Fires in Silos

Hazards, Prevention, and Fire Fighting

Edited by
Ulrich Krause
Fires in Silos

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Further Reading

Prager, F. H., Rosteck, H.

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Fire Performance Testing under Real Conditions
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Kubota, N.

Propellants and Explosives
Thermochemical Aspects of Combustion
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Hattwig, M., Steen, H. (Eds.)

Handbook of Explosion Prevention and Protection
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Meyer, R., Köhler, J., Homburg, A.

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Preface

This book is addressed first of all to engineers who work as plant designers or operators or in management in the process industries, in energy conversion, in recycling, in the woodworking industry or in the food industry where large amounts of flammable bulk materials are stored in silos. It is intended to provide a background of knowledge of the fire hazards in silo storage facilities together with recommendations for fire prevention and protection.

A second group which may be interested in this book are fire fighters. As all the experience gathered in some case studies of this book shows, fire fighting in large storage facilities is always a big challenge to those concerned. Large masses of flammable materials involved in the fire, huge emissions of heat, smoke and potentially harmful gases and awkward access to the fire sites lead to extensive, difficult, risky, time-consuming and costly fire fighting missions.

Therefore, the main focus should always be on preventing fires in silos. This can be achieved when plant operators are well aware of

- the hazards linked with the flammable materials they store or handle,
- the hazards resulting from processing itself, for example the appearance of explosive atmospheres and ignition sources,
- technical and operational measures which can reduce the probability of a fire or an explosion to occur or mitigate their consequences to protect people, equipment and the environment.

Finally, responsible authorities supervising storage facilities may be interested in this book as well to use it as a condensed knowledge base for a complex problem. That is why the purpose of the present book is

- to raise awareness of the fire hazard in storage facilities and the eventually disastrous consequences of such fires including losses of life and economic bankruptcy,
- to transmit lessons learned in previous incidents,
- to spread the expertise gathered by the contributors of this book to those confronted with the problem.

However, it seems impossible to reduce the risk of a fire to zero. The present book attempts to summarize the state of the art of technical and administrative precau-
tions to be taken, first of all to prevent incidents or – if they occur – to allow an effective fire fighting.

Most of the preventive and protective measures apply to storage of flammable bulk materials in facilities other than silos as well, for example heaps or free deposits or storage in bunkers.

The presentation of knowledge in this book is more on a technical than on a scientific level to ease readability. Mathematics has been reduced to an absolute minimum.

The board of authors of this book comprises fire investigators, researchers, fire consultants and providers of fire protection equipment. All authors have a long-term experience in the field. It is our strong desire that this book may help to prevent these specific kinds of events or at least to facilitate bringing them under control.

It is the strong wish of the editor to sincerely thank everybody who has contributed to this book. This includes the authors for providing their unique expertise and experience and the publisher, Wiley-VCH, for the professional treatment of the manuscript and for the patience with the editor when doing his part of the work and last but not least the editor’s beloved family giving him the freedom and time for writing and editing.

Bergholz-Rehbrücke, Germany

Ulrich Krause
1 Introduction

Ulrich Krause

1.1 Problem Description

In industry and transportation silos serve as containers for storing bulk materials or
dusts. Volumes of silos range from a few cubic meters as supply silos in process
chains to some thousand cubic meters for storing fuels, grain or sugar, for example.
Recently, in Europe some coal storage silos have been erected storing up to
50,000 tons of coal.

Many silos are of cylindrical shape but there are also silos with rectangular cross
section or those formed by the intermediate space between adjacent cylindrical silo
cells. As will be explained below, silo size and shape affect fire appearance and
fighting.

Silo batteries – an arrangement of up to 100 or more single silo cells on one site –
offer storage capacities for dozens of thousands of tons of material.

About 80% of bulk materials are flammable, among them those which are stored in
large masses like grain or other crops. Hence, in the case of a fire the release of an
enormous amount of energy has to be expected, which endangers the static integrity
of the structure and makes fire fighting extremely difficult. In addition, huge
emissions of smoke and flue gases impede the access to the fire site and harm the
environment.

Besides the fire itself the hazard of an explosion has to be taken into account
when flammable bulk materials are stored in silos. Fine particles may be
contained in the bulk material or are produced by abrasion during handling.
When these fine particles are dispersed in air as may happen during filling or
emptying the silo, eventually an explosive dust cloud is formed in the interior of
the silo. If an ignition source of sufficient energy is then in place a dust explosion
is likely to occur.

Another explosion hazard results from flammable gases. Under the action of
a heat source many organic bulk materials undergo thermal decomposition
(pyrolysis) whereby flammable gases like carbon monoxide, methane, propane