南華大學管理學院企業管理學系管理科學博士班

博士論文

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救治污染空氣之系統設計

Designing Systems to Treat Polluted Air

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博 士 學 位 論 文

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Designing Systems to Treat Polluted Air

博士生： 賴榮祥

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準博士推薦函

本校企業管理學系管理科學博士班研究生 賴榮祥 君在本系修業 7 年，已經完成本系博士班規定之修業課程及論文研究之訓練。

1、在修業課程方面： 賴榮祥 君已修滿 39 學分(參見附件之博士班歷年成績)，其中必修科目：最佳化理論、作業研究理論、書報討論、系統思考與決策等科目，成績及格。

2、在論文研究方面： 賴榮祥 君在學期間已完成下列著作：

(1)博士論文：救治污染空氣之系統設計

(2)學術著作：參篇學術論文被國際期刊 I.J.O.I.及 I.J.I.R.K.接受發表;此學刊被國際索引收錄(參見附件)其論文標題分別如下

i. An Innovative System Using Original Residential Water Towers and Pipes to Supply Solar UV-Lamp Sterilized Tap Water to Households

ii. Feasibility Analysis of Using Highway Guardrails to Produce Cleaned Carbon Dioxide to Nourish Economic Plants

iii.Planning and Implementing the Mechanism of cleanning Outdoor Air pollution

(3) 專利著作:獲台灣經濟部智慧財產局專利共兩項分別如下

i.專利名稱為管路清洗裝置;
專利証書號 M530190;
專利權期間自 2016 年 10 月 11 日至 2025 年 5 月 18 日止

ii. 專利名稱為淨化空氣污染物之車牌配件構造;
專利証書號 M570252;
專利權期間自 2018 年 11 月 21 日至 2028 年 5 月 1 日止(參見附件)

本人認為 賴榮祥 君已完成南華大學企業管理學系管理科學博士班之博士養成教育，符合訓練水準，並具備本校博士學位考試之申請資格，特向博士資格審查小組推薦其初稿，名稱：救治污染空氣之系統設計，以參加博士論文口試。

指導教授：＿＿＿＿＿＿簽章

中華民國 107 年 12 月 13 日

謝 誌

柒年的博士學程，用伍年完成博士論文，首先要感謝恩師 陳淼勝博士在求學期間諄諄地教導與鼓勵，一同探索學術領域並應用於實務，在恩師悉心指引下，從觀念的啟發及對論文內容不厭其煩的審閱斧正，使本論文得以順利完成，師恩浩瀚，永銘心中。

在學期間，承蒙系上師長的指導，在發掘問題及邏輯思考上，提供諸多寶貴建議，使我在管理科學領域與研究方法上收穫頗多。

校內初審口試，承蒙系上師長郭東昇主任、范惟翔老師、紀信光老師、許淑鴻老師提供諸多寶貴建議與指正，受益匪淺。在論文口試時，承蒙林進財博士、林明芳博士、賴奎魁博士與洪嘉聲博士不吝指正，經過他們嚴謹的審核，提供評論與建議，使本論文更臻完備，並感謝好友許崑峰的幫助，銘感五內。

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61 歲才獲得學位，真是彌足珍貴，真要讚許自己的勇氣與毅力。同時要感謝一路相持的陳淼勝老師、賴奎魁老師及摯友施育地博士、王憲斌博士及我最親愛的家人，願將此論文獻給父親賴得勝、母親賴蔡碧蓮，太太美華、兒女亭維、盈忻、昱辰及大姊素華、二姊素鐘、大哥志賢，特別是二哥榮賜及所有普蘭及普麗彩員工在這段期間辛勞相挺，願與他們分享多年來辛苦的收穫。

賴榮祥　謹誌

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南華大學企業管理學系管理科學博士班

107 學年度第 1 學期博士論文摘要

論文題目：救治污染空氣之系統設計

研 究 生：賴榮祥 **指導教授：陳淼勝 博士**

論文摘要內容：

本文將展示三個降低空汙的思想及方法。其中一個降低空汙的思想及方法內容為：利用太陽能提供動力，在既有公路護欄腹地上，架設具旋風動力之吸塵管及溼式洗塵管。此思想的特色是：在產生污染的第一時間蒐集汙染並同時淨化。這種將有害的空污轉化成有益於植物生長的碳來源，對缺乏自然資源之台灣，彌足珍貴。

本文第二個降低空污思想源自於：創造自來水生飲之節能省碳的降空汙效果。其背景及內容大致如下。台灣目前在電力能源的自行生產方面，無論是水力能、風力能、太陽能、廢棄物能、生質柴油能等，其理想成效尚有一段距離，因此節約電力更是應先被重視的議題，對此議題本文提出的系統設計如下：利用太陽能提供動力，以紫外線殺菌燈對住宅儲水塔中自來水殺菌，經此殺菌方法後的自來水，已被證實可達生飲的水準。本自來水生飲系統的創新設計做法是在原水管中架設醫用導管材質之小管，此小管穿透於大管中的穿透技術已獲台灣經濟部智慧財產局專利（詳見附錄 B）。其小管穿透並輸送生飲自來水的起點為原住宅頂樓儲水塔內，終點是各居家住宅廚房。此小管穿大管飲用水系統設計有下列幾項特徵：

1. 省略原有自來水必須煮沸才可飲用之程序而節省電力資源。
2. 使用如醫用導管材質製作輸送無菌自來水之小管，此材質穩定且

不會產生凹凸不平管壁（凹凸不平管壁容易產生細菌）。

3. 利用特殊裝備穿透技術，帶領小管前進或左右轉彎於大管中，其穿透技術是在待穿透前進小管前端裝置針孔攝影機，利用 5 個包裝一起的 5 個細管的加壓與否，控制各細管加壓與否的向後噴水反作用力；而使得小管在原水管中可向前推進直到廚房出口。

本文第三個降低空污思想是利用現有移動車輛淨化空氣污染物質，其主要內容是將每個汽車保險桿前之車牌往前移動，以便加裝空污濾網，利用所有行進中汽車一起過濾空氣污染，其中汽車加油時，加油站人員有義務抽換髒的濾網成乾淨濾網；而且不裝置此空污濾網汽車，加油時須繳較高單位油費。

關鍵字：溫室效應、移動污染源、自來水生飲、抵換

Title of Dissertation: Designing Systems to Treat Polluted Air
Department: Ph.D. Program in Management Sciences, Department of Business Administration, Nanhua University
Graduate Date: January, 2019 Degree Conferred: Ph.D.
Name of Student: Jung-Hsiang Lai Advisor: Miao-Sheng Chen, Ph.D.

Abstract

This paper contains three published journals and two patents covering the self-production of electric energy, the economical use of electric energy, and the idea and system design to improve air pollution. Energy is one of the public issues worthy of concern and promotion. Because Taiwan is located in a region with frequent earthquakes and typhoons, it should be more cautious in the choice of energy; and the way of generating electricity will be related to whether the emission reduction of Taiwan's CO_2 will meet the requirements of the Kyoto Protocol.

Gas waste recycling is an important issue; especially for a large number of emissions in locomotives and cars, not only carbon dioxide, but also pollutants such as sulfides, nitrides and fine aerosols are likely to cause allergies in the human respiratory system. The distribution of these pollutants is regional, so the degree of damage of pollutants in automobile exhaust gas should not only be paid attention to the extent which the pollutants are finally purified to, but also the problem of period from the initial point of production of pollutants to the time when they are purified.

In order to reduce the vehicle's exhaust pollution, it has been proposed to install a cyclone-powered dust suction pipe and a wet dust-washing pipe, with solar energy as power, on the hinterland of the existing road guardrail. Collect pollution and purify it at the same time as pollution occurs. This transformation

of harmful air pollution into a source of carbon, beneficial to plant growth, is invaluable to Taiwan, which lacks natural resources.

Taiwan is currently in the self-production of electric energy whether it is hydropower, wind energy, solar energy, waste energy, biomass diesel energy, and so on. Its ideal effect is still a long way to go; therefore saving electricity is a priority topic that should be paid more attention.

We have proposed how to sterilize tap water in residential water storage towers with solar energy as power, whose method has been confirmed that the number of bacteria is close to the level of raw drinking water. The method is to set up a small tube of medical conduit material in the raw water pipe, starting from the original residential water storage tower via the above-mentioned sterile tap water transported through the small pipe to the storage of the house to become a regular drinking water. This drinking water system is designed with the following characteristics:

(1) Save power resources by omitting the procedure with original tap water boiled before being drunk.

(2) The use of a medical catheter material as a small tube for transporting sterile tap water is stable in material and does not cause uneven wall (prone to bacteria on the uneven wall).

(3) Using special equipment (See Appendix B: Patent Certificate for Pipeline Cleaning Device), the mechanism can spray back the reaction force generated by the water at the front end of the water pipe as result in making the small pipe pushed forward in the original water pipe into the kitchen outlet.

Air pollution problems are becoming more and more serious, and relevant units of the government have also proposed prevention and control measures for various types of pollution sources. Preventing air pollution from pollution sources is considered to be a more economical way. However, when air pollutants are diffused, air pollutants are flooding the whole environment. How

to solve outdoor air pollution is really troublesome. This paper proposes three kinds of response mechanisms to try to solve the air pollutants that have been discharged into the outdoors, that is, to use the existing mobile vehicles to purify air pollutants, to recycle gas waste, and to promote tap water to drink.

Finally, it is recommended that the government implement the following policies:

(1) Implement pollution reduction in the area of air pollution control area, such as steam locomotives and other mobile pollution sources, and provide certain exchange to fixed pollution sources.

(2) The amount of electricity generated by tap water will be saved, whose saving can be supplied to a fixed source of pollution as a replacement.

Keywords: Greenhouse Effect, Mobile Pollution Sources, Drinkable Tap Water, ERCs

目錄

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第一章 緒論

1.1 研究背景

若依台灣目前二氧化碳 (CO_2) 排放來源的比率排序，則第一是發電產業;第二是含汽機車及鐵公路的運輸業;第三是含鋼鐵水泥石化等重工業。在所有能源中，以電力能源最引起關心與注意。概因它不僅與人民生活便利性直接產生關聯，且因台灣位於地震頻繁之區，核災風險是台灣應否繼續發展核能發電的嚴肅問題。此外另一須仔細研究的問題是:不同發電方式如何影響台灣 CO_2 之年排放量;其排放量是否可達成經濟部配合國際能源組織所制定的 CO_2 減量目標。目前台灣固體廢棄物的回收已具相當好的效果，這從近年來其焚化爐面臨無垃圾可燒之情況即可見一斑;詳見文獻 ([1],[2],[3],[6])。然而氣體廢棄物回收是一項尚待研發的重要產業。溫室氣體成分中，CO_2 為產生溫室現象的主要因素。CO_2 的產生主要是化石燃料(包括煤炭、石油、天然氣)的使用所造成的。京都議定書對各國未來 CO_2 排放的規範為 2020 年的排放量須回到過去 2005 年的排放量，而在 2025 年排放量須回到 2000 年的排放標準。然而從近年來台灣 CO_2 的排放數據得知:台灣欲在 7 年後之 CO_2 回到 2005 年之排放量(288.8 百萬公噸)，除非政府具有大刀闊斧的 CO_2 減量政策。否則，照此發展趨勢評估，台灣未來 CO_2 的年排放量，距離上述目標值將愈來愈遠([3],[7])。前述目標是能源局依國際京都議定書對台灣產業 CO2 之排放量要求而制定的。在日本福島發生核能災變後，同樣位於地震頻繁地區之台灣的核電政策，也開始被嚴格檢討。在台灣長期是否應採行無核家園政策的檢討聲浪中，本文期望先落實台灣自來水生飲之省電政策，再將此省電政策的省電效果，給予政府制定用電政策參考。

1.2 研究目的

本文是以台灣目前應如何救治污染空氣作為研究題材的主軸，其內容可綜合成下列三個研究主題。其中研究主題一將被展示在本文第三章。其內容為:利用原住宅水塔及原水管輸送經由太陽能電力之紫外線燈殺菌，將飲水輸至室內系統。研究主題二將被展示在本文第四章其內容為:利用原公路護欄腹地生產淨化二氧化碳滋養經濟植物的系統分析。研究主題三將被展示在第五章其內容為:規劃與實施戶外空氣污染淨化機制。其中第三章、第四章、第五章三個研究主題皆涉及空氣汙染的救治議題。這也是本博士論文名稱被取名為「救治污染之系統設計」。這表示在本論文題目下其問題將被細分成三個待解決的子題，此三個子題內容及研究結果將分別展示在本文的第三、四、五等三章，其中第三、四、五章之研究大要分別如下：

1. 子題一的研究大要是:利用太陽能電力在原公路護欄上架設具旋風動力之吸塵管及溼式洗塵管，利用原公路護欄腹地生產淨化二氧化碳滋養經濟植物在污染產生的第一時間，就吸收污化 CO_2 它並製成淨化的 CO_2。
2. 子題二的研究大要是:利用原住宅水塔及原水管，經太陽能電力紫外線殺菌燈，輸送飲水至室內系統是否能有效節省電力，以降低因發電而排放 CO_2 之量。
3. 子題三的研究大要是:利用行進中汽車設計裝置戶外空氣淨化系統。

1.3 研究架構

本文之研究架構如下列圖 1.1 所示。

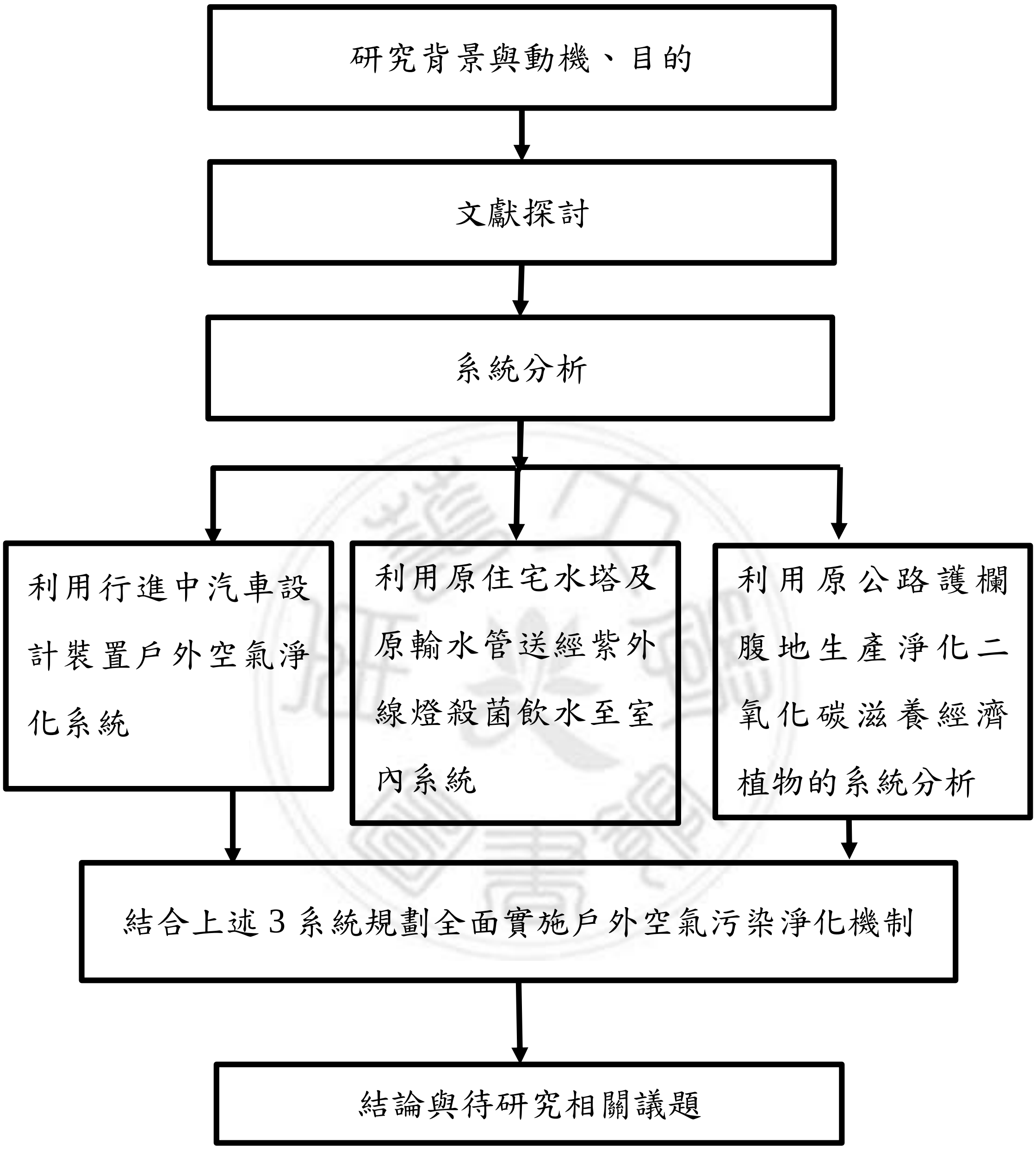

圖 1.1 研究架構圖

資料來源：本研究整理

第二章 文獻回顧

空氣污染包括固定污染源與行動污染源，污染物之淨化去除並無適當的對策，更不用說污染物之防治相關問題，政府等相關單位亦無法提出有效的解決措施。政府相關單位僅消極性規範境內污染物的產生，行政院環境保護署依空氣污染防制法第五條第三項規定訂定空氣品質標準，其監測空氣污染物以總懸浮微粒 (TSP)、細懸浮微粒 ($PM_{2.5}$、PM_{10})、臭氧 (O_3)、一氧化碳 (CO)、二氧化硫 (SO_2)、二氧化氮 (NO_2) 及鉛 (Pb) 為主。該標準依其濃度值作成空氣品質指標值 (AQI)，並定期公布之，以提醒民眾注意戶外活動適當時機降低暴露的危機。這些污染物質已被證實會導致人體罹患各種疾病。一般民眾面對空污問題在室內只能以加裝各類空氣清淨設備為主。

至於在戶外，民眾一般只能穿戴口罩來消極因應，截至目前尚無有效措施被提出來。近日報載（自由時報，民 107），對於戶外空氣污染問題的解決，中國已嘗試在空污嚴重的陝西省西安市建造高 100 公尺的空氣淨化塔。據稱該塔可淨化方圓 10 公里內的空氣，可去除 $PM_{2.5}$、氮氧化物、二氧化碳和二氧化硫等有害物質。每天可淨化 1 千多萬立方公尺的空氣，其中 $PM_{2.5}$ 可下降達 15%。此塔之真實的成效尚待官方進一步的評估公告。中國霧霾現象相當嚴重，以巨大影響其鄰近國家。瑞士 Climeworks 公司 (Climeworks，2018) 可直接從空氣中抓走二氧化碳，將其轉化成植物的養分，亦為減緩溫室效應作貢獻。

2.1 二氧化碳 (CO_2) 排放來源與回收

二氧化碳 (CO_2) 排放比率，第一是發電產業；第二是涉及民間消費之鐵公路運輸；第三是鋼鐵水泥石化等產業 (Tsai and Chen, 2001)。對台

灣而言，在所有能源中，以電力能源最應引起關心與注意。概因它不僅涉及位於地震頻繁之台灣，是否應繼續發展核能發電；同時也關係到台灣 CO_2 之年排放量是否可達成經濟部能源局所制定的 CO_2 減量目標(Chen and Chen, 2012)；前述目標是能源局依國際京都議定書對台灣產業 CO_2 之排放量要求而制定的。在日本福島發生核能災變後，同樣位於地震頻繁地區之台灣的核電政策，也開始被嚴格檢討。在台灣長期是否應採行無核家園政策的檢討聲浪中，本文期望先落實台灣自來水生飲之省電政策，再將此省電政策的省電效果，給予政府制定用。

台灣固體廢棄物的回收已具相當好的效果，這從近年來其焚化爐面臨無垃圾可燒之情況即可之一般 (Chen and Chen, 2012)。然而氣體廢棄物回收是一項尚待研發的重要事業。溫室氣體成分中，CO_2 為產生溫室現象的主要因素。CO_2 的產生主要是化石燃料（包括煤炭、石油、天然氣）的使用所造成的。京都議定書對各國未來 CO_2 排放的規範為 2020 年的排放量須回到過去 2005 年的排放量，而在 2025 年排放量須回到 2000 年的排放標準。然而從近年來台灣 CO_2 的排放數據得知 (Chen and Chen)：台灣欲在 2020 年之 CO_2排放量回到 2005 年之排放量（288.8 百萬公噸），除非政府具有大刀闊斧的 CO_2 減量政策，否則，照此發展趨勢評估，台灣未來 CO_2 的年排放量，距離上述目標值將愈來愈遠。

