

Natubhai V. Patel College of Pure & Applied Sciences

S. Y. B.Sc. (Industrial chemistry)

C-214: Chemical Process Industries

UNIT – 6B

Syllabus

Quality control: Quality control of products, concept of quality, important of quality, quality decision, quality management, quality cost, quality assurance, reliability, ISO 9001: 2000

QUALITY, QUALITY ASSURANCE, RELIABILITY AND ISO 9001:2000

6.14 INTRODUCTION

Quality Meaning: Generally, it can be said that a product is of satisfactory **quality**, if it **satisfies the customer**. The customer will buy a product or service, only if it meets his or her minimum needs. Thus customer's satisfaction is the main criteria.

Definition: Quality is an asset which may be offered to the potential customer of a product or service.

In certain cases, these **quality characteristics** can be **measured** easily against some numerical scale e.g., weight of biscuits in each packet in grams, length and width in meters, diameter of ball-bearing in millimeters, speed in kilometers, quantity in numbers etc.

Sometimes it becomes **impossible to measure** the quality characteristics against some numerical scale. One can say that a product or service is good or bad e.g. a purchaser of a scooter can correctly measure the fuel consumption per kilometer or total kilometers per liter of petrol but he or she cannot measure paint finish or the appearance of a scooter. He or she can only say that it is good or bad. Here the measurement or say the assessment of a quality becomes more difficult. It depends on the person making a decision.

Now to most of the people, **quality means high quality**. Actually it is not so. Generally, the customers want the **best quality** they can get for the **money** they are willing to **spend**. It does not mean that they want only the very best. The commitment made to the customer must be honored. When we say 20 carats, no one expects us to deliver 40 carats. But we must deliver 20 carats consistently.

6.15 TWO ASPECTS OF QUALITY

The first is called **quality of design** and the second, **quality of conformance**.

The degree of excellence of the design as related to the customer's requirement is called **quality of design**.

The measure of fidelity with which the product is taken at the point of acceptance confirms to the design is called the **quality of conformance**.

Some of the quality characteristics (properties or specifications) are acquired by a product at the design and development stage. Properties acquired by a product at this stage depend on the type of materials used, method of production safety factors knowledge and skill of the design, personnel employed etc. Quality of design refers to these specifications.

To provide a customer with a good quality product or service, quality of design is a fundamental prerequisite. Production function has the job to produce it according to specifications. The success with which this is achieved is called quality of conformance. A finished product or service must meet the design specification or say, must conform to the quality of design.

6.16 COST OF QUALITY (COQ)

To decide an **acceptable cost of quality**, we consider the **value** offered by the **finished product**. While increasing the quality of the product, we tend to increase its cost, but the value added to the final product tends to grow less rapidly. Consider the following graph.

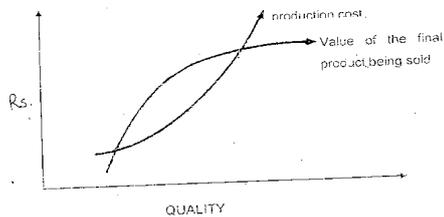


Figure: Cost and value of Quality

We would rather have a level of quality at which the value of the product exceeds its production cost. While ascertaining the cost of quality, we have achieved a trade-off between the losses on account of defects and the cost of inspection and quality control.

We are interested in increasing the value of the ratio, R, given by,

$$R = \text{Quality} / \text{Cost}$$

6.16.1 Cost are classified in three categories

1. **Prevention costs** help us in preventing flaws and defects, creating stable designs, educating workers and investing in preventive maintenance.
2. **Appraisal costs** consist of expenses on measuring the level of quality through testing, sampling etc.
3. **Failure costs** arise from re-working, rejections, machine downtimes, worker downtime, replacements, warranties given to the customer after sale etc. **Failure costs** are of **two types**.

Internal failure costs are generated before a product is dispatched as a result of non-performance to requirements.

External failure costs are generated after the product is dispatched as a result of non-conformance to requirements.

Quality is measured in terms of cost. There are **two dimensions of quality costs: positive and negative**.

