

FHKI
 Experience Sharing Seminar &
 Technical Workshop on Green
 Manufacturing
 Printing and Packaging Industry

IAQ Improvement

Presented By:
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 Hong Kong Indoor Air Quality Society
 30 April 2007

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23 April 2007

什么是 IAQ?

- 世界衛生組織(WHO)：輸送到樓宇‘佔用人’呼吸區內的室內空氣，[假如]沒有物理及化學性物質，可促使佔用人無論在精神和身體方面均處於最佳健康狀態，同時享有愉快的群體生活，而不單是沒生病或不感到身體虛弱。

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Pollutant Pathway 污染物通道

Source: Environmental Agency, UK

The diagram illustrates the flow of pollutants from source to receptor. It consists of three main stages connected by double-headed arrows:

- SOURCE (源头)**: A red octagon. Below it, a box lists control measures: "Reduce concentration, mobility, toxicity, of source" and "Contamination 减低污染物浓度, 流动性, 毒性".
- PATHWAY (通道)**: A blue octagon. Below it, a box lists control measures: "Break or intercept contaminant movement along the pathway 制止污染物在通道流动".
- RECEPTOR (受用/受害者)**: A green octagon. Below it, a box lists control measures: "Protect receptor from exposure to contamination by restricting / modifying behaviour 保护用者, 改变态度/行为, 避免受污染".

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Typical production wastes generated by the Printing & Packaging

- Solid Wastes** - empty containers, used film packages, outdated materials, damaged plates, developed film, dated materials, test production, bad printing or spoilage, damaged products, and scrap paper.
- Wastewater** - may contain lubricating oils, waste ink, clean-up solvents, photographic chemicals, acids, alkalis, and plate coatings, as well as metals such as silver, iron, chromium, copper and barium.
- Air Emissions** - Printing operations produce volatile organic compound (VOC) emissions from the use of cleaning solvents and inks, as well as alcohols and other wetting agents (used in lithographic printing). Larger plants can be the source of NOx and SO2 emissions.

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Key to pollution prevention

- Source control
- Emission control
- Pathway control

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Indoor Air Quality

- What is it in **Printing & Packaging** industry?
- VOCs emitted during production process of newspapers, books, flyers, wallpaper, plastic bags, food wrappers and pop cans**
- CAP 311W AIR POLLUTION CONTROL (VOLATILE ORGANIC COMPOUNDS) REGULATION**
 - “**coating**” (塗料) means a material that is applied to a surface in order to beautify, protect or provide a barrier to such surface;
 - 塗料(coating) 指為美化或保護物件的表面或為對物件的表面提供阻隔層而加於該表面上的物料；

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CAP 311W AIR POLLUTION CONTROL (VOLATILE ORGANIC COMPOUNDS) REGULATION



- "regulated consumer product" (受規管消費品) means a regulated consumer product listed in Part 2, 3 or 4 of Schedule 3;
- "regulated paint" (受規管漆料) means a regulated paint listed in Part 2, 3 or 4 of Schedule 1;
- "regulated printing ink" (受規管印墨) means a regulated printing ink listed in Part 2 or 3 of Schedule 2;
- "regulated product" (受規管產品) means a regulated paint, a regulated printing ink or a regulated consumer product;

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Schedule:1 :REGULATED PAINTS



- PART 3
MAXIMUM LIMITS OF VOLATILE ORGANIC COMPOUND CONTENT FOR REGULATED PAINTS TO WHICH SECTION 3(2) OF THIS REGULATION APPLIES

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Schedule 1: Part 3



Item	Regulated paints	Maximum limits of volatile organic compound content
1	Fire-retardant coatings (clear)	650
2	Flat coatings	50
3	Granite look-alike coatings or textured undercoaters	100
4	Japans or faux finishing coatings	350
5	Multi-colour coatings	250
6	Non-flat coatings	150
7	Roof primers (bituminous)	350

Grams of volatile organic compounds per litre of coating

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VOC



- Associated with process baths include chemical drag-out, spent bath treatment and disposal, and **releases of vapors and mists into the air.**
- 揮發性有機化合物 (volatile organic compound)—
 - (a) 就受規管漆料而言，具有附表1第1部給予該詞的涵義；
 - (b) 就受規管印墨而言，具有附表2第1部給予該詞的涵義；
 - (c) 就受規管消費品而言，具有附表3第2部第2條或附表3第6部 (視何者適用而定) 給予該詞的涵義；及
 - (d) 就平版熱固卷筒印刷機而言，具有附表4給予該詞的涵義；

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IAQ in Printing & Packaging Industry ?



- Indoor air quality for
 - Offices
 - Material Handling and Storage room/area
 - VOC through pathways from
 - a regulated paint
 - a regulated printing ink,
 - a regulated consumer product
 - a lithographic heatset web printing machine

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VOC in Printing Shop



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Prepress

- film/film processing chemicals
- developer/fixer
- wash water
- plates/plate chemicals/plate processes/plate miscellaneous
- proofing

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Pressroom

- paper waste
- blanket cleaning/maintenance
- roller washing/maintenance
- parts cleaning
- fountain solution/ink

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Pressroom



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Printing

- Solvents are used as a medium to transfer colour pigment as well as a cleaning material for the printing process. In the drying process, the solvents are forced off the substrate and released into the environment. In the cleaning process solvents naturally evaporate into the environment.

