QUALITY CIRCLE IMPLEMENTATION FOR MAINTENANCE MANAGEMENT IN PETROCHEMICAL INDUSTRY

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ABSTRACT
This paper deals with various aspects of Quality Circle and how improvements can be made by adopting practices of Quality Circle in petrochemical industries. The paper also presents a comparative discussion of various features of Quality Circle, Quality Improvement Group and Work Group/Project Team. The paper describes a case study of QC concept in a petrochemical industry which illustrates the effectiveness of QC approach.

KEYWORDS
Quality Circle, Petrochemical Industry, Quality Improvement Group, Work Group/Project Teams, Centrifuge, Maintenance Management, Deming Wheel, Fishbone Diagram, Pareto Chart, Activity Flow Diagram

1. INTRODUCTION
Maintenance is undertaken to preserve the proper functioning of a physical system so that it will continue to do what it was designated to do. Its function and performance characteristics not only take account of output, unit cost and effectiveness of using energy, but also such factors as end product quality, process control, comfort enhancement and protection of the employed personnel, compliance with environment protection regulations, structural integrity and even physical appearance of the productive system. Maintenance is often wrongly regarded as a cost centre, since the costs are visible, while the benefits are difficult to estimate.

2. DEFINITION
Quality Circle is a small group of 6 to 12 employees doing similar work who voluntarily meet together on a regular basis to identify improvements in their respective work areas.

3. PHILOSOPHY
Quality Circle is a people – building philosophy, which provides self motivation and improves work environment. It represents a philosophy of managing people specially those at the grass root level.

4. CONCEPT
The concept of Quality Circle is primarily based upon recognition of value of the worker as a human being, as someone who willingly put efforts to improve the job, his wisdom, intelligence, experience, attitude and feelings.

5. OBJECTIVE
The objectives of Quality Circles are multi-faced - Change in attitude; self development; development of team spirit, improvement in organizational culture.

6. ORGANISATIONAL STRUCTURE
The basic structure of a Quality Circle is depicted in fig. 1.

7. LAUNCHING QUALITY CIRCLES
The launching of Quality Circles involves the following steps:
- Expose middle level executives to the concept.
- Explain the concept to the employees and invite them to volunteer as members of Quality Circles.
- Nominate senior officers as facilitators.
- Form a steering committee.
- Arrange trainings
- A meeting should be fixed preferably one hour a week for the Quality Circle to meet.
- Formally inaugurate the circle.
- Arrange necessary facilities for the Quality Circle meeting and its operation.

8. TRAINING
Appropriate training for different sections of employees needs to be imparted.

9. PROCESS OF OPERATION
Fig. 2 exhibits the operation of quality circles:

Fig 2: Operation of Quality Circle

10. CHARACTERS OF QC
1. Circle membership: It is more or less homogeneous group of people usually from the same work areas. However, whenever required experts may be invited for guidance or advice.
2. Circle size: Usually a group of 6 to 12 members seems quite effective; however, it depends upon the people employed in a particular section.
3. Voluntary participation: The main objective of QC is attendance and participation in meetings voluntarily without any compulsion.
4. QC meetings: An hour’s duration is usually quite adequate for a meeting. Whatever may be the frequency, regular meetings should be ensured.
5. Autonomy: An important ingredient of a QC is the sense of autonomy experienced by its members.

11. PHASES IN QC DEVELOPMENT
Once a QC is formed, it has to pass through the following distinct phases of development:

1. Problem to be identified, analyzed and solved.
2. Solutions to be implemented in due time.
3. Monitoring to be carried out.
4. Higher management to encourage QCs to innovate problem solving methods.

12. BASIC PROBLEM SOLVING TECHNIQUES
The following techniques are most commonly used to analyze and solve work related problems.
1. Brainstorming.
2. Pareto Diagrams.
3. Ishikawa diagram (Fishbone diagram).
4. Cause & Effect Analysis.
5. Data Collection.
6. Data Analysis.

The tools used for data analysis are:
1. Tables.
2. Bar Charts.
3. Histograms.
5. Line graphs.
7. Control Charts.