Positive costs

These costs are attributed to having to spell out optimum quality right from procurement of raw materials to the delivery of the finished product to the final customer. The positive costs should **not exceed 6%** of total turnover.

Negative costs

It fall in **three categories**

- Costs attributable to defects creeping in the manufacturing process.
- Costs due to rectification of defects like after-sales service costs.
- Costs on account of rejection of a consignment by a customer for substandard quality goods, especially by an importer.

6.17 ECONOMICS OF QUALITY (QUALITY COST)

A manufacturer of a quality product can certainly earn the expected profit and can hold a big share of the market. Today **each manufacturer** is required to give **great importance** to the **quality factor** because there are many manufacture of the same type of products.

Now the **level of quality** is the **mirror for a manufacturer**, which reflects the design of the product, skill of the manpower employed, type of equipment, tools and machinery in use, amount of testing and inspection done.

High level of quality reflects lower proportion or small number of defectives products, high skill level of manpower, use of standard equipment and tools and better machinery, existence of effective resting and inspection methods etc.

Good quality ensures higher profitability, creates goodwill and makes the employment of highly skilled manpower with better wages possible

Poor quality or high proportion of defectives products results in the extra cost to a producer/manufacture/supplier.

6.18 HOW DOES A MANUFACTURER DECIDE THE QUALITY?

The assessment or the study of **customer's, needs** is generally made by the **marketing department** in terms of quality, quantity price. This information is provided to the **design engineering department** of a firm. On the basis of such information a **committee** consisting of **representatives of various concerned departments**, headed by a **design engineer** prepares detailed specifications of the product planned for production.

Now the design process is a **continuous process** because with the change in customer's taste, it becomes necessary to change the specification for customer's satisfaction. When products or goods are ordered on the basis of standard specifications, the buyer as well as the seller knows what is required. Generally, three types of specifications are used.

- Technical specification
- Performance specification
- Brand name

Technical specification states the physical and chemical properties desired in the products. **Performance specifications** describe, in words, the performance or use of the products or materials to be purchased or the services that a product will give. When it becomes very costly to develop performance or technical specification or if such a practice does not prove satisfactory, purchases are made on the basis of **brand name**.

6.19 QUALIFY MANAGEMENT

6.19.1 Quality assessment

It is a probe of the level of quality being achieved. **Quality control** starts with quality assessment, and includes action taken to do away with unacceptable quality. A typical QC program is based on **periodic inspection**, later followed by **feedback on results**, and the **adjustments** made where found **necessary**.

6.19.2 Total Quality Control (TQC)

It refers to a total commitment to quality in all its aspects. Total Quality Control (TQC) works on the basis of the following functions:

- Quality of design
- Quality of planning
- Quality of production
- Quality of shipment
- Quality of field service (market)

Its philosophy is "Do it right the first time, every time".

Total Quality Management (TQM) is one of the techniques; improve a company's operational effectiveness (OE). It is now proposed that organization culture (OC) is an integral part of post - TQM paradigm. TQM is now viewed thus a tool for organizational and attitudinal change.

Quality is not only, the concern of the **manufacturing department**. Quality is **everyone's business**. Each department has to contribute to quality. Poor quality can occur because of organizational problems anywhere or even outside, the organization. **Continuous training** is thus a key to quality control.

6.19.3 Quality assurance

Meaning and Importance: Quality assurance refers to the assurance to customers that the products, parts, components, tools etc. contain specified characteristics and are fit for the intended use. In today's competitive industrial world, **no businesses** unit can exist for a long time **without** adhering to the **quality**. It is now responsibility of everybody connected with the production, directly or indirectly e.g. **each and every department** connected with

production from design and raw materials stage to dispatch and transportation stage i.e. from the designing of the product to the sales and delivery of the finished product - is responsible. Therefore, everyone has to be alert and everyone should perform ones duty efficiently, because everyone's activity is directly or indirectly related to the quality of a product

6.20 FACTORS AFFECTING EMPLOYEES' MORALE

Increase in morale results in improvement of quality. If **workers** are **dissatisfied** or working **condition** are **poor**, employees **morale** will be at a **low level** and cases of rejections will increase in any manufacturing unit. Employees may not be able to work or may not work or generally do not work efficiently because of many factors which can be classified as under:

