Pollution and control

Section A – Look for a potential work based project that is related to monitoring and control of pollution in the workplace. This section of the assignment should give a brief description of the potential project in terms of ??? best practice??™ and allows you to identify and discuss cutting edge research that deals with specific issues in the management of environmental problems. Pollution has now become high on individuals??™, corporate and governments??™ agenda. Dramatic environmental effects, such as climate change, have helped to raise the profile of pollution and how this affects both quality of life and the sustainable use of the planet. Volatile Organic Compounds (VOCs) one of the most common forms of air pollutants emitted from chemical, petrochemical and related industries are responsible for a variety of environmental and human capital hazards (Kahn & Ghoshal, 2000, p.

527). This essay will look at one particular industry which uses solvents as part of the manufacturing process looking at how they control emissions, including an evaluation of some related control technologies and emerging technologies. The discussion will also look at how companies can collect and analyse data, in other words monitor and measure exposure to ensure they are effectively managing their environmental impacts. The atmosphere is subjected to pollutants from many sources some of which are natural and others which are man-made.

Carbon dioxide, for example, has been increasing to an extent which is adding to the ??? greenhouse effect???. Other pollutants include nitrogen oxides, methane, chlorofluorocarbons and ozone. Ozone formulation is related to the manufacture and use of VOCs (Suess, 1993, p. 27). The health effects have been categorised into three distinct categories; toxicity, human sensitivity i. e.

detection of odours and possible the most salient aspect relating to VOCs, the potential to cause cancer (Technical Guidance Note M16, 2005, p. 3). The environmental concerns relate to ozone production in the lower atmosphere by normal reactions to oxygen and oxides of nitrogen in the presence of sunlight. In normal circumstances these reactions are normal and the ozone is naturally created and destroyed. The problems however exists when VOCs contribute to ozone generation producing proxy radicals in the presence of sunlight which following complex chemical reactions result in the formulation of ozone (Fleming et al, 2006, p.

2193). Ozone has a direct impact on plant life and vegetation and is a greenhouse gas. Governments therefore have become increasingly aware of the need to restrict and control VOC emissions and through various legal apparatus strict legal standards are now adopted in most industrialised countries. One company, known here as Products UK, manufacture coating products for the vehicle refinishing industry. Raw materials are delivered to the bulk tanks, drums or power store. In paste production resins, solvents and fillers are weighed, added and the resulting paste is mixed in machines before passing to the filling lines for discharge into small containers. In paint production, resin solvents and other materials are added to the mixing vessels.

The paint produced passes to the paint filling line for discharge. Air is extracted from the vessels and filling line to atmosphere via filters. To comply with the relevant permit a determination of organic solvent consumption including solvents inputs minus solvents sent for recovery/reuse and fugitive releases must be made. To help companies prove compliance a VOC workbook has been produced and in recognition of its status has been afforded a unique distinction in that it has been given a direct reference within the Secretary of State??™s Guidance Note for the Manufacture of Coatings Materials, PG6/44(04 (Printing talk, 2008, p.

1). From the VOC emissions workbook computations are made to determine the annual VOC emissions as a % of input. This allows the company to take a step by step process to identify all relevant inputs and VOC emissions producing a numerical calculation of final results. The worksheet identifies both bulk storage filling solvent losses and bulk storage breathing solvent loses in tonnes per year. The Solvent Emissions Directive for paint operations is currently 3% and from secondary data obtained from the workbook the company record emissions as 1. 14%.

Historically pollution control regulations tended to focus on single medium emissions covering releases to air, land and water. However from the mid 1970??™s a new paradigm in pollution control emerged which reflected the integrated approach to pollution control, implying a holistic approach should be taken when considering harmful emissions. This line of thinking has resulted in the EU to develop its directive on Integrated Pollution Prevention and Control (IPPC) which came into force in 1996 (Harrison, 2000, p. 420). A central concept to the IPPC regime is the principal of Best Available Techniques (BAT). This requires operators to afford a high level of protection using the ??? best available techniques??™ to the environment as a whole (Bell & McGillivray, 2006, p.

