An Internship Report

In

“Safeguard Contraceptives Pvt Ltd"

Submitted by

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Under the guidance of

Prof. P. S. Kulkarni

Submitted in partial fulfilment of the requirement for the Degree of

Bachelor of Technology in Mechanical Engineering

Of

Dr. Babasaheb Ambedkar Marathwada University Chhatrapati Sambhajinagar.

Department of Mechanical Engineering

Maharashtra Institute of Technology, Chhatrapati Sambhajinagar

(An Autonomous Institute) Maharashtra, India

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CERTIFICATE

This is certified that the In Plant Training (IPT) Report of

“Safeguard Contraceptives Pvt Ltd"

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For the Academic Year

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ABSTRACT

This internship report provides a comprehensive overview of the experiences and learnings gained during a three-month internship at Safeguard Contraceptives Pvt Ltd, a leading manufacturer of condoms. The report delves into the intricate processes involved in condom production, shedding light on the company's commitment to quality, safety, and operational excellence.

The report begins by introducing Safeguard Contraceptives Pvt Ltd, its history, and its position within the condom manufacturing industry. It then proceeds to detail the various departments and their respective roles, including raw material procurement, compounding, production, packaging, quality assurance, logistics, marketing, and research and development.

Particular emphasis is placed on the production department, where the report meticulously describes the condom manufacturing process, from dipping and curing to lubrication, testing, and packaging. The report highlights the advanced machinery and automated systems employed by the company, ensuring consistent quality and adherence to stringent regulatory standards.

Furthermore, the report examines a critical case study involving the decreased lifecycle of glass Mold tubes used in the dipping process. Through a comprehensive root cause analysis, the report identifies manufacturing defects as the primary contributor to premature Mold failures. It then outlines the company's solution of transitioning to borosilicate glass Mold tubes, renowned for their exceptional thermal shock resistance and durability. The report quantifies the significant operational and cost benefits achieved by implementing this solution, underscoring the company's commitment to continuous improvement.

Overall, this report serves as a valuable resource for understanding the intricacies of the condom manufacturing industry and the best practices employed by a leading player in the field. It offers a unique perspective on the challenges faced and the innovative solutions implemented, contributing to the advancement of knowledge and the continued pursuit of excellence within the industry.

CHAPTER 1

INTRODUCTION

1.a Introduction of SAFEGUARD

Fig: Safeguard Contraceptives private limited

Safeguard Contraceptives Pvt Ltd is a leading company in the field of condom manufacturing and packaging. Established in 2006. The company has been dedicated to providing high-quality contraceptive products to promote safe sexual health practices. Throughout my internship at Safeguard Contraceptives Pvt Ltd, I had the opportunity to gain valuable insights into the processes involved in the production and packaging of condoms, as well as the overall operations of the company.

Safeguard Contraceptives Pvt Ltd, a pioneering force in the realm of sexual wellness, stands as a beacon of innovation and excellence in the healthcare industry. As a mechanical engineer with a passion for precision engineering and manufacturing processes, the opportunity to intern at Safeguard Contraceptives Pvt Ltd offered me a gateway into a world where technology intersects with human health and well-being.

From the outset, Safeguard Contraceptives Pvt Ltd captivated my imagination with its commitment to producing high-quality contraceptive products through state-of-the-art manufacturing techniques. As a mechanical engineer, I was drawn to the intricate machinery, automated systems, and precision engineering that underpin the production and packaging of condoms. The prospect of applying my engineering expertise to optimize processes, improve efficiencies, and uphold quality standards was a challenge I eagerly embraced.

During my internship tenure, which spanned from 28 Jan 2024 to 28 April 2024, I was immersed in a dynamic environment where innovation, collaboration, and continuous improvement were the cornerstones of success. Under the mentorship of seasoned engineers and industry experts, I gained invaluable insights into the complexities of condom manufacturing, from the formulation of latex compounds to the intricacies of packaging design.

As a mechanical engineer, I approached each challenge with a methodical mindset, leveraging problem-solving skills honed through years of academic study and practical experience. Whether it was troubleshooting equipment malfunctions, optimizing production workflows, or implementing quality control measures, I embraced each opportunity to apply my engineering acumen to real-world challenges.

1.b About the Company

- Sahil Kumar Jain Founder of Safeguard Contraceptives Pvt. Ltd. Established in the year 2004 at CH Sambhajinagar Maharashtra, India as a Private Limited Company, Safeguard Contraceptives Pvt. Ltd. is amongst the eminent names in the industry, highly engaged as a manufacturer, supplier and trader of Flavored Condom, Men's Condom, Flavored Dotted Condom & Female Condom.

- Safeguard Contraceptives Pvt. Ltd. is a company that produces and sells condoms in India under various brand names. The company was established in 2006 and has ISO certifications for quality and safety standards. The company aims to provide reliable and affordable condoms for a sustainable and clean-energy future. The company has a modern infrastructure, a skilled team, and a strong supply chain network.

- Safeguard Contraceptives Pvt. Ltd are manufacture condoms for over 100+ different companies named like, Premium, Soft Skin, SKINN, Vision, Black Panther, Touch Me, Love me, WOW, & more.

