HACCP and ISO9002 (ANSI/ISO/ASQC Q9002) in Breweries

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ABSTRACT

The consequences of failing to take adequate measures to ensure that product safety and quality are maintained can result in serious damage to the brand image, and in extreme cases, to its demise. To minimise the risk of such failures, many breweries are implementing HACCP (Hazard Analysis Critical Control Points) and quality management systems such as ISO9002-certified systems. This assists them to comply with legal and corporate governance requirements, to mitigate insurance costs and to protect brand quality and image.

Brewing Research International has been involved with breweries worldwide, implementing and auditing HACCP and ISO9002 and advising on corrective actions when problems with product safety or quality do occur. Our studies have enabled us to compare performance between breweries in implementing HACCP and some aspects of ISO9002 such as analytical and sensory performance. In addition, studies of incidents has resulted in recommendations for improving HACCP and ISO9002 and these are applicable to breweries worldwide.

Keywords: brewery, safety, quality, HAACP, ISO9002

INTRODUCTION

HACCP (Hazard Analysis Critical Control Points) is a management system for the production of safe product. Product safety is controlled by identifying hazards to the consumer at each process step and then establishing the critical control points (CCPs) where hazards can be eliminated or reduced. At each CCP, the process is monitored against defined critical limits and corrective actions to be taken, if the critical limits are exceeded, are defined.

The International Standard series ISO9000 provides a model for the assurance of quality. A new standard ISO9001:2000 will be implemented in 2001. The key points to be controlled to assure product quality are: management, resources, process and analysis.

Breweries worldwide are implementing HACCP and quality management systems (such as ISO9002 - certified systems) for a variety of reasons. These include:

1. Compliance with legal requirements: for example, in Europe, the Directive on the Hygiene of Foodstuffs makes it compulsory for food businesses in all Member States to implement HACCP or similar systems.

Las consecuencias del no tomar las medidas adecuadas para asegurar el mantenimiento de la calidad y seguridad del producto pueden resultar en serios daños la imagen de la marca, y en casos extremos, a su destrucción. Para reducir al mínimo el riesgo de tales consecuencias, muchas cervecerías están implementando el HACCP (Análisis de Riesgo de Puntos de Control Críticos) así como sistemas de manejo de calidad como el sistema certificado ISO9002. Esto los ayuda a cumplir con los requisitos gobernativos legales y corporativos, a mitigar los costos de seguro y a proteger la calidad e imagen de la marca.

Brewing Research International se ha involucrado con cervecerías a nivel mundial implementando y haciendo auditorias de ISO9002 y HACCP así como dando consejería sobre acciones correctivas cuando ocurren problemas con la calidad o seguridad del producto. Nuestros estudios nos han capacitado para comparar el rendimiento de cervecerías en cuanto a la implementación del HACCP y algunos aspectos del ISO9002 tales como el rendimiento analítico y sensorial. Además, los estudios de los incidentes han resultado en recomendaciones para el mejoramiento del HACCP y el ISO9002 y estos son aplicables a cervecerías de todo el mundo.
2. Compliance with Corporate Governance: breweries that are listed on the London Stock Exchange (and this includes several international breweries) must comply with the Turnbull Report on Corporate Governance. This requires that they set up internal control systems to protect shareholders and the business. Specifically:

- The Board should maintain a sound system of internal controls (financial, operational and compliance) to safeguard shareholder’s investments and the company’s assets.
- The Directors should, at least annually, conduct a review of the effectiveness of the company’s systems and report to shareholders that they have done so. The report should cover all controls, including financial, operational and compliance controls and risk management.

Any significant breakdown in the control systems must be reported in the Annual Accounts. Companies listed on the Stock Exchange had to have control procedures in place by 31 March 2000 and must review their effectiveness by 31 March 2001. Other European countries are also implementing similar requirements and it is expected to become standard practice throughout Europe.

3. Mitigating the cost of insurance: implementing control systems (such as ISO9000, HACCP, benchmarking, traceability, crisis planning, reputation protection and control of suppliers) can reduce the costs of insuring brands against incidents or product recall.