2.2 台灣與相關各國之 CO_2 的人均排放量比較

由文獻 (Chen and Chen) 得知：在各國每年人均 CO_2 排放量之比較中，以美國最多，這也是美國至今仍拒絕簽署京都議定書的原因之一。台灣雖然在 1997 年前 CO_2 人均的排放量皆低於日本，但在 1997 年後，皆超過日本；對於 CO_2 的人均排放量，台灣、中國大陸與南韓成長速度較

快 (Chen and Chen)。這表示近年來此三國之經濟發展仍高度依賴耗能產業。而美國、日本及香港之 CO_2 人均排放量，差異不大。新加坡 CO_2 排放量，從 1990 年之 15.41 公噸降至 2009 年之 6.39 公噸，其成效令人刮目相看。台灣 CO_2 之排放量恰與新加坡成反方向變化；從 1990 年之 5.88 公噸成長到 2000 年之 11.58 公噸。台灣面臨 CO_2 排放量如此嚴重惡化趨勢，似乎只有三種政策可改善它。分別為政策 1：改善能源結構；政策 2：調整產業結構（林唐裕，民 88；李高朝，民 102）及政策 3：直接淨化 CO_2 應用於經濟作物之光合作用上（將有害的 CO_2 變成有益的 CO_2）及減少發電量以降低碳排放。

關於政策 1，由於無核家園之民意高漲，也只能發展再生能源；而再生能源中因風力能限於成本太高（其中風力能又會產生低頻噪音及景觀問題）；水利能受限於水資源有限；廢棄物能面臨來源不足（近年，台灣垃圾分類成效高，焚化爐已面臨無垃圾可燒情況）；使得生質能源成為諸多再生能源中，唯一比較可能發展的項目。尤其比照台灣目前正實施之獎勵造林計畫（平均每公頃造林補助新台幣 9 萬元），將可生產生質柴油之痲瘋樹引入獎勵樹種，更是政府應考慮的能源政策之一。

關於政策 2：由於台灣企業大多中小企業，資本規模小，其產品須維持在高耗能低成本之原始產品上加工或整合，才有市場競爭力。因此短期內，台灣能調整產業結構的機會不大。

剩下來，就只有政策 3（直接淨化 CO_2 及減少發電量以降低碳排放）可以考慮立即採納；這也是本研究的問題狀況。

2.3 淨化二氧化碳之用途

二氧化碳是農作物進行光合作用的主要原料。光合作用形成有機物質約占作物總乾物質量的 90%~95%，只有 5%~10%的物質由土壤及肥料

提供；其中占乾物質密度比最大的碳、氧成分，皆從二氧化碳來的。其用途至少有下列幾種：

2.3.1 種植蔬果

以台灣種植黃瓜為例，其功效有下列五項 (Yao and Tian, 2008)：

(1) 促進蔬菜的光合速率

(2) 增加蔬菜的生物量（株重葉片厚度葉片面積等方向）

(3) 提高果菜的結果率

(4) 提高蔬菜產量（生長發育）

(5) 提高蔬菜的品質（顏色、口味等）

2.3.2 以淨化 CO_2 培育石油植物

所謂石油植物包含其樹液含有製作柴油之樹（如下列 1 所述)，或其樹種子可被提煉生質柴油之樹（如下列 2 所述)；或體內蓄積石油之水域藻類（如下列 3 所述)。

1. 在巴西熱帶雨林裡，發現一種能產出「石油」的奇樹，名為「科帕伊巴樹」。它是常綠喬木，品種繁多，數高達 20-25 公尺。每隔一年半或兩年開採一次，取油時，只要在樹幹上鑽一直徑約 5 公分小孔，1-2 小時內就能流出金黃色油狀樹液。一棵直徑在 1-1.5 公尺的科帕伊巴樹，每次可產樹液 15-20 公升。樹液化學成分與柴油相似，不須加工提煉，就可作為柴油使用 (Yao and Tian, 2008)。
2. 在台灣苗栗縣曾實驗，種子可提煉生質柴油之痲瘋樹（又稱小油桐學名為 Jatropha Curcas L.)：痲瘋樹幼苗 3 年後即成樹，其種子可提煉生質柴油，長達 50 年，惟痲瘋樹在成長過程中須吸收大

量 CO_2（其種子收成量隨 CO_2 肥增加而增加）。如果政府從 2008 年 3 月起實施 20 年之綠海計畫的獎勵造林樹種，可以包含麻瘋樹，則種植麻瘋樹之每位農民平均淨收入為 NT$304,760 元/年 (Yang and Chen, 2011)。日本佔據台灣時期，為了第二次大戰飛機燃料需求，有計畫在台灣中北部種植大戟科木油桐。目前已有 4000 公頃，數十年樹齡的木油桐。這是台灣在短期內可生產生質柴油的有利條件，其每公頃棵果量約 10 公噸，全乾種仁含油率 55%，如果再以淨化 CO_2 肥加以滋養產量更豐。由於桐樹各果實成熟時間不一致，須耗用人力採收，故樹高之油桐種子採收成本遠多於樹低之麻瘋樹（小油桐）。

3. 日本科研人員從一種淡水藻提取了石油，它不僅 CO_2 吸收需求率高，提煉石油發熱量高，且氮硫含量少。另巨藻含有豐富的甲烷成分；若有淨化 CO_2 協助海域進行大規模養殖，由於其葉片較集中海面上，可以每年機械化收割 3 次 (Perkins, 2009)。

2.3.3 淨化 CO_2 對溫室栽培蔬果的幫助

大氣中二氧化碳濃度約 0.03% (300mg/kg)。在溫室以日光代 替陽光之蔬果栽培，往往會因二氧化碳濃度不足而降低蔬果生長與產量，須以通風方式解決。但在寒冷的冬天，冷空氣的通風會降溫而影響蔬果成長；唯一解決之道，就是引進淨化 CO_2 入溫室施肥。理論上，不含硫、氮、鉛等污染源之汽、柴油，在完全燃燒下，會破壞燃料內碳氫鍵後與養重組，形成無害的二氧化碳及水，在環保民意高漲下，台灣生產的油品含鉛等金屬污染已大大降低。因此在公路行駛之汽車的氣體產生成分，除 CO_2 外，主要為不完全燃燒之碳氫 (HC)，排氣管廢氣中之硫 (S)、氮 (N)，及輪胎摩擦地面所產生微粒。

2.4 汽車行駛過程所產生的污染氣體

CO_2 由一單位探和二單位氧結合而成，它是一種無臭無味的氣體。雖然 CO_2 是造成溫室現象的主要原因，但嚴格而言，CO_2 並不是一種污染物，事實上它是所有植物行光合作用後產生根、莖、葉、果實等纖維成分的來源。CO_2 與人類的福祉關係可以用水 (HO_2) 能載舟(人類正面福祉)，水 (HO_2) 亦能覆舟（人類反面福祉）來形容。這也是為何淨化 CO_2 被稱為 CO_2 肥料的原因所在。因此本文所言之空氣污染物，並不包含 CO_2。

2.5 空氣污染物質

空氣污染係指在室內、外空氣中，存留有一種或多種的物質，如塵埃、燻烟、氣體、霧、臭味、煙、或蒸氣等，而其數量、特性和持久性足以損人體健康、危害動植物生命，使人蒙受財產損失或干擾生活之舒適性。空氣污染的來源可分為自然界產出及人類行為產出，自然界產出如火山爆發、岩床氡氣釋放、沙塵暴、龍捲風等；人類行為產出包含汽機車廢氣、工廠排放、石化燃料、核彈試爆、稻草燃燒、隧道橋樑工程爆破、煤礦開採、焚化爐焚燒等。因空氣污染物質繁多，本文僅列就台灣空氣污染防制法中空氣品質標準所監測之總懸浮微粒 (Total Suspended Particulate, TSP)、細懸浮微粒（Particulate Matter, PM，包括 $PM_{2.5}$、PM_{10}）、臭氧 (O_3)、一氧化碳 (CO)、二氧化硫 (SO_2)、二氧化氮 (NO_2) 及鉛 (Pb) 之空氣污染物為主。台灣以此制定依空污成份濃度值作成空氣品質指標值 (Air Quality Index, AQI)，定期公布以提醒民眾注意戶外活動適當時機降低暴露的危機。

2.6 空氣污染危害

空氣污染物是空氣中的物質，對人類和生態環境 生有害影響。該物質可以是固態顆粒、液態液滴、或是氣體。污染物可以是天然的，也可以是人為的空氣污染物中對人體危害最大的為懸浮微粒 (Particulate Matter, PM)。其中，直徑小於或等於 10 微米的顆粒物稱為 PM_{10}；直徑小於或等於 2.5 微米的顆粒物稱為 $PM_{2.5}$（細懸浮微粒）。$PM_{2.5}$ 的顆粒比 PM_{10} 的更危險，因為它小到可以穿透肺泡到達血液，引發心臟血管疾病、肺病，甚至肺癌 (Chen, 2015)。

Lin，Chen 與 Song (2018) 分析 2011-2015 年台灣全民健康保險資料庫 (National Health Insurance Research Database, NHIRD) 中的急性上呼吸道感染每週就診人次並探討季節效應及交互作用之影響。發現各年齡層急性上呼吸道疾病皆與 $PM_{2.5}$、PM_{10}、前期濕度、二氧化氮、二氧化硫等等空氣污染物質有關。環境中會造成空氣污染的物質，包括室內與室外的吸入型過敏原與空氣污染物 (Xu, 2015)。

2.7 空氣品質監測

為了就減少空氣污染對健康的影響提供全球性指導，世界衛生組織於 2005 年發佈了「空氣品質準則」，其中包括了對懸浮微粒濃度的限制，如表 2.1 所示。

表 2.1 世界衛生組織發佈之空氣品質準則

	PM_{10}	$PM_{2.5}$	選擇濃度依據
空氣品質準則值 (AQG)	20μg/m³	10μg/m³	對於 $PM_{2.5}$ 的長期暴露，這是一個最低水平，在這個水平，總死亡率、心肺疾病死亡率和肺癌的死亡率會減少(95%以上可信度)。

資料來源：本研究處理

台灣環境保護署於 2012 年 5 月公告修正空氣品質標準，增訂 $PM_{2.5}$ 空氣品質標準，並依據其國內健康影響研究結果，以健康影響為優先考量，將「$PM_{2.5}$」24 小時值訂為 35μg/m^3、年平均值訂為 15μg/m^3。台灣環保署訂於 2020 年達成全國細懸浮微粒濃度年平均值 15μg/m^3 的目標，同時將依國際管制趨勢發展，逐期檢討其 $PM_{2.5}$ 空氣品質標準，並朝達成 WHO 提出之空氣品質準則值為空氣品質改善目標。2014 年 6 月，教育部頒布「空污停課標準」。2014 年 12 月，台灣勞動部發布函釋，霾害應視同天然災害、可比照颱風假模式。根據「天然災害發生事業單位勞工出勤管理及工資給付要點」，地方首長可依權限宣布停班。但教育部訂出的空污停課標準卻是 $PM_{2.5}$ 達 350.4μg/m^3 以上才能停課，環保團體質疑此標準過高，學校根本放不到假。

2.8 空污防治措施

台灣環保署依據空氣品質模式分析結果，發現台灣 $PM_{2.5}$ 來自境內污染源比率約 60%-66%。而境內各類污染源對 $PM_{2.5}$ 濃度影響，則主要可分為工業源（如電力設施、鍋爐、鋼鐵業、石化業、水泥業、化學製品製造）、移動污染源（如交通工具）及其他污染源（如餐飲油煙、營建揚塵、露天燃燒）。了解各污染源之特性後，如何降低境內原生性 $PM_{2.5}$ 及衍生性 $PM_{2.5}$ 前驅物如硫氧化物、氮氧化物及揮發性有機物排放，則應是積極努力的目標 (Tsai, Yang and Huang, 2017)。台灣環保署除持續落實許可及排放量管理、排放標準管制、有害空氣污染物排放調查及管制、空氣污染防制費徵收與獎勵、逸散性粒狀污染物管制、揮發性有機物管制及工業區應變等固定污染源管制及新車管制、潔淨燃料推動、低污染車輛推廣等移動污染源管制之原有推動工作外，構思以創新思維加強整合部會量能。2016

年 12 月台灣行政院召集環保署等相關部會針對空氣污染防制召開策略規劃會議，於 2017 年 4 月通過「空氣污染防制策略」(Environmental Protection Agency, 2017)，採獎勵與法規管制並行的方式，規劃投入 365 億元，針對工業源、移動源與其他逸散污染源三大主要污染來源採防制措施。

2018 年 6 月台灣通過空氣污染防制法修正案，包含 5 大重點：增訂好鄰居條款、增訂工廠源頭管制機制、增加移動污染管制措施、提高罰則、和追繳不法利得與增訂吹哨者條款等。從空氣品質改善的規劃、污染源的源頭管制與中間管理，到管末處理及應變，都全面予以補強 (Environmental Protection Agency, 2018)，使空氣污染防治制度更加週全。落實空氣污染物總量管制總量管制區內，汽機車等移動污染源進行污染改善的污染減量 (Emission Reduction Credits, ERCs)，提供給固定污染源作為抵換 (Offset Practice) 使用。所謂抵換係指公私場所將空氣污染物削減量差額扣抵空氣污染物排放增量之作為 (Lin, 2015)。

第三章 利用原住宅水塔及原水管輸送太陽能紫外線燈殺菌飲水至室內系統

如何節約電力應被重視的議題。透過紫外線殺菌燈對住宅儲水塔中自來水殺菌後之自來水，證實接近無菌可飲用自來水。在原水管中加設如醫用導管材質之小管，以原住宅儲水塔為起點而以住宅廚房為終點，將前述無菌自來水透過小管方式，輸送並儲存於住宅室內成為經常備用的飲用水。此飲用水系統設計有下列幾項特徵：

(1) 省略原有自來水必須煮沸才可飲用之程序而節省電力資源。

(2) 使用醫用導管材質作為輸送無菌自來水之小管，其材質仍然穩定而不會產生凹凸不平管壁（凹凸不平管壁容易產生細菌）。

(3) 利用特殊裝備，其機構在水管前端可向後噴水產生的反作用力，而使得小管在原水管中可向前推進直到廚房出口。

3.1 本設計背景

本文期望先落實台灣自來水生飲之省電政策，再將此省電政策的效果，給予政府制定用電政策參考。

台灣能源極度缺乏，其能源供應地區大部分集中在中東及印尼，距離遙遠，不但運輸及交易成本高，且能源供給市場極易形成獨佔或寡佔。台灣面臨不穩定的能源供給現象，正凸顯自己生產能源及節約能源的重要性。在自行生產能源方面，台灣目前自產能源主要是再生能源，它包含水力能、風力能、太陽能、廢棄物能、生質柴油能等。

以發電為例（表 3.1），水力發電受制於台灣水資源逐漸匱乏，發展機會不大；風力發電在運轉過程中，會產生低頻噪音、景觀等問題而引起居民抗議；太陽電能發電成本高達生質能發電成本之 4 倍 (Chen and Chen,

2012)；廢棄物發電也因目前垃圾分類效果頗佳，許多焚化爐面臨無垃圾可燒情況。台灣核能發電裝置容量維持穩定，而火力發電裝置容量卻逐年升高，詳如表 3.2 所示。其中又以燃煤發電比最高，燃煤發電所產生的 CO_2 排放量最驚人，平均每度發電量，依煤炭品質，會產生 900-1000 公克 CO_2，大約為天然瓦斯的 2-3 倍 (Chen and Chen, 2012)。 如此高比例的火力發電，所產生的 CO_2 排放，在全球溫室氣體減量共識下，將不利台灣的形象，也可能因此招致國際制裁。從上述說明得知，如何發展生質能源及如何節約能源是台灣目前急待解決的能源政策問題。尤其自來水可生飲政策更是節約能源之立竿見影政策。這是本文聚焦於探討如何利用原有住宅水塔及水管輸送經太陽能儲電紫外線燈殺菌後之飲用水至室內之系統設計的原因所在。

從上述說明得知，如何發展生質能源及如何節約能源是台灣目前急待解決的能源政策問題。尤其自來水可生飲政策更是節約能源之立竿見影政策。這是本文聚焦於探討如何利用原有住宅水塔及水管輸送經太陽能儲電紫外線燈殺菌後之飲用水至室內之系統設計的原因所在。

表 3.1 台灣近 10 年再生能源發電裝置容量

年度	合計	水力發電	風力發電	太陽光電	生質能發電	廢棄物能發電
2005	2,607.6	1,909.7	23.9	1.0	99.1	573.8
2006	2,739.4	1,909.7	102.0	1.4	116.8	609.5
2007	2,848.9	1,921.2	186.0	2.4	116.8	622.5
2008	2,933.1	1,937.9	250.4	5.6	116.8	622.5
2009	3,060.0	1,936.9	374.3	9.5	116.8	622.5
2010	3,214.6	1,977.4	475.9	22.0	116.8	622.5

表 3.1 台灣近 10 年再生能源發電裝置容量（續）

年度	合計	水力發電	風力發電	太陽光電	生質能發電	廢棄物能發電
2011	3,417.1	2,040.7	522.7	117.9	111.3	624.4
2012	3,615.4	2,081.4	571.0	222.5	111.3	629.1
2013	3,828.1	2,081.4	614.2	392.0	111.3	629.1
2014	4,079.2	2,081.4	637.2	620.1	111.3	629.1
2015	4,318.6	2,089.4	646.7	842.0	111.3	629.1

單位：MWh

資料來源：能源局（民 105）

表 3.2 台灣近 10 年發電裝置容量表

民國	火力	核能	抽蓄水力	再生能源	總計
97	1503.6	392.6	34.6	71.7	2002.4
98	1434.9	399.8	32.9	68.4	1936.1
99	1567.6	400.3	30.5	75.5	2073.9
100	1616.9	405.2	28.9	79.4	2130.4
101	1602.5	388.9	29.2	96.5	2117.1
102	1604.3	400.8	31.7	97.5	2134.3
103	1665.3	408.0	31.1	87.9	2192.2
104	1716.5	351.4	30.2	92.9	2191.0
105	1804.5	304.6	32.8	116.0	2257.9
106	1949.5	215.6	33.2	112.5	2310.8

單位：MWh

資料來源：能源局（民 105）

3.2 台灣自來水生飲的省電情況

Lin (2007) 彙整台灣有關自來水質飲用水法規以作為自來水水質管理執行的目標，其目標實施法則包含對於水質水源的保護，以維護民眾水質乾淨、淨提升淨水監控系統、加強水質改善、供水普及率等等執行準則。台灣自來水營運初期以普及用水為主軸。後期，人民的生活水準提高，對水質的要求漸漸提升，因水質的要求也因此而提高，故水質的品質唯有不斷的改善以符合先進國家的生活標準。

臺灣自 1979 年開始禁止使用鉛管作為飲用水管，而為了改善飲用水的品質，自來水公司逐步進行管 線的汰換工程，不鏽鋼管為所選用的新管材。由於考慮到汰換管線的成本，因此汰換工程主要選擇在公共給水管線中進行，家用鉛管則繼續殘留在住戶中，而造成部分汰換的狀況產生 (Chen, 2016)。雖然自來水廠淨水處理後的水質標準已可生飲，但因輸水管在長久使用後，水管內壁已呈現凹凸不平而滋養細菌。故目前台灣民眾仍不放心，自來水廠出水至住家或機構房舍內之自來水可以生飲；因而其飲水習慣，仍必須將自來水煮沸冷卻後，才敢飲用。雖然將自來水煮沸之燃料來源主要有：電（電熱水瓶或電磁爐）、液化瓦斯及天然瓦斯等 3 種；但為分析方便，以下將以其用電量作為分析的基礎。

經本文實際實驗的結果得下列數據：

數據 (1)：平均每人每天飲用水 2 公升，煮沸所需熱量如下：

水每公升加熱上升 1 度 C 約需要 1 仟卡的熱量。因一般水溫約為 20 度，故一壺 2 公升的水加熱至 100 度所需的熱能為：

$$2（公升）\times (100 - 20)^{o}C = 160\ (kcal) \tag{3.1}$$

數據 (2)：若每人每天飲用水 2 公升，以電磁爐煮沸，則其電費如下：

電磁爐每度輸出熱量為：

$$860(\text{kcal / kWh}) \times \text{效率 } 90\% = 774 (\text{kcal / kWh}) \qquad (3.2)$$