- Besides being sold pan India, Safeguard Contraceptives Pvt. Ltd have successfully supplied condoms to the government of Sri Lanka, Ghana, Azerbaijan, also exported to Angola, Gambia, Banjul and building globally distributed supply chain

1.c Vision of company

To lead the way in promoting sexual health and well-being by providing innovative and reliable contraceptive solutions.

We envision a world where everyone has access to high-quality, affordable condoms, empowering individuals to make informed choices about their sexual health."

1.d Mission of company

Our mission is to manufacture and distribute condoms of the highest quality, meeting and exceeding international standards for safety and effectiveness.

Through continuous research, development, and collaboration, we aim to innovate our products and processes, ensuring accessibility, affordability, and reliability for all individuals worldwide."

1.e Policies of Safeguard

A) *Safety policy*

SAFEGUARD CONTRACEPTIVES PRIVATE LIMITED, recognizes people as x principal assets and hence safety as its No 1 priority

Safety represents avoidable:

- Personal hardship, pain and agony
- Property damage.
- Regulatory non-compliance.
- Compensations.

Company is committed to safety through:

- Providing safe working conditions.
- Safety training and awareness
- Bund up and implementation of safety standards and practices
- Building accountability responsibility
- Rewards, recognizes and include safety in performance appraisal

All employees are responsible for safety expected to:

- Follow Safety rules and practices.
- To report unsafe working conditions and behaviour.
- Actively Support in company's safety policy.

B) Quality Policy:

SAFEGUARD CONTRACEPTIVES PRIVATE LIMITED Ch Sambhajinagr Manufacturer of Latex Based Male Condoms shall meet the customer requirements by:

- Manufacturer of product that continually meets current regulatory, National & International Standards
- Satisfying the customer needs.
- Delivering right quality on right time
- Compliance of Statutory and Legal requirements

C) Environmental policy

SAFEGUARD CONTRACEPTIVES PRIVATE LIMITED is committed to the safety of our employee's property, surroundings, and the community we live in

- It is the policy of safeguard to manufacture, handle and disposes of all materials in a responsible manner without creating adverse effects to the life and health of our employees, our surroundings and be community.
- Towards this we shall provide the necessary infrastructure for the processing of our waster to be within the local Regulatory Norms before disposal
- We will continue support research on products manufactured or sold by the company for their environmental and health offers a required by law, will share our findings with our employees, customer, governmental agencies rand the scientific community.
- Through an awareness propre, we will encourage employees to adhere to this policy and in become environmentally conscious

CHAPTER 2
ACTUAL PLANT LAYOUT

Safeguard has working manufacturing plant. These plants are as follows:

1. The plant has a Fully Automatic Condom Dipping and Drying Machine as the main production line.

2. There is a Raw Material Section where latex is mixed in a Latex Mixing Unit.

3. The ET Machine Section consists of multiple machines (ET-01, ET-02, ET-03, ET-04, ET-05, ET-06) for various stages of condom production.