781). The Pollution, Prevention and Control (England & Wales) Regulations describe best practice as ??? the most effective and advanced stage in the development of activities and their methods of operation which indicates the practical suitability of particular techniques for providing in principle the basis of emission limit values designed to prevent and, where that is not practicable, generally to reduce emissions and the impact on the environment as a whole???. In relation to solvents the EU has passed the Solvent Emissions Directive (SED) which aims to limit the emissions of VOC due to the use of organic solvents in certain activities and installations (Process Guidance Note 6/44, p. 4). Since the adoption of the SED companies should be seeking to reduce their solvent consumption and enhance on site emissions controls. There are many different techniques available for controlling VOC emissions and principally they fall into two categories; (i) process and equipment modification and (ii) add on control techniques (Kahn & Ghoshal, 2000, p. 528).

The first group involves changing or modifying the process equipment in some way to achieve lower emissions whilst the second group involves adding on some form of abatement technology to meet a specific limit (Kahn & Ghoshal, 2000, p. 528). The former group is perhaps the most effective and could be said to comply with the spirit of IPPC, however in practice its applicability is sometimes limited as it is can be grossly uneconomic to modify the process and/or equipment (Kahn & Ghoshal, 2000, p. 528).

The initial stage when developing a control strategy is to prepare a comprehensive emissions directory and should cover the entire plant source by source evaluating the following; ??? Pollutants emitted; ??? The individual chemical composition within each vent stream; ??? Hourly, annual and worst case emission rates; ??? Existence and condition of control equipment; and ??? Regulatory status. (Kahn & Ghoshal, 2000, p. 528)Changing the process and equipment modifications are the most effective methods of controlling VOC emissions (Kahn & Ghoshal, 2000, p. 528) and include changing raw materials and ensuring escapes of VOCs are reduced by stringent maintenance and inspection regimes.

Add on control methods are divided into two groups: destruction and recovery and a variety of methods are available some of which are summarised in the following table adapted from (Hunter & Oyana, 2000, p. 18-27);| Method | Group | Advantages/Limitations || Condensation | Recovery | Recovered VOC can be recycled. System requires high levels of maintenance and || | | requires use of inert gas for explosion hazards increasing costs. || Adsorption | Recovery | Inexpensive and flexible however produces additional waste streams. || Absorption/scrubbing | Recovery | Allows for recovery of pollutants; produces additional waste streams in waste || | | water.

|| Thermal incineration | Destruction | Highly efficient; high explosion potential and can produce additional || | | pollutants NOx || Catalytic incineration | Destruction | Reduced fire hazards, energy efficient; high costs and no recycling potential. || Flaring | Destruction | Simple equipment and operation; no recovery of contaminate. || Biological treatment | Destruction |

Low energy requirements and lower operational costs; effectiveness is pollutant|| | | specific | Adsorption is the traditional method employed when abatement control methods are adopted for dealing with low levels of pollutants and the method employed by Products UK.

The technology involves trapping pollutants from a gas stream on a solid, typically activated carbon or a crystalline material, with a large surface area (Hunter & Oyama, 2000, p. 44). This method is often inexpensive and flexible and installations costs are often less than other systems (Kahn & Ghoshal, 2000, p. 528). However there are limitations principally that once the adsorbent material is saturated, unless it can be regenerated, further waste streams are created such as solid waste disposal (Hunter & Oyama, 2000, p. 20). Various comparisons have been made to establish the effectiveness of the control technologies available and factors that will ultimately determine the choice of abatement technology include ranges of concentrations, flow rates, control efficiency and the availability of utilities, labour and capital (Kahn & Ghoshal, 2000, p. 540).

