PROGRAMME BOOK

COSH 2012

15th Conference and Exhibition on Occupational Safety & Health

OSH Transformation:An Essential Investment

2nd - 4th September 2012

Sunway Pyramid Convention Centre, (SPCC) Selangor, Malaysia

In Conjunction With :

The Fourth Conference of Asian Occupational Safety and Health Research Institutes

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15TH COSH PROGRAMME

DAY 3 - Concurrent Session 2 (Hall 2)

4th September 2012 (TUESDAY - Morning)

TIME	ACTIVITY
0900 - 0930	Paper C2.1: Local Exhaust Ventilation: Past, Present, Future Ir. Nor Halim Hasan, PhD Candidate, Faculty of Mechanical Engineering, Universiti Teknikal Malaysia Melaka (UTeM)
0930 - 1000	Paper C2.2: Personal Transformation in OSH - A case study in oil and gas fabrication company Mr. Saravana Kumar Ramasamy, GD OSH Consultant
1000 - 1030	Paper C2.3: Office Ergonomics Issues with changing Technologies Prof. Alan Hedge, Cornell University, New York, USA
1030 - 1100	TEA BREAK & VISIT TO EXHIBITION BOOTH
1100 - 1130	Paper C2.4: Workplace Seasonal Influenza (Flu) Vaccination Campaign Dr. Abu Hasan Samad, President, Academy of Occupational and Environmental Medicine Malaysia (AOEMM) & Director of Medical Services, Prince Court Medical Centre
1130 - 1200	Paper C2.5: Transformation on the OSH Implementation in the Small Medium Enterprises: A Thought for Strategic Implementation. Dr. Busono Hadi, Senior Environmental Safety and Health Specialist, National OSH Center, Ministry of Manpower & Transmigration, Indonesia.
1200 - 1230	Paper C2.6: OSH Transformation in Business through Business Strategic Plan Mr. Ahmad Rosli Ahmad Bala, Arab Consultant Academy Sdn Bhd
1230 - 1400	LUNCH BREAK & VISIT TO EXHIBITION BOOTH

DAY 3 - 4th September 2012 (TUESDAY - morning)

Paper C2.1 : 9.00am - 9.30am

LOCAL EXHAUST VENTILATION: PAST, PRESENT, FUTURE

Ir. Nor Halim Hasan, PhD Candidate, Faculty of Mechanical Engineering, Universiti Teknikal Malaysia Melaka (UTeM)

Ir. Nor Halim joined the Department of Occupational Safety and Health (DOSH) Malaysia since 1994 and latest position as Deputy Director at DOSH Johor. He earned a Bachelor of Chemical Engineering (UTM-1992) and Masters in Industrial Safety Management (UKM-2006). He is also registered with the Board of Engineer Malaysia as a Professional Chemical Engineer since 2004. Currently he pursues his doctorate with Faculty in Mechanical Engineering at Universiti Teknikal Malaysia, Melaka. He is conducting research in the field of mechanical engineering with a focus on Local Exhaust Ventilation (LEV) for the industry that contributed much to the health problems of workers.

Local Exhaust Ventilation: Past, Present, Future - Engineering control is a method of controlling the risk of exposure to contaminants. Health effects to industrial workers are more severe whilst high exposure and time exposed to contaminants at workplace. Installation of industrial ventilation or local exhaust ventilation (LEV) system is the proposed method to reduce the risk. This paper will discuss the past, present and future relating to LEV system in Malaysia. Current issues related to monitoring reported by Hygiene Technician in compliance with Occupational Safety and Health (Use of Standard Chemical Hazardous to Health Regulation 2000) carried out in several states as a sample. The nanotechnology is a new issue at present and future. The involvement of government, employers and employees need to be justified due to the attention to prevent and control of any exposure. It is suggested that using the Computational Fluid Dynamic (CFD) simulation method and the needs to be considered for the new design and predicted LEV system performance and also to evaluate the existing LEV system.

Local Exhaust Ventilation: PAST, PRESENT, and FUTURE

Nor Halim Hasan[1, a*], M.R. Said[2,b] and A.M. Leman[3,c]

[1,2]Department of Structure and Material, Faculty of Mechanical Engineering, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia.

[a]Email: irnorhalim@student.utem.edu.my,

[b]Email: radzai@utem.edu.my

[3]Department of Plant and Automative Engineering, Faculty of Mechanical and Manufacturing Engineering, Universiti Tun Hussein Onn Malaysia, 86400 Parit Raja, Batu Pahat, Johor, Malaysia.

[c]Email: mutalib@uthm.edu.my

Abstract

Engineering control is a method of controlling the risk of exposure to contaminants. Health effects to industrial workers are more severe whilst high exposure and time exposed to contaminants at workplace. Installation of industrial ventilation or local exhaust ventilation (LEV) system is the proposed method to reduce the risk. This paper discusses the past, present and future relating to LEV system in Malaysia. Current issues related to monitoring reported by Hygiene Technician in compliance with Occupational Safety and Health (Use of Standard Chemical Hazardous to Health Regulation 2000) carried out in several states in Malaysia as a sample. The nanotechnology is a new area at present and future. The involvement of government, employers and employees need to be justified due to the attention to prevent and control of any exposure. It is suggested that using the Computational Fluid Dynamic (CFD) simulation, a new design of LEV system can be upgraded and predicted.