4. The plant has four Strainers (MS-01, MS-02, MS-03, MS-04) for filtering and processing the latex.

5. There is a Sealing & Packing Section where the condoms are sealed and packed.

6. The plant has a Manual Packing Table for manual packing operations.

7. There is a Store & Dispatch Section for storing and dispatching the finished products.

8. The plant has a dedicated Cleaning Area for maintaining hygiene.

9. There is a Staff Canteen for the workers.

10. The layout includes an In/Out Door and an Assembly Point, likely for safety and logistics purposes.

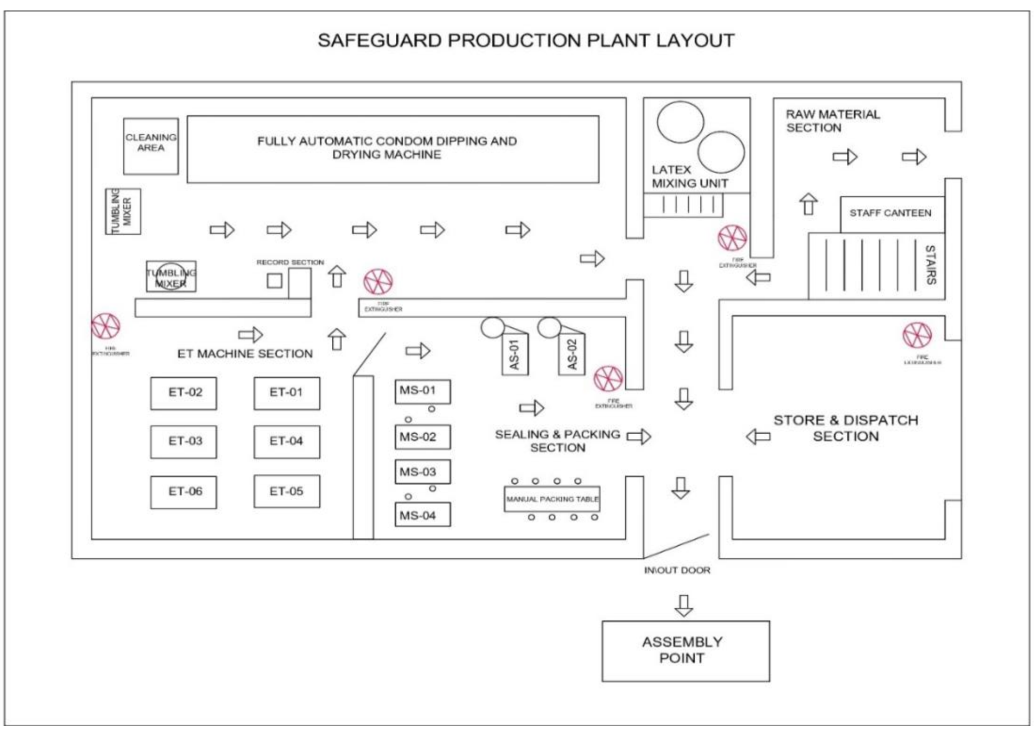


Fig: Plant layout

CHAPTER 3

PRODUCTS VARIETY at SAFEGUARD

1. Male Condoms:

- Description: Male condoms are thin sheaths made from materials such as latex, polyurethane, or polyisoprene. They are designed to be worn over the erect penis during sexual intercourse to prevent pregnancy by blocking the passage of sperm and reduce the risk of sexually transmitted infections (STIs) by creating a barrier between partners.

- Variety: Male condoms come in various sizes, shapes, and textures to accommodate different preferences and needs. They may be lubricated or non-lubricated, and some condoms feature reservoir tips for added safety.

- Usage: Male condoms are typically rolled onto the penis before intercourse and should be used only once. It's essential to follow the instructions provided with the condom for proper usage and disposal.

Fig: male condom

2. Flavoured Condoms:

- Description: Flavoured condoms are designed to add a pleasant taste during oral sex, making the experience more enjoyable for both partners. They are typically made from latex or non-latex materials and are available in a variety of Flavors such as strawberry, banana, chocolate, mint, and more.

- Usage: Flavoured condoms can be used in the same way as regular condoms. They should be rolled onto the penis before oral sex to provide protection against STIs and pregnancy.

- Safety: It's essential to choose flavoured condoms that are safe for internal use and free from harmful ingredients. Water-based lubricants are often used with flavoured condoms to enhance pleasure and reduce the risk of breakage.

Fig: Flavoured condoms

3. Textured Condoms:

- Description: Textured condoms feature raised bumps, ribs, or other textures designed to enhance pleasure for both partners during sexual intercourse. The texture creates additional friction and stimulation, increasing sensation and satisfaction.

- Variety: Textured condoms come in various designs, including ribbed, studded, dotted, or combination textures. Some condoms feature textures along the entire length, while others have textured areas strategically placed for maximum stimulation.

- Usage: Textured condoms are used in the same way as regular condoms. They should be rolled onto the erect penis before intercourse to provide protection and enhance sexual pleasure.

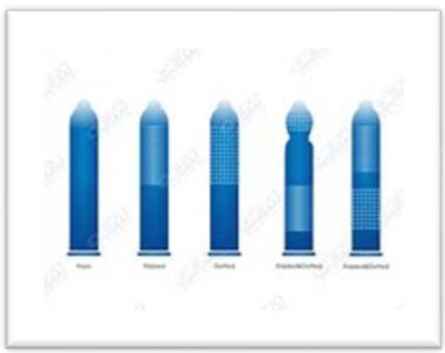


Fig: Textured Condoms

CHAPTER 4

PROCEDURES REQUIRED in PRODUCTION of CONDOMS

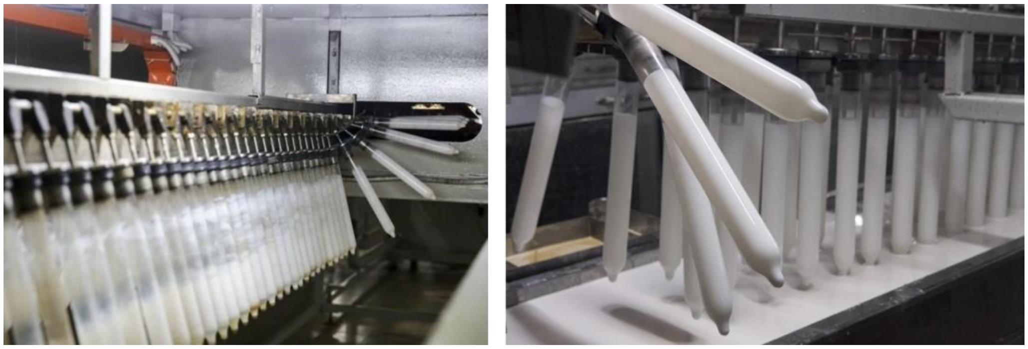


Fig: Mold tubes for dipping in latex

- ✓ *Raw Material:* This involves acquiring and preparing the necessary raw materials, such as natural rubber latex, lubricants, and any other additives or ingredients required for condom production.

- ✓ *Compounding:* In this step, the raw materials are carefully measured and mixed together to create the latex compound that will be used for dipping. The compounding process ensures consistency and uniformity in the latex mixture. The mixing is done in latex mixture.

- ✓ *Heating:* Before the dipping process, the Molds or formers used for shaping the condoms are heated to a specific temperature. This step prepares the Molds for the latex dipping process.