將(3.1)除以(3.2)

$$160 (\text{kcal}) \div 774 (\text{kcal / kWh})= 0.2067 \text{ kWh（度）} \qquad (3.3)$$

目前電費之收費對象以戶為單位，其中每戶電費收費標準為：若該戶用電超過 300 度，以每度 3.5 元收費；若未超過 300 度，則每度以 2.8 元收費。惟台灣人民生活養成非常依賴電的習慣（如冷氣機及各種電器用品使用普遍化），因此大部分家庭之每月每戶電費為 3.5 元。因此，每人每天飲用水電費為：

$$0.2067 (\text{kWh}) \times 3.5(\text{元 / kWh}) = 0.7235 \text{ 元} \qquad (3.4)$$

數據 (3)：每人每天飲用水量 2 公升，以電熱水瓶煮沸，則其電費如下：（以容量 3 公升每小時消耗 985 度電之象印牌電熱水瓶做實驗得知：將 3 公升自來水加入在容量上限為 3 公升之象印牌電熱水瓶中，其煮沸時間須 23 分鐘）

$$3.5 \text{ 元 / kWh} \times 0.985\text{kWh} \times 23\text{mins / } 60\text{mins} \times \frac{2}{3}$$

$$= 0.8808 \text{ 元} \qquad (3.5)$$

數據 (4)：平均每人每天飲用水量（2 公升）之煮沸電費為：

$$\frac{1}{2}\left[(2.4)\text{式} + (2.6)\text{式}\right] = \frac{1}{2}\left[0.7235 \text{ 元} + 0.8808 \text{ 元}\right]$$

$$= 0.8021 \text{ 元} \qquad (3.6)$$

因此由 (3.6) 得知，台灣 2300 萬人每年飲用水煮沸所需電費為：

$$0.23 \text{ 億} \times 0.8021 \text{ 元/天} \times 30 \text{ 天} \times 12 \text{ 個月}$$

$$= 66.4139 \text{ 億元/年} \qquad (3.7)$$

3.3 利用紫外線燈殺菌生產可生飲的飲水系統

本系統將利用太陽能儲電，並用此儲電作為紫外線 C (UV-C) 殺菌燈的電力來源。紫外線 C 對於細菌、病毒、微生物等有極大的摧毀作用。其殺菌原理是破壞細菌、病毒、微生物脫氧核糖核酸 (DNA)、核糖核酸 (RNA) 的結構，而導致其死亡。紫外線燈管以天然水晶為材料之純石英玻璃管所製造者最佳（其紫外線穿透率大於 80%）。因此，對殺菌、消毒完全度考量，當然必須採用石英玻璃管所製造的紫外線燈管。無論從哪一層面考量，此消毒法皆遠比氯或臭氧消毒法為佳（參見表 3.3）。

表 3.3 紫外線 C (UV-C)、氯、臭氧消毒法比較表

	紫外線 C	氯	臭氧
消毒方式	物理	化學	化學
成本投資	低	低	高
運行成本	低	中等	高
維護費用	低	中等	高
消毒效果	極好	好	不穩定
消毒時間	1-5 秒	25-45 分鐘	5-10 分鐘
對人體危害性	極低	中等	高
殘留有毒物質	無	有	有
對水、空氣的改變	無	會	會

資料來源：Hung and Lee (2012)

紫外線消毒法，是目前最先進、最有效、最經濟的消毒法。它只要幾秒鐘即可徹底對所有細菌、病毒、寄生蟲和藻類等殺滅（參見表 3.4）；而

且不會造成二度污染，不殘留任何有毒物質，而被消滅的物體，無腐蝕性、無污染、無殘留。

表 3.4 紫外線 C (UV-C)100%消滅各類細菌病毒所需時間

種類	名稱	殺滅所需時間（秒）	種類	名稱	殺滅所需時間（秒）
細菌類	炭疽桿菌	0.30	細菌類	結核(分支)桿菌	0.41
	白喉桿菌	0.25		霍亂弧菌	0.64
	破傷風桿菌	0.33		假單胞桿菌屬	0.37
	肉毒梭菌	0.80		沙門氏菌屬	0.51
	痢疾桿菌	0.15		腸道發燒菌屬	0.41
	大腸桿菌	0.36		鼠傷寒桿菌	0.53
病毒類	腺病毒	0.10	病毒類	流感病毒	0.23
	噬菌胞病毒	0.20		脊髓灰質炎病毒	0.80
	柯薩奇病毒	0.08		輪狀病毒	0.52
	愛柯病毒	0.73		煙草花葉病毒	16
	愛柯病毒 i 型	0.75		B 肝病毒	0.73
黴菌孢子	黑麯黴	6.67	黴菌孢子	軟孢子	0.33
	麯黴屬	0.73-8.80		青黴菌屬	2.93-0.87
	大糞真菌	8.0		產毒青黴	2.0-3.33
	毛黴菌屬	0.23-4.67		青黴其它菌類	0.87
水藻類	藍綠藻	10-40	水藻類	草履蟲屬	7.30
	小球藻屬	0.93		綠藻	1.22
	線蟲卵	3.40		原生動物屬類	4-6.70
魚類病	Fung1 病	1.60	魚類病	感染性胰壞死病	4.0
	白斑病	2.67		病毒性出血病	1.6

*UV 強度：30 mw / cm^2

資料來源：Qinhuangdao Shijiyuan Water Treatment Technology (2012)

在本文之自來水生飲系統設計構想中，將會在原住宅水塔內，嵌入一不鏽鋼（水）塔。此不鏽鋼塔左右上方各有一入水口，當水塔內水位上升至入水口高度，不鏽鋼塔內自動就會流水並被紫外線燈殺菌，殺菌後之可生飲水，將以在原水管內加裝心導管材質之小管輸送至室內廚房出口處備飲使用。當不鏽鋼塔之儲備飲用水低於某水位時，可透過感應器開啟補充自來水至水塔，直到水塔水位高度達到不鏽鋼塔左右入水口高度為止。當不鏽鋼塔外水位恰低於不鏽鋼塔內水位時，即啟動紫外線燈殺菌，詳見圖 3.1 (Lai and Chen, 2016)，在圖 3.1 中，不鏽鋼塔左右邊緣各設有一鋸齒狀之條狀物，此設計之目的，乃是為了方便能將不鏽鋼塔提升出來，以便清理其底層的沉澱雜質。

本研究在原水管內加裝醫材級導管材質之小管以輸送可生飲水至室內廚房出口處備飲使用。所謂醫材料為用於製造體內或體外使用的醫學器材材料，這些醫學器材基本上直接或間接的會與人體的組織、體液或血液等接觸。傳統的生醫材料研發概念認為，適用在人體內理想的生醫材料必須符合以下的條件：良好的生物相容性質、惰性 (Inert)、無毒性 (Non-Toxic)、不產生過敏(Non-Allergic Response)、不致癌 (Non-Carcinogenic)及容易獲得且便宜等特性。臨床上使用的生醫材料可以分為四大類，金屬與合金材料 (Metals And Alloys)、陶瓷材料 (Ceramics)、高分子材料(Polymers)與生物組織材料等 (Sung and Chen, 2003)。本研究即採用具高惰性安全性之高分子導管材質，以確保生飲水之安全衛生。

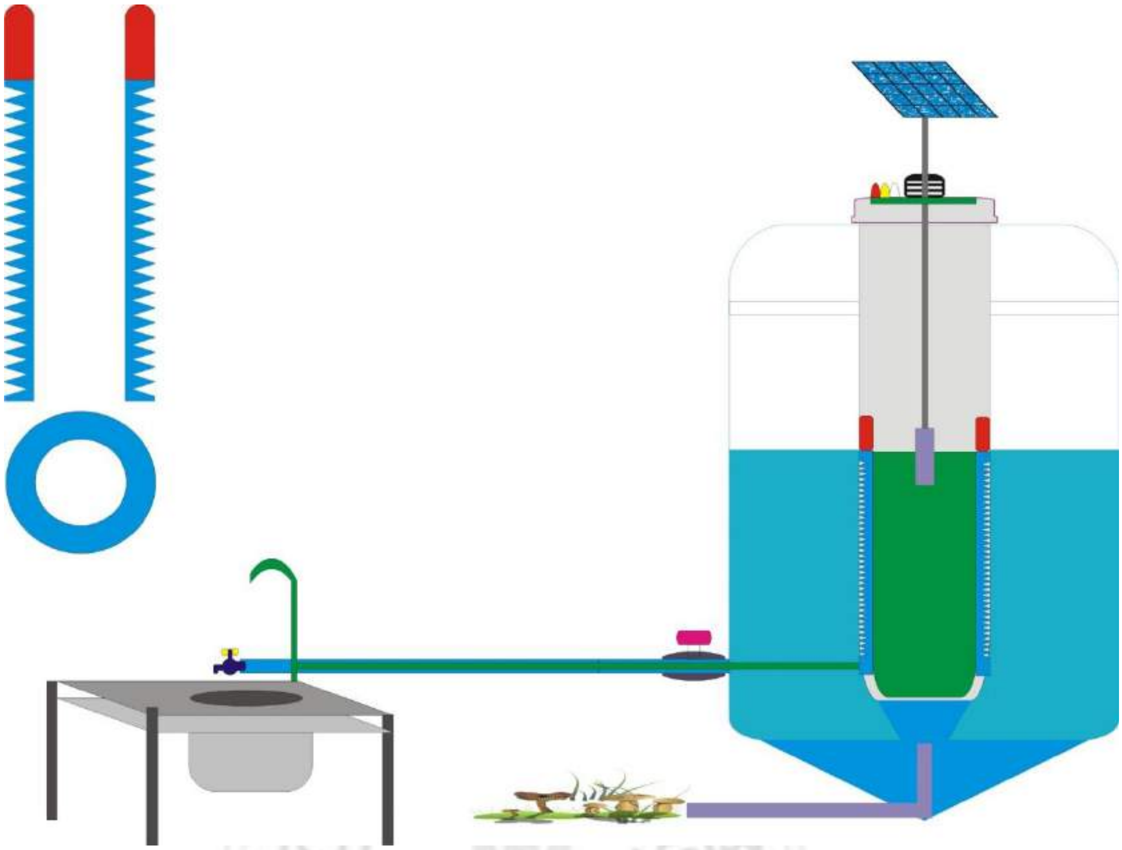

圖 3.1 自來水生飲系統設計架構圖

資料來源：本研究整理

3.4 將住宅水塔無菌飲水輸送至室內之輸送系統

Lai, Chen and Chen (2016) 以新型專利「管路清洗裝置」來解決習知管路清洗裝置清潔效果不佳的問題。此具自走式影像傳出功能之管路清洗裝置的創新設計詳述如後，並如圖 3.2 所示。管路清洗裝置包含一清洗頭本體，其設有一個推進槽道、一個旋轉噴注槽道、數個噴洗槽道和一個旋轉刷頭，其中該旋轉刷頭可旋轉地設於清洗頭本體前端。該推進槽道位於清洗頭本體內部的一端呈封閉狀，另一端連通至該清洗頭本體的外表面。清洗頭本體具有一中心軸線，推進槽道位則沿著此一中心軸線開設。數個噴洗槽道環設於推進槽道的外周，各噴洗槽道的一端則連通至該清洗頭本體的環周面。清洗頭本體的前端外緣設有一刮片。管路清洗裝置另

包含數個設於清洗頭本體後端之管件，並分別由一端連接該推進槽道、旋轉噴注槽道和數個噴洗槽道。此管路清洗裝置亦另包含用以容納流體的一個容器，該數個管件的另一端連接至該容器，並由一控制器控制此容器內的流體供出或收回。此管路清洗裝置亦另包含一監看系統，此系統具有一攝影機耦接一台聯接顯示器之控制主機。清洗頭本體設有一容槽，而此容槽在清洗頭本體的前端端面呈開放狀以容置該攝影機，而其蓋體是以可透視材質製成的。此容槽不連接該推進槽道、旋轉噴注槽道和數個噴洗槽道，其容槽的底部則呈封閉狀。其中，旋轉刷頭包含一蓋體及一刷具，此蓋體的內表面圈圍形成一容室，而清洗頭本體的前端端面鄰接該容室，該刷具則連接於此蓋體之外表面。該清洗頭本體具有一中心軸線，旋轉噴注槽道的一端連通至該容室並偏離該中心軸線。蓋體的內表面設有數個凸片，此凸片則以該中心軸線為中心成環狀的角度間隔排列。清洗頭本體的前端設有一環狀的內凹槽，該蓋體則在環周緣設有數個卡鈎以卡扣至該內凹槽。

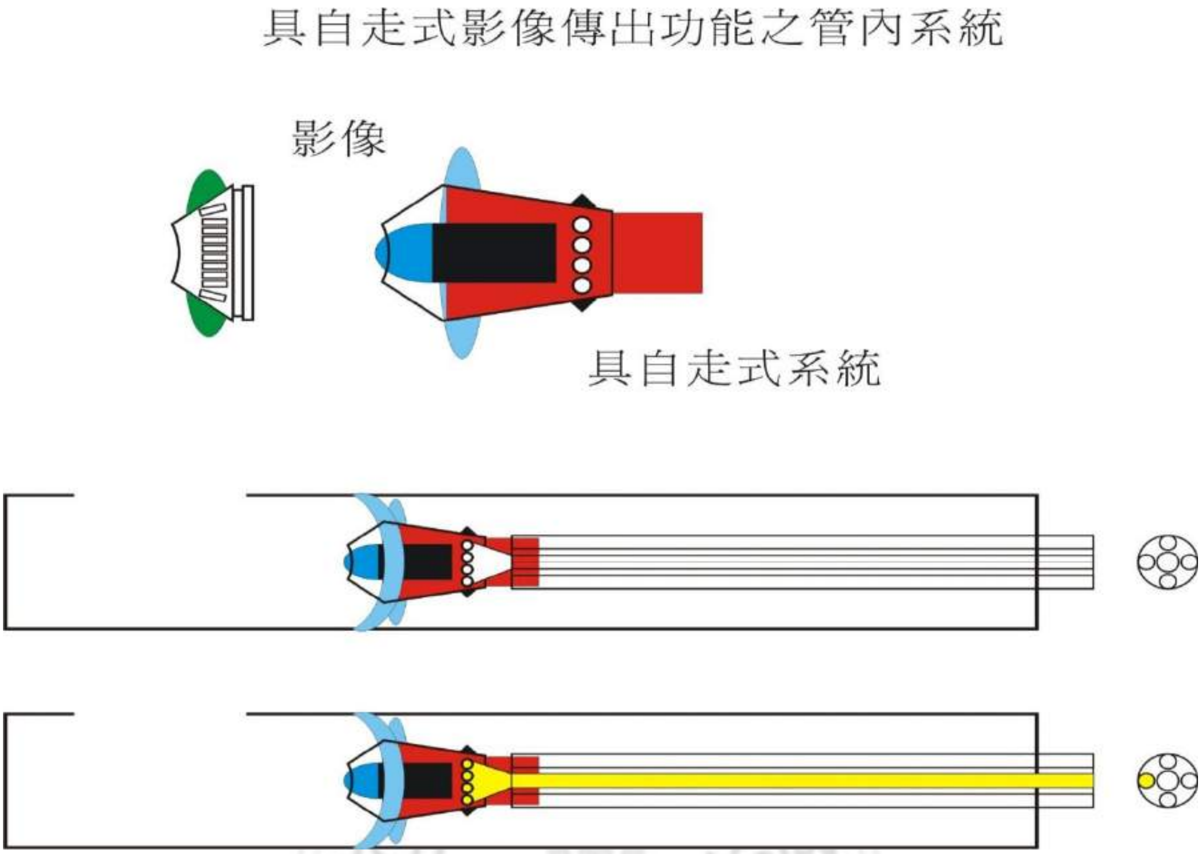

圖 3.2 具自走式影像傳出功能管內系統

資料來源：本研究整理（參見本文附錄）

3.5 本章小結

台灣在能源持續短缺，溫室效應問題所產生的副作用持續升高下，不僅颱風頻繁發生且其風雨所帶來的災害愈來愈嚴重。近幾年更因颱風或午後雷陣雨，帶來之黃色自來水而引起公憤。引起公憤的主要原因出自於飲用水的短缺。概因將黃色自來水用於生活之民生非飲用水使用尚可接受，但人們卻不能一天沒有可飲用的自來水。如果各家庭皆在其水塔內裝置本文所設計之太陽能儲電紫外線燈殺菌後的可飲用儲水槽，以如醫材導管材料作成之小管，透過既有水管（大管包小管）將前述可直接飲用自來水輸送至各住宅廚房；則在其無菌生飲水儲量可用天數，超過政府緊急治理黃色自來水所需天數之情況下，將大大降低民眾前述對黃色自來水

事件的抱怨。

這表示本文所設計之無菌自來水系統，具有下列幾項優點：

(1) 節省能源（不必煮沸可直接生飲）

(2) 原水管中所嵌入之小管材質不會受環境影響而變質生菌

(3) 接水管嵌入不鏽鋼儲水塔底部可將污水排至外可用於清洗和其它用途不浪費水資源

(4) 裝置本無菌飲水系統，可避免飲用因颱風或雷陣雨所產生的黃色自來水。

至於是否可在前述小管外周圍加設光纖，使得輸送無菌飲用水之小管，同時具有網路線的傳輸功能，將是未來值得再進一步研究的議題。

第四章 利用原公路護欄腹地生產淨化二氧化碳滋養經濟植物的系統分析

4.1 本設計背景

汽車廢氣中之含污物質危害程度的衡量，不應只是含污物質最終被淨化到何種程度，還應包含污染物質產生時點至其被淨化時點之時間長短的多寡。本研究利用太陽能電力在公路護欄上架設具旋風動力之吸塵管及溼式洗塵管，達到在污染產生的第一時間，就吸收它並製造淨化的 CO_2。這種將被認為缺點的空污 CO_2 轉化成被認為優點的淨化 CO_2 之作為，對缺乏自然資源之台灣，彌足珍貴。

4.2 台灣與相關各國之 CO_2 的人均排放量比較

由文獻 (Chen and Chen, 2012) 得知：在各國每年人均 CO_2 排放量之比較中，以美國最多，這也是美國至今仍拒絕簽署京都議定書的原因之一。台灣雖然在 1997 年前 CO_2 人均的排放量皆低於日本，但在 1997 年後，皆超過日本；對於 CO_2 的人均排放量，台灣、中國大陸與南韓成長速度較快 (Chen and Chen, 2012)。這表示近年來此三國之經濟發展仍高度依賴耗能產業。而美國、日本及香港之 CO_2 人均排放量，差異不大。新加坡 CO_2 排放量，從 1990 年之 15.41 公噸降至 2009 年之 6.39 公噸，其成效令人刮目相看。台灣 CO_2 之排放量恰與新加坡成反方向變化；從 1990 年之 5.88 公噸成長到 2000 年之 11.58 公噸。台灣面臨 CO_2 排放量如此嚴重惡化趨勢，似乎只有三種政策可改善它。分別為政策 1：改善能源結構；政策 2：調整產業結構及政策 3：直接淨化 CO_2 應用於經濟作物之光合作用上（將有害的 CO_2 變成有益的 CO_2）。

政策 1：由於無核家園之民意高漲，也只能發展再生能源；而再生能源中因風力能限於成本太高（其中風力能又會產生低頻噪音及景觀問題）：水利能受限於水資源有限；廢棄物能面臨來源不足（近年，台灣垃圾分類成效高，焚化爐已面臨無垃圾可燒情況）；使得生質能源成為諸多再生能源中，唯一比較可能發展的項目。尤其比照台灣目前正實施之獎勵造林計畫（平均每公頃造林補助新台幣 9 萬元），將可生產生質柴油之痲瘋樹引入獎勵樹種，更是政府應考慮的能源政策之一。

政策 2：由於台灣企業大多中小企業，資本規模小，其產品須維持在高耗能低成本之原始產品上加工或整合，才有市場競爭力。因此短期內，台灣能調整產業結構的機會不大。剩下來，就只有政策 3（直接淨化 CO_2）可以考慮採納；這也是本研究的問題狀況。