13. CAUSES FOR FAILURE OF QC
Some of the common causes for failure are:
1. Low morale of employees due to autocratic management and lack of trust.
2. Lack of training.
3. Incompetent leadership.
4. Lack of management support.

Quality circle concept succeeded in Japan, South Korea and a few other Asian countries, but it was a different kind of experience in Europe and USA. In Europe and USA, it became very popular from middle of 70s to middle of 80s, and subsequently, started its journey of declining from there onwards. The reasons can be attributed to:
- In Japan, it was mainly considered as a development process of grass-root employees, and organizational improvement was given secondary importance, whereas in Europe and USA, the focus was given to organizational improvement and no proper attention was paid to improvement of people.
- Work associated to QC is totally carried out as an internal process in Japan, whereas in Europe and USA, it was left to the external consulting agency.

In India too, these reasons are equally valid and applicable.

14. COMPARISON AMONG QUALITY CIRCLE, QUALITY IMPROVEMENT GROUP AND WORK GROUP/PROJECT TEAM
Table 1 presents the comparison among Quality Circle, Quality Improvement Group and Work Group/Project Team:
Table 1: Comparison among Quality Circle, Quality Improvement Group and Work Group/Project Team

<table>
<thead>
<tr>
<th>Feature/Criteria</th>
<th>Quality Circle</th>
<th>Quality Improvement Group</th>
<th>Work Group/Project Team</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orientation</td>
<td>Performance-oriented</td>
<td>Problem-oriented</td>
<td>Problem/project-oriented</td>
</tr>
<tr>
<td>Time-frame</td>
<td>Decided by circle members</td>
<td>Decided by management</td>
<td>Decided by management, specific duration is assigned</td>
</tr>
<tr>
<td>Nature of group</td>
<td>Homogeneous</td>
<td>Homogeneous</td>
<td>Heterogeneous</td>
</tr>
<tr>
<td>Communication</td>
<td>Bottom to top</td>
<td>Top to bottom</td>
<td>Top to bottom</td>
</tr>
<tr>
<td></td>
<td>Usually restricted to work and mostly to low intellect problems</td>
<td>Machine/process specific</td>
<td>Depends on objectives given by senior management</td>
</tr>
<tr>
<td>Scope</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expertise required</td>
<td>Practical and limited</td>
<td>Predetermined by nature of quality problem</td>
<td>Work or project dependent</td>
</tr>
<tr>
<td>Technical approach</td>
<td>Innovative and experimental</td>
<td>Traditional and technically established</td>
<td>Project dependent but mostly traditional and established</td>
</tr>
<tr>
<td>Dependence on</td>
<td>Independent</td>
<td>Partially dependent</td>
<td>Part of management function</td>
</tr>
<tr>
<td>management function</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size of group</td>
<td>Small, usually 7-9</td>
<td>Small, usually less than 7</td>
<td>Varies, project/work-dependent</td>
</tr>
<tr>
<td>Decisions</td>
<td>By consensus followed by presentation before executives</td>
<td>By leader, no presentation is needed</td>
<td>By leader/in charge, presentation is situation-dependent</td>
</tr>
<tr>
<td>Formal Training</td>
<td>Formal training is a must, which must be systematic</td>
<td>Discipline specific training/work experience</td>
<td>As such, no specific training is required</td>
</tr>
</tbody>
</table>

15. QC SUCCESS STORY IN INDIA

QC took birth in India in 1982 and some of the industries to launch QC first were Bharat Electronics Limited, Bangalore and Bharat Heavy Electricals Limited, Trichy. However, with the progress of time, QC achieved success in a number of industries in India. To name a few are TATA, TELCO, Reliance Industries Limited, Kirloskar Brothers Limited and so.

16. CASE STUDY OF QUALITY CIRCLE

In a powder plant, consumption pattern of grease in centrifuges was not uniform. To optimize the grease consumption, a quality circle was formed and root-cause of the non-uniform grease consumption was identified, and recommendations were implemented to optimize the consumption.

- Name of the organization: XYZ Industry.
- Number of circle: 01.
- Section: Powder Plant.
- Number of meetings held: 24 (in 2 years).
- Members: 8.