- ✓ *Dipping:* The heated Molds are dipped into the latex compound mixture, forming the initial shape and thickness of the condoms. This step may involve multiple dips, depending on the desired thickness and type of condom being produced.

- ✓ *Stick:* After the dipping process, the latex-coated Molds undergo a "sticking" process, where the condoms are carefully removed from the Molds and inspected for any defects or irregularities.

- ✓ *Dipping:* Depending on the type of condom being produced, the condoms may undergo an additional dipping process. This second dipping can be used to apply lubricants, spermicides, or other coatings on the inner or outer surface of the condom.

- ✓ *Latching:* In this step, the condoms are rolled and unrolled to ensure proper lubrication and prevent the condom surfaces from sticking together.

- ✓ *Stripping:* The condoms are carefully removed from the Molds or formers in a process called "stripping." This step separates the condoms from the Molds, allowing them to be further processed.

- ✓ *Powdering*: After stripping, the condoms are dusted with a lubricating powder, typically made from corn starch or other approved materials, to prevent sticking and aid in donning.
- ✓ *Hydro*: This could refer to a hydration or wetting process, where the condoms may be exposed to water or a liquid solution for a specific purpose, such as lubrication or quality testing.

- ✓ *Tumbling*: The condoms are tumbled or agitated to remove any excess powder or lubricant and ensure uniform distribution of coatings in Tumbling machine.

- ✓ *Electronic* Testing: The condoms undergo electronic testing, often referred to as "SETA" (Safety Electronic Test Analysis), to detect any holes, defects, or weak spots in the latex. This is a critical quality control measure.

- ✓ *Sealing*: The condoms that pass the quality tests are sealed into individual packaging or foil pouches to maintain their integrity and freshness.

- ✓ *Packaging*: The sealed condoms are packaged into larger batches or cartons, labelled with necessary information, and prepared for distribution.

- ✓ *Dispatch*: The final packaged condoms are dispatched or shipped to their respective destinations, such as distributors, retailers, or customers.

4.a) Specification of Condom dipping machine

Production Line Size	**Length 65m×Width 3m× Height 4.5m or Customized**
Production Capacity	200000 pcs/24hr or Customized
Number of Installed Molds	2045 pcs
Chain Length of Production Line	215M
Mold Spacing	60mm
Chain Speed	0-10m/min
Voltage	380V, 50HZ
Drive Motor Power	3*2.2Kw
Power Consumption	70KW
Water Consumption	6Tonn/hr

Heat Energy Consumption (steam)	1Tonn/hr

CHAPTER 5
MACHINARIES at SAFEGUARD

Process	Machinery used	No. of units	Make
Condom dipping	**Full Automatic Condom Dipping Machine**	**01**	**Dermi latex machinery (Ahmedabad)**
Condom drying	**Full Automatic Condom Dipping & drying Machine**	**01**	**Dermi latex machinery (Ahmedabad)**
Condom cleaning mixer	**Industrial products cleaning mixer**	**01**	**Verito engineering**
Testing, lubrication & wrapping	**Lubrication & wrapper**	**04**	**Shree Engineering**
Sealing & packing	**Automatic Condom Packing Machine**	**02**	**Sed Pharma**
Sealing & packing	**Manual Condom Packing Machine**	**05**	**Shree Engineering**
Latex mixer	**Latex making machine**	**2**	**YG machinery**

Fig: Latex mixture

5.a) Latex Mixture

A latex mixer is a crucial piece of equipment used in the process of mixing latex, particularly in industries like condom manufacturing. Here's some information about latex mixers and their role in the latex mixing process:

1. Purpose:

Latex mixers are used to blend various ingredients together to create latex compounds with specific properties suitable for different applications. In condom manufacturing, the latex mixer is used to mix natural rubber latex with other additives and chemicals to create the condom material.

2.Components:

Latex mixers typically consist of a mixing chamber, agitators or mixing blades, motor, controls, and sometimes heating/cooling systems.

The mixing chamber is where the latex and other ingredients are combined and blended together. Agitators or mixing blades are responsible for mixing the latex and additives thoroughly to ensure uniform distribution and consistency. The motor provides the power to rotate the mixing blades and agitate the latex mixture.

Controls allow operators to adjust mixing speed, temperature, and other parameters as needed.

3. Mixing Process:

The process begins by loading the required amount of latex and additives into the mixing chamber.

The mixer is started, and the agitators or mixing blades rotate to thoroughly mix the ingredients.

Depending on the specific formulation and requirements, the mixing process may involve different speeds, mixing times, and temperature controls. The goal is to achieve a homogeneous mixture with consistent properties.

5.b) Mold Dipping Machine:

Fig: Mold dipping machine

- *Function:* The Mold dipping machine is designed to precisely control the dipping of Molds or formers into the latex compound mixture. It ensures consistent and uniform coating of the latex on the Molds, which ultimately determines the thickness and quality of the condoms produced.

- *Operation:* The machine typically consists of a tank or vat containing the latex compound mixture, and a mechanical arm or system that dips the Molds into the mixture at a controlled speed and depth. The dipping process can be automated or semi-automated, depending on the machine's complexity.

- *Programmability:* Advanced Mold dipping machines may be programmable, allowing operators to set specific parameters such as dipping speed, dwell time (time the Mold remains submerged), and number of dips required for different condom types or specifications.