Adsorption and catalytic incineration are recognised as being effective and relatively cost effective however each has its own limitations. The option that has long term benefits is a process change in order to either eliminate or reduce organic compounds i. e. reduction at source and although some initial limitations including high investments costs etc. would be incurred, savings in operating costs as well as fewer man hours dedicated to complying with environmental permits etc. make this option a possible solution (Hunter & Oyama, 2000, p. 27). As solvent emissions limits become ever more stringent, industry has been forced to adopt even more sophisticated methods for controlling emissions and for most the main focus has been on end-of-pipe abatement systems, which recover solvents from waste gas streams prior to their release into the environment.

As discussed many industries have relied on traditional methods such as carbon adsorption, to manage the recovery of VOC, but one significant drawback of such systems is that the VOC contaminated carbon waste requires either incineration or disposal at landfill sites. With increasing landfill and energy costs this is increasing becoming less efficient. A next generation cryogenic recovery system is an example of one such innovative solution which uses cryogenic technology to recover solvents by using liquid nitrogen to literally freeze out VOCs from process gas flows and recover them efficiently and cleanly. Whilst historically such technology was prohibitly expensive, too inflexible and complex in recent years cryogenic technology has advanced setting new standards in solvent emissions control, operating to near zero efficiency. (Institute of Clean Air Companies, 2008, p. 2). ISO 14001 requires organisations to identify aspects associated with activities, products and services that it can control or influence and determine those aspects that can have a significant impact on the environment. This in part entails preparing an aspects and impacts register which aims to evaluate elements of the organisations??™ activities that may interact with the environment.

To establish useful and emission limits in line with current legal standards, sampling and monitoring to collect real time data is required. Both quantitative and qualitative methods of collecting data can be used. Products UK in line with permit requirements adopt such a monitoring regime and carry out annual stack monitoring in line with current best practice and legal requirements. Obtaining quantitative data involves extracting a sample from a stack or duct and transferring the sample to a calibrated instrument for appropriate analysis (Technical Guidance Note M16, 2005, p.

9). Qualitative data is obtained by performing perceptive odour evaluations which relies on the assessor??™s subjective assessment however should usually be performed by highly experienced and competent persons. The methods adopted by Products UK include the use of Sorbent Tubes and Flame Ionisation Detection. In the case of the Sorbent Tube a sample collection is taken using a calibrated pump into a tube containing activated charcoal which is analysed in a laboratory. Sample collection in the case of the Flame Ionisation Detector would last for one hour per stack and is carried out using a heated portable flame ionisation detector. The sample gas would be passed to the analyser via a heated sampling line and on site calibration of the unit is carried out before and after the sampling period. The FID is most suited to measure emissions of single VOCs and to verify the performance of abatement equipment, however there are limitations and these include FIDs do not differentiate between different compounds and they require a source of fuel. Alternative methods of measurement include Photo Ionisation Detection which utilises the ionising effects of a beam of photon and has as advantage over the FID in that it can detect very low concentrations of gas although they are not recommended for continuous monitoring (Technical Guidance Note M16, 2005, p.

12). Finally another method available relies on the principal that VOC absorb electromagnetic radiation and this is exploited for measurements known as the Spectroscopic method. One drawback with this method is when there may be a mixture of different VOCs in the sampled gas which can cause interference resulting in a greater probability of false readings (Technical Guidance Note M16, 2005, p. 14). IPPC implies that a holistic approach be adopted for pollution control and prevention. One such method that adopts such a philosophy is that of Life Cycle Assessment (LCA). The ISO standard for LCA defines a life cycle assessment as ??? the compilation and evaluation of the inputs, outputs and potential environmental impacts of a product system throughout its life cycle???. (Guinee, 2002, p.

5). Known simply as the cradle to grave assessment the tool is designed to evaluate the environmental burden of products throughout all stages of their life cycle ??“ from extraction of raw materials, production of the materials and final use of the product including how it is discarded either by recycling or landfill disposal. (Guinee, 2002, p. 5) The cradle to grave approach can be important as for example it discourages problem shifting to another part of the process.