4. Protecting brands; there has recently been an increase in the number of product recalls or incidents involving well-known brands. This can result in high costs, adverse publicity, loss of confidence in the brand, litigation costs and demands from retailers to recoup losses. Threats to brands can arise from incidents within the brewery, extortion, malicious tampering and accidental contamination.

BRI has been involved with breweries world-wide to implement HACCP and quality management systems and to recommend corrective actions and improvements to these systems when incidents occur. This paper gives the results of our studies on comparing performance between breweries in HACCP and ISO9002. In addition, it gives the results and recommendations from a study of incidents in breweries; these recommendations are relevant to breweries world-wide.

RESULTS AND DISCUSSION

HACCP and ISO9002 in Breweries

Our studies have enabled us to compare HACCP systems in many different breweries. Based on this, common critical control points have been identified. Tables 1 and 2 show some common critical control points in breweries, together with the hazards controlled at that point, examples of the control measures used, critical limits, monitoring procedures and corrective actions.

In the brewhouse, common critical control points are malt intake, malt storage, extract recovery, wort cooling and addition of hops. Some of these are shown in more detail in Table 1. For example, malt and grain storage is a critical point as it can result in formation of mycotoxins. This is controlled by correct storage conditions; common critical limits are a humidity of less than 15% and a storage temperature of around 20°C. These critical limits are monitored to ensure the process remains in control.

In bottling, the bottle washer, bottle filler and pasteuriser are critical points (Table 2). Bottle washing is used to control hazards such as foreign bodies, glass fragments, moulds and label fragments. Common control measures include correct operation of the washer, (maintenance of the jets, rinse/detergent sections and discharge areas) and correct operation of the empty bottle inspector. Monitoring procedures, to ensure that the process remains in control, include measuring the time and temperature of washing and the detergent concentration, checking the jets in the washer and regular, recorded checks on the Empty Bottle Inspector with test bottles.

For ISO9002 systems, analyses (both sensory and analytical) are important as decisions about product quality are taken on the basis of this data. Proficiency testing can be used to compare performance against other laboratories. This provides a check on the reliability of sensory and analytical data and identifies areas for improvement. Figures 1 and 2 compare performance for sensory and laboratory analyses for breweries world-wide.

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FIGURE 1

Proficiency Testing of Sensory Analysis

Figure 1 shows data from the Brewing Analytes Proficiency Scheme (BAPS) for sensory analysis. In this scheme, a sample of beer and unknown flavour compound is supplied to each brewery. Tasters taste the mixture and choose from a list of terms to describe the flavour. Some of these are shown in more detail in Table 1. For example, malt and grain storage is a critical point as it can result in formation of mycotoxins. This is controlled by correct storage conditions; common critical limits are a humidity of less than 15% and a storage temperature of around 20°C. These critical limits are monitored to ensure the process remains in control.

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### TABLE 1
Generic HACCP Plan for Brewhouse

<table>
<thead>
<tr>
<th>PROCESS STEP</th>
<th>HAZARD DESCRIPTION</th>
<th>CONTROL MEASURES</th>
<th>CRITICAL LIMITS</th>
<th>MONITORING PROCEDURES</th>
<th>CORRECTIVE ACTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malt/grain intake</td>
<td>Mycotoxin, NDMA, Pesticides heavy metals, contamination from delivery lorry</td>
<td>1. Supplier Quality Assurance</td>
<td>Agreed specification</td>
<td>Audits carried out of supplier premises</td>
<td>Revision of approved supplier register</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Intake procedure</td>
<td>Absence of Moldy material</td>
<td>Supplier liaison</td>
<td>Return to Supplier Audit Supplier</td>
</tr>
<tr>
<td>Malt/grain storage</td>
<td>Mycotoxin</td>
<td>Controlled conditions of storage (dry)</td>
<td>&lt;15% Humidity at &lt;20°C</td>
<td>Scheduled temp/humidity measurements</td>
<td>Isolate material for further examination</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Reject if moldy</td>
</tr>
</tbody>
</table>