- *Mold Handling:* The machine is equipped with a system to securely hold and manoeuvre the Molds during the dipping process, ensuring precise and consistent dipping angles and depths.

5.c) Testing, Lubrication & Wrapping

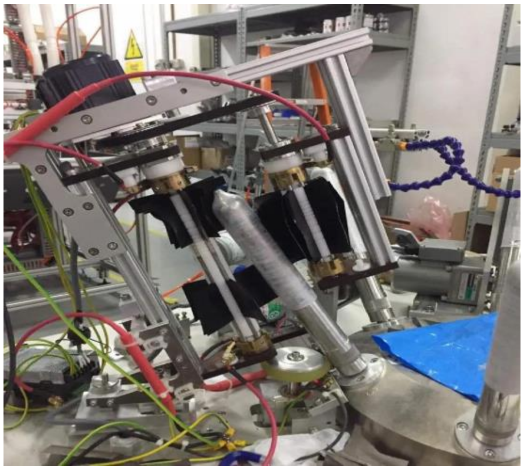


Fig: Testing & lubrication

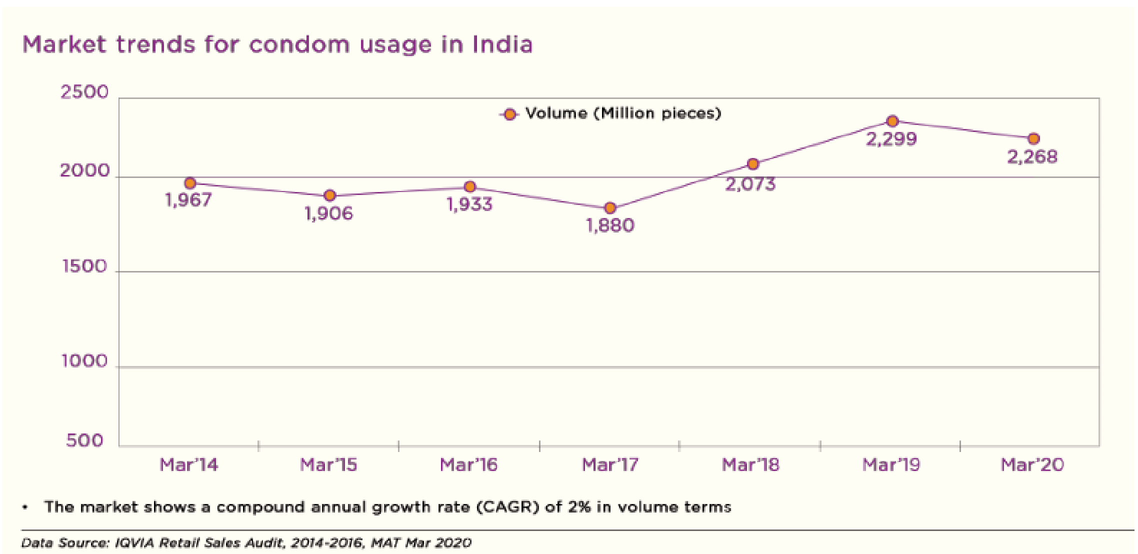
Fig: Sealing & Packaging

The machine is a remarkable feat of engineering, designed to streamline and accurately execute multiple crucial processes, ensuring the highest quality and consistency of the final condom products.

- *Lubrication Application:* One of the key functions of this system is the precise application of lubricants onto the condoms. The machine features a series of nozzles and applicators that evenly distribute the lubricating substances onto the condom surface. Proper lubrication is essential for user comfort and reducing friction during use.

- *Integrity Testing:* Integrated into the system are various testing mechanisms that rigorously assess the structural integrity of each condom. These tests include inflation stations, where condoms are inflated to specific pressures to detect any holes, tears, or weak points in the latex material. Additionally, advanced electrical testing methods are employed to identify even the smallest defects or irregularities.

- *Wrapping and Packaging:* Once the lubrication and testing processes are complete, the machine seamlessly transitions to wrapping and packaging the approved condoms. This involves carefully enclosing each condom in individual foil or plastic pouches, ensuring they are properly sealed and protected for distribution and storage.



CHAPTER 6

PROBLEM STATEMENT

The glass Mold tubes used in the condom dipping process at the facility were experiencing a significantly reduced lifecycle, leading to frequent failures and replacements. This issue caused production disruptions, increased operational costs, and potential quality concerns.

6.a) Root Cause Analysis:

1. Manufacturing Defects:

- The primary root cause identified was manufacturing defects in the glass Mold tubes.

- Defects such as inconsistencies in material composition, variations in wall thickness, or impurities could lead to weaker structural integrity and increased susceptibility to cracking or breakage under the high temperatures and mechanical stress of the dipping process.

2. Material Composition:

- The glass material used for the Mold tubes may not have been optimized for the specific operating conditions of the dipping process.

- Factors like thermal shock resistance, chemical resistance, and strength properties could have contributed to the reduced lifecycle.

3. Thermal Stress:

- The dipping process involves heating the Mold tubes to a temperature of 15°C, which could induce thermal stress on the glass material.

- Repeated heating and cooling cycles during production could cause microscopic cracks to propagate over time, eventually leading to failure.