It is no good changing the use of a particular raw material simply because it may have a lesser environmental impact if the cost of extracting it requires more energy (Guinee, 2000, p. 6). LCA does have limitations and these include a single focus on environmental aspects and no consideration to both the economic and social characteristics. Furthermore LCA relies on the application of reliable secondary data which can be a major limitation in its use. Conclusion. Preventing and controlling pollution is now a complex and integral component of environmental management. Strict standards and laws have evolved in order to combat some of the effects caused by pollution and in the case of Volatile Organic Compounds these include potentially catastrophic alterations in the planets eco-system.

The company outlined in the discussion comply with legal permits using traditional adsorption abatement methods and on the whole it could be said that these controls are effective in that SED limits for solvents are not exceeded and that internationally approved methods of measurements are deployed to determine this fact providing suitable data for analysis. Various methods and technologies for controlling and monitoring VOC emissions were discussed and we can conclude here that each may have its advantages and disadvantages in terms of performance and reliability. The company do not however employ the use of a recognised Environmental Management System such as IOS 14001 or the Environmental Management & Audit System. Adopting such a system may help the company identify where improvements in process design or even product development, that reduces the amounts of VOCs used, may be achieved.

Other tools such as Life Cycle Assessment could ensure all parts of the supply chain are working towards the development of a sustainable product. It is here that we may have reached an impasse in terms of environmental protection. Should the company strive to reach zero emissions, is this achievable in practice What incentive is there for companies to innovate and adapt to the challenges posed by environmental concerns. The next section of the essay will therefore aim to examine some of the aspects including a critical look at the legal provisions in place to control solvent emissions such as the BAT concept and evaluating if these concepts encourage innovation in control technology. Section B – Section A of this assignment allows for the communication of ideas associated with putting theory into practice and along with section B your project forms a proposal for informing government policy. With this in mind, identify any legal issues that affect the uptake of ideas as recommended in section A, identifying evidence of policy concerns. Section A discussed the implications with the use of Volatile Organic Compounds (VOCs) within industry in particular solvents used in the production of vehicle refinishing products in the UK.

We established that there are two major reasons why the control of VOCs creates particular interest from authorities; first some compounds have direct toxicity, for example benzene which is listed as a chemical carcinogen and secondly from their function as precursors of photochemical ozone (Harrison, 2000, p. 185). The company in question relies namely on end of line abatement technologies and procedural aspects such as reformulation, good housekeeping and storage arrangements for solvents to contribute to decreasing their emission limits. Pollution control law demands that such companies apply for an operating permit which is based on the Integrated Pollution Control and Prevention concept of best practice which is weighed against the costs of application and the associated environmental impacts (Emmott & Haigh, 1996, p. 303).

This section of the essay will therefore look at the specific legal issues surrounding solvent emissions with the objective of identifying is there are any limitations in current legal standards, for example does the concept of Best Available Techniques encourage innovation in control technologyEmissions of solvents from industrial processes are regulated under Part 1 of the Environmental Protection Act 1990 and the use of solvents and the management of waste solvents is now highly regulated due to their hazardous and volatile nature. As such successive UK governments have signed up to a number of international conventions aimed at reducing air pollution which in turn will effect solvent management. According to figures published by the Department of Environment, Food and Rural Affairs (DEFRA) VOC emissions have fallen steadily between the period 1970 to 2005 and in particular fell by 62 per cent between 1990 and 2006 to 0. 6 million tonnes (Department For Environment, Food & Rural Affairs [DEFRA], environmental statistics, 2008, p.

