Practical Experience in the Main Fertilizers Containing Nitrogen

Explosion Hazards in Urea Plants

Removal from Hydrogen from Carbon Dioxide

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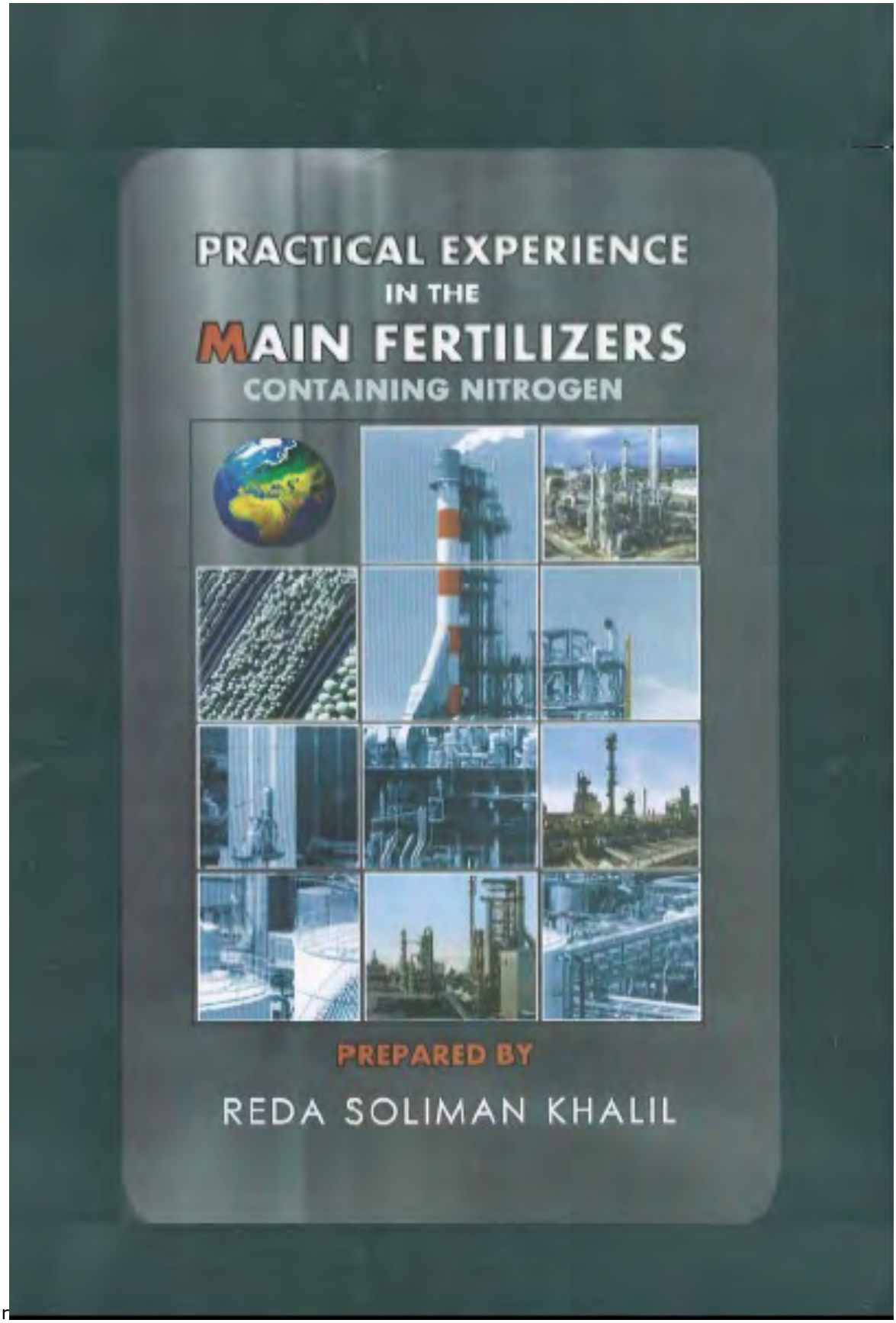
1. Introduction

In March 2004, Engineer Reda Soliman Khalil has published the first edition of a very interesting and elaborative book describing the Practical Experience in the Main Fertilizers Containing Nitrogen.
In this book, which is unique in the industry, Engineer Khalil's focuses on three main fertilizer types: Urea, Ammonium Nitrate and Ammonium Phosphate, in addition to Nitric Acid, which is highly involved in the manufacturing of other various nitrogen-based types of fertilizers.
This book aims at combining the theoretical and practical experience in the main popular fertilizers produced mainly from ammonia, which is the basic access to all the nitrogenous fertilizers that involve nitrogen as a manufacturing component.
Currently Engineer Khalil is Managing Director, Fertilizers, ORASCOM CONSTRUCTION INDUSTRIES and Board Member, SORFERT ALGERIA.
This part discusses Explosion Hazards in Urea Plants and more specific the removal from Hydrogen from Carbon Dioxide.