5. Cleaning and Handling Procedures:

- While the facility used only water for cleaning the Mold tubes, improper handling or cleaning techniques could potentially introduce surface scratches or defects, creating potential stress points for cracking or breakage.

6.b) Impact Analysis:

1. Production Disruptions:

- Frequent Mold tube failures led to unplanned production stoppages, resulting in significant downtime and reduced output.

- This impacted the facility's ability to meet customer demand and delivery timelines.

2. Increased Operational Costs:

- The need for frequent Mold tube replacements incurred substantial material and procurement costs.

- Additional labour costs were associated with the replacement process and any necessary cleanup or maintenance activities.

3. Quality Concerns:

- Broken Mold tube fragments could potentially contaminate the latex compound or become embedded in the condoms, compromising product quality and safety.

- This could lead to increased quality control rejections, customer complaints, and potential liability issues.

4. Safety Risks:

- Handling and disposing of broken glass Mold tubes posed potential safety hazards for workers, requiring additional protective measures and training.

CHAPTER 7

Case Study: Enhancing Condom Manufacturing Efficiency with Borosilicate Glass Mold Tubes - A Case Study for Safeguard Contraceptives Pvt Ltd

7.a) Introduction:

Safeguard Contraceptives Pvt Ltd, a leading manufacturer of condoms, prioritizes product quality, efficiency, and innovation in its manufacturing processes. To maintain its competitive edge in the market, Safeguard aims to optimize its condom manufacturing process by evaluating the potential benefits of using borosilicate glass Mold tubes in its dipping machines.

7.b) Background:

Safeguard currently utilizes standard glass Mold tubes in its condom manufacturing dipping machines. While these tubes have been effective to a certain extent, the company faces challenges related to thermal stress, breakage, and occasional product defects during the dipping process. Recognizing the importance of addressing these issues, Safeguard explores the feasibility of upgrading to borosilicate glass Mold tubes.

7.c) Objectives:

- *Performance Evaluation:* Conduct a assessment to evaluate the performance and suitability of borosilicate glass Mold tubes compared to standard glass tubes currently employed in Safeguard's condom manufacturing dipping machines.

- *Quality Improvement:* Determine the potential impact of transitioning to borosilicate glass Mold tubes on enhancing product quality, reducing defects, and ensuring the consistency and reliability of condom manufacturing processes.

- *Operational Efficiency*: Analyse the effect of utilizing borosilicate glass Mold tubes on improving operational efficiency, including throughput, uptime, and overall equipment reliability, to streamline production processes and meet demand requirements effectively.

- *Cost-Benefit Analysis:* Perform a thorough cost-benefit analysis to assess the financial implications of upgrading to borosilicate glass Mold tubes, considering factors such as upfront investment, maintenance costs, downtime reduction, and long-term savings to determine the economic viability of the transition.

7.d) Impact on Operations:

1. <u>Production Delays:</u> Each time a glass Mold broke, the entire production line had to be halted, resulting in significant delays and decreased output. This affected the company's ability to meet customer demand and delivery timelines.
2. <u>Increased Costs:</u> The frequent replacement of broken glass Molds led to substantial material and procurement costs, straining the company's operational budget.
3. <u>Quality Concerns:</u> Broken Mold fragments posed a potential quality risk, as they could contaminate the latex compound or become embedded in the condoms, compromising product safety and integrity.
4. <u>Safety Risks:</u> The handling and disposal of broken glass Molds presented safety hazards for workers, requiring additional protective measures and training.

7.e) Root Cause Analysis: To address the issue, Safeguard Contraceptives formed a cross-functional team to investigate the root causes of the decreased production lifecycle of the glass Molds. The team's findings included:

- <u>Material Composition:</u> The composition and quality of the glass used in the Molds were not optimal, leading to increased brittleness and susceptibility to cracking or breakage under the high temperatures and mechanical stress of the dipping process.
- <u>Thermal Cycling:</u> The repeated heating and cooling cycles during the dipping process subjected the glass Molds to significant thermal stress, causing microscopic cracks to propagate over time, eventually leading to failure.
- <u>Cleaning and Handling:</u> Improper cleaning methods and handling procedures contributed to surface scratches and defects on the glass Molds, creating potential stress points for cracking.
- <u>Manufacturing Defects:</u> Inconsistencies in the manufacturing process of the glass Molds led to variations in wall thickness, resulting in uneven heat distribution and increased susceptibility to breakage.

7.f) I Standard Glass Mold Tubes:

- <u>Material Composition:</u> Standard glass Mold tubes are typically made from soda-lime glass, which is less expensive compared to borosilicate glass. However, soda-lime glass is more prone to thermal expansion and contraction, which may lead to cracking or breakage during the manufacturing process.
- <u>Thermal Properties:</u> Soda-lime glass has lower thermal resistance compared to borosilicate glass. This means it may not withstand rapid temperature changes as effectively, potentially leading to issues such as thermal shock during the dipping process.
- <u>Durability and Lifespan:</u> Due to its lower resistance to thermal stress, standard glass Mold tubes may have a shorter lifespan and require more frequent replacement, contributing to higher maintenance costs over time.
- <u>Chemical Resistance:</u> Soda-lime glass is generally more susceptible to chemical corrosion compared to borosilicate glass. This may be a concern if the dipping process involve aggressive chemicals or cleaning agents.

