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INDUSTRIAL AIR TECHNOLOGY – “THE REASON WHY”

PURPOSE

Through increased awareness of factors with influence on health, safety, productivity and energy efficiency in industry, the following benefits from advanced industrial air technology can be achieved:

Through improved systems and equipment the indoor air quality is improved, which results in higher productivity and reduced number of failures in production.

Through improved indoor air quality the damage on building constructions, machinery and products will be reduced and this leads to essential savings in maintenance costs.

Improved indoor air quality also reduces absenteeism and increases work satisfaction.

With improved systems and equipment and better usage patterns, the air flow can be reduced and thus a significant reduction in energy consumption can be achieved.

Increased awareness leads to better selection of new energy-efficient systems in ventilation design.

Environmental pollution is reduced through lower energy usage and lower emissions to the surroundings.

Improvements in systems and equipment also result in cleaner surroundings and better image of the company.

EUROVENT/CECOMAF

**EUROPEAN COMMITTEE OF
AIR HANDLING, AIR CONDITIONING AND REFRIGERATION
EQUIPMENT MANUFACTURERS**

WHY ATTENTION TO INDUSTRIAL AIR TECHNOLOGY?

A young scientist said “I have never seen a complex scientific area such as industrial ventilation, where so little scientific research and brain power has been applied”. This is one of the major reasons why activities in the industrial ventilation field at the global level were started. The young scientist was right, the challenges faced by designers and practitioners in the industrial ventilation field, compared to comfort ventilation, are much more complex. In industrial ventilation, it is essential to have an in-depth knowledge of modern Computational Fluid Dynamics (CFD), 3-dimensional heat flow, complex fluid flows, steady state and transient conditions, operator issues, contaminants inside and outside the facility, etc.

In all ventilation, indoor air quality (IAQ) and the exposures for the occupants are important. In industrial facilities, the contaminant emission rates may be 10-100 times higher than in non-industrial facilities, but for many contaminants, the IAQ levels may be the same. The first priority is to consider the process, but other important issues such as occupants, energy, environment, corporate image etc., must also be considered.

Energy is a key issue and is closely limited with the environment. Global environmental issues must be addressed where energy chain from resources to end users is of vital importance.

It is recognized that some countries are leaders in the area of scientific research and experimental development. It is also known that Scandinavian countries have been in the forefront of implementing leading-edge technology for good environmental practice and energy efficient plants in the 80’s and 90’s. The challenge is the implementation of the best industrial ventilation technology and practice to all workplaces on a global basis.

The objectives of new innovations, procedures, systems and equipment to fulfil the end user’s needs must be included as a part of the on-going development program. Significant advances in technology presented in this book are target levels, systematic design methodology, indoor air quality strategies, and control of flow in facilities. The objective is to make them work on practice and to continue the development process.

Updating is one actual thing. Never stop the developing process and study, develop, update everything taking into account life-cycle ecological issues.

Industrial Air Technology (IAT) is a challenging technology. When we compare it with comfort ventilation we can see that technologically our task is very challenging. To fulfil all the needs of the end user the task is often impossible. If the IAQ is fulfilled the amount of air is so high that draught is too high. We must also have the courage to say, what is possible or what is not. We have to create also tools to validate this.

The benefits of advanced Industrial Air Technology are:

* Improved health of workers and reduced absenteeism as a result of better IAQ.

* Improved indoor air quality gives improved work satisfaction, higher productivity and reduced production failures.

* Reduction in maintenance costs for the building fabrics, machinery and products.

* Reduction in energy consumption can be achieved with improved usage patterns and reduced air flow rates.

* Increased awareness allows improved selection of new energy-efficient systems in ventilation design, with same results as in the previous point.

* Improved systems and equipment result in cleaner surroundings and thus improve also the image of the company.

* Environmental pollution is reduced by lower energy usage and lower emissions to the surroundings.

* High level industrial air technology systems and equipment improve the life cycle economy.

Field studies have revealed a significant potential for energy saving by modern industrial air technology. For example, one study revealed a great variation in energy consumption (a ratio of 5:1) in technically similar welding halls; This particular study showed the best indoor air quality was achieved in the hall with the lowest energy consumption. With commercially available high-level design concepts it is possible to decrease the contaminant load by about 90% and the heat load by about 60% compared to medium-level applications.

The above shows the need to increase the level of knowledge ”from rules of thumb” to a more rigorous scientific procedure based on validated data and design methods.

DEFINITION AND PURPOSE OF INDUSTRIAL AIR TECHNOLOGY

Industrial Air Technology (IAT) can be defined as:

Air flow technologies to control workplace indoor environment and emissions

A longer definition is:

1. Air flow technologies to achieve and maintain a safe, healthy, productive and comfortable indoor environment in premises and occupied enclosures where this need is determined not only by human occupancy, normal human activities, and construction and finishing materials, but also and often primarily by other factors, for example production processes.