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TVOC Spot Check in a Printing Company in HK – in Sept 2006

Time: a.m.	Location	TVOC in ppb
10:50	Conference Room	130
10:55	Computer Room	480
11:00	Printing Room	600
11:05	Outside printing room	1090
11:06	RA Cabinet AC	1200
11:07	Outside print room	1500

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Chain Reaction VOC – O₃



- $\text{NO}_2 + \text{sunlight} \rightarrow \text{NO} + \text{O}$ (1)
- $\text{O} + \text{O}_2 \rightarrow \text{O}_3$ (2)
- $\text{O}_3 + \text{NO} \rightarrow \text{O}_2 + \text{NO}_2$ (3)
- Ozone can't build up - formed in reaction (2), it is destroyed in reaction (3).
- VOC allow NO_2 to be regenerated without destroying ozone because VOC allow reaction (3) to be bypassed

Source: Joel Schwartz Environment & Climate May 2006

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Remediation ?



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V.O.C. abatement system



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Integrating and installing VOC emissions control equipment



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Innovations (?)



- In-line, six-color, carousel-style screen printing press with ultraviolet curing for the inks
- A carousel press consists of a separate screen-printing head for each color
- One motor drives all six screens, instead of one motor per screen as in the straight-line process
- The press uses ultraviolet ink, which contains no hazardous air pollutants (HAPs) or volatile organic compounds (VOCs).

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Innovation (?)



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Alternatives



- Water-based ink technology targeting VOC emissions from the solvent-based inks.
- Completely alcohol free alcohol substitute products used on all presses targeting Isopropyl alcohol
- Fountain solution in lithographic printing targeting Isopropyl alcohol

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Three main considerations



- A system with competitive capital cost and the lowest possible operating cost
- A system that did not affect the sensitive production process
- The necessity to install a compliant system (with ISO?)

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Source Control –



- Removal of alcohol from fountain solutions
- VOC from fountain solution that was neutral, effective and completely compatible with all inks

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Flexography



- Flexography is a process for continuous printing on a paper, plastic or aluminium film, using ink diluted in a mixture of solvents (VOC) which can separate from the ink by drying in hot air
- **Incineration** most widely used to burn the VOC - with high operating costs and formation of more CO₂
- **Solution:** VOCs are converted by bacteria to methane gas

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Anaerobic Treatment



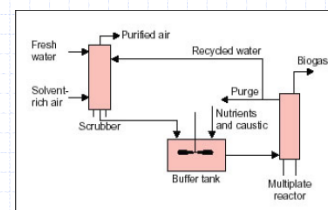
- Consists of a water-based purifier (scrubber), a buffer tank and a multi-plate reactor
- VOCs are removed from the contaminated air by the scrubber
- Clean air is discharged into the atmosphere, while the water containing the VOCs leaving the washer is taken to the buffer tank, where nutrients are added
- This effluent is then directed to the anaerobic reactor, where the VOCs are converted into biogas containing 75% methane
- The cleaned liquid effluent is returned to the scrubber
- The generation of the biogas could be used within the plant as a source of energy.

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Anaerobic Treatment



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Flexographic ink systems



- Solvent-based inks
- Water-based inks
- Ultra-violet cured inks

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Lithographic Printing



- Switch to blanket washes, used to remove ink and debris from the printing press rollers, containing fewer volatile organic compounds (VOCs), lower vapor pressure, and fewer hazardous chemicals

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Gravure Printing



- Solvent losses can be prevented and print quality can sometimes be improved by controlling ink temperature

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Screen Printing



- The most versatile of the printing techniques
- Unique environmental challenges
- Utilizes various materials in a printing process that differs greatly from other printing methods
- Screen Reclamation due to cost
- Chemicals used can be toxic
- Alternative Screen Reclamation Technology
 - High-Pressure Water Blaster
 - Automatic Screen Reclamation Technology

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Screen Printing Equipment



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Regenerative Thermal Oxidizer



- Exhaust from the printing presses is heated as it passes through stoneware beds located in an energy recovery chamber
- The process air moves from the recovery chamber toward the combustion chamber, where the VOCs are then oxidized, releasing energy into the second energy recovery chamber
- A flow-control valve switches the air flow direction so both energy recovery beds are fully utilized, thereby reducing any auxiliary fuel requirement.




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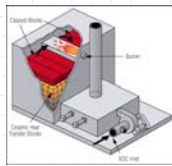
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Regenerative catalytic oxidation (RCO)




- Oxidize VOCs at low temperatures and to reduce the high operating costs of direct-flame thermal oxidation
- The process gases are oxidized across a catalyst bed, releasing energy in the second stoneware bed.

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More Solutions




- Carbon adsorption for odour control
- Oil Mist units for reducing machine tool emissions
- Wet Scrubbers for toxic emission control

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More Solutions



- Corrugated industry:
 - Web cleaning (RSP) - continuous contact cleaning of film and paper materials for narrow and wide web printing applications such as labels, holographics and packaging. No special chemicals, wipes, or handling
 - vacuum transfer dust collection
- Printing Industry:
 - Ozone extraction from printing presses
- Paint in Prepress:
 - VOC removal from mixing vessels



Source: Jenton International UK



Source: Heidelberg

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More Solutions



- 使用碳吸附技术的 溶剂回收空气净化系统



小型系统

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Thank you



- www.hkiaqs.org.hk
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- *The biggest problem in the world could have been solved when it was small.*
(The master of it) anticipates things that are difficult while they are easy, and does things that would become great while they are small. -- Lao-Tzu
- 圖難於其易，為大於其細：
天下難事，必作於易，
天下大事，必作於細。(道德經 第六十三章)
- 天長地久。
天地所以能長且久者，
以其不自生，故能長生。
是以聖人後其身而身先；外其身而身存。
非以其無私邪。
故能成其私(道德經第七章)

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