUDY

Test results from a major paper mill in Germany

Purpose: A side-by-side analysis was performed to determine the positive effects of chemical filtration. This test compared two 3200 CENTAC compressors, one outfitted with a CIF 404, two-stage chemical filter using Puracarb and Purafil media, to a second compressor without chemical filtration. Both compressors were located side-by-side and used the same air supply.

Procedure: An analysis of the condensate for pH, Copper (Cu), Iron (Fe), and Aluminum (Al), was conducted on the compressors during normal operation. This analysis was performed by an independent laboratory retained by the paper mill.

Results: Monitoring the condensate from the CENTAC compressor with chemical filtration showed four times less copper loss, three times less iron loss and half the aluminum loss than did the CENTAC compressor without chemical filtration.The analysis below also shows that monitoring the pH alone, will not give the results of metal loss during operation.

	pH	Cu,mg/l	Fe,mg/l	Al,mg/l
With Purafil	6.6	3.3	0.51	1.2
Without Purafil	6.6	13	1.7	2.9

Conclusion: In this case the copper intercoolers service life was extended four-fold as a result of the chemical filtration. Also, maintenance dollars spent on the CENTAC compressor without filtration could be four times higher than the CENTAC compressor with filtration. With these analysis results, the paper mill concluded that chemical filtration should be installed on all CENTAC compressors at this and other similar paper mill locations.

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