(a) Psychological factors

- **Monotony and boredom:** when a person is required to perform the same type of work a number of times repeatedly over a long time, he gets bored or tired. This ultimately badly affects the quality of a product, resulting in higher rejections.
- **Frustration:** Employees get frustrated due to various reasons. They may not find any chance of promotion or scope for self-development. The boss may not be co-operative or may be ill-tempered. Management may not have trust in the employees. Under such circumstances, employees may not work with interest.
- **Absence of incentives:** Absence of incentives in the form of wages linked with productivity, incentive wage rates, prizes for quality work etc. makes the employee dissatisfied.

(b) Physiological factors

After working for a certain period continuously, a worker experiences stress, this leads to fatigue. If fatigue is severe, it will affect the quality as well as the quantity of production.

(c) Technical factors

- **Unclear specifications and faulty design:** Faulty design make the product unfit for use, quality of the products suffers heavily and it results in higher proportion of rejection.
- **Improper or unsuitable or substandard tools and equipment:** Tools which are not proper or suitable or of standard quality, affects the quality badly even if the workers are deficient and sincere.
- **Complex** or unsystematic operations or **process** and **improper maintenance** and repair of tools and machine.

(d) Other factors

Working conditions in a factory should be satisfactory. **Absence of** (i) Proper ventilation, (ii) sufficient Light, (iii) normal temperature, (iv) Subsidized canteen facilities, (v) urinals and latrines is sufficient numbers, (vi) provision of safety gloves, safety glasses, helmets etc for workers, if found necessary etc results in decreased efficiency

6.21 HOW TO MOTIVATE THE EMPLOYEES?

The following are some of the important corrective measures, which may prove to be useful for motivating the employees:

- An employee should be moved from one work to another at a regular interval.
- This type of job rotation reduces monotony and boredom. Unnecessarily interface by a supervisor, while a worker is performing his job should be avoided as far as possible.
- Suggestion from employees for improvement of quality should be encouraged and prizes should be awarded for good suggestions.
- Quality campaigns should be initiated and continuously promoted.
- Reasonable wage rates linked with productivity and quality should be implemented to encourage the workers to work sincerely and carefully.
- Provision for adequate training to workers should be made for improvement of quality and productivity

- Promotion policy should be framed in such a way, which can provide an incentive to honest, sincere and hardworking employees. The boss should take care of his subordinates.

After working for a **certain** number of **hours** continuously workers get exhausted physically as well as mentally. Therefore, **sufficient rest period** during working hours should be provided. Drawings, designs, operations, methods of production etc. should be simple, well defined and technically practicable as far as possible. Employers should be provided with suitable tools and equipment of standard quality.

6.22 WHAT SHOULD BE DONE FOR QUALITY ASSURANCE?

For quality assurance, first of all **quality specifications** for the product should be established, so that it can meet the **requirements of a customer**. Suitable **quality standards** for raw materials, parts, components, tools and equipment, production process etc. are also determined in advance so as to manufacture quality products as per the predetermined standard.

Proper inspection and testing procedures and methods should be evolved to check the quality specifications of raw materials, parts components, tools and equipment, production process and methods and also final product

Lastly, **periodical evaluation** of methods and procedures of inspection as well as quality control is a must to measure their efficiency and effectiveness.

To evaluate the efficiency and effectiveness of inspection as well as control methods, **random checking** and testing of the products at various stages of production and also random checking and testing of tools, equipment etc. should be done.

6.23 CONTROL OF QUALITY

Today, in the modern era of industrialization, production things like tooth brushes, tooth pastes, screws, nuts, bolts, cloth, sugar etc. are produced in huge quantities every day. But one screw is not exactly the same as another in all respects. There are bound to be some variations in the size or compositions of 1 product. **For example**, if screws of length 1.5 cm are produced, some screws will be slightly longer than 1.5 cm, say 1.59 cm or 1.6 cm etc and some screws will be slightly smaller than 1.5 cm., say 1.49 or 1.4 cm etc. variations within certain limits are tolerable, as they are unavoidable, but if they are too large, the product becomes useless. Maintaining the quality of a product means keeping its size and composition within the tolerance limits.