PRACTICAL EXPERIENCE
IN THE
MAIN FERTILIZERS
CONTAINING NITROGEN
PREPARED BY
REDA SOLIMAN KHALIL

6. Removal of Hydrogen from Carbon Dioxide

E.1) Reasons for removing the Hydrogen from Carbon Dioxide

The carbon dioxide to the urea plant is contaminated with too many incondensable gases such as; hydrogen, nitrogen, methane, carbon monoxide, argon, and helium, in addition to air added as a source of oxygen to form a protective layer on the equipment to avoid corrosion.

If it is taken into consideration that ammonia to the urea plant can contain traces of these gases that will cause an extensive overload of the synthesis loop by these inert gases, along with that its concentration will increase in the HP scrubber, where most of carbon dioxide and ammonia are condensed or absorbed. The increase of hydrogen and oxygen may form an explosive mixture and the possibilities of ignition of this mixture can exist.

To eliminate the hazard of hydrogen in the carbon dioxide to the urea plant, the catalytic removal unit was implemented at the suction of the carbon dioxide compressor normally at the suction of the second stage of the compressor. The catalyst used in the hydrogen reactor unit is made from about 0.3% platinum on aluminium.

The hydrogen removal catalyst normally works at a high temperature.

E.2) Poisoning for Hydrogen Removal Catalyst

The main poisoning for the hydrogen removal unit is sulphur and carbon monoxide.

If sulphur exists, it increases the activation temperature of the catalyst up to 220°C with the presence of one ppm of sulphur. Carbon monoxide also increases the activation temperature of the catalyst.

E.3) What is the maximum limit of hydrogen in carbon dioxide after removing unit (converter)?

The maximum allowable hydrogen content after the hydrogen converter is 50 ppm.

E.4) What are the reasons of the increase in hydrogen?

If the hydrogen increase in the carbon dioxide, it can be due to:

a) Problem in carbon dioxide removal unit in the ammonia plant.
b) Low contents of oxygen in the outlet gas from the converter.
c) The temperature of gases inlet to the converter is low.
d) False reading of the gas analyzer after the converter.
e) Drop in the catalyst efficiency.

E.5) What are the reasons for the decrease of Oxygen content outlet converter?

The oxygen content drop at the converter outlet is due to the increase of the inlet hydrogen, or due to decreasing the airflow inlet at the suction of the compressor.

E.6) What is the limit of oxygen in the flow of gases to the synthesis loop?

The normal operating range of oxygen in the gas inlet to the HP stripper is 0.60 – 0.65% volume.

E.7) What is the minimum limit for oxygen in the gas to the HP synthesis loop?

The minimum level of oxygen in the gas flow to the synthesis loop is 0.55% volume for only not more than 15 minutes, if the amount or time is exceeded, the plant should be stopped immediately.

E.8) What is the result if the oxygen increases in the gases to the synthesis loop?

If the oxygen increases in the gases to the synthesis loop, it will increase the inert in the HP scrubber and consequently increase the synthesis pressure, and increase ammonia losses due to the improper ratio.

E.9) What are the reasons for the low temperature differences between the inlet and outlet of the hydrogen converter?

The reasons for the low temperature differences between the inlet and outlet of the hydrogen converter are:

a) *Poisoning of the catalyst.*
b) *Low hydrogen content in carbon dioxide gas.*
c) *Low oxygen content at the converter inlet.*
d) *No reaction due to the too low temperature at the converter inlet.*

E.10) What is the reason of the high temperature differences at the inlet and outlet of the converter?

The high temperature differences at the inlet and outlet of the converter is due to the too much hydrogen in the carbon dioxide at the inlet of the converter.

E.11) What is the reason for the increase in the pressure drop over the hydrogen removal converter?

The pressure drop can increase over the hydrogen removal converter due to the pulverization of the catalyst.