4.3 淨化二氧化碳之用途

二氧化碳是農作物進行光合作用的主要原料。光合作用形成有機物質約占作物總乾物質量的 90%-95%，只有 5%-10%的物質由土壤及肥料提供；其中占乾物質密度比最大的碳、氧成分，皆從二氧化碳來的。其用途至少有下列幾種：

4.3.1 種植蔬果

Yao 及 Tian 以黃瓜作為實驗對象，提高種植時空氣中二氧化碳的濃度，發現到可以促進蔬菜的光合速率並增加蔬菜的生物量（株重葉片厚度葉片面積等方向），所種植的黃瓜果實具高結果率、高產量及高品質（顏色、口味等）等優點。

4.3.2 以淨化 CO_2 培育石油植物

所謂石油植物包含其樹液含有製作柴油之樹（如下列 4.3.2.1 所述），或其樹種子可被提煉生質柴油之樹（如下列 4.3.2.2 所述）；或體內蓄積石油之水域藻類（如下列 4.3.2.3 所述）。

4.3.2.1 在巴西熱帶雨林裡，發現一種能產出「石油」的奇樹，名為「科帕伊巴樹」。它是常綠喬木，品種繁多，數高達 20-25 公尺。每隔一年半或兩年開採一次，取油時，只要在樹幹上鑽一直徑約 5 公分小孔，1-2 小時內就能流出金黃色油狀樹液。一棵直徑在 1-1.5 公尺的科帕伊巴樹，每次可產樹液 15-20 公升。樹液化學成分與柴油相似，不須加工提煉，就可作為柴油使用 (Yao & Tian, 2008)。

4.3.2.2 在台灣苗栗縣曾實驗，種子可提煉生質柴油之痲瘋樹（又稱小油桐學名為 Jatropha Curcas L.）：痲瘋樹幼苗 3 年後即成樹，其種子可提煉生質柴油，長達 50 年，惟痲瘋樹在成長過程中須吸收大量 CO_2（其種子收成量隨 CO_2 肥增加而增加）。如果政府從 2008 年 3 月起實施 20 年之綠海計畫的獎勵造林樹種，可以包含痲瘋樹，則種植痲瘋樹之每位農民平均淨收入為 NT$304,760 元/年 (Yang and Chen, 2011)。日本佔據台灣時期，為了第二次大戰飛機燃料需求，有計畫在台灣中北部種植大戟科木油桐。目前已有 4000 公頃，數十年樹齡的木油桐。這是台灣在短期內可生產生質柴油的有利條件，其每公頃棵果量約 10 公噸，全乾種仁含油率 55%，如果再以淨化 CO_2 肥加以滋養產量更豐。由於桐樹各果實成熟時間不一致，須耗用人力採收，故樹高之油桐種子採收成本遠多於樹低之痲瘋樹（小油桐）。

4.3.2.3 日本科研人員從一種淡水藻提取了石油，它不僅 CO_2 吸收需求率高，提煉石油發熱量高，且氮硫含量少。另巨藻含有豐富的甲烷成分；若有淨化 CO_2 協助海域進行大規模養殖，由於其葉片較集中海面上，可以每年機械化收割 3 次 (Perkins, 2009) 。

4.3.3 淨化 CO_2 對溫室栽培蔬果的幫助

大氣中二氧化碳濃度約 0.03% (300mg/kg)。在溫室以日光代替陽光之蔬果栽培，往往會因二氧化碳濃度不足而降低蔬果生長與產量，須以通風方式解決。但在寒冷的冬天，冷空氣的通風會降溫而影響蔬果成長；唯一解決之道，就是引進淨化 CO_2 入溫室施肥。

理論上，不含硫、氮、鉛等污染源之汽、柴油，在完全燃燒下，會破壞燃料內碳氫鍵後與養重組，形成無害的二氧化碳及水，在環保民意高漲下，台灣生產的油品含鉛等金屬污染已大大降低。因此在公路行駛之汽車的氣體產生成分，除 CO_2 外，主要為不完全燃燒之碳氫 (HC)，排氣管廢氣中之硫 (S)、氮 (N)，及輪胎摩擦地面所產生微粒。

4.4 汽車行駛過程所產生的污染氣體

CO_2 由一單位探和二單位氧結合而成，它是一種無臭無味的氣體。雖然 CO_2 是造成溫室現象的主要原因，但嚴格而言，CO_2 並不是一種污染物，事實上它是所有植物行光合作用後產生根、莖、葉、果實等纖維成分的來源。CO_2 與人類的福祉關係可以用水 (HO_2) 能載舟(人類正面福祉)，水 (HO_2) 亦能覆舟（人類反面福祉）來形容。這也是為何淨化 CO_2 被稱為 CO_2 肥料的原因所在。因此本文以下之空氣污染物，並不包含 CO_2。

汽車行駛過程所產生的空污，可分為：內燃（引擎）系統空污與廢棄系統空污。

4.4.1.內燃系統空污

他產生地點有燃料箱、化油器及曲軸箱三處，其污染過程幾乎全是在上述三處空隙蒸發溢出的碳氫化合物 (HC)。在未設防污措施前（如圖 4.1），此三處所溢出之 HC 量約佔空污 HC 總量的百分之四十；另百分之六十的空污 HC 由廢棄系統排放出來。

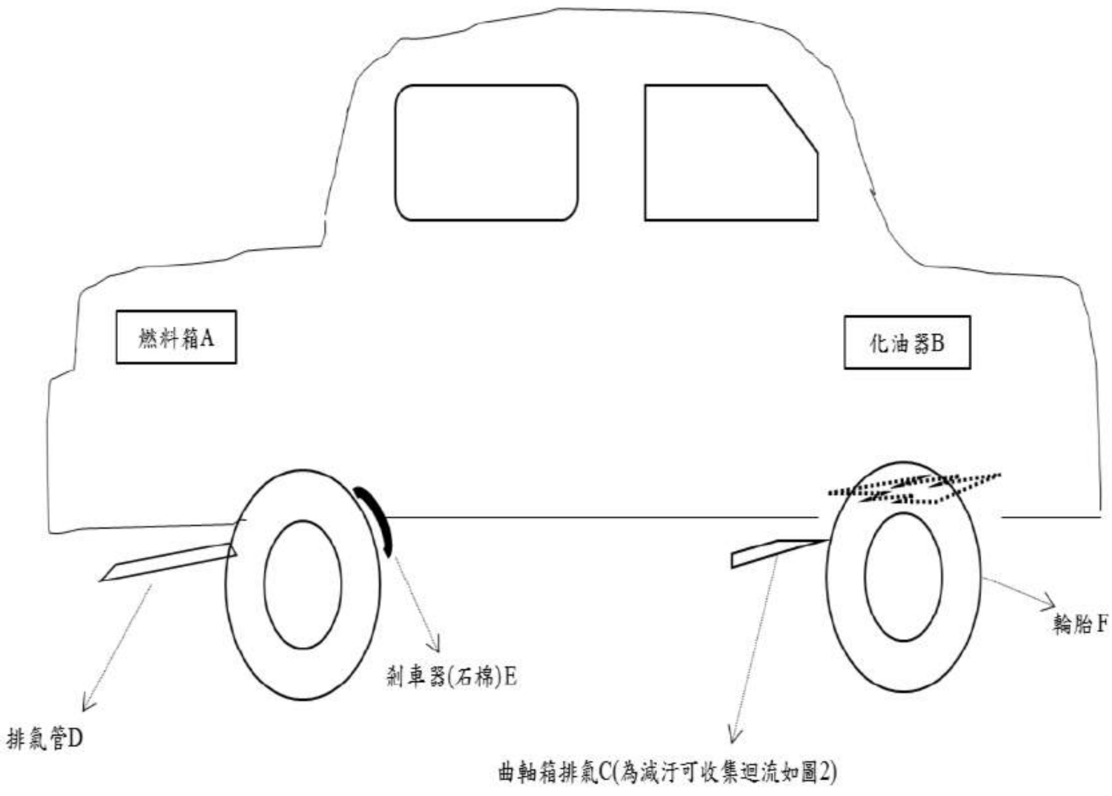

圖 4.1 汽車行駛產生的污染氣體 (Perkins, 2009)

資料來源：本研究整理

汽車排放的 HC：A 與 B 合佔 20%；C 佔 20%，D 佔 60%

汽車排放的 CO，NO_x，鉛，D 皆佔 100%

汽車行駛中的微粒污染：E 與 F 和佔 100%

有效降低內然系統空污之措施如下（參見圖 4.2 虛線部分）：

措施 (1)：強化燃料箱 A、化油器 B、曲軸箱 C 及引擎的設計，以避免 HC 從中溢出或蒸發。

措施 (2)：將從燃料箱 A、化油器 B 溢出之 HC 截流於活性碳罐內，壓縮空氣將其打入引擎再燃燒（參見圖 4.2 右上方）。

措施 (3)：封閉原從曲軸箱直接通往車外空氣之出口，將已蒸發之 HC 氣體收集迴流至具有逆止排氣閥的歧管 (Intake Manifold) 後再燃燒（參見圖 4.2 左方）。上述三措施 2 已是目前內然系統減污 HC 的共識。

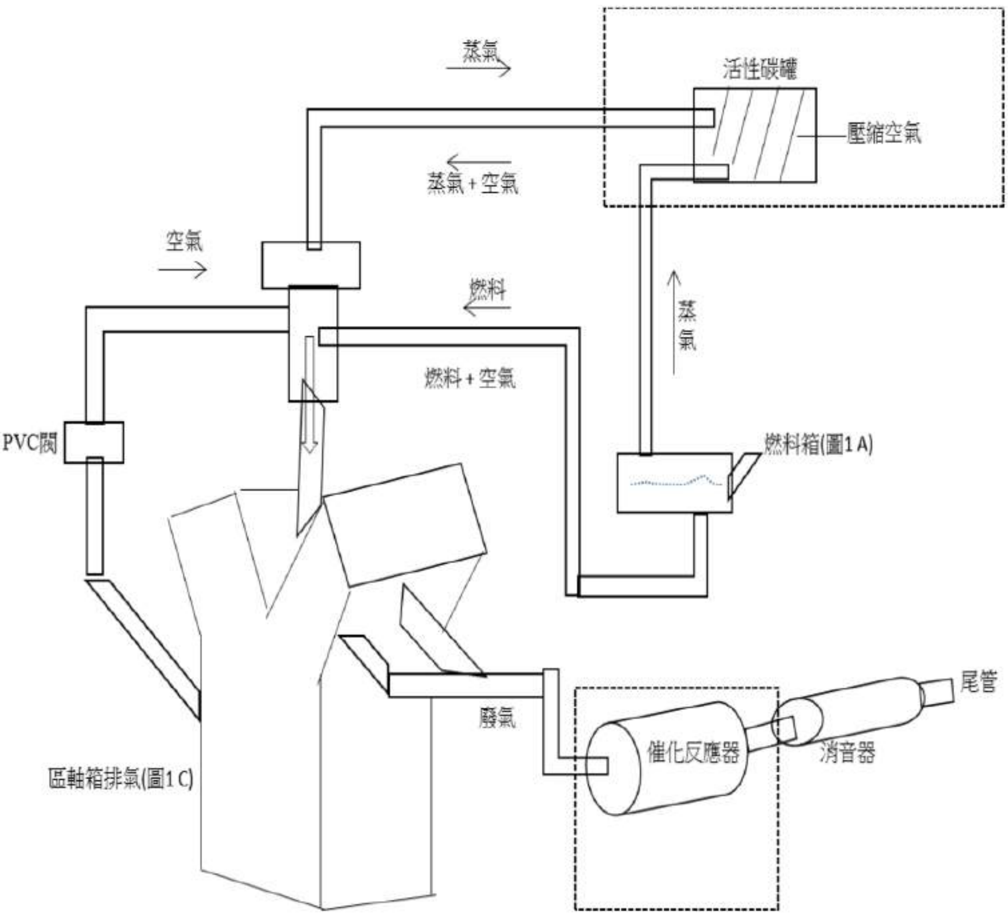

圖 4.2 在內然引擎減少 HC 方式（如虛線框內所示）

資料來源：本研究整理

4.4.2 廢棄系統空污

其減污方式是在排氣管之消音器前加裝催化反應器，其功能是將 CO 及 HC 氧化成 CO_2 及水，將 NO 還原成 N。目前欲在美國上市出售的汽車，必須裝設有催化反應器。在內然引擎中，雖然增加空氣對燃料量比，可減少 CO 與 HC 量，但卻增加 NO 量。站在減污的目標立場，內然引擎之空氣對燃料量的最佳比值決定於：邊際 CO、HC 之減污成本，等於邊際 NO 減污成本之數值。

台灣政府亦可比照美國，要求製造汽車廠商所使用的引擎系統及廢棄系統，需有上述的減污設施，如此可將操作汽車所造成的污染源降到最低。剩下來的就是將公路上汽車外 CO_2 從混雜污染空氣中分離出來問題。

4.4.3 在公路護欄上架設減污設施

本文結合並改良現有旋風集塵器及填充塔洗塵器 (Perkins, 2009)，成為如圖 4.3 之「旋風灑水減污器」。同樣的旋風灑水減污器可以無數個，掛設於公路（特別在高速公路）護欄上，如圖 4.4 所示。

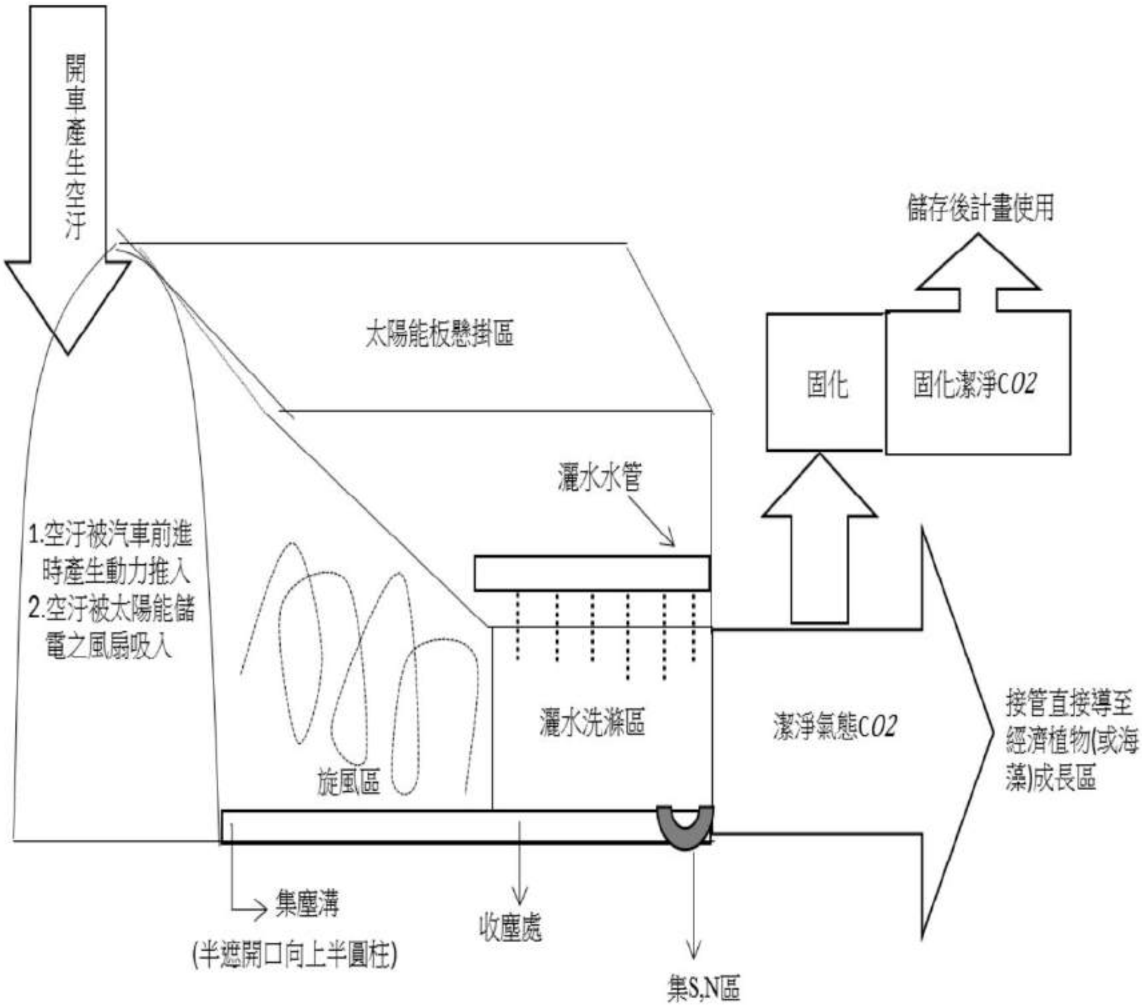

圖 4.3 旋風灑水減污裝置示意圖

資料來源：本研究整理

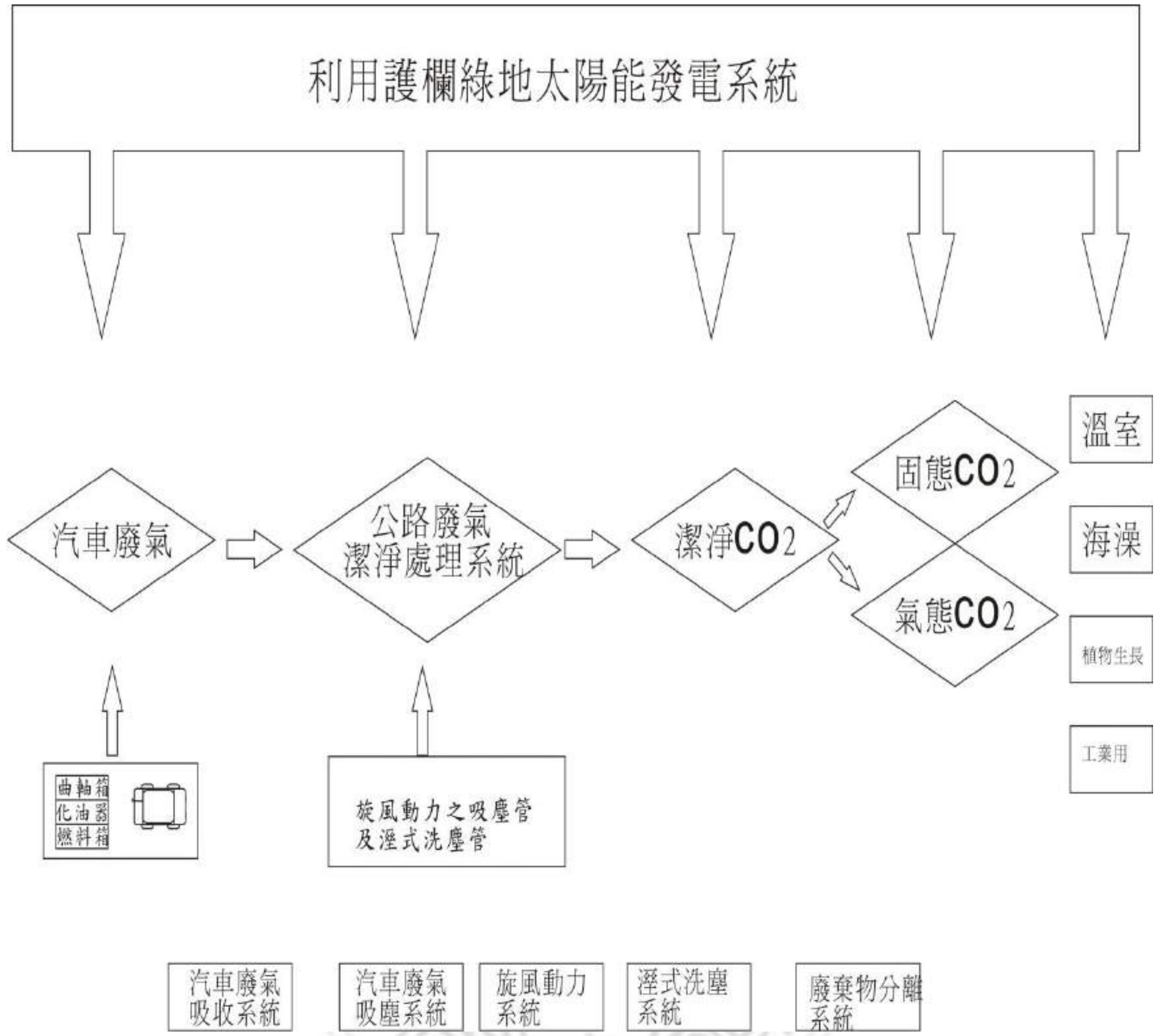

圖 4.4 利用護欄綠地太陽能發電系統回收 CO_2 系統示意圖器

資料來源：本研究整理

如此設計的理由如下：

(1) 公路兩旁（含安全島）皆有樹木需要定期澆灌。為節省澆灌人力，可考慮加設水管，透過電源的定時開關，一方面可澆灌路旁花木，另方面可切換成圖 4.3 灑水洗滌區用水。