6.23.1 Functions of quality control

- To see that the product or service is designed in such a way so that it meets customer's specifications.
- To see that the product or services used by a customer is not harmful or injurious and meets safety conditions.
- To maintain discipline amongst the employees and to boost their morale healthy atmosphere in a firm is to be maintained for this purpose.
- To see that the materials, parts components, tools, equipment etc. of standard quality only are purchased and used. If a material worth Rs. 50 is inspected before it sent for further processing, it saves Rs. 500 at the final stage, because the cost of labour and overheads spent on the same during the production cycle is saved, if it is found at the initial stage that the material is defective.
- To provide current information on variations and trends shown by the process for the purpose of control. It is necessary to find out the causes of variations so that corrective actions can be designed in a proper way.
- To make the employees qualify conscious by fixing their responsibility at various stages of production.
- To reduce the proportion of scrap, waste and spoilage during the process.
- To see that product support services are provided satisfactorily after the products have been sold.

6.24 THE QUALITY IS REQUIRED TO BE CONTROLLED AT VARIOUS STAGES OF PRODUCTION

- Design stage
- Purchasing stage
- Production stage
- After a product is sold (product support services)

(1) **Control at design stage**

Design standards, design drawings, design specifications, etc. prepared by a committee of the heads of various departments can service the purpose in a better way. The quality control people have to see whether the predetermined standards, specifications, drawings etc. are being enforced properly or not.

(2) **Control at purchasing stage**

The responsibility for the procurement of materials components, parts, tools, equipment etc, of standard specifications, in a required quantity at a reasonable price rests with the purchase department. All the materials, parts components etc. should be inspected at the receiving end to ensure that the items procured conform to the predetermined standard as stated in the purchase order.

New materials, parts components etc are stored until they are used. Therefore, to preserve or maintain their quality, periodical checking should be carried out.

(3) **Control at production stage (during the production process)**

Production department is responsible for the production of quality products as per the specifications determined by the design and engineering department.

(4) **Control at delivery and after sales service stage**

Careful handling, proper storage and systematic packing save the products from rain, dust, sunlight, temperature etc. and maintain the quality of the products.

6.25 METHODS USED TO ASSURE OR TO CONTROL THE QUALITY: QUALITY OF A PRODUCT CAN BE ASSURED OR CONTROLLED BY:

1. **Inspection method** - 100% inspection or a sample inspection
2. **Statistical quality control method**
 - Various types of control charts
 - Pareto analysis
3. **Automated control**

6.25.1 Inspection method

To assure the quality of materials, parts, components, tools equipment, finished products, process or methods of production etc. inspection and testing is done by component personnel called inspectors. The inspection department sees whether,

- The **purchase department** has produced materials, parts, components, tools, equipment etc. as per the specifications or standards.
- The **production department** has produced standard quality products and standard processes, methods of production and tools and equipments are used in that department
- The **repair and maintenance department** has worked properly to repair and maintain the tools and equipment used in the factory
- The **stores department** has taken proper care in storing materials until they are used and finished products until they are sold.

Acceptance of substandard or defective goods: (i) spoils the quality of products, (ii) increases customers dissatisfaction due to inferior quality (iii) results in loss of trade or markets, (iv) increases cost of production in the form of higher rate of spoilage and defective, rework on defective etc. (v) results in production stoppage due to poor quality of material, parts, components, etc. (vi) increases servicing, repairing and replacement costs, etc.

Finished products are also **inspected** and if found necessary tested before they are delivered to the stores. Testing may be necessary to measure performance or chemical properties of the products. Sometimes, testing may destroy the whole product e.g. a gun-

shot or missile or a rocket. In such circumstances only samples are tested. Products should also be inspected or tested while delivering the same to customers, so as to minimize the rejections.

