

## 改善五加侖蒸餾水生產線效率及生產能力

Improve the 5 Gallon Distill Water line efficiency and production throughput

### 團隊背景 Background of the Team



團隊名稱 Team Name	雙飛螺 Double Screw Nut
成立日期 Date of Formation	2014年4月 April 2014
業務單位 Business Unit	工程部 / 生產部 Engineering Department / Production Department
部門促進員 Team Facilitator	朱瑞榮 Andrew Chu
隊長 Team Leader	李志強 Vincent Lee
團隊 Team Members	阮澤廉 馮景漢 鄧柱業 湯兆方 葉巧君 陳志榮 Yuen Chak Lim Fung King Hon Tang Chu Yip Tong Siu Fong Yueh Hau Kwan Chan Chi Wing

### 背景 Background

- 2013年五加侖蒸餾水銷量只為生產線產出之89%，生產線使用率仍有空間供業務增長。
- 銷售需求量不斷增加。
- 2014年需求量已到達五加侖蒸餾水生產線最高產出。
- 另生產效率時會出現不穩定情況，造成間歇影響銷售供應，導至客戶投訴。
- 故集合製造部及工程部成員組成團隊，全力改善生產效率及生產能力，令業務持續增長。
- 5 Gallon Distill Water sales demand was only 89% of the line throughput in 2013. There was room for raising the line capacity to tie in with the business growth.
- Sales demand continuously increased.
- Till 2014 the sales demand had reached to the maximum throughput level of the 5 Gallon Distill Water line.
- There may be variations in the line efficiency. Sometimes it affected the sales supply and caused customer complaints.
- A team with members from Production and Engineering department was formed. The target was to improve the line efficiency and throughput so as to sustain the business growth.

### 問題成因 Cause of the Problem

團隊從流程開始研究，並搜集導致生產機故障的數據作分析，並繪畫柏拉圖及魚骨圖，找出問題成因如下：

- A) 生產線效率不穩定原因：  
上樽機故障 - 波子絲桿每條只安裝了1個波子絲母，但每條波子絲桿有4條螺紋，重壓不能平均分佈在4條螺紋上，導致螺紋磨損。
- B) 生產能力制約原因：  
充填速度 - 制約在於充填速度已經達致能力上限，每次充填時間為11秒，導致每小時產量只能在780支。

The team started from processing map analysis and collected the data of machine downtime with Pareto and Fishbone diagrams. The causes of the problem were identified as follows:

- A) The cause of variation in line efficiency: Carboy Loader downtime – One nut was only installed in each screw, but there were 4 threads on the screw. The load weight could not be evenly distributed on the threads and lead to wear and tears on the threads.
- B) The constraints of Line throughput: Carboy Filling time – The filling time had reached its optimum speed, the filling time is 11 seconds for each cycle and therefore, the hourly output is limited at 780 bottles.

### 解決方法 Solution

利用力場分析及TRIZ創新思維，團隊得出以下改善方案：

- A) 生產線效率改善：  
每條波子絲桿安裝2個波子絲母，盡用波子絲桿4條螺紋，重壓平均分佈在4條螺紋上，大大減低螺紋磨損。
- B) 生產能力制約移除：  
增加供水泵壓力以增加供水量及加裝六支濾芯以增加流量，從而提高供水及填充速度。
- Using the Force-Field analysis and TRIZ innovated thinking, the team identified the solutions as follows:
- A) Line efficiency improvement  
Modify the mechanism by having two nuts on each screw so that all 4 threads are now used to support the load weight. The stress is evenly spread. Wear and tear on threads could be dramatically reduced.
- B) Line throughput constraint removal:  
Increase pump pressure to max 2.0 bar in order to improve water supply pressure and installed 6 additional filter elements to improve water flow and filling speed.

## 成果及效益 Achievement & Benefit

### 有形得益

- 1) 銷售增加：
  - 每小時產出增加 100瓶，增幅12.65%。
  - 每年生產量共增多250,000瓶供銷售增長，全年銷售收入增多港幣1千6百萬元。
- 2) 降低生產成本：
  - 全年總生產成本節省港幣75萬元
- 3) 節省零件耗損：
  - 延長螺絲和螺母的使用壽命，全年節省零件費用港幣八萬元。
- 4) 項目支出：
  - 螺母及過濾濾芯全年合共港幣四萬元。

全年總得益超過1千6百萬元

### 無形得益

- 1) 產能得以提升，減低生產、工程及銷售員工之工作壓力。
- 2) 上樽機故障大大降低，避免了員工以體力將水樽搬運上架，造成工傷意外之風險。
- 3) 增強跨部門合作性及士氣。

### Tangible Benefits

- 1) Sales revenue increase:
  - Hourly output increase 100 bottles, percentage increase 12.65%
  - Annual total output increases by 250,000 bottles for increased sales demand, annual sales revenue increases by HK\$16 M
- 2) Production cost reduction:
  - Annual total production cost saving HK\$750,000
- 3) Spare parts saving:
  - Prolong the shelf life of screws and nuts, spare parts saving HK\$80,000 per year
- 4) Items expenses:
  - Nuts and filter elements, total expenses HK\$40,000 per year.

Annual total tangible benefit is over HK\$16million per year.

### Intangible Benefits

- 1) The line throughput was increased and that has greatly reduced the work pressure of all staff in production, engineering and sales departments.
- 2) As Carboy loader breakdown was significantly reduced, the risk of work accident caused from manually lifting the Carboy bottles to the rack was eliminated.
- 3) Cross-departmental cooperation and the staff morale has been enhanced.



五加侖疊板機  
Carboy Loader - new mechanical design improves the service life time and reduce downtime



五加侖灌注機  
Integrated Carboy washer / rinsers / fillers - improves the filling time to achieve a faster filling process