

## Control of Pneumatic Conveying Using ECT

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**Abstract** - *The control of dense-phase pneumatic conveying systems is notoriously difficult. Specifically, achieving sufficiently low air velocity to ensure efficient power utilisation, low product degradation and plant wear, whilst ensuring that blockage of the pipeline does not occur, is the greatest challenge. ECT could potentially offer a cheap, durable and potentially effective method of visualising solids movement within conveying pipelines and ultimately act as a primary sensory input to an optimal control system.*

*A pneumatic conveying rig has been designed and constructed in order to simulate the slug flow of plastic pellets when using air as a transportation media. Twelve electrode ECT sensors have been placed on a test section of the rig to measure variations of slug flow and to further investigate any potential for control. A prerequisite paper [1] details the successful time-based "animation" of solids flow through the pipeline, the analysis of these flow patterns and the potential of this work for the control of pneumatic conveyors. This "bolt-on" paper will describe two parallel control strategies, which may be employed in association with an ECT system for the optimisation of pneumatic conveyors. One technique will utilise parametric modelling of conveying systems, while the other will be based on a fuzzy logic approach, where the membership functions will be optimised by the use of genetic algorithms.*

**Keywords:** ECT, pneumatic conveying, control, parametric modelling, fuzzy logic.

### 1. INTRODUCTION

Pneumatic conveying is defined as the transport of various granular solids and dry powders using an air (or other inert gas) stream as a transportation media. Pneumatic conveying offers many advantages over other methods of granular solids transport, factors such as low routine maintenance and manpower costs, dust free transportation and flexible routing. The main disadvantage is the reliance upon empirical procedures for conveyor design, which in effect limits the design to a specific solid material. Relatively minor changes in pipeline layout or operating conditions can often result in unpredicted blockage problems. In addition, power consumption, wear rate, product degradation and particle size separation can be major problems.

Dense phase pneumatic conveying systems are categorised as such by the solid particles not being fully suspended and therefore moving at low velocities. As such, these systems have the relative attributes of a low air requirement and hence energy demand, low pipeline erosion and low product degradation. However, the control requirements of such a transportation system are

clearly far more acute in respect to the maintenance of flow regime and the prevention of blockage. As a safety measure and to accommodate future changes in the system, most dense phase systems are operated at a much higher air velocity than necessary, thereby reducing the potential benefits of this mode of operation.

The flow regime within a pipeline, for a given particulate material, can often be controlled by variation of the air velocity. It would normally be expected that industrial scale pneumatic conveyors would operate with discontinuous dense-phase flow regimes. This may take the form of discrete plugs of material, rolling dunes or a combination of the two. In reality, a pneumatic conveying system may simultaneously exhibit several flow regimes throughout its length. If unstable flow occurs it can result in violent pressure surges which will increase both plant wear and product degradation problems. In addition, the identification of the flow regime at critical sections of the pneumatic conveyor is fundamental to any void fraction estimate, upon which many standard measurements, such as solids mass flow rate, will depend.

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## **Table of Contents Control Of Pneumatic Conveying Using Ect Vcipt**

1. Understanding the eBook Control Of Pneumatic Conveying Using Ect Vcipt
  - The Rise of Digital Reading Control Of Pneumatic Conveying Using Ect Vcipt
  - Advantages of eBooks Over Traditional Books
2. Identifying Control Of Pneumatic Conveying Using Ect Vcipt
  - 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 Control Of Pneumatic Conveying Using Ect Vcipt
  - User-Friendly Interface
4. Exploring eBook Recommendations from Control Of Pneumatic Conveying Using Ect Vcipt
  - Personalized Recommendations
  - Control Of Pneumatic Conveying Using Ect Vcipt User Reviews and Ratings
  - Control Of Pneumatic Conveying Using Ect Vcipt and Bestseller Lists

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