6.25.2 Statistical quality control method

Statistical quality control can be described as an application of **statistical methods** of sampling and tests of significance to ensure that the process of production is under control and to give a red signal as soon as it goes out of control. The dimensions of product, for example, are likely to vary every time we make it. It is impossible to avoid this completely. The question is what variation from specification is allowable. There are **two types of variations**: variation **due to chance** and variation due **to assignable causes**.

To **SQC Methods** can be useful

- To control the quality of finished products and the quality of products during the manufacturing process.
- To decide whether accept or reject a lot of products, already manufactured and also the incoming materials, parts, components etc.
- To provide management with quality information of the products manufactured in its own factory.

6.25.3 Automated control

Technological advancement has made it possible today to **control the quality, automatically**. Quality control devices are being built into the machines, which control the quality of products during the process automatically. Diameters of automatic pistons coming off any time are examined automatically and any significant deviation sends off an alarm signal.

Computers are also used. They may be on line or on line real time. In case of on line real time computers, operation is connected at all times to a central computer or these may be satellite mini computers located at several key operations, which are tied to central controlling computer. The **output** of the machine or the process is **constantly monitored** and **defects** are **reported** in real time or quickly. The computer keeps track of defects as well as of good units turned out of the process or machine. If the proportion of defective goes up, the computer reports to the person responsible for locating the trouble or for taking necessary actions. Sometimes, the computer adjust the process or sets the machine right automatically.

6.26 RELIABILITY

6.26.1 Meaning and Importance

The term reliability was developed during the late 1940s and early 1950s by American manufacturing and research organizations to test and improve the life of electronic components, particularly radio valves used in civilian and military aircraft applications. **Reliability** is something **different from quality**. It is related to quality but is something more than that. It is the **probability** that a product or a part or a system or equipment will **perform satisfactorily** for a **given time under normal conditions of use**. Quality is related to the initial performance of a product or a service, but **reliability** is related to the **continuation of performance** over a **period of time**. A product with better initial performance may fail to give the same performance afterwards. In such a case a product is not considered reliable.

6.26.2 How can it be measured?

The measurement of reliability depends on the **type of products**. For example (i) certain products function only on one occasion (ii) certain products have a long life, but if they fail they cannot be repaired, and (iii) certain products have a long life and if they fail they can be repaired and then again can be put to use.

A guided missile or a bomb or a gunshot can function only on one occasion. If such a product functions successfully only on one occasion, it is considered to be 100% reliable. If the expected life of a bulb is 1000 hours and if the probability of failure is 3 bulbs out of 100, it can be said that the bulbs have the reliability of 0.97.

A shot can be fired only once and therefore its successful functioning on one occasion is not the proof of its 100% reliability. A scooter has a useful life of thousands of

kilometers and therefore its failure its journey of 1000 kilometers cannot be considered as its 100% failure of "zero"% reliability, because it can be used again after its repairing is done.

6.26.3 How can it be improved?

Reliability is measured to see to what extent a product or a part or a machine or a component or a process is reliable. If the reliability shows decreasing trend, corrective actions to improve the reliability are taken.

Therefore, to improve the reliability of a certain product:

- More perfect parts should be used to make the product
- Standard quality materials, purchased from the reliable supplies should only be used,
- Plant and machinery, tool and equipment must be repaired and maintained properly. A car if checked after a journey of every 500kms and if properly maintained, may not put the owner in difficulty in the middle of the way.
- Standard and suitable tools and equipment should only be used.
- Parts of tools or machines should be replaced at the interval of every 800 to 900 hours; there will be no possibility of its failure.

6.27 ISO 9001: 2000

Today the most talked about quality initiative is ISO9001:2000 quality system standards. Most of the organizations all over the world seek to register to this standard. By the end of 1993, nearly 250 Indian companies would have registered for ISO. As many as 99 countries have adopted them and more than 1.5lac companies have been certified Ground the world.

6.27.1 What is ISO?

ISO quality system standard series was developed by the **technical committee 176** of the international standard organization (ISO) and **approved** in its present form in **1987**. The environment is competitive. Customers were required to perform special inspections at great expenditure to assess the supplier's quality standards ISO is the result of the joint action of **25 largest consumer and producer nations including India** under the sponsorship of international standards organization (ISO). These standards were issued by ISO in Geneva in 1987. **ISO9001:2000** series is considered as the minimum acceptable level or standards. Since then several countries have adopted it as their national quality standard. Its Indian equivalent is commonly referred to as IS:14000 series.