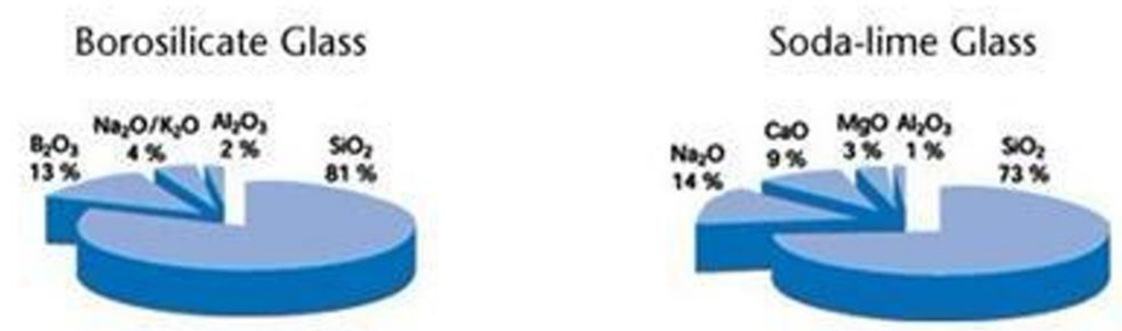


Fig: Chemical compositions of borosilicate and glass Mold

7.f) II Borosilicate Glass Mold Tubes:

Material Composition: Borosilicate glass, known for its superior thermal and chemical resistance, is the primary alternative to standard glass in industrial applications. It contains boron trioxide, which gives it unique properties such as low coefficient of thermal expansion.

Thermal Properties: Borosilicate glass exhibits exceptional thermal shock resistance, making it highly suitable for applications involving rapid temperature variations, such as the condom dipping process. This property can contribute to smoother operations and reduced downtime.

Durability and Lifespan: Borosilicate glass Mold tubes tend to have a longer lifespan compared to standard glass tubes due to their ability to withstand thermal stress and chemical exposure better. This translates to lower maintenance costs and improved overall equipment reliability.

Cost Considerations: While borosilicate glass is more expensive upfront compared to soda-lime glass, its longer lifespan and reduced maintenance requirements can result in cost savings over the equipment's lifecycle.

7.g) Comparison: Standard glass Molds and Borosilicate Molds:

I Standard Glass Mold Tubes:

Average Lifespan of glass Mold tubes	12-14 months
No of Molds installed on dipping machine	2045Molds
Latex temperature in dip tank	15`C
No of products Manufacture in a day	2lakh products in 24 hours
No of products Manufacture in an hour	8.3k products in 1 hour
Advantage	Low in cost
Disadvantage	lower thermal resistance and may experience thermal shock, leading to breakage and downtime.

II Borosilicate Glass Mold Tubes:

Average Lifespan of Borosilicate Mold tubes	16-18 months
No of Molds installed on dipping machine	2045Molds
Latex temperature in dip tank	15`C
No of products Manufacture in a day	2lakh products in 24 hours
No of products Manufacture in an hour	8.3k products in 1 hour
Advantage	Lifespan is high, superior thermal and chemical resistance,
Disadvantage	High in cost

7.h) Literature:

I History

History and Evolution:

Glass Mold tubes have been an integral part of the condom manufacturing process for decades, as they provide a suitable surface for dipping and shaping the latex condom material. The use of glass Molds can be traced back to the early 20th century when condoms were first mass-produced using a dipping process.

Initially, conventional soda-lime glass was used for manufacturing Mold tubes due to its affordability and availability. However, as the industry evolved and quality standards became more stringent, the limitations of soda-lime glass became evident, particularly in terms of its thermal shock resistance and susceptibility to cracking or breakage under the high temperatures and mechanical stresses involved in the dipping process.

In the 1960s, borosilicate glass emerged as a superior alternative for condom Mold tubes. Borosilicate glass, also known as heat-resistant glass, is a type of glass with a unique composition that includes silica, boric oxide, and other oxides like sodium oxide and aluminium oxide. This composition gives borosilicate glass exceptional thermal shock resistance, making it an ideal material for applications involving high temperatures and rapid temperature changes.

Composition and Properties:

The typical composition of borosilicate glass used for condom Mold tubes is approximately:

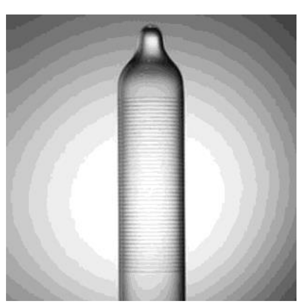
- Silica (SiO_2): 80%

- Boric Oxide (B_2O_3): 13%

- Sodium Oxide (Na_2O) or Potassium Oxide (K_2O): 4%

- Aluminium Oxide (Al_2O_3): 2-3%

Fig: Standard Glass Mold Tube



Technical Information: Borosilicate Glass Properties

Unless otherwise specified all Wilmad-LabGlass technical glassware meets ASTM specification E438 for Type 1, Class A Borosilicate Glass. Glassware is manufactured from PYREX® Glass Code 7740 or equivalent.

