جامعة عين شمس
كلية الهندسة
قسم الهندسة المعمارية

تأثير التحكم في مقدار التلوث على تصميم

" الغرف فائقة النظافة "

رسالة مقدمة إلى كلية الهندسة – جامعة عين شمس
كجزء من متطلبات الحصول على درجة الماجستير
في الهندسة المعمارية

إعداد

المهندسة / عزة جمال الدين محمود حجاج

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٢٠٠٧

جامعة عين شمس
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الدرجة العلمية : **الماجستير**

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التعريف بالباحثة

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تاريخ المنح:

إقـرار

هذه الرسالة مقدمة إلى جامعة عين شمس للحصول على درجة الماجستير في الهندسة المعمارية .

وقد تم إجراء العمل الذي تحتويه الرسالة بمعرفة الباحثة بقسم العمارة – كلية الهندسة – جامعة عين شمس في الفترة الواقعة بين ٢٠٠٢–٢٠٠٧م. هذا ولم تقدم أي أجزاء من هذا البحث لنيل مؤهل أو درجة علمية من أي كلية أو جامعة أو معهد علمي آخر.

وهذا إقرار مني بذلك.

اسم الباحثة : عزه جمال الدين محمود حجاج

التوقيع:

التاريخ:

شكر وتقدير

أشكر الله العلي القدير أولاً وأخيراً فيما أعانني فيه ووفقني إليه . و أتقدم بخالص الشكر والتقدير إلى الأساتذة الذين قاموا بالإشراف على الرسالة وهم :

الأستاذ الدكتور/ علي فتحي عيد وذلك لكريم تعاونه في إخراج هذه الرساله بصورة جيدة وذلك بالإرشاد الموجه والسديد .

الدكتورة/ حنان مصطفى كمال صبري وذلك لما بذلته من مجهود متواصل في جميع مراحل العمل، حيث لم تتوانى عن المتابعة والتوجيه طوال فترة إعداد البحث .

الدكتور/ أحمد عاطف الدسوقي فجال وذلك لحسن توجيهه وتشجيعه المستمر .

كما أخص بالشكر الجزيل الأستاذ الدكتور/ علي فؤاد الفرماوي الذي وجهني منذ البداية إلى اختيار هذا الموضوع الشيق للدراسة والبحث.

وكذلك العاملين بشركات الأدوية محل الدراسة التطبيقية لما أمدوني به من لوحات معمارية ومعلومات ساهمت كثيراً في رفع الوعي المتكامل بموضوع البحث.

وأخيراً أشكر كل من ساندني بالعلم والتشجيع من أسرتي وزملائي في إتمام هذا العمل وخروجه بصورته النهائية .

وحمداً وشكراً دائمين باذن الله له سبحانه وتعالى في كل وقت وحين.

الباحثه

إهــداء

إلى أمي وأبي الحبيبين .....

إلى زوجي وإبنتي الصغيرة....هانيا

وإلى كل من تمنى لي التوفيق.....

بسم الله الرحمن الرحيم

" وقل اعملوا فسيرى الله عملكم ورسوله والمؤمنون"

سورة التوبة ,آية ١٠٥

Dept.of Architecture
Faculty of Engineering
Ain Shams University

The Influence of Contamination Control On The Design of "Cleanrooms"

Thesis Submitted to Faculty of Engineering- Ain Shams University
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Introduction

Man's existence was, is, and will always be confined and defined by Time and Space. The Environment is indisputably the physical manifestation of the time-space continuum, the womb in which Man is expected to sow the seeds of spiritual, intellectual, and cultural growth and development; Civilization. Man's basic needs and instincts called upon him to explore, collect, and benefit of the environmental resources and bounties offered by nature in abundance. The exploration and even exploitation processes of natural resources resulted in humongous technological development, which in turn required more resources, presented new demands and needs, and made essential the innovation of new strategies, solutions and techniques. New technological processes inevitably required new spaces and environments where such processes could be carried out efficiently. The need for spaces in which the behaviors of ventilation, temperature, humidity, atmospheric pressure and other environmental factors could be controlled have suddenly become essential. Architects, engineers and scientists collaborated offering a solution to this technological problem; Cleanrooms. A hundred years ago Man's hospitals boasted the presence of sanitized, sterilized, insulated rooms for the first time in history. Later, new types of insulation, sanitization, and sterilization were needed for newly invented and diversified research and applications. Manufacturing of or research involving semi-conductors, optical lenses, electronics, genetics, nuclear applications, medical devices, and pharmaceutics are examples of where and why such new spaces were urgently needed.

Research Problem

Cleanrooms are very important spaces found and needed in diverse domains, which requires special architectural design, construction and operating specifications. In the time being, cleanrooms are considered efficient only when the related technical standards and specifications are meticulously guarded and applied, with less or no regard to the quality of the direct architectural design input. Despite the fact that cleanrooms are essentially architectural spaces, normally expected to fulfill a technological demand, no adequate weight is given to the

architectural design contribution in evaluating the efficiency and quality of cleanrooms. Technicians and scientists have said their word and were clearly heard on cleanrooms. Architects, on the other hand, as initiating, vital and decisive as their role should be, have not laid down their body of knowledge and experience systemically, methodically, accumulatively and cohesively. Not yet.

Hence there is an urgent need to clearly define the following:

- Architectural and spatial requirements and specifications for cleanrooms as an independent "Prototype"

- The definition of the role of the architect as a key contributor to this multi-disciplinary design, construction and operating process.

Research Limitations

Study Limits: Studying cleanrooms generally and then strongly focusing on the architectural design aspects in a detailed manner which will not be offered to all the other aspects contributing to the creation of cleanrooms.