(2) 公路上之護欄上方空間開闊，可被用來裝設太陽能板，一方面作為吸收污染空氣風扇的動力來源，另方面作為圖 4.3 灑水洗滌區的動力來源。

(3) 既有的旋風集塵器有兩種，一種是乾式旋風集塵器；另一種是溼式旋風集塵器。雖然溼式旋風集塵器知吸塵效果較佳，但其污染泥如何處理卻產生另一個問題。因此圖 4.3 才被設計成除塵之乾溼區分離。

(4) 汽車排氣管出來的污染物成分複雜，且顆粒的形狀不同、重量不一。污染空氣如圖 4.3 被吸進或推入（被行進汽車所帶動的氣流推入）後，經半圓錐體（污染空氣入錐體的面積大，出錐體的面積小）造型所產生的旋轉效果，較重的顆粒在碰撞半圓錐體的內壁後會摩擦減速沿壁面滑下至集塵溝。因集塵溝為開口向上之半圓柱，在沒外力干擾下，最後會沿半圓柱壁面滑至半圓柱溝的底部。但半圓錐旋風器卻隨時皆有外在風力吹進，可能會使得已隨壁面滑至溝底之顆粒，再度被風力吹揚起來；為防患此再度被揚起顆粒的可能性，故半圓柱形集塵溝上方加設只遮一半的的蓋子。它既方便污染顆粒沿壁滑至溝底，又降低已滑至溝底之顆粒再度被後續的風力吹揚起來。

(5) 污染顆粒物在圖 4.3 左側之旋風集塵區被淨化後，剩下的空污成分當屬硫 (S) 與氮 (N)。由於濕式洗滌不僅可吸收 SO_2 也可吸收 NO_2，故在圖 4.3 之右式設計了灑水洗滌區。因淨化的 SO_2 與 NO_2 可作為除蟲液、消毒液、清潔液使用，故圖 4.3 之旋風洗滌減污器才如此設計。

(6) 如果政府可以賞罰並列的要求，汽車排氣管之排氣方向具選擇功能；則在要求近內車道行駛小車之排氣方向為向左，近慢車道行 駛大車之排氣方向為向右的情況下，將增進圖 4.3 污染廢氣被吸進旋風洗滌減污器之效率。

(7) 生產淨化 CO_2 與生產電一樣，它們在生產後皆應立刻分配到需求處而不可儲存，雖然本文曾提及淨化 CO_2 的用途，但產出與需求之間

幾乎無時間落差的搭配措施，是一項必須思考的問題。

4.5 本章小結

台灣從 1990 年至 2005 年的溫室氣體排放量增加 134%，是世界第一，這表示台灣在過去數十年的經濟發展，仍非常依賴耗能產業。既然台灣短期內無法透過產業結構改善達到減碳成效；生產淨化 CO_2 將 CO_2 的缺點轉化成優點，似乎就成為唯一的選擇。

無法生活與生存的狀況。本文適時提出,不但可節能且可即時淨化公路 CO_2之思想架構。此淨化公路 CO_2 的思想架構是應用現有公路護欄，廣設本文設計的「旋風灑水洗滌器」，以達成生產淨化 CO_2 之目標。本文不僅展示旋風灑水洗滌器的元件架構，並說明其設計所秉持的道理。生產淨化 CO_2 的部分成效，與製造汽車公所採行的引擎之防污效果有關，也與汽車駕駛人之排氣管的排氣方向有關；本文對此皆有論述與說明。

本文之生產淨化 CO_2 的思想，仍屬初步的構想，其是否真的可行？仍需多少配套措施加入其間？這些皆尚待將「旋風灑水洗滌器」製造出來，架設於高速公路護欄上，用實際的實驗數據來說明可行性。

第五章 規劃與實施戶外空氣污染淨化機制

在眾多空氣污染源排放管制外，以排放於戶外空氣污染物質之回收或淨化，截至目前，尚無有效措施被提出來。雖然以空氣淨化塔 (Liberty Times, 2018)、從空氣中抽取二氧化碳 (Climeworks, 2018)、或推動電動車取代燃油車皆可以做為淨化戶外空氣污染物的努力之一。但電動車之電能需求會增加火力發電，連帶增加因火力發電而產生的空污。再加上台灣境外污染物質與境內產生的污染物質，勢必要有新的機制與措施來改善及緩和日益嚴重的戶外空污問題，以改善民眾健康與生活品質。

5.1 戶外空氣污染淨化機制

無論空污淨化設備多好，若無法在污染物質產生的第一時間就將其淨化，則其淨化效果就要打折扣。空氣污染物質一旦飄散開後，要捕捉它、淨化它是非常不容易的。因此本文提出以佛學妙有的義理為立論依據，嘗試以產生污染物質之汽機車為載具來配置淨化空氣污染物質系統，將淨化後的乾淨空氣再排出於大氣中，以達到淨化空氣污染物質之目的。架在每部汽機車上的淨化系統將使得每部行進中車輛產生污染物質，也同時能淨化空氣中污染物質。本車淨化他車所產生之污染物質，他車淨化本車所產生的污染物質。雖然此淨化系統規模小，但以其高機動性與高密度性，將以螞蟻雄兵之態，以最低成本有效地達成淨化或減低戶外污染物質之目的。其淨化成效將是目前淨化設備無法做到的。

為達到上述目的，提出一種空氣汙染物淨化之車牌配件構造，包含：一本體，具有中空結構；該本體包含進氣口及出氣口；具有擋泥斜板構造於進氣口處（參見圖 5.1），係用於阻擋泥砂進入濾清器內部；擋水幕於擋泥斜板與進氣口之間，係用於阻擋雨水與地面積水進入濾清器內部；一濾

清結構位於本體之中空結構內，係用於過濾由進氣口經擋泥斜板與擋水幕所過濾的空氣；兩固定孔，可藉由車牌之固定螺絲將本體固定於車牌與車輛之間（參見圖 5.2）。

本案的優點在於其一為不需要額外的電能供應，因此更加的環保，其二為此裝置隱藏於車牌後，可避免影響車輛美觀。其三為在使用位置在汙染濃度最高的街道上，比起配置於家中或是隨身用之過濾器，有更好的效率。

綜合上述，本設計，相當符合公益之需求，可以為原本僅能配備口罩去消極面對空氣汙染的民眾，提供更加良好的路上空氣品質，確實具有功效之增進，且非易於達成。本案未曾公開或揭露於國內與國外之文獻與市場上，已符合專利法規定。

上列詳細說明係針對本創作之一可行實施例之具體說明，惟該實施例並非用以限制本創作之專利範圍，凡未脫離本創作技藝精神所為之等效實施或變更，均應包含於本案之專利範圍中。

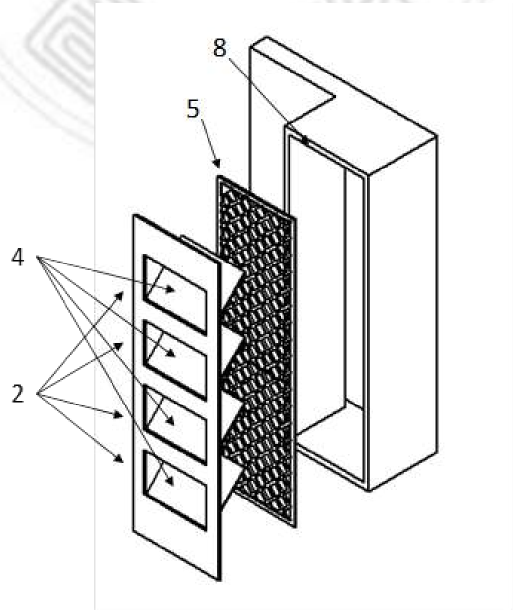

圖 5.1 進風口結構示意圖

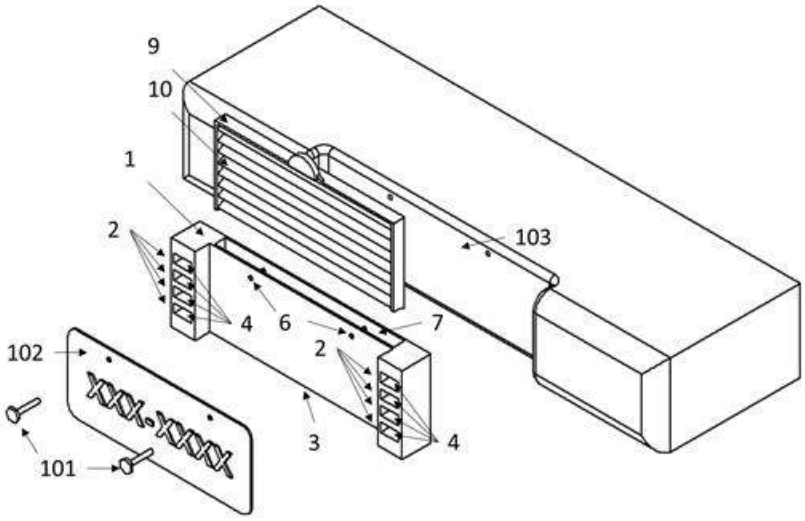

圖 5.2 過濾設備裝置示意圖

5.2 本章小結

就如本文研究，空氣是所有污染物質中最難處理，因為它以 3D 立體傳播，速度最快，一旦飄散開後非常不容易淨化，各國莫不以各種方式試圖改善，但投資巨大且成效未知，因此本文嘗試以汽機車為載具，用現有裝置用最少資源，提出淨化空氣減少污染物質系統，將淨化後的乾淨空氣再排出於大氣中，不斷循環再生有如妙有理論，以達到淨化空氣及減少污染物質之目的。本章歸納出以此特性，能對已飄散開的空氣污染，有效捕捉它、且淨化它，提出貢獻。

特性一：利用現有汽機車移動中的車輛，產生風動力，帶動本機構中可抽換濾網，以達到淨化空氣，減少污染物質

特性二：本機制不需提供額外的動力能源，即可淨化空氣，減少污染物質，且可減少能源消耗。

特性三：不影響使用者的開車習慣，亦不改變及違背現有法規（改造車輛），利用現有的車牌機構，達到立即有效淨化空氣，減

少污染物質。

第六章 結論

本文以台灣目前應如何救治污染空氣作為研究內容的主軸，空氣污染源大致上可區分為固定污染源與流動污染源二類，其中固定源主要是發電產業所產生的污化 CO2；流動污染源主要是汽機車所產生的行車廢氣。目前不僅台灣政府對此兩類污染物之淨化去除並無有效的對策，更不用說污染物之防治相關問題，連政府外圍相關組織亦未提出立竿見影的解決措施。本文嘗試對此二類空氣污染源的救治，分別提出可行方法如下。

6.1 綜合研究結果

對固定污染源的空氣污染問題，本文提出的救治方法是設計自來水生飲機制，概因自來水生飲可以省電，省電就能減少發電後的污化 CO_2。

排放量而降低空污，易言之，本文對因發電所引起的污染空氣的防制方法，是發電量的節能而不是發電的開源，其中如何利用現住戶的既有水塔及水管，以大水管內加入小水管穿進其間；以便利用水塔所加設的太陽能電力紫外線殺菌後可生飲水；透過大管中小管至戶內生飲，為其主要研究成果，此大水管中加入小水管之穿管技術已獲台灣經濟部智慧財產局專利，如何將自來水生飲問題制作成可具體討論的型態；並將其設計成自來水可生飲機制，是本文在此議題的重要貢獻。

對流動污染源的空氣污染問題，本文提出兩種救治方法。此兩種救治方法皆是基於下列概念產生的思想。

無論空污淨化設備多好，若此淨化機制無法在污染物質產生的第一時間就將其管制及淨化，則其淨化效果就會因污化空氣隨時間擴散而救治空污效果打折扣。亦即空氣污染物質一旦飄散開後，要捕捉它、淨化它

是非常不容易的。但對已存在於戶外空氣中的污染物質仍須嚴肅地面對如何防治它的問題。本文流動空氣污染源的第一種救治方法就是:分析利用公路護欄淨化二氧化碳滋養經濟植物行光合作用產生作物的可行機制,此機制需有下列配合輔具共同參與,包括須在公路護欄上架設具有旋風動力之吸塵管,溼式洗塵管及太陽能電力以便操動前述兩輔具。其尚待研發的技術在於淨化後的二氧化碳如何儲存與移至他處使用問題。如何將污化的二氧化碳製作成淨化的二氧化碳之問題製作成可具體討論的型態,是本文在此議題的重要研究成果與貢獻。

本文對流動空氣汙染源的第二種救治方法就是:以現有汽機車為載具,在其外車牌處加裝抽裝容易的空污濾網;利用行進中汽機車動力過濾污化空氣成淨化空氣。其中將汽車前保險桿中央處車牌往前移,以便裝置空污濾網之系統設計的完成為本文在本議題的重要研究結果,此研究結果雖已獲得台灣經濟部智慧財產局專利,惟其專利欲落實尚需政府公權力配合辦理下列三項措施,其中措施一為汽車至加油站加油時,油站服務員有義務抽換車牌的空氣濾網,措施二為若汽車車主不裝置本文所設計的空污濾網,則該車加油時車主須支付較高的加油費,措施三為政府須責成汽車製作商在新出產的汽機車一律要安裝本文所設計的汽車空污淨化系統。

6.2 未來尚待研發相關議題

為擴充本文研發成果的應用面及落實本文兩項專利的公益效果,尚有下列各項後續研究亟待開發。

6.2.1 本文自來水生飲專利尚待後續研究項目

待開發項目之一:各國政府皆規劃將燃油車全面改成電動車以降空

污。雖然移動車輛污染排放能獲得控制，殊不知電動車之電能需求會增加火力發電（因台灣以非核家園作為能源政策主軸），連帶增加因火力發電而產生更多的空污。任何能降低、節省用電量的設備，皆能對空污減量產生貢獻。完善的自來水生飲系統將進一步節省發電量，因而會對發電空污排放進一步降低。政府除戮力於確保自來水品質外，制度上要鼓勵民眾安裝本文前述的自來水生飲系統。協助此自來水生飲系統的安裝設置量，可換算其污染減量，亦提供給固定污染源作為抵換使用。如此將能有效地、快速地推廣自來水生飲，抑制發電空污的排放量。

研發項目之二：考慮在本文所設計之大水管中之小水管的管壁材質中加設光纖，使得輸送無菌飲用水之小管，同時具有網路線的傳輸功能。

6.2.2 本文之利用原公路護欄淨化汽車空污機制尚待後續研究項目

待研發項目之一：被淨化的二氧化碳如何被固化或液化，以便淨化的二氧化碳可以儲存及搬遷至需要光合作用的遠處田園或海域中的成長植物。

待研發項目之二：既然各公路護欄處可產生淨化的二氧化碳，那些公路旁有適合土地及配合氣候溫度的樹種可使淨化的二氧化碳直接控制使用增進經濟作物產值。

6.2.3 本文之利用汽車保險桿中央車牌處加裝空污濾網機制，尚待後續研究項目

待研發項目：為擴大本專利之應用場合，考慮將類似汽車的降空污機制用於機車上。即比照本專利的思想方法，於機車適當處加裝淨化空氣過濾器。用於機車車牌在機車後端中央處（與汽車車牌位於汽車前端不同），故欲以機車為載具行過濾空氣之機

制的設計，須另行思考重新設計。如果所有機車與汽車皆能同時加入淨化空氣的救治，預期其減污效果必令人滿意。

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附錄

A-1

International Journal of
Organizational Innovation

DATE: February 26, 2018
INVOICE #: 2018-0833

Dear Po-Yu Chen, Miao-Sheng Chen, Jung-Hsiang Lai, and Hsien-Bin Wang,

Your article has been accepted for publishing in the *International Journal of Organizational Innovation.* Your article titled:

AN INNOVATIVE SYSTEM USING ORIGINAL RESIDENTIAL WATER TOWERS AND PIPES TO SUPPLY SOLAR UV-LAMP STERILIZED TAP WATER TO HOUSEHOLDS,

will be published in the issue of the journal due **April 1, 2018.** At the time of publication, your article may be viewed at the "Current Issue" on the journal homepage online: http://www.ijoi-online.org/

If you have any questions, please email them to me: ijoinnovation@aol.com

Thank you,

Dr. Frederick L. Dembowski

President, The International Association of Organizational Innovation
Editor, *The International Journal of Organizational Innovation*
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Organizational Innovation

AN INNOVATIVE SYSTEM USING ORIGINAL RESIDENTIAL WATER TOWERS AND PIPES TO SUPPLY SOLAR UV-LAMP STERILIZED TAP WATER TO HOUSEHOLDS

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Abstract

In Taiwan, the production of in-house electric energy and the economization of electric energy are public affairs most worthy of concern and popularization. They are related to the justifiability of the advocacy of carrying on nuclear electric power generation in Taiwan, with deep concern of its frequent earthquakes. Moreover, can Taiwan's annual CO_2 emission reduction meet the requirement of the Kyoto Protocol? In terms of the production of in-house of electric energy in Taiwan, hydraulic energy, wind energy, solar energy, waste energy and biodiesel energy are not yet ideal. Therefore, how to economize power utilization becomes a subject of great concern. The tap water from residential water towers is sterilized by ultraviolet germicidal lamps, which has been proved to produce almost aseptic tap water. A cardiac catheter material-like tubule is inserted into the original water pipe, starting from the original residential water tower and ending in kitchen. The aforesaid aseptic tap water is delivered through the tubule at a low rate and stored in the room as reserved drinking water. This potable water system design has the following features: (1) omitting the original procedure of boiling tap water before drinking to economize power resource; (2) using human cardiac catheter material as the tubule to deliver aseptic tap water, while the material is very stable at high temperature, there will not be rough inner wall of tubule because rough tube walls are likely to breed bacteria. (3) using jets water backward at the front end of a water pipe, this special equipment generates a counterforce to push the tubule forward in the original water pipe till it reaches the kitchen outlet. (4) if necessary, setting an optical fiber around the aforesaid tubule, the tubule can have the transmission function of a network cable.

Keywords: Carbon Dioxide, Drinkable Tap Water, Ultraviolet Sterilization, Cardiac Catheter Material

Background

In terms of Taiwan's CO_2 emission, its ranking is the power generation industry, rail/road transport and steel, cement, and petrochemical industries (Tsai & Chen, 2001). In Taiwan, electric energy shall be highly considered among all energy sources, which is related to frequently occurring earthquakes and their effect on nuclear electric power generation; and whether Taiwan's annual CO_2 emission rate can attain the goal of CO_2 reduction, as established by the Bureau of Energy, Ministry of Eco nomic Affairs (Chen & Chen, 2012). The aforesaid goal is established by the Bureau of Energy according to Taiwan's industrial CO_2 emissions, as required by the Kyoto Protocol. After the Fukushima nuclear catastrophe, the nuclear power policy of Taiwan was strictly reviewed regarding whether Taiwan shall exercise a nonnuclear homeland policy in the long-term. This paper hopes to implement the energy saving policy of drinkable tap water in Taiwan, where the energy saving effect of this energy saving policy is provided as reference for the government to establish a power utilization policy.

Taiwan is very short in energy, and its energy is mostly supplied from the Middle East and Indonesia, which are far away. Thus, their transport and transaction costs are high. And, the energy supply market is very likely to be monopolistic or oligopolistic. As Taiwan is confronted with such unstable energy supply situation, it highlights the importance of indigenous energy production and energy saving. In terms of indigenous energy production, Taiwan's indigenous energy is mainly renewable energy at present, including hydraulic energy, wind energy, solar energy, waste energy, and biodiesel energy. Taking power generation as an example (referring to Table 1), hydro power generation is limited by decreasing water resources in Taiwan, and there is little opportunity for development. Wind power generation generates low-frequency noise and landscape damage in operation, and thus, is protested by residents. Solar power generation costs are as high as 4 times that of biomass power generation costs (Chen & Chen, 2012). In terms of waste power generation, while garbage classification is quite good at present, many incinerators have no waste to burn. The installed capacity of nuclear electric power generation remains stable in Taiwan, whereas the installed capacity of thermal power generation increases year by year, as shown in Table 2. Coal fired power generation has the largest proportion in the most striking CO_2 emissions, as each kWh of electricity generation produces 900~1000 g CO_2 according to the coal quality, which is 2~3 times that of natural gas (Chen & Chen, 2012). The CO_2 emission resulted from such a high percentage of thermal power generation is adverse to Taiwan's image in the global consensus on greenhouse gas reduction, and thus, may incur international sanctions.