These standards are in use for external quality assurance for contracts to provide third party assurance to the customer of a company's ability to satisfy contractual requirements. ISO 9001:2000 is today recognized internationally as a benchmark for measuring quality.

6.27.2 ISO 9001:2000 and exports to EC countries

The popular conception is that this **registration is necessary to export to EC countries**. Incentives declared to ISO registered companies have added to this conception. ISO has come to be regarded as a trade barrier.

6.27.3 Steps for ISO 9001:2000 Implementation

- Understand the standard system and its interpretation
- Conduct necessary training programming
- Line managers should generate documentation outside consultants may be appointed for this purpose.

It takes a year or a year and a half's concerted efforts to achieve ISO 9001:2000 registration. The **control of all documents** related to quality is an important requirement of ISO 9001:2000. It covers all such as elements as drawings, specs, blueprints, work instructions, test procedure, inspection reports, calibration data and quality cost reports.

Training and consultancy may be need for those who wish for implement ISO 9001:2000. There is **multiplication of certification agencies**, which treat certification as a commercial proposition. There are now 15 certification agencies, which treat certification as a commercial proposition. There are now 15 certification agencies operating in India. There are variations in their procedures and modus operandi.

6.27.4 ISO 9001:2000

The new modified standards are focused more on results and quality management principles. In April, 2000, QCI has announced the first two accreditation bodies in India: National accreditation board for certification and national accreditation board for auditors and training.

6.27.5 Revision of ISO 9001

The proposed changes are summarized below:

- The standards will be known as DIS 9000 :1993
- The services have been included. Even the scope has been enhanced by including quality assurance in design and development, production, installation and servicing.
- With respect to contractual changes, the draft requires the quality policy to be relevant to organizational goals of the supplier and expectations and needs of customers.
- On responsibility and authority, both DIS 9001 and 9002 require these to be defined not only to those personnel who, identify and record any product quality problems, but identify and record any product, process and quality system problems.
- On contract review, the requirement is slated to get more specific where each accepted tender; contract and order will be considered as per definition and documentation.
- There are changes proposed in the areas of design control, document and data control, purchasing management and review.

6.27.6 Salient features of ISO 9001:2000

- It is obligatory to identify non conformities. Non conformity is a shortfall between what is desired to be achieved and what is actually achieved. It leads to identification of problem areas or prospective areas of improvement.
- Systematic prevention of non conformities is another salient feature of ISO 9001:2000.
- ISO 9001:2000 requires a formally documented procedure for each and every activity which is likely to have a bearing on quality either directly or indirectly.
- It requires faithful implementation of procedures and their revision if called for.
- ISO confines itself to standard formulation. Implementation is left to individual nations. In India, there is National Accreditation Board which in turn accredits the certifying bodies who conduct certification audits. The organization has to furnish documentary evidence (proper quality standards) to substantiate the effective operation of quality management system. The certification is valid for no more than 3 years. In this period also surveillance audits are carried out to see compliance.

6.28 EXERCISE

1. Define catalyst and catalysis. Write a notes on types of catalysis
2. Write notes on
 - Homogeneous catalysis
 - Enzyme catalysis
 - Autocatalysis
 - Promoters
 - Negative catalysis
 - The adsorption theory
 - Catalytic poisoning
 - Reliability
3. Justify the statement " a catalyst does not affect the final equilibrium position although it shortens the time required to established equilibrium"
4. Justify the statement " a catalyst is specific in action"
5. List and discuss about various characteristic of catalyst.
6. Define the term quality and discuss the factors affecting the moral of employees.
7. Write notes on control of quality with respect to function of quality control
8. Give an understanding of ISO9001:2001
9. Discuss different methods used to assure or to control quality

10. Discuss aspect of quality and types of cost

6.29 FURTHER READING

1. Industrial chemistry by B. K. Sharma