2. Process air technology such as air and gas purification, drying, or pneumatic conveying.

3. Safety air technology, including risk assessment, to minimize damages and hazards caused by accidents, fire and explosion

It is typical for industrial premises to have, in one space, **zones** with different target levels. The target levels may be determined for the whole area or locally. Often only a part of the space requires controlling of the indoor environment parameters. In addition to the main controlled zone there may be one or more local controlled zones with different target levels than the main controlled zone.

Except measures to control the indoor environment, Industrial Air Technology includes also measures to prevent harmful emissions from industrial processes to be discharged outdoors, such as conveying and cleaning technologies and controlled discharge of exhaust air to outdoors. Other systems are included, such as drying (pulp drying, milk drying etc.), process ventilation and safety air systems.

The scope of industrial air technology includes premises other than traditional industrial process buildings, such as hospitals, underground car parks, mining, railroad and vehicle tunnels, livestock buildings, and other similar premises and processes.

AIR TECHNOLOGY SYSTEMS

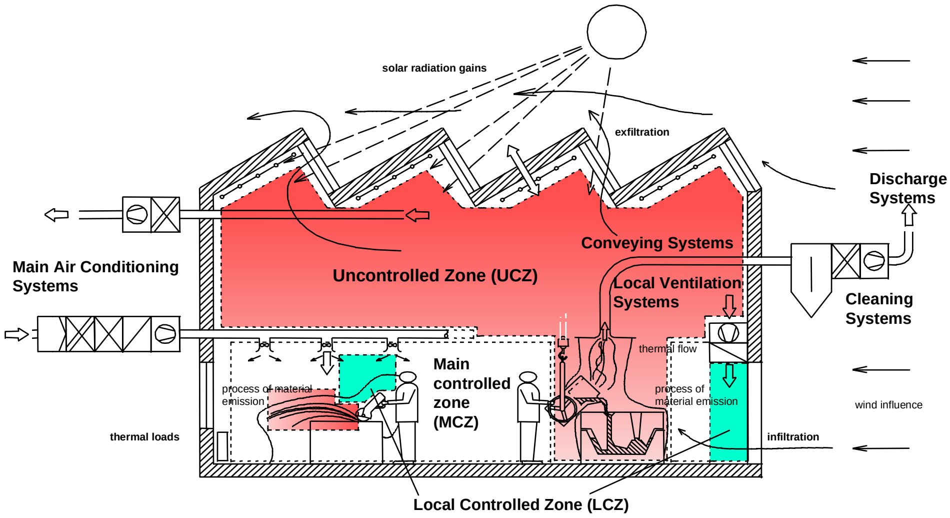

Figure 1. Industrial Air Technology

Industrial air technology system categories are the following according to Figure 1:

1. INDUSTRIAL VENTILATION

1.1 Air conditioning systems
Air conditioning systems include control of air quality and thermal environment for both human occupancy and for processes.

1.2 General ventilation systems
In general ventilation system some indoor air parameters are controlled only partially. Target levels are usually lower than for air conditioning.

1.3 Local ventilation systems *are used for local controlled zones. These systems are based on local capture of contaminants.*

1.4 Process ventilation systems
In process ventilation the target is to maintain defined conditions to ensure the process performance, e.g. paper machine hoods.

2. PROCESS AIR TECHNOLOGY

2.1 Cleaning systems
Cleaning systems are used to remove contaminants, clean the resulting fluid flows and collect materials before discharging the exhaust air.

2.2 Pneumatic conveying systems
Conveying systems are used to transport captured pollutants from processes to a collection point.

2.3 Drying system
Drying systems are used to remove moisture, gases and vapours from the product

3 SAFETY AIR TECHNOLOGY SYSTEMS

DESIGN GUIDE BOOK (DGB)

History and state-of-art:

A group of international specialists in the area of industrial ventilation have decided to write the ”Bible” of industrial air technology. The book, Design Guide Book of Industrial Air Technology will be written as a major co-operation effort. In the year 2000, people and organizations from following countries participate the work of one or more international actions within the scope: Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Hungary, Italy, Japan, Netherlands, Norway, Russia, Sweden, Spain, Switzerland, U.K, and U.S.A. Australia and Poland are also interested.

The available systematic information regarding industrial air technology is scarce. There are some handbooks, such as Hemeon (USA), Baturin (with its latest edition 1972), Heinsohn (USA), Goodfellow (Canada) and ACGIH (USA), but they don't cover the whole field of industrial air technology. There is no internationally accepted handbook available, and the designer has no validated solutions at his disposal. According to the present state-of-the-art, both capturing and ventilating systems are designed to comply with know-how-rules (e.g. air exchange rate) and rarely achieve the targeted heat and contaminant load removal - without overdimensioning and excessive costs. This expertise is not generated by systematic investigations but by experience from various plants under construction and in operation. This is obviously due to a total lack of approved design criteria and lack of international or European standardisation, which make effective ventilation design impossible.

