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Project Summary

Acidic Deposition and the Corrosion and Deterioration of Materials in the Atmosphere: A Bibliography. 1880-1982

D. R. Flinn, S. D. Cramer, J. P. Carter, P. K. Lee, and S. I. Sherwood

Materials exposed to the atmosphere are subjected to a wide variety of stressing agents such as wind, solar radiation, temperature, biological species, many forms of water, and chemical species including pollutant gases, particulate matter, and components of rainfall, dew, snow, sleet, fog, and aerosols. This bibliography contains more than 1300 article citations and abstracts on the effects of acidic deposition, air pollutants, and biological and meteorological factors on the corrosion and deterioration of materials in the atmosphere. The listing includes citations for the years 1950 to 1982, with selected citations for the years 1880 to 1949. The citations are catalogued by year in six sections for metallic materials—ferrous material, aluminum, copper, nickel, zinc and galvanized steel, and other metals—and six sections for nonmetallic materials—masonry, stone and ceramics, elastomers, fabrics, paints, plastics, and other nonmetals. An author index and an index of chemical, biological, and meteorological variables are provided.

This Project Summary was developed by EPA's Environmental Sciences Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

Materials exposed to the atmosphere are subjected to a wide variety of stressing agents such as wind, solar radiation, temperature, biological species, many forms of water, and chemical species including pollutant gases, particulate matter, and components of rainfall, dew, snow, sleet, fog, and aerosols. While each of these agents may contribute to the deterioration of materials, in most cases the combination of two or more agents causes more significant damage.

This bibliography contains more than 1300 citations of articles on the effects of acidic deposition, air pollutants, and biological and meteorological factors on the corrosion and deterioration of materials in the atmosphere. Both peer-reviewed and grey literature have been included. No attempt has been made to define the term "acidic deposition"; instead, the literature was searched for all reasonable material and chemical, biological, and meteorological interactions.

Procedure

Many sources were consulted to ensure as complete a record as possible of the pertinent literature. These sources include the extensive conservationist and foreign literature on the degradation and corrosion of materials in statuaries, memorials, monuments, buildings, historical artifacts, and cultural objects. The sources also include the literature detailing the substantial European experience with pollutant effects. Manual and computer-assisted searches of data bases were conducted, existing bibliographies were utilized, and appropriate proceedings, publications, and documents were reviewed. Furthermore, reference lists for

the many articles, proceedings, publications, books, and public documents available to the authors were searched for literature that was suitable for the bibliography. Coverage of the literature is intended to include all pertinent articles from the years 1950 to 1982. For the years prior to 1950, the coverage is incomplete but includes at least the more important articles from these years; this has resulted in coverage extending back to 1880.

Results

The bibliography is divided into 12 principal sections according to the material at risk. There are six sections for metallic materials—ferrous material, aluminum, copper, nickel, zinc and galvanized steel, and other metals—and six sections for nonmetallic materials—masonry, stone and ceramics, elastomers, fabrics, paints, plastics, and other nonmetals. Citations are organized in these sections by year of publication. Within each year, the citations are arranged alphabetically by title to emphasize the contents of the article and to facilitate identification of articles of interest. Each citation begins with the title of the article, followed by name(s) of the author(s), name of journal or publication, volume and/or issue number, date of publication, page numbers, and parenthetically, the language of publication if the article is not in English. Abstracts are printed with the first appearance of a citation. All subsequent citations to the same article in other materials sections, resulting when an article reports studies on more than one material, are indexed to the earliest citation and the abstract is not repeated.

An author index follows the individual materials sections. Approximately 1500 authors appear in this index. Authors are listed alphabetically and are accompanied by a coded listing of their publications which is used to locate the appropriate citations in the materials sections.

An index of chemical, biological, and meteorological variables completes the bibliography and provides access to all citations according to subcategories of these variables. However, water, water vapor, dew, rain, snow, sleet, ice, fog, moisture, and humidity are not indexed as chemical variables because water is a common component in all corroding systems. All inorganic sulfur compounds except hydrogen sulfide also were excluded from the list of chemical variables because a great majority of the citations, particularly those considering metallic materials, had these compounds as components of the corrosive environment. Certain general phraseology was not interpreted with respect to the index of chemical, biological, and meteorological variables without more specific information. Examples of these phrases are: rural, industrial, urban, weathering tests, atmospheric pollutants, atmospheric exposure, polluted sites, four sites, atmospheric pollution, natural atmospheres, atmospheres at seven locations, and atmospheric corrosion. When phrases such as these were the only descriptors of the environment referred to in the citation, the citation was not catalogued in the index.

Conclusions

The processes that occur during material deterioration are complicated and often involve a combination of two or more causative agents. Therefore, many studies have been conducted in attempts either to ascertain the agent responsible for a certain type of damage to a specific material or to determine the best materials to use in certain types of characterized environments. In the former case, most work has been conducted in laboratory environments where the suspected pollutant or other agent could be introduced under controlled conditions. In the latter case, materials have been field tested in somewhat arbitrarily designated "typical" rural, urban, industrial, and marine environments. Only a few field studies have attempted to monitor the air quality and meteorological variables during the exposure. Virtually no studies to determine the effects of "acidic rain" on materials have been reported.

For structures comprised of a number of materials and subject to local microclimates, an analysis of the causes of deterioration becomes more difficult and even the definitions of "damage" may change. Certainly this analysis is usually much more descriptive and subjective compared to that for single, well-characterized materials. Despite these difficulties, there is a large amount of useful information regarding the effect of contact with the environment on materials. However, a large proportion of the literature contained in this bibliography resulted from studies that have limited scope. Because the information desired by any particular reader could not be determined, no critical assessment of this literature has been attempted. Through the various sections of the bibliography and the indexes, the reader should be able to determine the extant literature for a given combination of material with chemical and/or biological agent and meteorological variables.

One of the earliest surveys of materials damage resulting from pollutant gases in the atmosphere was the 1939 Bureau of Mines Information Circular on the *Effect of Sulfur Compounds in the Air on Various Materials* (I.C. 7064, L.R. Burdick and J. F. Barkley, 9 pp.). The circular reflected an already growing concern with the potential effect of air pollution on materials deterioration in the atmosphere. The various materials included cement, stone, paint, leather, paper, cloth, copper, nickel, steel, and zinc. Twenty-seven references were cited. Similar reviews have been written in the intervening years as the study of atmospheric corrosion has greatly expanded.

D. R. Flinn, S. D. Cramer, J. P. Carter, and P. K. Lee are with the Bureau of Mines, USDI, Avondale, MD 20782; S. I. Sherwood is with the National Park Service, USDI, Washington, DC 20240.
***John W. Spence** is the EPA Project Officer (see below).*
The complete report, entitled "Acidic Deposition and the Corrosion and Deterioration of Materials in the Atmosphere: A Bibliography 1880-1982," (Order No. PB 83-236 091; Cost: $40.00, subject to change) will be available only from:
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650
The EPA Project Officer can be contacted at:
Environmental Sciences Research Laboratory
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

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