As stated above, how to develop biomass energy and save energy are urgent energy policy issues for Taiwan at present. The drinkable tap water policy is an instantly effective policy for energy saving, which is why this paper aims at a system design that uses original residential water towers and pipes to deliver drinking water sterilized by solar energy electricity storage UV-lamp to households.

Energy Saving with Drinkable Tap Water in Taiwan

Lin (2007) compiled Taiwan's drinking water regulations regarding tap water quality as the objective of tap water quality management. The objective implementation rules included water source protection to maintain clean water, and enhancing the water purification monitoring system, water quality

Table 1. The Renewable Energy Installed Capacity in Taiwan in Recent 10 Years

Year	Total	Conventional Hydro Power	Wind Power	Solar Photo-voltaic	Biomass	Waste
2005	2,607.6	1,909.7	23.9	1.0	99.1	573.8
2006	2,739.4	1,909.7	102.0	1.4	116.8	609.5
2007	2,848.9	1,921.2	186.0	2.4	116.8	622.5
2008	2,933.1	1,937.9	250.4	5.6	116.8	622.5
2009	3,060.0	1,936.9	374.3	9.5	116.8	622.5
2010	3,214.6	1,977.4	475.9	22.0	116.8	622.5
2011	3,417.1	2,040.7	522.7	117.9	111.3	624.4
2012	3,615.4	2,081.4	571.0	222.5	111.3	629.1
2013	3,828.1	2,081.4	614.2	392.0	111.3	629.1
2014	4,079.2	2,081.4	637.2	620.1	111.3	629.1
2015	4,318.6	2,089.4	646.7	842.0	111.3	629.1

Unit: MW

Source: Bureau of Energy (2016)

Table 2. The Capacity of Power Generating in Taiwan in Recent 10 Years

Year	Grand Total	Pumped Hydro Power	Coal-Fired	Oil- Fired	LNG Fired	Nuclear Power
2005	43,162.6	2,602.0	16,906.6	4,740.4	11,162.0	5,144.0
2006	45,049.8	2,602.0	18,235.3	4,548.3	11,780.8	5,144.0
2007	45,879.2	2,602.0	17,906.8	4,581.9	12,795.6	5,144.0
2008	46,371.1	2,602.0	17,865.2	4,553.9	13,272.8	5,144.0
2009	47,974.4	2,602.0	17,924.2	4,481.4	14,762.8	5,144.0
2010	48,884.4	2,602.0	18,014.7	4,185.1	15,724.0	5,144.0
2011	48,794.6	2,602.0	18,014.7	3,755.5	15,861.3	5,144.0
2012	48,423.9	2,602.0	17,443.7	3,743.5	15,875.3	5,144.0
2013	48,859.5	2,602.0	17,462.2	3,739.9	16,083.3	5,144.0
2014	48,475.6	2,602.0	16,827.5	3,857.1	15,965.7	5,144.0
2015	48,703.2	2,602.0	16,815.7	3,697.0	16,125.9	5,144.0

Unit: MW

Source: Bureu of Energy (2016)

Table 3. Comparison among UV-C, Chlorine, and Ozone Disinfections

	UV-C	Chlorine	Ozone
Sterilization mode	Physical	Chemical	Chemical
Cost investment	Low	Low	High
Operating cost	Low	Moderate	High
Maintenance cost	Low	Moderate	High
Sterilization effect	Excellent	Good	Unstable
Sterilization time	1-5 sec	25-45 min	5-10 min
Hazards to the human body	Very low	Moderate	High
Residual toxic substance	No	Yes	Yes
Change in water and air	No	Yes	Yes

Source: Hung & Lee (2012)

improvement, and water supply diffusion rate. Taiwan focused on the popularization of water utilization at the initial stage of the operation of tap water. Afterwards, as the living standard of the public was increased, the demand for water quality grew gradually. Therefore, water quality must be continuously improved to meet the standard of developed countries.

Taiwan prohibited using lead pipes for drinking water pipe in 1979. In order to improve the quality of drinking water, water utilities gradually replaced the pipelines with stainless-steel pipelines. Considering the cost of replacing pipelines and household privacy, the replacement engineering was mainly conducted in public water supply lines, while household lead pipes remained in houses, resulting in partial replacement (Chen, 2016). While water treated by waterworks can be directly drunk, after long-term use, the inner walls of delivery pipes become rough, which nourishes bacteria, thus. The public still worry about whether the tap water delivered from the waterworks to houses can be directly drunk, or whether they must boil tap water before drinking. The main fuel sources for boiling tap water include electricity (electric hot water bottle or electromagnetic oven), compressed petroleum gas, and natural gas. For convenient analysis, power consumption is used as the basis of analysis.

The following data are obtained from actual experimental results:

Data 1: each person drinks 2 liter (L)

water per day on average, and the heat for boiling is described, as follows: Heating a liter water by 1°C requires about 1 Kcal. As ordinary water temperature is about 20°C, the heat required for heating 2 L water to 100°C is:

$$2 \times (100 - 20) = 160 \text{ (Kcal)} \quad (2.1)$$

Data 2: if each person drinks 2 L water a day, and the water is boiled by an electromagnetic oven, the electric cost is:

The calorific value of an electromagnetic oven is:

$$860 \text{ Kcal/kWh(electricity)} \times 90\% \text{ (combustion efficiency)} = 774 \text{ Kcal/kWh} \quad (2.2)$$

(2.1) is divided by (2.2)

$$160 \text{ (Kcal)} / 774 \text{ (Kcal/kWh)} = 0.2067 \text{ kWh} \quad (2.3)$$

At present, electricity is charged in household units, and the household electricity charging standard is: if the household power consumption exceeds 300 kWh, it is charged at NT$3.5/kWh (note: the exchange rate of US$: NT$ is 1: 30.41 as of 2017/4/18); if the power consumption is not in excess of 300 kWh, it is charged at NT$2.8/kWh. Taiwanese people highly depend on electricity in daily life (e.g. air- conditioners and electric appliances), and for most households the monthly applicable unit of electric charge is NT$3.5/kWh. Therefore, the electric cost of daily drinking water per capita is:

Electric cost of (2.3)

$$= 0.2067 \text{ kWh} \times \text{NT\$ } 3.5\text{/kWh} = \text{NT\$ } 0.7235 \quad (2.4)$$

(the two costs are free of electromagnetic oven setup cost, and only include the cost of power consumption)

Data 3:
if each person drinks 2 L water a day, and the water is boiled by an electric hot water bottle, the electric cost is:

A 3 L Zojirushi electric hot water bottle, which consumes 985 kWh per hour, is used for this experiment.

3 L tap water is poured into the Zojirushi electric hot water bottle, which has an upper capacity limit of 3 L, and boiling time is 23 minutes, thus, the corresponding electric cost is:

$$\text{NT\$5/kWh} \times 0.985 \text{ kWh} \times 23 \text{ min/60 min} = \text{NT\$1.3212} \quad (2.5)$$

Therefore, when the daily drinking water per capita (2 L) is boiled by an electric hot water bottle, the electric cost is:

$$(2.5) \times \frac{2}{3}$$

$= NT\$1.3212 \times \frac{2}{3}$

$= NT\$\,0.8808$ (2.6)

Data 4: the electric cost of boiling daily drinking water per capita (2 L) is:

$\frac{1}{2}$ [Eq. (2.4) + Eq. (2.6)]

$= \frac{1}{2}$ [NT\$ 0.7235 + NT\$0.8808]

$= NT\$0.8021$ (2.7)

According to (2.7), the annual electric cost of boiling drinking water for 23 million Taiwanese people is:

23 million × NT\$ 0.8021/day × 30 days × 12 months
= NT\$6.64139 billion/year

System Using UV-lamp Sterilization to Produce Drinkable Tap Water

This system uses solar energy electricity storage as the power source for the UV-C sterilamp, which is very effective at destroying bacteria, viruses, and microorganisms. Its sterilization principle is to damage the structures of bacteria, viruses, microorganism DNA, and RNA to kill them. The best material for the UV-lamp pipe is pure quartz glass cell, which is made of mineral crystal with UV transmittance greater than 80%. Therefore, considering sterilization completeness, the UV-lamp tube must be made of quartz glass cells. From any angle, this disinfection is much better than chlorine or ozone disinfection as shown in Table 3.

Ultraviolet disinfection is the most advanced, effective and economic method for disinfection, as it can thoroughly kill all bacteria, viruses, parasites and algae in a couple of seconds (referring to Table 4). It will not cause secondary pollution or leave any toxic substance, and the sterilized object is non-corrosive, pollution free, and free of residues.

In the drinkable tap water system concept, as designed in this paper, a stainless steel water tower is embedded in the original residential water tower. There are water inlets at the right and left top of the stainless-steel tower. Thus, when the water level in the tower rises to the inlet height, the water flows in the stainless-steel tower and is sterilized by the UV-lamp. And this sterilized drinkable tap water is delivered through the tubule of a cardiac catheter material inserted into the original water pipe to the household. When the drinking water reserved in the stainless-steel tower is lower than the water level, as detected by a sensor, the tap water is supplemented into the water tower till the water level in the tower reaches the right and left water inlet height of stainless steel tower. When the water level outside the stainless-steel tower is lower

Table 4. The 100% Bactericidal Efficiency to the Common Bacterial Virus of the UV-C'S

Type	Name	Time required for 100% kill(s)	Type	Name	Time required for 100% kill(s)
Bacterial	Anthrax bacili	0.30	Bacterial	Tuberculosis (branches) bacili	0.41
	Diphtheria bacili	0.25		Vibrio cholerae	0.64
	Tetanic bacili	0.33		Pseudomonas spp	0.37
	Clostridium botulinum	0.80		Salmonella	0.51
	Dysentery bacillus	0.15		Intestinal fever bacteria	0.41
	Colon bacillus	0.36		Rat typhoid bacillus	0.53
Virus	Adenovirus	0.10	Virus	Flu virus	0.23
	Phagocytic cell virus	0.20		The polio virus	0.80
	Coxsackie virus	0.08		Rota virus	0.52
	Love ke virus	0.73		Tobacco mosaic virus	16
	Love ko virus type i	0.75		Hepatitis b virus	0.73
Mold spores	Aspergillus	6.67	Mold spores	Soft spores	0.33
	Aspergillus	0.73-8.80		Penicillium species	2.93-0.87
	Dung fungi	8.0		Poison penicillium	2.0-3.33
	Mucor	0.23-4.67		Other fungi penicillium	0.87
Water algae	Blue-green algae	10-40	Water algae	Paramecium	7.30
	Chlorella	0.93		Green algae	1.22
	Line worm eggs	3.40		Protozoa	4-6.70
Fish disease	Fungl disease	1.60	Fish disease	Infectious pancreatic necrosis	4.0
	White spot disease	2.67		Viral bleeding	1.6

*UV Intensity: 30 mw/cm^2

Source: Qinhuangdao Shijiyuan Water Treatment Technology (2012)

than the water level in the stainless-steel tower, the UV-lamp is activated for sterilization as shown in Figure 1(Lai & Chen, 2016). Figure 1 shows that there is a jagged stick on the right and left edges of the stainless-steel tower, thus, the stainless-steel tower can be conveniently lifted to clean the bottom precipitates.

A biomedical material grade tubule made of cardiac catheter material is inserted into the original water pipe to delivery drinkable tap water to kitchen outlets for drinking. This biomedical material is used for making medical appliances used in vivo or in vitro. Basically, these medical appliances can safely, whether directly or indirectly, contact human tissues, body fluid, and blood. In the traditional biomedical material research and development concept, the ideal biomedical materials applicable to the human body must conform with the following conditions: good biocompatibility, inert, non-toxic, non-allergic response, non-carcinogenic, easily procured, and inexpensive. Clinically used

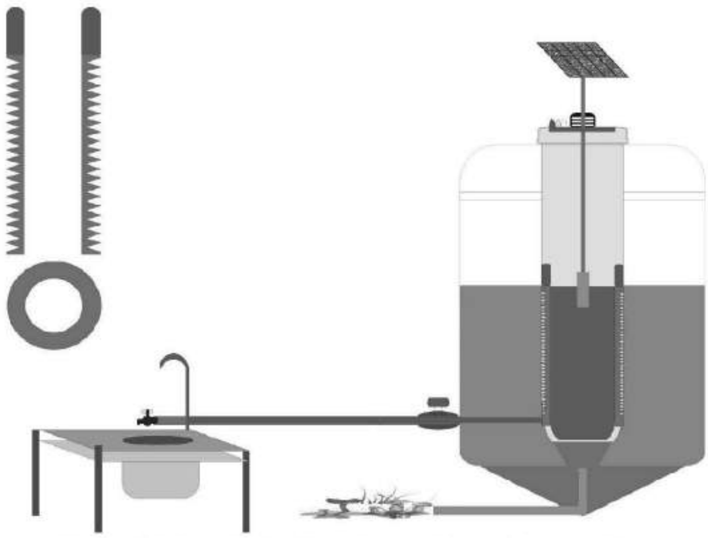

Figure 1. Drinkable Tap Water System Design Structure Diagram

biomedical materials can be divided into 4 main classes, metals and alloys, ceramics, polymers, and biological materials (Sung & Chen, 2003). This study uses polymer cardiac catheter material with high inert safety to guarantee the sanitation of drinkable tap water.

System Delivering Aseptic Drinking Water from Residential Water Towers to Households

Lai, Chen, and Chen (2016) used a new model patent "Pipeline Cleaning Device" to solve the poor cleaning effect of known pipeline cleaning devices. The innovative design of this pipeline cleaning device, with a self-propelled image output function, is detailed as follows, and shown in Figure 2. The device contains a cleaning head body, and is provided with a propelling channel, a rotary jetting channel, several spraying channels and a rotary brush head. The rotary brush head can be rotationally located in the front end of the cleaning head body. The propelling channel is located in the cleaning head body, where one end is closed, while the other end is connected to the external surface of the cleaning head body. The cleaning head body has a central axis, and the propelling channel is opened along this central axis. Several spraying channels are located around the

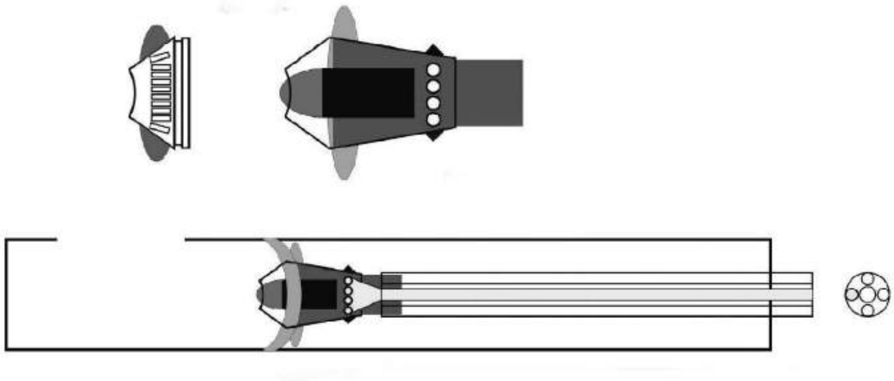

Figure 2. The in-Pipe System with Self-Propelled Image Output Function
Source: Lai, Chen & Chen (2016)

propelling channel. One end of the spraying channel is connected to the circumference of the cleaning head body. There is a blade on the front end outer edge of the cleaning head body. The pipeline cleaning device has several pipe fittings at the back end of the cleaning head body, where one end is connected to the propelling channel, the rotary jetting channel, and several spraying channels. This pipeline cleaning device also contains a container for holding fluid. The other end of the pipe fittings is connected to the container, and a controller controls the supply or recovery of the fluid in this container. This pipeline cleaning device contains a monitoring system, which has a camera coupled to a control host connected to a display. The cleaning head body is provided with a holding slot, which is open on the front-end face of the cleaning head body to hold the camera, and the cover body is made of perspective material. This holding slot is not connected to the propelling channel, rotary jetting channel, or spraying channels. And, the bottom of the holding slot is closed. The rotary brush head comprises a cover body and a brushware. The inner surface of this cover body forms a holding chamber, where the front end face of the cleaning head body adjoins the holding chamber, and the brushware is connected to the outer surface of the cover body. The cleaning head body has a central axis, where one end of the rotary jetting channel is connected to the holding chamber, and deviates from the central axis. There are several lugs on the inner surface of the cover body, which are arranged at annularly angular intervals centering on the central axis. The front end of cleaning head body has an annular groove, and there are several grabs on the circumference of the cover body to catch this groove.

Conclusion

Taiwan is confronted with economics growing side effects resulted from continuous energy shortage and the greenhouse effect, as typhoons frequently occur, and disasters caused by rain and wind are increasingly severe. Yellow tap water after a typhoon or afternoon thundershower has aroused public indignation. The first cause for public indignation is the shortage of drinking water. While using yellow tap water as non-drinking water is fairly acceptable, people cannot live without drinkable tap water. If various households mount the solar energy electricity storage UV-lamp sterilized drinkable water storage tank, as designed by this paper, in their water towers, the tubule made of cardiac catheter material will convey the aforesaid drinkable tap water through the original water pipe (the big pipe contains a tubule) to various kitchens. As the supporting duration of the aseptic drinkable tap water reserve exceeds the number of days required for the government to urgently deal with yellow tap water, public complaints regarding yellow tap water events will be greatly reduced.

The aseptic tap water system, as designed in this paper, has the following advantages: (1) saving energy (tap water can be drunk directly without boiling) (2) the tubule material embedded in the original water pipe will not deteriorate to breed bacteria under the effect of temperature difference (3) the stainless steel water storage tower embedded in the original water pipe can be lifted out along the gears for cleaning bottom precipitate (4) this aseptic drinking water system avoids from drinking yellow tap water, as resulted from typhoons or thundershowers.

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FEASIBILITY ANALYSIS OF USING HIGHWAY GUARDRAILS TO PRODUCE CLEANED CARBON DIOXIDE TO NOURISH ECONOMIC PLANTS

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Abstract

Gaseous waste recovery is an important undertaking to be developed, especially the recycling of Carbon Dioxide from automobile emissions. The extent of harm of the pollutant in automobile emissions shall be measured not only by how much the pollutant can be eventually cleaned, but also by how long the duration from the point of time the contaminant generated to the point of time the contaminant cleaned. The dust absorbing chamber and wet-dust cleaning pipes with cyclone power can be mounted on highway guardrails powering by solar energy. Once a contaminant is generated, it is absorbed, and the cleaned Carbon Dioxide is produced. This framework of con-

verting harmful air polluted Carbon Dioxide into beneficial cleaned Carbon Dioxide is more precious for Taiwan, due to its insufficient natural resources.

Keywords: Greenhouse Effect; Cyclonic Dust Absorption; Wet Dust Cleaning

Background

The recovery of solid waste has been considerably effective in Taiwan, which is reflected by the situation that incinerators have no waste to burn in recent years (Chen & Chen, 2012). However, gaseous waste recovery is an important undertaking to be developed. CO_2 (Carbon Dioxide) is the major factor in greenhouse gas composition, which causes the greenhouse phenomenon. As CO_2 is generated mainly by using fossil fuels (coal, petroleum, natural gas), the Kyoto Protocol specifies that the future CO_2 emissions of various countries must return to the 2005 emissions by 2020, and 2025 emissions must return to the emission standard of 2000. However, according to Taiwan's CO_2 emission data in recent years (Chen & Chen, 2012), in order to return to the 2005 CO_2 emissions (288.8 million MT), the government must make drastic CO_2 reduction policies, otherwise in the current development trend, the annual CO_2 emission of Taiwan will far exceed the aforesaid target value in the future.