1). However the use of solvents in industry remains significant and governments aware that VOCs contribute to global warming are keen to ensure emission limits continue to fall. Historically British pollution control law has avoided imposing nationally binding targets, preferring instead to allow discretion for controlling authorities (Harrison, 2000, p. 526). As an example of this for over one hundred years the term ??? best practicable means??™ was a key criteria in the legislation which regulated air pollution. The term, not clearly interpreted, was rarely challenged by the courts as regulators favored keeping the courts away from the process of defining pollution law, unlike the United States for example where civil litigation can be a major driver in pollution control (Harrison, 2000, p. 526). Regulation therefore in the early 19th century was driven by the need to control local issues and by adopting end-of??“ pipe technologies and the early Alkali Act of 1874 is an early example of this approach.

In recent years the emphasis has changed somewhat, pollution law is more explicit than ever before and the courts now play an active role in challenging the interpretation of the law (Harrison, 2000, p. 526). The classical legal approach towards the regulation of pollution was the requirement for a permit/license to be granted from a government body. The permit would describe stipulations aimed at controlling emissions to an acceptable level. Initially a non integrated approach was used i. e.

the mediums of water, land and air were regulated separately. This was the case until the Environmental Protection Act 1990 which introduced the Integrated Pollution Control concept under part 1 of the Act. Central to the system was the ??? operating license??™ requirements and additionally the Act introduced the BATNEEC principal which supported by technical documents focuses on technical solutions equaled out by practicable and economic considerations (Harrison, 2000, p. 534). The major limitation of this approach was that it was process orientated and recognizing this the EU further strengthened and supported this by adopting the 1996 directive in Integrated Pollution Prevention and Control (IPPC) which came into force in 1999 requiring national implementation.

IPPC offered some changes from IPC notably the change from Best Available Techniques (BAT) rather than BATNEEC and an inclusion of noise and energy efficiency within the scope. The IPPC system represented a fundamental shift in pollution prevention and control. Whereas industry was seen as the problem now industry was seen as part of the solution (Harrison, 2000, p. 549). However it has been argued that while accepting that IPPC & BAT have made a significant impact, more fundamental changes in policy will be required as increased industrial activity to cope with a growing population could produce more waste than the natural eco system can absorb (Anex, 2000, p.

188). This is reflected by various government initiatives such as carbon trading to supplement the traditional command and control approach (Harrison, 2000, p. 549). To meet these challenges industry will have to be innovative in order to maintain ecomonical competitiveness whilst further minimizing their environmental impact. Does however the concepts of BAT encourage innovation and does the cost of environmental compliance stifle progress and performance One argument put forward is that by emphasizing phrases such as ??? Best Available Techniques??™ or the United States ??? Best Available Control Technologies??™ regulation may in fact be implying that recommending one particular technology such as catalysts or scrubbers is always the best, almost guarantees that innovation will not occur (Porter & Linde, 1995, p.

110). This argument is countered by the flexible nature of IPPC which it has been suggested encourages innovation as opposed to adopting fixed uniform targets which are perceived to be economically inefficient because there may be no incentive to reduce pollution below the standard even if this could be achieved at a lower cost (Bell, 2006, p. 792). The relationship between minimizing environmental impacts and industrial competiveness remains the issue of balancing society??™s desire for environmental protection against the financial commitment of industry. Put basically one side call for greater standards and the other forces them back and the ensuing tug of war cycle begins (Porter & Linde, 1995, p.

97). Several studies have been completed pointing to high costs of regulatory compliance suggesting that there is some form of trade off between regulation and competiveness. There are plenty of opportunities to learn of occasions where industry has in fact moved ahead of regulation and the adoption of a new manufacturing standard in the US for solvent based paint to ensure a safer, more sustainable product is available is one such example of this (Reuters, 2008, p. 1). Factors which influence innovation include competition, market uncertainty, industrial life cycle and of course government regulation and it is suggested that some industries are more conductive to innovation than others which may also imply that government policy could be further directed to industries where innovation has stagnated (Anex, 2000, p. 194).