### TABLE 2
Generic HACCP Plan for Bottling

<table>
<thead>
<tr>
<th>PROCESS STEP</th>
<th>HAZARD DESCRIPTION</th>
<th>CONTROL MEASURES</th>
<th>CRITICAL LIMITS</th>
<th>MONITORING PROCEDURES</th>
<th>CORRECTIVE ACTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bottle washing</td>
<td>Foreign bodies, glass fragments, molds, label fragments</td>
<td>1. Correct operation of bottle washer</td>
<td>Detergent concentration, temperature and time</td>
<td>Temperature, time and detergent concentration</td>
<td>Suspect bottles rechecked</td>
</tr>
<tr>
<td>(returned glass)</td>
<td></td>
<td>2. Good housekeeping of washer including jets</td>
<td>Rinse liquor temperature</td>
<td>Jets checked for correct action</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Empty bottle inspection (EBI)</td>
<td>Jet pressures</td>
<td>Test bottles through Empty Bottle Inspector</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Planned maintenance</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figure 2 compares the performance of breweries for the measurement of pH in beer; this data was taken from the BAPS scheme. The range of values measured by these breweries was 4.20 to 4.69, the mean was 4.42 and the standard deviation was 0.07. To allow easy comparison, the data in Figure 2 is given as Z-scores (where \( z \)-score = \( \frac{\text{measured result} - \text{assigned value}}{\text{standard deviation}} \)). Best practice is breweries with \( z \)-scores between +2 and -2. Breweries with \( z \)-scores between 2 and 3 (or -2 and -3) have questionable performance and values outside this are unsatisfactory. This enables comparison of the performance of laboratories in different breweries so that corrective actions to improve performance can be taken where necessary.

Corrective actions might include improving the method used, procedures, chemicals, equipment calibration or training of analysts.

![Figure 2](image)

**FIGURE 2**

**Proficiency Testing of Measurement of pH in Beer**

**PRODUCT SAFETY/QUALITY INCIDENTS**

There have recently been several incidents in which the quality of brands has been affected. The incidence of these has been increasing in frequency and severity. Three examples of recent incidents are given below. In each case the recommendations for improving HACCP and ISO9002 systems to prevent a recurrence are given. These are, in general, applicable to many breweries that use the same type of equipment or processes as in these examples.

**Example 1:** A brewery had a taint in liquor that had been passed through an ion-exchange resin. The taint was described as chlorine, cleaning agent, sterilant, plastic, medicinal and phenolic. Analysis of the tainted brewing liquor by gas chromatography-mass spectrometry (GC-MS) showed the presence of 6 bromophenolic compounds (Figure 3). These included di-bromo-methylphenols (peaks A to C in Figure 3) and di-bromo-anisoles (peaks D and E in Figure 3) at levels below parts per billion. It seems likely that these compounds originated from the ion-exchange resin.

More extensive washing of a sample of the ion-exchange column with caustic soda produced other bromophenolic compounds such as iso-butyl-bromophenol and bromodimethylphenol.

![GC-MS Analysis of Tainted Liquor](image)

**FIGURE 3**

**GC-MS ANALYSIS of Tainted Liquor**

Analysis of the beer by gas chromatography - mass spectrometry showed that both di-bromo-methylphenols and di-bromo-anisoles were present in beer which had a taint but were not present in the control, untainted beer. Chlorophenols and choranaisoles have been reported previously in liquor after passing through an ion-exchange resin. These compounds have also been reported in beer and are known to be flavour-active. However, there have been few reports of bromophenolic compounds in beer.

As a result of this incident, some corrective actions were recommended for the regeneration of ion-exchange resins. These were specifically aimed at this brewery but are applicable to all breweries using ion-exchange resins. The recommendations are to:

1. check the acid used to regenerate ion-exchange columns (For example, by diluting and neutralising the acid and then sniffing to check for medicinal taints due to chlorophenols or bromophenols)
2. have procedures for regenerating ion-exchange columns
3. taste the liquor daily using tasters that have been screened for their ability to detect bromophenols, chlorophenols and related compounds
4. control other potential sources of bromophenols or their precursors in breweries that can pose a threat to beer brands. Bromophenols occur widely, for example, in wood treatments, paint, disinfectants, fungicides and rodenticides. Appropriate measures should be taken to minimise risk from these sources.