**Objective:** Optimization of grease consumption in centrifuges (Pressure and Atmospheric).

**Centrifuge:** In the powder plant, the centrifuges separate water from slurry of powder. The plant, under consideration, has two centrifuges-pressure centrifuge, operating at 4 bar pressure; and atmospheric centrifuge, operating at atmospheric pressure.

**Greasing Components:**
- Special purpose process compatible, FS-1292 MOLYCOTE GREASE.
- Pneumatic Grease Gun.

**Activity Flow Diagram before QC Implementation:**
Activity flow diagrams are graphical representations of workflows of stepwise activities and actions with support for choice, iteration and concurrency. An activity flow diagram shows the overall flow of control. Fig. 4 exhibits the activity flow diagram for greasing before implementation of QC:

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**Fig. 3:** Centrifuge Diagram

**Fig. 3:** Exhibits the detailed diagram of the centrifuge:
Deming Wheel:
Deming wheel is an iterative four-step problem solving process. It is also known as PDCA (plan-do-check-act) cycle. Fig. 5 exhibits the Deming wheel:

Fig. 4: Activity flow diagram

Fig. 5: Deming wheel
4 W and 1 H:

4W and 1H represent What, When, Where, Who and How regarding the problem being discussed. Fig. 6 exhibits the 4W and 1H:

Data collection of grease consumption:

Table 2 presents grease consumption (in kg) in eight no. of centrifuges (two no. of powder plants):

<table>
<thead>
<tr>
<th>Year</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centrifuge</td>
<td>FL</td>
<td>EX</td>
<td>FI</td>
<td>FL</td>
<td>EX</td>
<td>FI</td>
</tr>
<tr>
<td>M1-1411A</td>
<td>10</td>
<td>2</td>
<td>9</td>
<td>2</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>M1-1411B</td>
<td>10</td>
<td>2</td>
<td>2</td>
<td>9</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>M1-1421A</td>
<td>10</td>
<td>2</td>
<td>3</td>
<td>9</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>M1-1421B</td>
<td>10</td>
<td>2</td>
<td>9</td>
<td>2</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>M2-1411A</td>
<td>10</td>
<td>2</td>
<td>3</td>
<td>9</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>M2-1411B</td>
<td>10</td>
<td>2</td>
<td>2</td>
<td>9</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>M2-1421A</td>
<td>10</td>
<td>2</td>
<td>3</td>
<td>9</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>M2-1421B</td>
<td>10</td>
<td>2</td>
<td>2</td>
<td>9</td>
<td>2</td>
<td>8</td>
</tr>
</tbody>
</table>

FL- Flush Shutdown, FX- Extra, FI- Failure

Table 3 presents grease consumption in centrifuges during flush shutdown, extra greasing and greasing after failure:

<table>
<thead>
<tr>
<th>Grease Consumption(kg)</th>
<th>Pressure Centrifuge</th>
<th>Atmospheric Centrifuge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flush Shutdown</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Extra</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Failure</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>

Observations:

QC members collected data for last four years & found certain observations:

1. Irregular availability of machines for greasing.
2. The amount of grease could not be identified.
3. Failures of trunion seal “o” rings.
4. No grease found from outlet of trunion bearing at gear end side.
5. During seal failure, greasing frequency was increased.
6. Amount of grease discharged by grease gun was not known.

Brain storming for possible cause identification: After brainstorming, following causes identified are:

1. Improper method of greasing.
2. Failure of mechanical seal.
3. Unavailability of m/c for regular greasing.
4. No proper planning for greasing.
5. Over greasing.
7. Improper grease gun.
8. Amount of grease not known.
9. Poor grease quality.
10. Grease passed away to non utilized cavity.
11. Grease leaked out from connector tubing.

Fishbone Diagram:

Fishbone diagram is a diagram that shows causes of a certain event. Each cause or reason for imperfection is a cause of variation. Causes are usually grouped into major categories to identify these sources of variation. The categories typically include: Man, Material, Method and Machine. Fig. 7 exhibits fishbone diagram for the problem concerned.