Functional limits:

- Focusing on Positive Pressure Cleanrooms, which aim first and foremost at securing the production process from contamination by any polluter that may compromise the quality and safety of the final product.

- Focusing on Aseptic Preparation Products such as Parenteral Products as our main application of all the tests, and studies intended to be carried out through this research.

- Addressing cleanrooms regardless of the type and nature of a specific industry or a specific product.

Research Objectives

- The research aims at **identifying the architectural principles and parameters that could achieve the cleanrooms special requirements** , including:

- Identifying and defining the architectural spaces comprising any industrial cleanroom and the hierarchical interrelations between those spaces in terms of levels of cleanliness

- Identifying and introducing architectural design solutions which optimally respond to the air requirements inside cleanrooms

- Specifying the requirements of the working tops used in cleanrooms and introducing the most suitable materials accordingly.

Research Methodology

The research methodology follows a typical scientific sequence that begins with problem definition until the conclusions and recommendations are unveiled. The research problem is investigated in both theory and application.

The theoretical part of the study comprises of the first three chapters, which inductively investigate the influence of contamination control on the architectural design and prototyping of cleanrooms, in addition to the fourth chapter which demonstrates different solutions for preserving the cleanliness and purity of cleanrooms.

The second part of the study which concerns itself with application follows both analytical and comparative analytical approaches in investigating the methods used in controlling the level of contamination in relation to their standard specifications within three select case studies and comparing the results to arrive at a conclusion.

Research Contents

The research comprises five chapters present the followings:

Chapter One: Cleanrooms- Introduction and Definitions

This chapter elucidates the very meaning of cleanrooms, the purpose of its existence, and its fields of application in different domains, within a historical narrative of displaying the evolution of cleanrooms as a simple idea in hospitals and operation rooms

until its emergence as a defined and needed space in industrial applications. The chapter also introduces the most vital standard codes and references which define and classify cleanrooms according to the levels and sources of contamination.

Chapter Two: Technical Criteria and Parameters for Cleanrooms

This chapter offers a thorough technical account of the many techniques and factors used to control the levels of contamination inside cleanrooms, mostly orchestrated by the air-conditioning system which controls the air flow, atmospheric pressure, temperature, humidity, and other air related parameters. In addition to that, facilities and amenities expected to be found in cleanrooms and how to guarantee that they would not compromise the level of purity in cleanrooms is discussed.

Chapter Three: The impact of the parameters controlling levels of contamination on the architectural design and prototyping of cleanrooms.

This chapters introduces the design criteria for cleanrooms and how such criteria is influenced by the central idea of controlling levels of contamination in cleanrooms. The study begins by establishing the basis upon which the location and general layout of a building containing a cleanroom is selected. It elaborates on the position and location of cleanrooms from a zoning point of view, architectural spaces forming cleanrooms, the impact of the production line on designing cleanrooms including the study of circulation concerning both labor and raw materials involved in production processes. Finally, the study terminates upon mentioning criteria used to select furnishings, fixtures, and colors of cleanrooms' interiors. in addition to all previously mentioned, the study concerns itself with methods used in constructing walls and partitions of cleanrooms, surface treatments and specifications as in flooring, ceilings, and work tops.

Chapter Four: Cleanrooms – Preservation and Maintenance

A proposal for maintenance methods and preservation systems is exhibited in this chapter. The proposal first checks the strict application of standard specifications and the abidance by cleanrooms' users regulations. It discusses the tools and methods needed to clean and sanitize cleanrooms, in addition to studying the importance of monitoring processes and tests used as an effective procedure to maintain the required efficiency and level of absolute isolation.

Chapter Five: : Analyzing Procedures Used to Control Contamination and its Impact Upon Cleanrooms (case study)

This chapter analyzes procedures of controlling contamination levels and their impact on the architectural design outcome through three case studies chosen according to previously established framework and research limitations, but also sharing the same production-line type. The case studies are consequently compared and examined against standard specifications to be finally able to decide upon the most suitable architectural solution for diverse technical purposes, hopefully leading to the establishing of general design criteria for cleanrooms later on.

The research ends with a set of conclusions and recommendations focused on the most important design parameters suggested for cleanrooms.

عدد الجزيئات / قدم3									
حجم الجزيئات	≤ 0.1 µ		≤ 0.2 µ		≤ 0.3 µ		≤ 0.5 µ		≤ 5.0 µ	
وحدة قياس الحجم / الدرجة	م3	قدم3	م3	قدم3	م3	قدم3	م3	قدم3	م3	قدم3
M 1	٣٥٠)	9.91	75.7	٢.١٤	30.9	0.875	10	0	0	0
M 1.5	1240	35	265	7.5	106	3	35	1	0	0
M 2	3500	99.1	757	2104	309	8.75	100	3	0	0
M 2.5	12400	350	2650	75.1	1060	30	350	10	0	0
M 3	35000	991	7570	214	3090	87.5	1000	28	0	0
M 3.5	0	0	2650	750	10600	300	3530	100	0	0
M 4	0	0	75700	2140	30900	875	10000	283	0	0
M 4.5	0	0	0	0	0	0	35300	1000	247	7
M 5	0	0	0	0	0	0	100000	2830	618	17.5
M 5.5	0	0	0	0	0	0	353000	10000	2470	70
M 6	0	0	0	0	0	0	1000000	28300	6180	175
M 6.5	0	0	0	0	0	0	3350000	100000	24700	700
M 7	0	0	0	0	0	0	10000000	283000	61800	1750

جدول (٤-١). التصنيف الفيدرالي E ٢٠٩ للغرف النظيفة.

المصدر: (Whyte,W.;"Cleanroom Technology: Fundamentals of Design, Testing and Operation",Wiley&Sons,١٩٩٩.pg.٢٥)

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