CO_2 Emission per Capita of Taiwan and Relevant Countries

According to the reference (Chen & Chen, 2012), the U.S. has the highest annual CO_2 emission per capita, which is one of the reasons the U.S. still refuses to sign the Kyoto Protocol. Taiwan's CO_2 emission per capita was lower than that of Japan before 1997, but higher than that of Japan after 1997. The CO_2 emission per capita grew rapidly in Taiwan, China, and Korea (Chen & Chen, 2012), meaning the economic development in these three regions still highly depend on energy-consuming industries. There is slight difference among the U.S., Japan, and Hong Kong in CO_2 emissions per capita. Singapore's CO_2 emission decreased from 15.41 MT in 1990 to 6.39 MT in 2009, and the effect was outstanding. Taiwan's CO_2 emissions changed inversely to Singapore's, from 5.88 MT in 1990 to 11.58 MT in 2000. It seems that Taiwan only has three policies to improve severely worsening CO_2 emissions, including Policy 1: improving the energy structure; Policy 2: readjusting the industrial structure; and Policy 3: cleaning CO_2 directly for the photosynthesis of economic crops, changing harmful CO_2 into beneficial CO_2.

Regarding Policy 1, as the demand

for a nonnuclear homeland rises, only renewable energy can be developed. Among the renewable energy sources, wind energy is limited by high cost, as wind energy will result in low-frequency noise and landscape problems. Hydraulic energy is limited to water resources. Waste energy is confronted by insufficient sources. In recent years, as the recycling classification is effective in Taiwan, incinerators have no waste to burn. Thus, biomass energy becomes a unique item that may be developed among numerous renewable energy sources. According to the encouraging afforestation efforts (forestation is subsidized with NT$90,000 per hectare) being implemented in Taiwan, importing the barbadosnut as an encouraged tree species, which can produce biodiesel, is one of the energy policies the government shall consider.

Regarding Policy 2, as Taiwan's enterprises are mostly small and medium-sized enterprises, their capital capacity is relatively small, and their products must be made from or integrated with high energy-consuming low-cost primary resources for marketability. Therefore, Taiwan is unlikely to readjust the industrial structure in the near future. Only Policy 3, cleaning CO_2 directly, may be adopted; which is the focus of this study.

Use of Cleaned CO_2

CO_2 is the principal raw material for the photosynthesis of crops, as the organic substances formed by photosynthesis account for 90%~95% of the total solid yield of crops, while only 5%~10% of substances are supplied from soil and fertilizer. Carbon and oxygen contents with the highest solid density ratio are derived from CO_2, which has, at least, the following kinds of use:

Planting Vegetables and Fruits

Taking cucumber planting in Taiwan as an example, there are five effects (Yao & Tian, 2008): (1) promoting the photosynthetic rate of vegetables; (2) increasing vegetable biomass (plant weight, leaf thickness, leaf area); (3) increasing fruit set percentage of fruit and vegetables; (4) increasing vegetable yield (growth and development); (5) upgrading vegetable quality (color and taste).

Cultivating Petroleum Plants with Cleaned CO_2

Petroleum plants include trees with sap that can be made into diesel oil, biodiesel that can be abstracted from tree seeds, and algae that contains petroleum.

A particular tree able to produce "petroleum" was found in the Brazilian tropical rain forest, known as the "Copaiba tree", which is an evergreen tree with wide varieties, is as tall as 20-25 m, and can be exploited once every 1.5 to 2 years. A small hole with a diameter of about 5 cm is drilled into the trunk, and golden yellow oily sap flows out within 1-2 hours. A Copaiba tree with a diameter of 1-1.5 m can produce 15-20 L of sap each time, and the chemical composition of the sap is similar to diesel oil, thus, it can be used as diesel oil without refining (Yao & Tian, 2008).

The barbadosnut (also known as the small tung tree, which scientific name is Jatropha Curcas L.), from which bio-diesel can be extracted from the seed, was tested in Miaoli County, Taiwan. The barbadosnut seedling is grown in 3 years, and biodiesel can be extracted from its seeds; during its average 50 year growth, the barbadosnut absorbs a great deal of CO_2 in the growing process, as the seed harvest increases with CO_2. If the encouraging forestation tree species of the 20-year green sea project, as implemented by the government since March 2008, included barbadosnut, the average net income per farmer from planting barbadosnut was NT$304,760/year (Yang & Chen, 2011). During the Japanese occupation, in order to supply aircraft fuel for World War II, Euphorbiaceae wood oil trees were planted in north central Taiwan in a planned manner, and there are 4,000 hectare, which are tens of years old, wood oil trees at present. This is an advantage of Taiwan's ability to produce biodiesel in the short-term, as the yield per hectare is about 10 MT, the bone-dry kernel oil content is 55%, and if it is nourished with cleaned CO_2, the yield will increase. As the fruit ripening time of tungs is inconsistent, collection has high labor costs. The seed collection cost of tall tungs is much higher than that of the short barbadosnut (small tung).

Japanese research and development personnel extracted petroleum from a type of limnetic algae, which has high CO_2 absorbsion, and the extracted petroleum has high heating value and low nitrogen and sulfur contents. In addition, the kelp contains high CH_4 content; if cleaned CO_2 assists large-scale culture in the sea area, as the leaves are mostly on the sea surface, there can be three mechanized harvests annually (Perkins, 2009)

Cleaned CO_2 Help the Greenhouse Culture Vegetables and Fruits

The CO_2 concentration in the atmosphere is about 0.03% (300mg/kg). With daylight substituting sunlight in a greenhouse to cultivate vegetables and fruits, the CO_2 concentration is sometimes insufficient. Thus, the growth and yield rate of vegetables and fruits is reduced, but the ventilation system can help. However, in cold winters, the ventilation of cold air will reduce the temperature, which affects the growth rate of vegetables and fruits. The only solution is to import cleaned CO_2 into the greenhouse.

Theoretically, in the complete combustion of gasoline and diesel oil with free of sulfur, nitrogen and lead pollution sources, the hydrocarbon chain in the fuel is restructured with oxygen to form harmless CO_2 and water. With rising environmental considerations, metal pollutions, such as lead pollution, in Taiwanese produced oil products, have been greatly reduced. Therefore, besides CO_2, the main constituents of gas from vehicles running on the highway are unburnt HC, S, and N in the exhaust gas, as well as the particles resulted from the friction between tires and the ground.

Pollution Gases Generated in Vehicle Running Process

CO_2 is formed by one unit of carbon and two units of oxygen, and is odorless and tasteless. While CO_2 is the first cause of the greenhouse phenomenon, strictly speaking, CO_2 is not a pollutant, but is actually the source of the fiber components for roots, stems, leaves, and fruit after the photosynthesis of all plants. The relationship between CO_2 and human welfare can be described as: the water (HO_2) that bears the boat (human positive welfare) is the same that swallows it up (human negative welfare), which is why cleaned CO_2 is known as CO_2 fertilizer. Therefore, the air pollutants discussed as following do not include CO_2.

Air pollutants generated by the vehicle running process are divided into internal combustion (engine) system air pollutants and waste gas system air pollutants.

Internal Combustion System Air Pollutant

The internal combustion system is resulted from the fuel tank, carburetor, and crankcase. And, the pollution process is almost all the HC spilled by evaporation from the aforesaid three systems. Before antipollution measures were taken (Figure 1), the amount of HC spilled from the three systems account for about 40% of the total amount of air pollutant HC; in addition, 60% of air pollutant HC is discharged from the waste gas system.

The effective measures for reducing internal combustion system air pollutants are described as follows, as dotted portion in Figure 2: Measure 1: enhancing the design of fuel tank A, carburetor B, crankcase C, and the engine to avoid HC spilling or evaporating. Measure 2: intercepting the HC spilled from fuel tank A and carburetor B in a charcoal canister, where compressed air drives it into the engine for secondary combustion (see the upper right of Figure 2). Measure 3: sealing the air outlet connecting the crankcase to the outside, and collecting the evaporated HC gas into the Intake Manifold with a back-stop exhaust valve

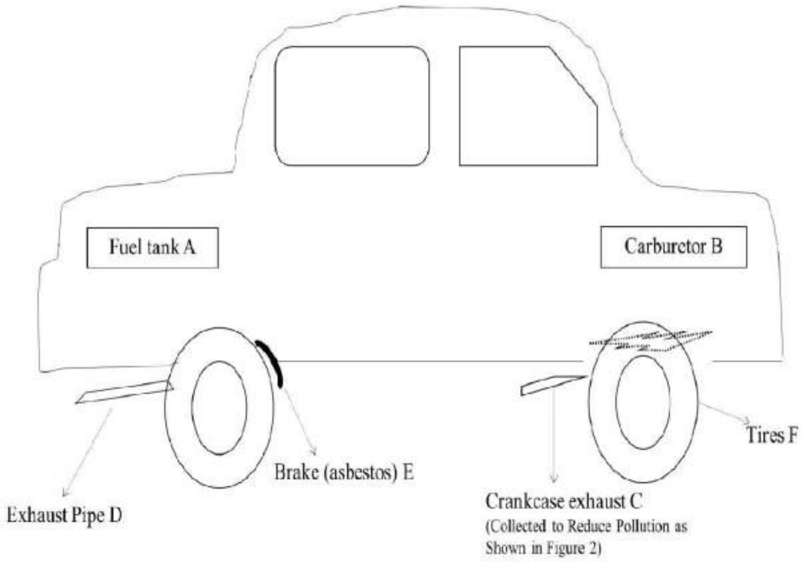

Figure 1. Traffic Pollution Generated by the Vehicle

Notes:

- HC Emissions: A & B 20%; C 20%; D 60%
- CO, NO_x, Lead & D Emissions: 100%
  Particle Pollution during driving: E & F 100%

for secondary combustion (see the left of Figure 2). At present, the aforesaid three measures are the consensus for reducing internal combustion HC system pollutants.

Waste Gas System Air Pollutant

The pollution reduction method is to mount a catalytic reactor in front of the silencer of the exhaust pipe, which has the function of oxidizing CO and HC to CO_2 and water, as well as to reduce NO to N. At present, vehicles to be sold in the U.S. must be equipped with a catalytic reactor. In the internal combustion engine, increasing the air-fuel content ratio reduces CO and HC contents, but increases the NO volume. In the view of pollution reduction, the optimum ratio of air to fuel content of the internal combustion engine depends on the cost of marginal CO and HC pollution reduction being equal to the marginal NO pollution reduction cost value.

Referring to the U.S., Taiwan's government can require that the engine

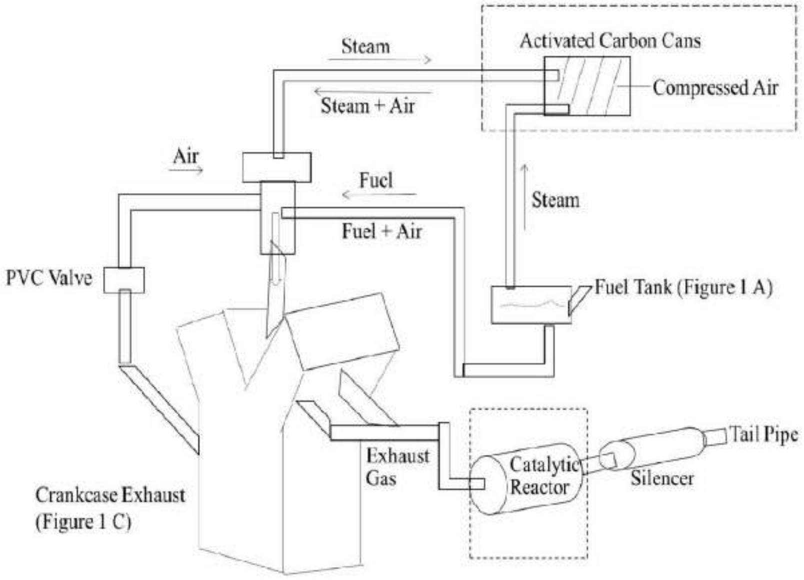

Figure 2. The Way to Reduce HC in the Internal Engine (As Shown in the Dashed Box)

systems and waste gas systems used by auto plants are equipped with the aforesaid pollution reduction facility, in order to minimize the pollution source resulted from operating vehicles. The next issue is to separate the CO_2 outside the vehicles on the highway from the mixed polluted air.

Mounting Pollution Reduction Facilities on Highway Guardrails

The existing cyclone collector and packed column dust scrubber are combined and improved in this paper (Perkins, 2009) to form the (temporarily named) "cyclonic sprinkling pollution reducer", as shown in Figure 3. There can be numerous identical cyclonic sprinkling pollution reducers located on highway (especially freeways) guardrails.

The reasons for this design:

1. There are trees on both sides of highways (including safety islands), which require regular irrigation. In order to economize irrigation labor, additional water pipes can be mounted, roadside flowers and trees can be watered by an automated time switch, and the water required for the sprinkle scrubbing section in Figure 3 can also be

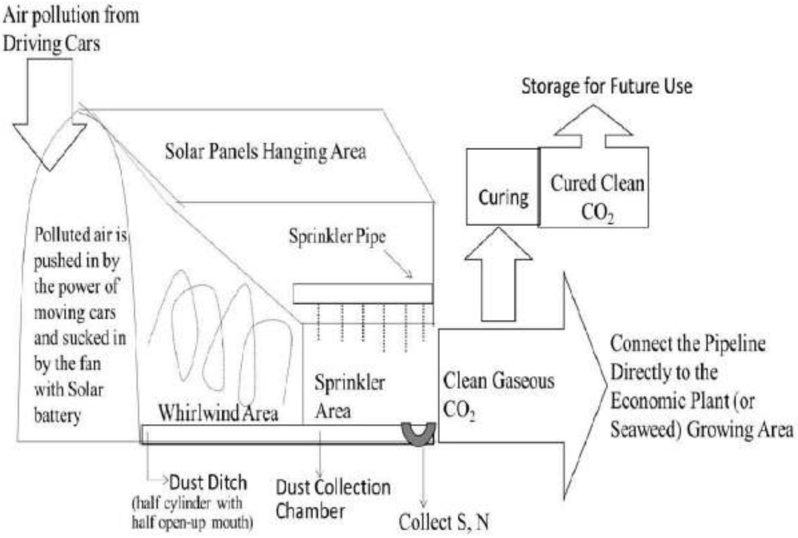

Figure 3. The Solar Power Generation System Installed in Highway Guardrail Zone

switched.

2. There is an open space above highway guardrails where photovoltaic panels can be installed, which can provide the power source for the pollution absorbing fans and the sprinkling scrubbing section, as shown in Figure 3.
3. There are two types of existing cyclone collectors, the dry cyclone collector and the wet cyclone collector. While the wet cyclone collector has better dust absorption effect, the question of how to dispose of its polluted mud presents another problem. Therefore, Figure 3 is designed for dedusting dry-wet region separation.
4. The pollutants from automobile exhaust pipes are complex, and the particle shapes and weights are different. The polluted air, as shown in Figure 3, is sucked or pushed in (pushed in by the airflow driven by a running vehicle) under the rotation effect, as resulted from the semicone (large in-cone area of polluted air, small out-cone area) shape, where heavier particles impact the inner wall of the semicone, which are then slowed down by friction as they slide down along the wall surface to the dust collecting groove. As the dust collecting groove is a semicircular column opened upward, without the interference of external force, the particles slide along the semicircular column wall surface to the bottom of semicircular column groove. However,

the semiconic cyclone has external air blown in at any time, thus, the particles that slid along the wall to the groove bottom may be raised again by the air. In order to avoid the probability of raising the particles again, a half cover is mounted above the semicolumnar dust collecting groove, which enables the contaminated particles to slide along the wall to the groove bottom, which also reduces the particles that have slid to the groove bottom from being raised again by subsequent airflow.

5. When the contaminated particles are cleaned in the cyclone dust collection zone (on the left of Figure 3), the residual air pollutant components are S and N. As the wet scrubbing absorbs SO_2 and NO_2, the sprinkling scrubbing section is designed on the right of Figure 3. The cleaned SO_2 and NO_2 can be used as disinsectization solution, disinfection solution, and cleaning solution; Figure 3 shows the cyclone scrubbing pollution eliminator.
6. If the government gives rewards and punishments; as the exhaust directions of automobile exhaust pipes are optional, the exhaust direction of small vehicles running near the inside lane can be left, while the exhaust direction of large vehicles running the near slow lane can be right, thus, the efficiency of sucking exhaust gas in the cyclone scrubbing pollution eliminator in Figure 3 will be increased.
7. Producing cleaned CO_2 is the same as producing electricity, meaning they shall be distributed according to demand immediately after production, instead of being stored. While the use of cleaned CO_2 is mentioned in this paper, the short time lag between yield and demand must be considered.

Conclusion

Taiwan's greenhouse gas emission was increased by 134% from 1990 to 2005, which ranked first in the world, meaning Taiwan's economic development remains highly dependent on energy-consuming industries in the past. As Taiwan cannot improve its industrial structure to reduce carbon emission in the short-term, producing cleaned CO_2 to turn the defect in CO_2 into an advantage seems to be a unique option.

Under the circumstance of being hard to live, this paper proposes a framework that not only saves energy, it also cleans highway CO_2 instantly. This framework of cleaning highway CO_2 extensively mounts the "cyclone sprinkling scrubber", as designed in this paper, on existing highway guardrails, in order to produce cleaned CO_2. This paper demonstrates the component structure of the cyclone sprinkling scrubber, and describes the principle of the design. A partial effect of producing cleaned CO_2 is related to the engine pollution prevention effect, as implemented by vehicle manufacturers, as well as to the exhaust direction of exhaust pipes, which are discussed and described in this paper.

The idea of producing cleaned CO_2 in this paper is still a preliminary concept. Is it feasible? How many supporting measures are required? Feasibility is to be proved through actual experimental data after "cyclone sprinkling scrubbers" are manufactured and mounted on freeway guardrails.

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Acceptance Letter

July 14, 2018

Dear **Jung-Hsiang Lai,**

With much pleasure this is to inform that, the paper entitled ***"Planning and Implementing the Mechanism of Cleansing Outdoor Air Pollution"*** by **Hsien-Bin Wang, Po-Yu Chen, Miao-Sheng Chen & Jung-Hsiang Lai;** Manuscript ID: **IJIRK-RR-J-0307003** has been accepted by the Editorial Board based on the reviewers' reports and editorial considerations. The International Journal of Innovative Research and Knowledge (IJIRK) has decided to publish the paper with content unaltered in the running issue ***(Volume-3 Issue-7, July-2018).***

Your valuable work is very much appreciated by the International Journal of Innovative Research and Knowledge (IJIRK). The success and reputation of IJIRK owes much to all our submitting authors, who have toiled in the production of their work, and have chosen IJIRK as the journal they would like to publish in.

I believe that our collaboration will help to accelerate the global knowledge creation and sharing one step further. Again, thank you for working with IJIRK and I look forward to working together in the future.

With warmest regards,

Dr. Paul William
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Planning and Implementing the Mechanism of Cleansing Outdoor Air Pollution

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Abstract

As air pollution problem becomes increasingly serious, the government and non-government put forward all kinds of measures to prevent and control various pollution sources. It is considered to be the most economic and effective way to prevent and control air pollution from the pollution source. However, when air pollutants are spread out, the environment will be filled with air pollutants. Thus, how to solve outdoor air pollutants is a really tough job faced. This paper proposed three kinds of mechanisms to try to solve the problem of outdoor air pollution, that is, adopt the existing vehicles to cleanse air pollutants, recycle gaseous wastes and promote drinkable tap water. The government is suggested to implement the policies: within the area of Total Air

Pollutants Quantity Control, (1)The Emission Reduction Credits from vehicles and other mobile pollution sources is provided to fixed pollution sources for offset or trading; (2)The electricity saved due to drinkable tap water is also provided to fixed pollution sources for offset or trading.

Keywords: *Mobile Pollution Sources, Drinkable Tap Water, Recycling Air Wastes, ERCs*

1. Introduction

As air pollution problem becomes increasingly serious, the government and non-government organizations put forward all kinds of measures to prevent and control various pollution sources. It is considered to be the most economically viable to prevent and control air pollution from its sources. However, when air pollutants are spread out, the environment where we live will be filled with air pollutants. Thus, how to cleanse outdoor air pollutants is a really tough job faced. At present, the relevant government organizations only negatively specify the generation of domestic pollutants accounted for about 66-66% PM2.5, among which PM2.5 pollution sources were generated from fixed pollution sources (about 27-31%), mobile pollution sources (about 30-37%) and other pollution sources (about 32-43%) (Tsai, Yang, & Huang, 2017). Taiwan government has legislated laws to regulate and control the generation of mobile pollution sources (Environmental Protection Administration, 2018), but proper measures have not been proposed to cleanse and eliminate the existing outdoor air pollutants, not to mention the issues related to prevention and treatment of foreign pollutants. Environmental Protection Administration (EPA) of Taiwan formulated air quality standard in accordance with the Law on the Prevention and Control of Air Pollution. It mainly monitors air pollutants of Total Suspended Particulate (TSP), Particulate Matter (PM, including PM2.5 and PM10), Ozone (O3), Carbon Monoxide (CO), Sulfur Dioxide (SO2), Nitrogen Dioxide (NO2) and Lead (Pb). The standard makes up their concentration value as Air Quality Index (AQI), which is issued regularly so as to remind the public to pay attention to the right time for outdoor activities to reduce the exposure risk. These pollutants have been proven to lead to various diseases.