![Fishbone Diagram](image)

Fig. 7: Fishbone diagram

Average grease consumption from year 2005 to year 2009:
Table 3 presents average grease consumption from year 2005-2009:

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Grease Consumption</th>
<th>Consumption in kg</th>
<th>% Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>During Flush S/D</td>
<td>430</td>
<td>44</td>
</tr>
<tr>
<td>2</td>
<td>Due to Re-gressing</td>
<td>320</td>
<td>33</td>
</tr>
<tr>
<td>3</td>
<td>Due to Failure</td>
<td>200</td>
<td>20</td>
</tr>
<tr>
<td>4</td>
<td>Leak of Tubings</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>960</td>
<td>100</td>
</tr>
</tbody>
</table>

Pareto Chart:
Fig. 9 exhibits Pareto chart:

![Pareto Chart](image)

Fig. 9: Pareto chart
Why-Why technique:
Why-Why technique is a question-asking method used to explore the possible cause and effect of a particular problem. The technique was applied to man, material, method and machine as follows:

**Man**
1. Over greasing.
2. Lack of knowledge.
3. Improper greasing.

**Material**
1. Grease gun not proper.
2. Improper grease quality.
3. Leakage of grease tubing.

**Method**
1. Improper method of greasing.
2. Amount of re-greasing not taken.
3. Unpredictable greasing schedule.
4. Machine available for greasing only in flush shutdown.

**Machine**
1. Grease leak to spline shaft cavity.
2. Failure of mechanical seal.
3. Improper greasing point.
4. Greasing not possible in running condition.

Brain storming for possible solutions:
Brain stormsing was carried out to find out possible solutions of this problem. Following were the possible solutions:
1. To develop proper greasing method.
2. To develop proper greasing schedule as per vendor recommendation.
3. Grease leak to be eliminated from trunion seal ‘O’ rings.
4. To review design of trunion seals.
5. Grease quantity to be decided.
6. Inlet and outlet to be plugged after greasing.
7. Grease gun tubing leak to be arrested.

**Actions Taken:**
- Schedule for greasing is prepared.
- Required quantity of grease is identified in each bearing and seal.
- Quantity of grease to be delivered is identified by pneumatic grease gun in gm/min, which was found to be 500gm/min.
- Training imparted to all technicians.
- Leak-proof greasing connection was made to prevent leakage.

**Flow diagram after implementation:**
Fig. 10 exhibits flow diagram for greasing after implementation of QC:

Fig. 10: Flow diagram after implementation

**Observations after implementation:**
- Grease consumption is reduced to 5 kg from 8 kg in atmospheric centrifuge.
- Grease consumption is reduced to 8 kg from 10 kg in pressure centrifuge.
- No abnormalities are observed in any of the machines.

**After implementation:**
- Greasing time is reduced.
- Down time is decreased.
- Quality of grease is improved in removed centrifuge.

**Tangible benefits:**
Grease saved:
- Pressure centrifuge-2 kg per machine.
- Atmospheric centrifuge-3 kg per machine.
5 Scheduled greasing + 2 extra re-greasing,
- Total 104 kg Grease saved in one year.
Grease price / kg = Rs. 9000,
- Total Saving = Rs. 936000.

**Intangible Benefits:**
- Housekeeping is improved due to less spillage.
- Easy safe working condition for maintenance & operation.
• Improvement in inter-departmental relations.
• Boosting-up self confidence.
• Knowledge-gain.
• Team building.
• Development of cost consciousness among employees.
• Enhancement in employees’ morale and team spirit.

RESULTS AND DISCUSSIONS:
Implementation of Quality Circle led to identification of excessive grease consumption in the centrifuges due to reasons attributed to deficiency in man, material, method and machine. Each deficiency was handled separately and corrective measures are implemented to optimize the grease consumption in the centrifuges.

CONCLUSION
Quality Circle technique proved to be very effective for the problem selected by the quality circle members for the petrochemical industry. Optimization of grease consumption in the centrifuges led to reduction in maintenance costs, enhancement in reliability and availability of the equipment, enhancement in morale and development of a sense of team dynamics among the employees, which proved to be beneficial to the employees and the organization as a whole.

ABBREVIATION
QC  Quality Circle
SMP  Standard Maintenance Procedures
TQM  Total Quality Management
SGA  Small Group Activity
QIG  Quality Improvement Group
O/H  Overhauling
S/D  Shutdown
PM  Preventive Maintenance

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