Formulas for metal under wear

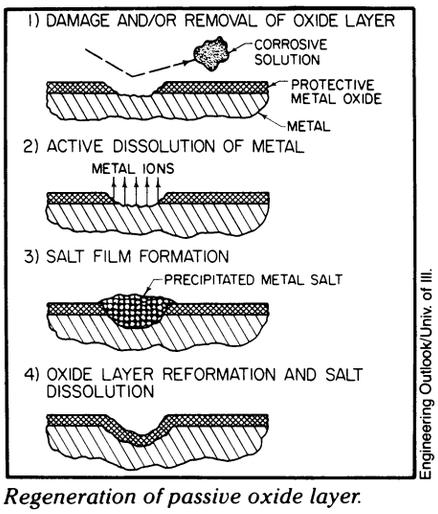
On a clear, November day — with winds from the northwest at 15 miles per hour, a relative humidity of 5 percent and a high temperature of 55°F — the total sulfur level is 31.8 parts per billion, while levels of hydrocarbons, oxides of nitrogen and ozone are negligible. Based on this information, calculate the rate and the nature of corrosion on an aluminum test square.

Such a mathematical problem soon may work its way into college textbooks, for a first attempt has been made to establish a set of equations that correlate corrosion behavior and atmospheric conditions. Leading the pack of corrosion-equation writers are F. Mansfeld of Rockwell International in Creve Coeur, Mo., and Fred H. Haynie of the U.S. Environmental Protection Agency at Research Triangle Park, N.C. Haynie and Mansfeld recently released the results of a 30-month study of the corrosive effects of air pollutants and atmospheric conditions on building materials and house paints. The researchers observed the corrosion on samples of galvanized and weathering steel, aluminum, silver, marble, nylon and two types of house paints exposed for various lengths of time to different atmospheric conditions at nine test sites in St. Louis.

An analysis of the data collected at those test sites reveals, for example, that sulfur pollutants contribute most to the accelerated corrosion of weathering and galvanized steel, marble and paints, but that oxides of nitrogen also are to blame for the corrosion of galvanized steel. In addition, "For galvanized steel, a pronounced effect of time of first exposure was observed, while the corrosion behavior of weathering steel did not seem to depend on the seasonal effects," Haynie and Mansfeld report. The researchers also found that for both latex and oil-base paints, exposure to the south was more corrosive than exposure to the north and that the integral corrosion rates for latex-base paints were higher than those for oil-base paints.

In related research, Richard Alkire of the University of Illinois at Urbana-Champaign is developing mathematical formulas that eventually may be applied to corrosion control. To this end he is investigating the natural corrosion-protection system of some structural metals.

All structural metals — iron, aluminum and stainless steel, for example — exist as oxides or sulfides in their natural state. The extraction of a metal from ore creates a thermodynamically unstable condition, and the corrosion reaction is simply a metal's attempt to return to its natural, more stable chemical form. But some structural metals have a protection system — called a passive oxide film — that covers the surface and prevents the metal from returning to its natural oxide state. When this protective film is damaged, it can regenerate and the chemical operations involved in that process are under Alkire's scrutiny.



Engineering Outlook/Univ. of Ill.

Regeneration of passive oxide layer.

To understand the regeneration process, though, the chemistry of the metal itself must first be understood. When a material such as iron oxide is converted into metal, two electrons are added to the positively charged oxide to create zero-charged iron. To revert to the oxide state, the metal must donate these electrons to the atmosphere's ready receivers — either oxygen or sulfur. A metal's natural protective oxide layer (which is about 0.000000025 centimeters thick) prevents such a reversion to the oxide state by sealing in these active electrons. When this layer is damaged — such as when iron is exposed to dilute sulfuric acid — electrons gather to form an oxide or sulfide, and the resulting positive ions are absorbed by the corrosive agent (in this case, to form iron sulfate). When these ions can no longer be absorbed, they form a crystalline salt layer that allows the oxide film to regenerate. Alkire hopes to apply knowledge of this regeneration process to predict the precise flow conditions that would allow the healing of corroded pipes. □

The Pill, again

Boston University researchers report in the Oct. 20 NEW ENGLAND JOURNAL OF MEDICINE that women who have used estrogen/progestogen oral contraceptive pills are at half the risk of developing endometrial cancer as women who have never used the Pill. They also found that the reduced risk persists for at least five years following discontinuation of the Pill.

The decreased endometrial cancer finding agrees with a previous report by University of Washington researchers who also found that women on sequential oral contraceptives (off the market since 1976) are at 7.3 times the risk of endometrial cancer. □

Vitamin A as a cancer shield

Some of the more promising cancer prevention research these days concerns vitamin A's protective effects against cancer. Since 1975, for instance, seven retrospective studies have shown that persons with a higher vitamin A intake or blood level are less susceptible to cancer, particularly lung cancer, than are individuals with a lower vitamin A intake or blood level. And now a prospective study, reported in the Oct. 18 LANCET, suggests the same thing. This latest investigation was conducted by Nicholas Wald, Marianne Idle and Jillian Boreham of Radcliffe Infirmary in Oxford, England, and by Alan Bailey of British United Provident Association Medical Research (a private medical insurance company) in London.

Wald and his colleagues collected blood from 16,000 men 35 to 64 years of age who attended the B.U.P.A. medical center in London for a comprehensive health-screening examination between 1975 and 1978. The blood samples were frozen and stored. By the end of 1976, 86 of the men had been identified as having developed cancer. Then 172 men from the study population who were alive and without cancer and of similar age and smoking habits as the cancer patients were selected as controls.

Blood samples from both cancer patients and control subjects were then examined for vitamin A levels, and Wald and his team then compared the levels of vitamin A in subjects who later came down with various cancers to those of subjects who remained free of cancer.

As they report in LANCET, the mean vitamin A level for subjects with all kinds of cancers — 210 international units/deciliter — turned out to be significantly lower than that for controls (231 i.u./dl.), with the difference being greatest for subjects with lung cancer and then for subjects with gastrointestinal cancer. In fact, the mean vitamin A level for subjects with lung cancer — 183 i.u./dl. — was much lower statistically than for controls.

Thus, lower levels of vitamin A in the blood seem to predispose people to cancer, especially lung and gastrointestinal cancers, whereas higher levels seem to protect people against it. These results, Wald and his team conclude, suggest that measures taken to increase blood levels of vitamin A in humans "may lead to a reduction in cancer risk." Efforts along these lines, in fact, are already being pursued by other investigators.

Because vitamin A can be highly toxic if consumed in large amounts, nontoxic analogs of vitamin A have been successfully used to prevent cancer in animals and are now being tested in humans to see whether they can perform the same feat (SN: 6/23/79, p. 414). □