Major Physical Characteristics	**Type 1, Class A**	**PYREX®**
Linear Coefficient of Expansion	32-33 x 10^{-7}cm/cm°C	32.5 x 10^{-7}cm/cm°C
Strain Point		510°C
Annealing Point	560°C±10°C	560°C
Softening Point	815-820°C±10°C	821°C
Density, Annealed	2.23-2.24±0.02g/cm³	2.23g/cm³
Refractive Index		1.474 @ Sodium D Line
Temperature Limits		490°C / 230°C**
Maximum Thermal Shock		160°C

** Extreme Service / Normal Service

Chemical Compound	**Type 1, Class A**	**PYREX®**
SiO_2	81%	80.6%
B_2O_3	13%	13.0%
Na_2O	4%	4.0%
Al_2O_3	2%	2.3%

This unique composition imparts several desirable properties to borosilicate glass, including:

1. Thermal Shock Resistance: Borosilicate glass can withstand extreme temperature changes without cracking or breaking, making it suitable for the heating and cooling cycles involved in the condom dipping process.

2. High Heat Resistance: Borosilicate glass has a higher melting point and can withstand higher temperatures compared to soda-lime glass, allowing for more efficient dipping and curing processes.

3. Chemical Resistance: The glass is resistant to chemical attack and corrosion, ensuring its durability and longevity in the manufacturing environment.

4. Mechanical Strength: Borosilicate glass exhibits superior mechanical strength and is less prone to scratches or surface defects, which can act as stress points for cracks or breakage.

II Manufacturing Process:

Borosilicate glass Mold tubes are typically manufactured using specialized glassblowing techniques or extrusion processes. The manufacturing process involves melting the glass raw materials at high temperatures and then forming the glass into the desired Mold tube shape and dimensions.

Precise temperature control and annealing processes are crucial to ensure the glass Mold tubes have uniform wall thickness, consistent material properties, and minimal residual stresses that could lead to premature failure.

III Quality Control and Inspection:

Due to the critical role of Mold tubes in the condom manufacturing process, stringent quality control measures are implemented during their production and inspection. These measures may include:

1. Dimensional Inspections: Verifying the Mold tube's dimensions, including length, diameter, and wall thickness, to ensure compliance with specifications.

2. Surface Inspection: Conducting visual and microscopic inspections to detect any surface defects, scratches, or imperfections that could compromise the Mold's performance.

3. Material Testing: Performing material tests, such as composition analysis, thermal shock resistance tests, and mechanical strength tests, to ensure the borosilicate glass meets the required standards.

7.i) Case Study Analysis:

Material Composition and Properties:

Standard Glass Mold Tubes: Safeguard currently utilizes soda-lime glass Mold tubes, which are cost-effective but prone to thermal stress and breakage.

Borosilicate Glass Mold Tubes: Borosilicate glass offers superior thermal and chemical resistance, making it an ideal alternative for demanding industrial applications.

Thermal Properties and Durability:

Standard Glass: Soda-lime glass tubes have lower thermal resistance and may experience thermal shock, leading to breakage and downtime.

Borosilicate Glass: Borosilicate glass exhibits exceptional thermal shock resistance, enhancing durability and minimizing the risk of breakage during the dipping process.

Operational Efficiency and Product Quality:

Standard Glass: Thermal stress and breakage issues with standard glass tubes can result in production interruptions, affecting operational efficiency and product quality.

Borosilicate Glass: The thermal stability of borosilicate glass contributes to smoother operations, higher throughput, and improved product quality by minimizing defects and impurities.

Cost Considerations:

Initial Investment: Borosilicate glass Mold tubes entail a higher upfront cost compared to standard glass tubes.

Long-Term Cost Savings: However, the longer lifespan and reduced maintenance requirements of borosilicate glass can result in significant cost savings over the equipment's lifecycle, enhancing overall cost-effectiveness.

Fig: Borosilicate Glass Mold

7.j) Conclusion

1. The decreased lifecycle of the glass Mold tubes used in the condom dipping process at our facility posed significant challenges, leading to frequent Mold replacements, production disruptions, and increased operational costs. Through a comprehensive investigation, it was determined that manufacturing defects played a crucial role in the premature failure of the Mold tubes.

2. To address this issue, a strategic decision was made to transition to borosilicate glass Mold tubes, renowned for their exceptional thermal shock resistance and durability. Borosilicate glass, with its unique composition consisting of approximately 80% silica, 13% boric oxide, 4% sodium or potassium oxide, and 2-3% aluminium oxide, offered superior properties compared to the previously used glass material.

3. While no changes were made to the dipping process parameters, cleaning/handling procedures, or quality control measures, the implementation of borosilicate glass Mold tubes yielded remarkable results. Despite operating under the same dipping temperature of 15°C and with 2,045 Mold tubes installed on the dipping machine, the lifecycle of the Mold tubes experienced a significant increase.

4. The use of borosilicate glass Mold tubes not only extended their lifespan but also contributed to cost savings by reducing the frequency of Mold replacements and minimizing production losses associated with downtime. Additionally, the improved Mold performance ensured consistent product quality and maintained operational efficiency, enabling our facility to meet customer demands reliably.

8. REFERANCES

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