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# A Discussion on the Selection and Operation Maintenance of Chemical Equipment

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**Abstract:** The selection and maintenance of chemical equipment are key links in ensuring safe, efficient, and economical chemical production. This paper discusses equipment selection and maintenance. In terms of selection, the principles of safety, applicability, reliability, economy, and advancement should be followed, considering factors such as production process, scale, site conditions, energy supply, and environmental protection requirements. Equipment selection is completed through demand analysis, market research, technical evaluation, economic analysis, and procurement decision-making. For operation and maintenance, the focus is on daily inspection, preventive maintenance, fault diagnosis and handling, spare parts management, and personnel training to improve equipment reliability and service life. The study aims to provide systematic reference for equipment management in chemical enterprises and ensure production stability and sustainability.

**Keywords:** Chemical equipment; Selection; Operation maintenance; Discussion

## 1. Introduction

In the chemical industry, equipment is the material foundation of production processes. The rationality of equipment selection and the effectiveness of maintenance directly affect production efficiency, safety, environmental protection, and economic benefits. With the increasing complexity of chemical processes and stricter environmental standards, equipment selection must meet process requirements while balancing safety, economy, and technological advancement. Operation and maintenance require scientific management to reduce failure risks and extend service life. At present, some enterprises frequently experience production interruptions and safety incidents due to improper equipment selection or insufficient maintenance, highlighting the necessity of systematically studying equipment selection and maintenance systems. This paper analyzes selection principles, influencing factors, strategies, and key maintenance activities to provide theoretical and practical guidance for full lifecycle management of chemical equipment.

## 2. Principles of Chemical Equipment Selection

### 2.1 Safety Principle

Chemical production often involves flammable, explosive, toxic, and hazardous chemicals; therefore, safety is the primary consideration in equipment selection. Equipment must be equipped with safety protection devices such as pressure relief valves, explosion-proof structures, and leakage alarm systems to prevent accidents caused by overpressure or leakage. The material of construction must resist corrosion by process media to avoid leaks due to material failure.

Additionally, operational safety in use and maintenance should be ensured through reasonable layout and sufficient workspace, preventing risks to personnel and ensuring safe and stable operation.

### 2.2 Applicability Principle

Applicability requires that equipment match the specific needs of the chemical process. Different processes have different requirements regarding function, performance parameters, and operating conditions. For example, the volume and stirring type of reactors must match the material characteristics, and the heat transfer area and material of heat exchangers must meet heat transfer requirements. Equipment size and specifications must align with the production flow to ensure smooth material transfer and avoid inefficiencies or quality issues.

### 2.3 Reliability Principle

Reliability is essential for long-term stable operation. Selection should consider manufacturing quality, component durability, and resistance to interference. Mature and advanced equipment should be prioritized to avoid frequent failures and downtime. Equipment design should ensure structural stability under complex operating conditions. Maintainability must also be considered—equipment should be easy to disassemble and repair to minimize downtime and reduce production losses.

### 2.4 Economy Principle

Economy requires balancing procurement cost, operating cost, and maintenance cost while meeting production needs. Procurement should compare prices among brands and models to avoid excessive investment. Operating costs should consider energy consumption, and maintenance costs depend on maintenance frequency and spare parts. Through lifecycle cost analysis, enterprises can optimize investment-return balance and enhance economic efficiency.

### 2.5 Advancement Principle

With rapid technological development, equipment selection should consider technological advancement. Advanced equipment offers higher automation, better production efficiency, and more precise quality control. It also provides advantages in environmental protection and intelligent management, helping enterprises meet stricter regulations. Although advanced equipment may involve higher initial investment, long-term benefits in efficiency and cost savings justify the choice[1].

## 3. Factors Influencing Chemical Equipment Selection

### 3.1 Process Requirements

The production process is the core basis for equipment selection. Different processes determine equipment types, functions, and parameters. For example, polymerization requires precise temperature control and agitation, while distillation requires specific tray structures and separation efficiency. Material properties and operating conditions (pressure, temperature, pH) also determine material selection and sealing methods.

### 3.2 Production Scale

Production scale influences equipment size and quantity. Large-scale production requires high-capacity, automated equipment to improve efficiency and reduce cost per unit. Small-scale production is more suited to flexible and compact equipment. Production capacity must match market demand to avoid both undercapacity and idle investment.

### 3.3 Site Conditions

Site constraints such as space, height, terrain, and load capacity affect equipment size and layout. Narrow spaces may require horizontal rather than vertical equipment. Locations with extreme climates must consider heat dissipation or moisture protection. Site factors directly determine feasible installation and operating conditions.