Air cleansing equipment can be used to reduce indoor air pollution. As for outdoor pollution, people can only wear masks to negatively cope with it. There have been no effective response measures being mentioned so far. Haze phenomenon in China is quite serious, which has a great effect on the air quality of its neighboring countries. It is reported in the recent newspapers (Liberty Times, 2018) that China has tried to build a 100-meter height air cleansing tower in Xi'an, where the air pollution is very serious, to solve outdoor air pollution. It is said that such tower can cleanse the air within the area of 10 km in radius, which can remove PM2.5, nitrogen oxides, carbon dioxide, sulfur dioxide and other harmful substances. It can cleanse the air of more than 1,000 cubic meters per day, and PM2.5 can be lowered by 15%. Switzerland Climeworks Company (Climeworks, 2018) develops new technology to directly extract carbon dioxide from the air and transform it into fertilizer of plants, which can also make contributions to slowing down the greenhouse effect. The Taiwan government has announced recently that electric vehicles will be adopted comprehensively by 2030 so as to reduce the harm of air pollution. Under the guidance of nuclear-free homeland policy in Taiwan, it is hardly realized that the demand for electric power supply will increase the amount of thermal power generation, resulting in increasing more air pollution caused by coal-fired power. Recent research has shown that the carbon emission by electric vehicles is even greater than that of fuel vehicles (Engaged Tracking, 2018). Due to the foreign and local pollutants in Taiwan, it is bound to have new mechanisms to ease the issue of increasingly severe outdoor air pollution, so as to improve people's health and quality of life.

2. Literature Review

Literature review was conducted in terms of air pollutants, harms of air pollution, air quality monitoring and prevention, and control measures for air pollution.

2.1. Air Pollutants

Air pollution refers to one or more substances existing in indoor and outdoor air, such as dust, fumigation, gas, mist, odor, smoke or steam, whose quantity, characteristics and durability are enough to damage human health, harm life of plants and animals, make people suffering from property loss or interfere with the comfort of life. The sources of air pollution can be resulted from either the Nature or human behaviors. The pollution from the Nature includes volcanic eruptions, radon gas releasing from the bedrock, dust storms or tornadoes, while the pollution from human behaviors includes from vehicle emissions, factory emissions, fossil fuels, nuclear bomb test, straw burning, tunnel blasting, bridge engineering, coal mining or incinerator burning. As air pollutants are various, this paper mainly explored the air pollutants of Total Suspended Particulate (TSP), Particulate Matter (PM, including PM2.5 and PM10), Ozone (O3), Carbon Monoxide (CO), Sulfur Dioxide (SO2), Nitrogen Dioxide (NO2) and Lead (Pb). They are monitored in accordance with the air quality standard in the Law on the Prevention and Control of Air Pollution. Based on this, Taiwan formulates the concentration value of air pollutants as Air Quality Index (AQI) and issues it regularly so as to remind the public to pay attention to the reduction of exposure to outdoor activities at the right time.

2.2. Harms of Air Pollution

Air pollutant means that the substance in the air does harms to human health and ecological environment. The substance can be solid particles, liquid droplets or gases. Pollutants can be natural or Particulate Matter (PM) with the largest harm to the human in the man-made air pollutants. Among them, the particles with the diameter of less than or equal to 10 microns are known as PM10; the particles with the diameter of less than or equal to 2.5 microns are known as PM2.5. PM2.5 particles are more dangerous than those of PM10, as it is small enough to penetrate the alveolar to arrive in the blood, thus causing cardiovascular disease, lung disease and even lung cancer (Chen, 2015).

Lin, Chen, and Song (2018) analyzed the number of people in treatment of acute upper respiratory tract infection each week from 2011-2015 National Health Insurance Research Database of Taiwan (NHIRD) and discussed the effect of seasonal effect and interaction. They found that acute upper respiratory tract disease of all ages is related to PM2.5, PM10, moisture in early stage, nitrogen dioxide, sulfur dioxide and other air pollutants. Substances causing air pollution in the environment include indoor and outdoor inhaled allergens and air pollutants (Xu, 2015).

2.3. Air Quality Monitoring

In order to provide global guidance on reduction the effect of the air pollution affecting the health, World Health Organization (WHO) issued Air Quality Guidelines (AQG) in 2005, including the limitation on the concentration of suspended particulate, as is shown in Table 1.

Table 1: Air Quality Guidelines Issued by the World Health Organization

	PM10	PM2.5	Basis for Selection of Concentration
Air Quality Guidelines (AQG)	20 µg/m³	10 µg/m³	This is the lowest level of long-term exposure to PM2.5, at which total mortality, cardiopulmonary disease mortality and lung cancer mortality are reduced (more than 95% credibility).

The EPA made a public announcement in 2012, to revise air quality guidelines and to add air quality standard for PM2.5. The effect on health was considered in priority based on the research findings regarding Taiwanese health. The value of PM2.5 in 24 hours was set to be 35µg/m3 and yearly average value was set to be 15µg/m3. The EPA sets the target that the national fine suspended particulate will reach the average value of the concentration of 15µg/m3 by 2020. Meanwhile, it will be based on the trend of international control to gradually review its PM2.5 air quality standard to achieve the air quality improvement target in AQG proposed by WHO. The Ministry of Education of Taiwan promulgated "Class Suspension Standard due to Air Pollution" in 2014. The Ministry of Labor of Taiwan issued the letter in 2014 to state that the haze should be regarded as natural disasters, which may refer to typhoon holiday mode. By laws, local governors can announce the suspension of classes in accordance with their authorities. However, it is stipulated, in the class suspension standard due to air pollution developed by the Ministry of Education, that the class can be suspended when PM2.5 reaches more than 350.4µg/m3. Therefore, the environmental protection group doubts that this standard is too high for schools to have class suspension due to air pollutions.

2.4. Prevention Measures for Air Pollution

The EPA found that, based on the analysis results of air quality model, about 60% - 66% of PM2.5 pollution sources come from within the territory of Taiwan. And, the PM2.5 pollution sources in Taiwan can mainly be divided into industrial pollution sources (such as electric power facilities, boiler, steel industry, petrochemical industry, cement industry and chemical product manufacturing), mobile pollution sources (such as transportation tools) and other pollution sources (such as dining fume, construction dust and open fires). After understanding the features of various pollution sources, it should be set the goal of active efforts that how to reduce the emission of native PM2.5 and derivative PM2.5, such as sulfur oxides and nitrogen oxides and volatile organic compounds, within the territory of Taiwan (Tsai, Yang & Huang, 2017). The EPA has continued to fulfill on licensing and emissions management, control of emission standard, survey and control of emission of harmful air pollutants, fee collection and reward for air pollution control, fugitive granular pollutant control, volatile organic substances control, the fixed pollution sources control, new vehicles control, clean fuels promotion, and promotion of vehicles with low pollution to control various mobile pollution sources. In order to bring creative thinking to the tasks and integrate the cross-departmental resources, the Executive Yuan convened the EPA and other departments to hold strategy planning meeting for air pollution prevention and control in December 2016. In April 2017, the Executive Yuan passed the Air Pollution Control Strategy (Environmental Protection Administration, 2017), which adopts both rewards and law enforcement. With an investment of NTD 36.5 billion, the prevention and control measures aim to focus on three main pollution sources, namely industrial source, mobile source and other fugitive pollution sources.

Taiwan passed an amendment to the Air Pollution Control Act in June 2018, including five key points: add good neighbor clause, add control mechanism for factory pollution sources, add mobile pollution source control, increase the penalty and recover illegal gains, and add whistleblower clause. The measures strengthen comprehensively for the planning of air quality improvement, pollution source control for managing initial sources, intermediates and the end of pollution phases (Environmental Protection Administration, 2018). The measures make much more perfect system for air pollution prevention and treatment. Within the area of Total Air Pollutants Quantity Control (TAPQC), it is implemented that the Emission Reduction Credits (ERCs) from vehicles and other mobile pollution sources could be provided to fixed pollution sources for offset or trading. The offset refers to the act of deducting the increased quantity in air pollutant emission by fixed sources from the difference in quantity of air pollutant reduction upon the public or private places (Lin, 2015).

3. Cleansing Outdoor Air Pollutants

In addition to the control of emission by air pollution sources, there have been no effective measures proposed for recycling or cleansing air pollutants emitted to outdoors so far. There are efforts to cleanse outdoor air pollutants through air cleansing tower (Liberty Times, 2018), to extract carbon dioxide from the air (Climeworks, 2018), or to replace fuel vehicles by electric vehicles. Whereas, for the electric vehicles, the demand for electric power supply will increase the thermal power generation, thus increasing air pollution caused by coal-fired power. Due to either foreign or local pollution, it is bound to have new mechanisms to ease the issue of increasingly severe outdoor air pollution so as to improve people's health and quality of life.

No matter how good the air pollution cleansing equipment is, the clean effect is greatly discounted if the pollutants cannot be captured in the first place after they are discharged. Once the pollutants disperse into the air, it will become very difficult to capture and cleanse them. So this paper proposed the following three kinds of mechanisms to cleanse or relieve outdoor air pollutions:

Mechanism 1: *adopt the existing mobile vehicles to cleanse air pollutants*

The thinking of Switzerland and China in recovering of cleansing air pollutants is quite different from that of this paper. No matter how good the air pollution cleansing equipment is, its clean effect will be discounted if the pollutants cannot be captured in the first place after they are generated. Once the pollutants disperse into the air, it will become difficult to capture and cleanse them.

Based on the righteousness of Marvelous Existence in Buddhism, this paper tried to adopt vehicles, which generate pollutants, as the carriers to configure the system of cleansing air pollutants. Then, the clean air is re-emitted to the atmosphere to reach the goal of cleansing air pollutants. The cleansing system installed in each vehicle will make the running vehicle generate pollutants and simultaneously cleanse pollutants. In this way, this vehicle will cleanse pollutants generated by other vehicles and other vehicles will simultaneously cleanse pollutants generated by this vehicle. Although the scale for this cleansing system is quite small, it can effectively reach the goal of reducing outdoor pollutants at the lowest cost through the Empire of Ants with their high mobility and density. This kind of clean effect cannot be achieved by the cleansing equipment mentioned earlier.

Mechanism 2: *recycle gaseous wastes*

The measurement of the harms of pollutants contained in the vehicle exhaustion should not only be the extent of final pollutants cleansed, but it should also be the duration of period of time from generating to cleansing pollutants. Chen, et al. (2018b) adopted solar power to equip dust absorption pipe and wet type dust flushing pipe with cyclone power on the highway guardrail so as to absorb the pollutants at the first time when they are generated and produces the clean CO_2. The mechanism of recycling CO_2 in the air pollution into clean CO_2 can also cleanse air pollutants during its operation.

Mechanism 3: *promote the drinkable tap water*

Taiwan has forbidden the use of lead pipes as drinking water pipes since 1979. Taiwanese Water Company gradually replaces the lead pipeline with stainless steel pipes in order to improve the quality of drinking water. Considering the cost of replacing pipeline and the privacy of homes, replacing engineering is conducted mainly in the public water supply pipeline. Whereas, the original lead pipes still remain in the household. It results in partial replacement (Chen, 2016). Although the tap water, after the purification by the water company, can be drunk according to the water quality standard, at present, the public in Taiwan are still worried about drinking tap water, which is delivery from the water company to their house, as the inner walls of water pipes have nourished bacteria due to uneven surface after the use for a long period of time. Their drinking habit is to drink boiled water. The main energy resources, which can boil the tap water, are electrical energy (electric heating water bottles or induction cooker), liquefied gas and natural gas. Chen et al. (2018a) proved that their proposed drinkable tap water system is feasible technologically and economically, based on analyzing the electric water boiling. In the system of Chen et al., an ultraviolet germicidal lamp is adopted to kill bacteria in the tap water within the residential water tower. Then, the small tube with cardiac catheter material is installed in the origin water pipes to transport the sterile tap water in residential as regular serve of drinking water.

4. Conclusion and Suggestions

No matter how good the air pollution cleansing equipment is, its clean effect would be discounted if it cannot be cleansed in the first place after they are generated. Once the pollutants disperse in the air, it will become difficult to capture and cleanse them. But it still needs to cope with the pollutants seriously which already have existed in outdoor air.

This paper proposed three kinds of mechanisms to cleanse air pollution or alleviate the issue of outdoor air pollution. In order to effectively cleanse outdoor air, the mechanism can be promoted smoothly only after the intervention of the power of government. Therefore, this paper proposes the following suggestions from the perspective of system in order to smoothly promote the three kinds of mechanisms to cleanse outdoor air pollution:

(1) The ERCs from vehicles and other mobile pollution sources within the area of Total Air Pollutants Quantity Control is provided to fixed pollution sources for offset or trading.

In order to transform vehicles and other mobile pollution sources into the main force to cleanse air pollutants in "Mechanism 1", the vehicle owners should be encouraged and rewarded to install this system in terms of policy in addition to the perfect planning and setting of the system itself. This policy must meet the following principles: (1) the existing vehicles have to install it, or they will be investigated and punished in case of failure to install it; (2) the tax burden of car owner will be reduced; (3) the cleansing system should be installed for all the automobiles newly produced; (4) the number of devices sponsored can be converted into the ERCs to be provided to fixed pollution sources for offset or trading.

It needs to equip air cleansing system on highway guardrail so as to recycle gaseous wastes in "Mechanism 2". The investment in this system is quite big, so the owners with fixed pollution sources should be encouraged to invest the system, in addition to be subsidized by the government. The total of ERCs can be calculated based on the quantity of cleansed pollutants and recycled CO2, which will be used by the owners for offset or trading according to their investment shares.

Therefore, the resources of investment from owners with fixed pollution sources (large capitalists) will greatly benefit to smoothly operate mechanism 1 and Mechanism 2. The two mechanisms can also reduce the harms of pollution sources from foreign or local Taiwan.

(2) The electricity saved due to drinkable tap water is provided to fixed pollution sources for offset or trading.

Governments of all the countries are planning to replace fuel vehicles with electric vehicles comprehensively so as to reduce air pollution. Although the pollution emission of vehicles can be controlled, it is hardly realized that the demand of electric vehicles for the power supply will increase thermal power generation (nuclear-free homeland is the main axis of the energy policy in Taiwan), thus increasing more air pollution caused by coal-fired power. Any equipment which can reduce and save power consumption can all contribute to the reduction of air pollution. In addition to making great efforts to ensure quality of tap water, the government should encourage the public to install drinkable tap water system recommended in Mechanism 3. The number of installed set, sponsoring this drinkable tap water system, can be used to calculate the ERCs, which is also provided to the fixed pollution sources for offset or trading. Therefore, drinkable tap water system can be promoted effectively and rapidly. Meanwhile, the emissions of air pollutants caused by power generation can be lowered.

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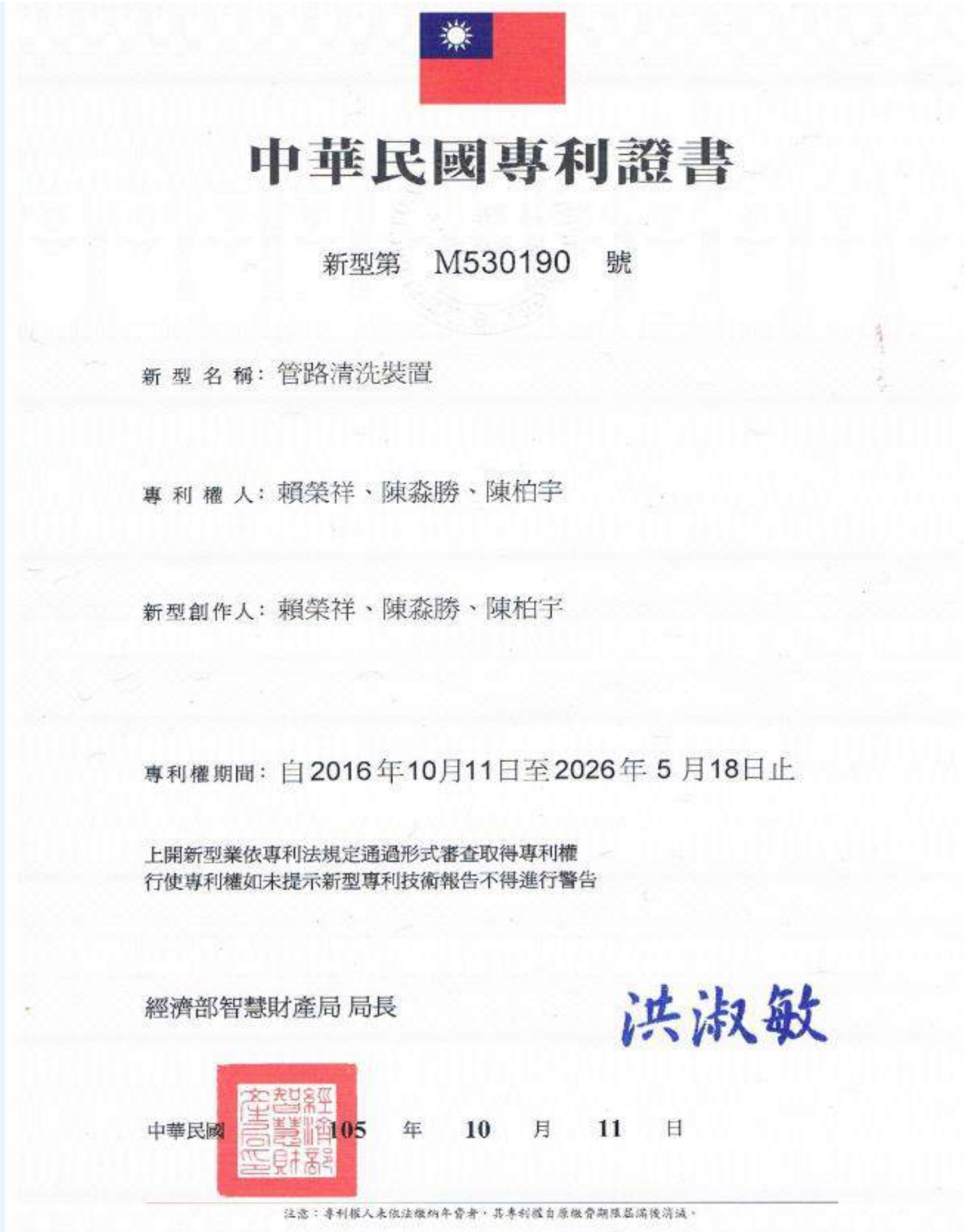
B-1 管路清洗裝置專利證書



中華民國專利證書

新型第 M530190 號

新 型 名 稱：管路清洗裝置

專 利 權 人：賴榮祥、陳淼勝、陳柏宇

新型創作人：賴榮祥、陳淼勝、陳柏宇

專利權期間：自2016年10月11日至2026年 5 月18日止

上開新型業依專利法規定通過形式審查取得專利權
行使專利權如未提示新型專利技術報告不得進行警告

經濟部智慧財產局 局長 洪淑敏

中華民國 105 年 10 月 11 日

注意：專利權人未依法繳納年費者，其專利權自原繳費期限屆滿後消滅。

B-2 淨化空氣汙染物之車牌配件構造專利證書

中華民國專利證書

新型第 M570252 號

新 型 名 稱：淨化空氣汙染物之車牌配件構造

專 利 權 人：賴榮祥

新 型 創 作 人：賴榮祥、陳淼勝、陳柏宇、賴昱辰

專利權期間： 自2018年11月21日至2028年 5 月 1 日止

上開新型業依專利法規定通過形式審查取得專利權
行使專利權如未提示新型專利技術報告不得進行警告

經濟部智慧財產局 局長 洪淑敏

經濟部智慧財產局

中華民國 107 年 11 月 21 日

注意：專利權人未依法繳納年費者，其專利權自原繳費期限屆滿後消滅。