**Example 2:** A brewery suffered a leak of glycol from a heat exchanger, resulting in contamination of product. As a result, a working party was set up under the auspices of the Brewers and
Licensed Retailers Association (BLRA) in the United Kingdom, and involving representatives from a number of breweries, to share the experience and lessons learned with the industry as a whole. The working party produced a series of recommendations on the use of plate heat-exchangers in breweries to avoid contamination of product. The key recommendations include:

1. improved specifications for heat exchangers (such as minimum plate thickness and the use of double-walled plates)
2. control of operations (such as avoiding sudden high pressure, repetitive pressure or temperature variations and using localised header tanks that have a low volume of glycol)
3. checks on the glycol (such as the level, specific gravity, frequency of top-up and investigation of losses)
4. periodic checks on heat exchangers to check for cracks in plates
5. regular monitoring of product for the presence of contaminating coolants

Example 3: A benchmarking exercise of 25 breweries in the UK showed that 40% of them reported incidents with product safety within the last year. All the incidents occurred in small pack product and all were due to either physical contamination (such as glass fragments, pieces of plastic, pieces of plaster, crisp packets, etc) or chipped necks on bottles which may harm consumers if they drink from the bottle. As a result, recommendations were made for additional HACCP studies in bottling halls. These included:

1. additional checks on bottle washers (such as the rinse and detergent sections, correct operation of the washer and additional checks on the operations of the jets) and additional monitoring of washers (for example, the time and temperature of washing and the detergent concentration)
2. additional, more frequent checks on the empty bottle inspector and corrective actions if test bottles are rejected
3. checks on the operations of contact bottlers to check the effectiveness of their HACCP systems.

DISCUSSION

The results given above show that breweries have successfully implemented HACCP and ISO9002 systems (and use tools such as proficiency testing to improve performance) and experience shows that these are effective in controlling product safety and quality. Nevertheless, incidents can still occur, as shown by the examples given above. Indeed, there has been an increase in the number and severity of incidents involving well-known brands. The recommendations given as corrective actions are useful in strengthening existing HACCP and ISO9002 systems and preventing a recurrence of these types of incidents. However, the examples show that problems can arise from a wide variety of sources; some of them from unexpected sources. This highlights also the need for sophisticated chemical analyses to detect and identify these compounds when they occur. It also shows the need for the industry to identify in advance, where possible, potential sources of problems.

Many breweries now integrate HACCP and ISO9002 systems to provide a unified approach to assuring product safety and quality. The changes to the ISO9001:2000 standard should make this easier to achieve as the new standard is more process-oriented than the previous one.

Nevertheless, both HACCP and ISO9002 are centred on processes. It is suggested that to protect brands a different, “holistic” approach is needed; this is Brand Protection Audit. This moves the emphasis away from processes to the brand itself. The aim of Brand Protection is to reduce the risk of product recalls, reduce the cost of incidents and comply with legal and corporate requirements. It should encompass all steps from materials purchase to consumption of product and should consider all aspects that may affect the brand. These should include supplier auditing, HACCP, ISO9002, laboratory performance and due diligence analyses, sensory benchmarking, the use of genetically-modified materials, etc. The aim is not to use Brand Protection to replace HACCP and ISO9002 systems but to build on their effectiveness to protect the brewery’s main assets.

CONCLUSION

Tools such as HACCP and ISO9002 are being implemented world-wide by breweries to protect beer brands. There are many threats to brands; these include incidents within breweries as well as legal and corporate requirements. As the value of brands increases and the threats to them rise, it is suggested that an integrated approach – the Brand Protection Audit – which incorporates and builds on existing HACCP and ISO9002 systems should be taken to protect the brewery’s most valuable assets - its brands.

REFERENCES


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