### 3.4 Energy Supply

Energy type, stability, and cost affect equipment selection. Equipment requiring stable electricity, steam, or compressed air must align with available resources. Energy-efficient equipment should be prioritized to reduce long-term operating costs.

### 3.5 Environmental Protection Requirements

Strict environmental policies require equipment that minimizes emissions of waste gas, wastewater, and solid waste. Low-leakage sealing, high-efficiency purification devices, noise reduction, and recyclability must be considered. Non-compliance may result in penalties or shutdowns[2].

## 4. Strategies for Chemical Equipment Selection

### 4.1 Demand Analysis

Demand analysis identifies process requirements and

equipment performance parameters. Collaboration among process, production, and safety departments ensures accurate equipment positioning and specification definition. Consideration of future expansion and modularity ensures long-term adaptability.

### 4.2 Market Research

Market research gathers information on suppliers, technical features, and user feedback. Site visits, exhibitions, and expert consultations help evaluate equipment performance in real applications. Monitoring industry trends ensures updated knowledge of emerging technologies.

### 4.3 Technical Evaluation

Technical evaluation verifies whether candidate equipment meets process requirements. Key considerations include automation level, safety features, stability, ease of operation, and maintainability. Equipment with advanced but mature technology should be preferred.

### 4.4 Economic Analysis

Economic analysis optimizes lifecycle cost. It assesses procurement, installation, operating energy consumption, maintenance, and disposal costs. Equipment with higher initial cost but lower long-term operating expense may provide better overall value.

### 4.5 Decision-Making and Procurement

A cross-department decision committee should evaluate all data and select the optimal equipment. Procurement contracts must specify technical parameters, delivery dates, service terms, and warranty provisions. Strict acceptance procedures ensure equipment meets requirements[3].

## 5. Key Aspects of Chemical Equipment Operation and Maintenance

### 5.1 Daily Inspection

Daily inspection forms the first line of defense. Standardized inspection lists should include temperature, pressure, vibration, sealing, lubrication, and appearance checks. High-risk equipment requires more frequent monitoring and record keeping for early problem detection.

### 5.2 Preventive Maintenance

Preventive maintenance relies on operating data to preempt failures. It includes regular replacement of worn parts, calibration, filter cleaning, and lubrication. Advanced monitoring methods such as vibration analysis, oil analysis, and infrared thermography can predict equipment condition and optimize maintenance cycles.

### 5.3 Fault Diagnosis and Handling

When faults occur, rapid diagnosis is essential. Techniques such as fault tree analysis, expert systems, and online monitoring help identify root causes. Remote diagnostics can assist in complex cases. Repair should follow standardized procedures, and failure cases should be archived for continuous improvement.

### 5.4 Spare Parts Management

Effective spare parts management reduces downtime. Inventory should consider equipment importance, failure probability, and procurement lead time. Key spare parts require safety stock, while general parts can use shared procurement or vendor consignment. Information systems can track inventory and consumption.

### 5.5 Personnel Training

Personnel training ensures high-quality maintenance. Operators and maintenance workers need tailored training programs including theoretical knowledge, practical skills, and safety protocols. Regular skills updates help staff adapt to new technologies and equipment[4].

## 6. Conclusion

Equipment selection and operation maintenance are central to achieving safe, efficient, and sustainable chemical production. Selection should follow principles of safety, applicability, reliability, economy, and advancement, while considering process, scale, and environmental factors. Maintenance depends on daily inspection, preventive maintenance, fault handling, spare parts management, and personnel training. The two aspects complement each other. As the industry moves toward intelligent and green production, enterprises must continuously optimize equipment management and adopt new technologies to meet increasingly complex production and environmental challenges, promoting high-quality development of the chemical industry.

## References

[1] Wang, Q., Zhang, Z., & Zhang, X. (2011).

Analysis on the optimization and innovation of chemical equipment maintenance and overhaul. *Chemical Management*, (36), 160–162.

[2] Liu, C. (2013). Application of condition monitoring and fault diagnosis technology in chemical equipment maintenance. *China Petroleum and Chemical Standards & Quality*, (13), 220.

[3] Miao, H., & Li, Z. (2011). Construction and engineering application of chemical equipment maintenance expert system based on EAM. *China Equipment Engineering*, (10), 276–277.

[4] Liu, W. (2011). Application of condition monitoring and fault diagnosis technology in chemical equipment maintenance. *Value Engineering*, 30(17), 243.