Empirical research identifies three hypotheses related to the effect of industrial innovation. First technology push which argues the complexity of the industry will affect research and subsequent innovation, secondly the demand/pull hypotheses which suggests that economic opportunities drive innovation and finally the overall life cycle pattern of an industry which relates to how market niches are created and innovative products and processes are created (Anex, 2000, p. 194). Joseph Schumpeter supported these varying theories when he expressed his view that ??? innovation is the very essence of economics and most certainly that of a modern economy??? (Drucker, 1983, p.

3). The ability therefore to develop and re-design industrial process to meet environmental obligations lies therefore both with governments and industry. Government regulation could be used to stimulate technological innovation in industry by the use of taxes, which fulfils the polluter pays principal, subsides or heavy penalties for non-compliance.

Government policy could also be directed to encourage the use of mass balances or increase reporting and accountability requirements such as the ISO 14001 Environmental Management Standard which can help companies identify waste reduction opportunities. (Anex, 2000, p. 198). The use of mass balances involves considering all relevant inputs into an industrial process for example raw materials, energy and water etc.

and all of the outputs which could be in the form of fugitive emissions, pipes and stacks. Although certain permit authorisations require this type of approach only specified industries are included within the scope of IPPC and perhaps regulation could be extended here to cover small and medium sized businesses. Most environmental reporting is encouraged voluntarily however some nations now require mandatory CSR reporting. The USA for example has implemented the Toxic Release Inventory and other countries such as Denmark, the Netherlands, Norway and Sweden, now require certain reporting requirements for specific industries. (Elkington, 1997 p. 176) Reporting has now been extended to include the so called Triple Bottom Line in where the economic, social and environmental aspects of organisations are included within company reports. Criticism in the past has been levelled at this voluntary reporting of biased and self sycophantic environmental information in standalone CSR reports, choosing to emphasise policies or CSR practices rather than targets and outcomes (Vogel, 2005, p.

68). But this perception is changing with new legal reporting requirements under the EU Accounts Modernisation Directive, (AMD) and the Companies Act, 2006 which require qualifying companies to have regard to their impacts on the environment, which are material to their business performance, and to disclose these to the extent necessary for the companys position and performance to be understood in the annual report. What part then should tools such as Life Cycle Assessment play in environmental management To possibly answer this question we need to look at legislation and regulation. The Environmental Protection Act 1990 introduced the concept of Integrated Pollution Control which takes into account the combined emissions from a process and whilst regulating all emissions IPC considered the process element only. Further legislative developments increased and extended this view with the Integrated Pollution Prevention and Control which requires processes to be assessed on a wider basis. Therefore IPPC implies that companies adopt controls which aim to prevent pollution at source rather than traditional end-of pipe abatement technologies.

Thus IPPC extends the focus on emissions from the process to consider the wider impacts such as energy use, raw materials and waste disposal. This may imply that life cycle assessment be used to determine the ??? best available technique??™ as specified under IPPC (Harrison, 2000, p. 421). Conclusion. The initial part of the discussion looked in particular at a vehicle refinishing products manufacturing company regulated under the Solvent Emission Directive.

The company control emissions of VOCs into the atmosphere by adopting end-of-pipe technologies with supplemental maintenance and procedural arrangements. Air pollution and in this case emissions from solvents are now highly regulated and this is coupled with an ever increasing awareness amongst society to produce and manufacture sustainable products whilst minimizing the impact to the environment. This may be exacerbated by the ability of our natural system to absorb waste produced significantly by an increasing population and substantial economic growth (Anex, 2000, p. 207). Regulation in the United Kingdom has evolved to now encompass an integrated approach reflecting a holistic and life cycle approach from raw material, energy use, process design and waste disposal. Industry has historically favored end-of pipe abatement technologies however this trend may be slowly changing.