One of the main reasons to write a Handbook for Industrial Air Technology was also the fact that there are large gaps and inaccuracies in the technical literature.

The project will be carried out in phases including the Fundamentals, Systems and Equipment, and Applications. The main target of the DGB project is to write internationally accepted handbook, a much needed scientific reference, covering the whole field of industrial air technology with validated and updated knowledge and through it raise the technical level of industrial air technology worldwide.

The first book, Fundamentals, describes the basic theories and science behind the technical solutions for Industrial Air Technology. Equipment-specific theories will be completed in the Systems and Equipment book. The Applications will describe technical solutions for specific industrial sectors and technology areas, including design and construction methodology.

Structure of the DGB Book Fundamentals

The Volume A ”Fundamentals” is structured in 16 Chapters as follows:

1. Industrial Air Technology - Description
Introductory chapter to the Design Guide Book. Describes the reasons why more attention should be paid on industrial air technology. Describes also the definition and purpose of industrial air technology, and the basic system principles.

2. Terminology
Describes the set approach dealing with units, symbols and definitions, which are essential in providing texts which do not cause confusion by various chapters using different symbols relating to the same unit. Provides a common language throughout the book.

3. Design Methodology
Design Methodology is the systematic description of the technical design process of industrial air technology, as an elementary part of the whole life cycle of the industrial plant.

4. Physical Fundamentals
Introduces the important topics of fluid flow, properties of gases, heat and mass transfer and physical/chemical characteristics of contaminants. The aim is to assist all engaged in industrial air technology to understand the physical background of the issues involved.

5. Physiological and Toxicological Considerations
The chapter introduces fundamentals of human physiology and health requirements relevant in the control of indoor environment within industrial buildings.

6. Target Levels
The chapter presents a new concept called target levels. It outlines the role target levels in the systematic design methodology, scientific and technical grounds for assessing target levels for key parameters of industrial air technology, hierarchy of different target levels as well as some examples of quantitative targets.

7. Principles of Air and Contaminant Movement inside and around Buildings
This chapter presents the basic processes of air and contaminant movement, such as jets, plumes and boundary flows.

8. Room Air Conditioning
This chapter describes the room air conditioning process including interaction of different flow elements: room air distribution, heating and cooling methods, process sources and disturbances. Air handling equipment, including room air heaters etc. is discussed as ”black boxes” as far as possible

9. Air Handling Processes
Describes the fundamentals of air handling processes and equipment, and given answers to questions relating to the theoretical background of air handling unit and ductwork dimensioning and building energy systems optimization

10. Local Ventilation
Describes the aerodynamic principles, models and equations that govern the flow and the contaminant presence and transport in a designated volume of a work room. The purpose of Local ventilation is to control the transport of contaminants at or near the source of emission, thus minimizing the contaminants in the workplace air.

11. Modelling Techniques
The chapter describes calculation models for building energy demand and air flow in and around industrial buildings. Special attention is paid to simulation of airborne contaminant control. Four methods for industrial air technology design are presented: Computational fluid dynamics (CFD), thermal building dynamics simulation, multi-zone airflow models, and integrated airflow and thermal modeling. In addition to the basic physics of the problem, the purpose of the methods, recommended applications, limitations, cost and effort, and examples are provided.

12. Experimental Techniques
Experimental techniques cover a description of conventional measurement techniques used in ventilation, also other related topics like flow visualisation, laser based measurement techniques and scale model experiments.

13. Gas Cleaning Technology
Describes the fundamentals of gas cleaning technology in branches of removal of particles and gaseous compounds. This chapter includes also the fundamentals of particulate and gaseous measurements technology.

14. Pneumatic Conveying
Basic principles of pneumatic conveying and equations are presented. A new pressure loss equation is presented with examples.

15. Environmental Life-cycle Assessment
Life cycle assessment, LCA is a compilation and evaluation of inputs, outputs and the potential environmental impacts of a product system throughout its life cycle. The LCA methodology is comprehensively described based on the ISO 14000 series standards. References are also given to LCA information sources.

16. Economical Aspects
Life Cycle Cost (LCC) calculations are made to make sure that both the purchase price and the operating costs for life cycle are considered in investment decisions. In the chapter the basic calculation methods and sensitivity analysis are introduced. Examples of calculation results and references to LCC information sources are given.

Other volumes - Practitioners' point of view

From the practitioner's point of view the most useful volume will consist of branch by branch Applications. It will be possible to check the theoretical background from Volume A and the technical background from Volume B:

A — Fundamentals
-scientific
-main target groups: scientists, education/ university level, engineers in industry and practice

B — Systems and equipment
-practical
-main target groups: designers, manufacturers

C — Applications
-practical
-main target groups: designers, end users

D — Brochures, legislation, standards
-practical, also commercial information
-main target groups: end users suppliers, purchasers, installers, designers