

THERMODYNAMICS OF SOIL MOISTURE¹⁾

G. H. BOLT and M. J. FRISSEL

Laboratory of Soils and Fertilizers, State Agricultural University,
Wageningen, The Netherlands

SUMMARY

The various equations used by several authors to express the partial molar free energy of soil moisture as a function of certain parameters are compared with a "parent" equation derived in this paper. It is pointed out that aside from differences in terminology also some more basic differences of approach seem to exist, which only lead to identical results under certain limiting conditions. It is shown that from this "parent" equation some equations with practical applicability may be derived. The methods available for the experimental determination of the partial molar free energy of soil moisture are reviewed, with special reference to the assumptions underlying the application of the freezing point depression of soil moisture.

1 INTRODUCTION

Since the appearance of EMERSON and ANDERSON's "Thermodynamics of Soil moisture" in 1943 (6) several authors (ref. 1 through 15) have attempted to extend the treatment given by E. and A. in the light of increasing knowledge of the system soil-water. Although undoubtedly useful improvements on the original approach of EMERSON and ANDERSON were obtained, at the same time a diversion in the use and meaning of certain thermodynamic variables occurred which may occasionally give rise to confusion. This diversion in terminology is partly a matter of personal preference, although in certain cases differences of opinion may exist with regard to the principles governing the interaction between water and solid phase.

As progress in any field is always hindered by such a lack of unanimity in symbols and definitions, it would seem useful to reconsider the existing literature in order to establish in what respect differences are only of superficial nature or whether actually basic differences of opinion exist. This should be of special interest to those, who, although not having worked on the subject themselves, are concerned with the application of the thermodynamics of soil moisture to soil physical problems.

Naturally it is outside the scope of this paper to give complete derivations of all thermodynamic equations employed. Instead it has been attempted to give satisfactory evidence for the equations to render them plausible and allow the reader to acquire an insight in their background and limitations. For further detail the reader is referred to standard textbooks and to ref. 6.

As will be shown it seems doubtful whether one generalized equation for the system soil water will exist, which combines absolute generality with both sufficient detail and practical applicability. Depending on the specific nature of the system considered, different variables may be determinable, and accordingly different "working" equations would be preferred. Nevertheless it should be possible to relate all these equations to one "parent" equation which, although

¹⁾ Received for publication December 18, 1959.

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C. M. A. De Bruijn



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Encyclopedia of Soil Science Ward Chesworth, 2007-11-22 The Encyclopedia of Soil Science provides a comprehensive alphabetical treatment of basic soil science in a single volume It constitutes a wide ranging and authoritative collection of some 160 academic articles covering the salient aspects of soil physics chemistry biology fertility technology genesis morphology classification and geomorphology With increased usage of soil for world food production building materials and waste repositories demand has grown for a better global understanding of soil and its processes longer articles by leading authorities from around the world are supplemented by some 430 definitions of common terms in soil sciences **The Influence of Soil Compaction Upon the Thermodynamics of Soil Moisture** James E. Box Jr., 1961 The retention of water in soils is a very interesting subject Soil water research presents a great challenge to research workers The challenge is broad in scope and extends from the field problems of large irrigation projects to the atomic scale of the solid liquid interface If scientists are going to describe scientifically soil water relations they must ultimately utilize the instruments of science and the language of mathematics To the end of the latter the mathematics of thermodynamics has been applied in these studies of water retention in soils **Thermodynamics of Water Movement in Soil** John W Cary, Sterling A Taylor, 1962 *Theory of Soil Moisture: Moisture properties of soils and movement of soil moisture* Alekseï Andreevich Rode, 1969 *Thermodynamics of Expansive Soils* C. M. A. De Bruijn, 1963 **Soil Moisture**, 1967 *Soil Moisture* National Research Council of Canada. Subcommittee on Hydrology, Canada. Inland Waters Branch, 1968 Water Resources Research Catalog, 1966 *Selected Water Resources Abstracts*, 1973 **An Analysis of the Irreversible Thermodynamics Model for Coupled Heat and Moisture Transport Phenomena in Unsaturated Porous Media** Jerry A. Havens, 1980 **Theory of Soil Moisture** Alekseï Andreevich Rode, 1969 **Thermodynamics of Expansive Soils** Cornelis Marinus Adrianus De Bruijn, 1962 *Some Thermodynamic Properties of Soil Moisture and Their Variation with Temperature* John Samuel Robins, 1951 Technical Note, 1915 Humidity and Moisture: Fundamentals and standards. A. Wexler and W.A. Wildhack, editors Arnold Wexler, 1965 Journal of Non-equilibrium Thermodynamics, 1992

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Table of Contents Thermodynamics Of Soil Moisture

1. Understanding the eBook Thermodynamics Of Soil Moisture
 - The Rise of Digital Reading Thermodynamics Of Soil Moisture
 - Advantages of eBooks Over Traditional Books
2. Identifying Thermodynamics Of Soil Moisture
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Thermodynamics Of Soil Moisture
 - User-Friendly Interface
4. Exploring eBook Recommendations from Thermodynamics Of Soil Moisture
 - Personalized Recommendations
 - Thermodynamics Of Soil Moisture User Reviews and Ratings

- Thermodynamics Of Soil Moisture and Bestseller Lists
- 5. Accessing Thermodynamics Of Soil Moisture Free and Paid eBooks
 - Thermodynamics Of Soil Moisture Public Domain eBooks
 - Thermodynamics Of Soil Moisture eBook Subscription Services
 - Thermodynamics Of Soil Moisture Budget-Friendly Options
- 6. Navigating Thermodynamics Of Soil Moisture eBook Formats
 - ePub, PDF, MOBI, and More
 - Thermodynamics Of Soil Moisture Compatibility with Devices
 - Thermodynamics Of Soil Moisture Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Thermodynamics Of Soil Moisture
 - Highlighting and Note-Taking Thermodynamics Of Soil Moisture
 - Interactive Elements Thermodynamics Of Soil Moisture
- 8. Staying Engaged with Thermodynamics Of Soil Moisture
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Thermodynamics Of Soil Moisture
- 9. Balancing eBooks and Physical Books Thermodynamics Of Soil Moisture
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Thermodynamics Of Soil Moisture
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Thermodynamics Of Soil Moisture
 - Setting Reading Goals Thermodynamics Of Soil Moisture
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Thermodynamics Of Soil Moisture
 - Fact-Checking eBook Content of Thermodynamics Of Soil Moisture
 - Distinguishing Credible Sources

13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
14. Embracing eBook Trends
 - Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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