The discussion has tried to determine what role if any legislation has had in ensuring environmental responsibility and concluded that responsibility will likely fall not only to governments, but the private sector who should be encouraged to be innovative and dynamic. Critics have stated there is no accountability for the sustainable use of the environment and although the use of reporting models such as triple bottom line and corporate social responsibility strategies are increasing in their use, the voluntary aspect of the models leave them open to doubt. Environmental reporting has become mandatory within some countries around the world; however it is hoped that market forces can be used to encourage organisations to take action in this direction. The question of regulation and innovation was further explored and although some studies have attempted to reveal a link between regulatory compliance and economic burden countering evidence is available which suggests leading companies for a variety of reasons are ready to innovate even if the motivator is market lead.

Governments it has been suggested have an unique opportunity to develop policy to encourage innovation, encourage tools and strategies such as life cycle assessments and eco-labeling and it may be possible to identify if concepts such as eco-labeling and IPPC could be intrinsically linked to fully achieve a more effective integrated approach (Emmott & Haigh, 1996, p. 309). Bibliography1.

Anex, R. P. (2000). Stimulating Innovation in Green Technology: Policy Alternatives and Opportunities. American Behavioural Scientist. 44, 188-212.

2. Bell, S., McGillivray, D. (2001). Environmental Law(6th ed,). New York: Oxford University Press.

3. Department For Environment, Food & Rural Affairs. (2008). Environmental Protection, Key Facts About: Air Quality. Retrieved November 29, 2008, from www. Defra.

gov. uk/environment/statistics/airqual/aqemvoc. htm4. Department For Environment, Food & Rural Affairs. (2004). Process Guidance Note 6/44(04): Secretary of State??™s Guidance for the Manufacture of Coating Materials. Environment Agency.

5. Elkington, J. (1997).

Cannibals with Forks The Triple Bottom Line of 21st Century Business. Oxford: Capstone Publishing Limited. 6. Emmott, N., & Haigh, N. (1996).

Integrated Pollution Prevention and Control: UK and EC Approaches and Possible Next Steps, 8(2), 301-311. 7. Fleming, Z., & Monks, P. S.

, & Rickard, A. R., & Heard, D.

E., & Bloss, W. J., & Seakins, P. W., et al. (2006). Peroxy radical chemistry and the control of ozone photochemistry at Mace Head, Ireland during the summer of 2002.

Atmospheric Chemistry and Physics, 6, 2193-2214. 8. Guinee, J., B.

(2002). Handbook on life cycle assessment: operational guide to the ISO standard. Boston: Kluwer Academic Publishers.

9. Harrison, M. R. (2001) Pollution: Causes, effects and control. Cambridge: The Royal Society Of Chemistry.

10. Hunter, P., Oyama, S. T.

(2000). Control of Volatile Organic Compound Emissions ??“ Conventional and Emerging Technologies. USA: John Wiley & Sons, Inc. 11. Institute of Clean Air Companies.

(2008). VOC Control Technologies. Retrieved October 10, 2008, from www. Icac. com/i4a/pages/index. cfmpageID= 3400&textonly= 112. Kahn, I. F.

, & Ghoshal, A., Kr. (2000). Removal of Volatile Organic Compounds from polluted air. Journal of Loss Prevention in the Process Industries, 13, 527-545. 13. New Paint Standard Defines Green Leadership.

(2008, July 9), Reuters, p. 114. Porter, M. E.

, & Linde, C. (1995). Toward a New Conception of the Environment-Competitiveness Relationship. Journal of Economic Perspectives, 9(4), 97-118. 15.

Printing Talk. (2008). Free VOC Book Tackles New VOC Emission Compliance. Retrieved November 11, 2008, from www. printingtalk. com/news. brs/brs104.

html16. Suess, J., M, (1993). Air Pollution: Issues and Solutions. Environmental Management & Health, 4(4), 27-30. 17.

Vogel, D. (2005). The Market for Virtue, The Potential and Limits of Corporate Social Responsibility Washington: Brookings Institute Press.