Keywords - *Volatile Organic Compounds, Occupational Safety and Health, Local Exhaust Ventilation, Computational Fluid Dynamic, Green Technology.*

1. Introduction

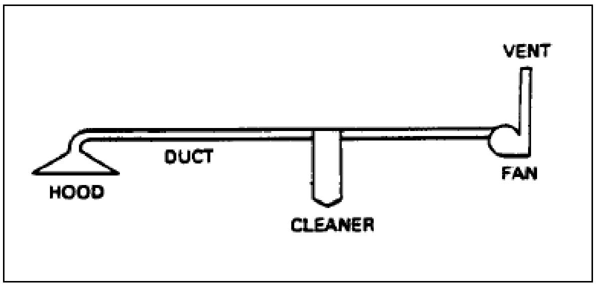
Industrial ventilation is a system of controlling airborne toxic chemicals or flammable vapors by exhausting contaminated air away from the work area and replacing it with clean air. It is an alternative to control the employee's exposure to air contaminants in the workplace. Other alternatives include process changes, work practice changes, substitution of toxic substances with less toxic, or total elimination. Industrial ventilation is typically used to remove welding fumes, solvent vapors, oil mists or dusts from a work location and exhaust these contaminants outdoors.

The objective of a local exhaust ventilation system is to remove the contaminant that being generated at a source. Industrial which involved and used with ventilation systems are required to comply with Malaysian Legislation such as Occupational Safety and Health Act 1994, Use of Standard Exposure Chemical Hazardous to Health Regulation and Factory and Machinery Act 1967 and Regulations under this Act.

1.1 Local Exhaust Ventilation (LEV)

The initial opening through which contaminated air enters a local exhaust system is called the hood. The term hood is used generically for any opening whether it is specifically designed or consists of simply the open end of a round or rectangular duct section. Hoods are specifically designed and located to meet the requirements of the operation and the contaminant being generated. After the contaminated air has entered the hood, it flows through a duct system that directs the flow of contaminated air and prevents the mixing of this air with the workroom atmosphere. Branches may exist within the duct to join separate local systems into one single exhaust system. The third component of a local exhaust system is filter or air cleaner. It is often necessary to remove the contaminant from the air before exhausting the air into the atmosphere to prevent hazardous materials from entering the breathing [1].

Figure 1: Illustration of local exhaust ventilation



1.2 Why do we need LEV?

To comply with the local legislation, Industries need to install the LEV system to remove the contaminants in a workplace will involves a cost. Estimating cost must consider in system design before install. Buy and Mathews (2005) in their investigation using *QUICKcontrol* simulation for initial cost model found that without a fairly detail design and costing model, no accurate cost estimation can be made[2].

1.3 LEV related with to VOC

Volatile Organic Compounds (VOC) has an impact on health. A study by Yu & Crump[3]found that release of VOC comes from polymeric materials used in buildings. Information obtained from European standards based on the chamber test of VOC emissions from building materials and the wet solid, the level of emissions and materials used in a building need further testing. They concluded polymeric materials such as vinyl flooring; carpets and so major sources of VOC. VOCs also cause Sick Building Syndrome. European has European standards for VOC emissions testing for product certification. Yu and Crump (1998), proposed in their study of labeling Schemes for Develop and material of emission databases in a market to meet the needs of products with low VOC emission rates for less risk to the occupier.

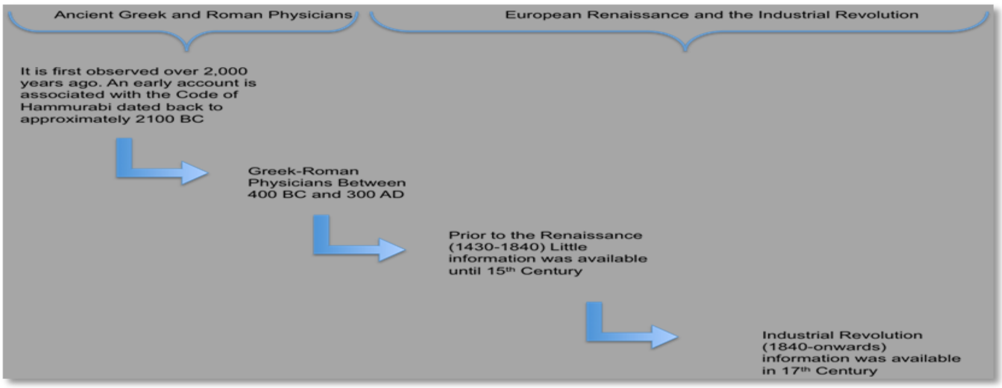
Other study by Hasan, Said, and Leman [4] related with painting activities and impact to workers health. They found that workers in interior construction and office are highly exposed. To control exposed to VOCs are to install good ventilation system and good filters to absorbed and performances of activated carbon fiber to absorb the VOCs.

2. Past Histories

2.1 History on Occupational Safety and Health

OSH started 2,000 years ago. Early Historical of OSH is based on Ancient Greek and Roman Physicians [5][6][7]Figure 2 below illustrates evolution on OSH. The Field of OSH has undergone significant change over the past two decades, Some of the reason include the following: technological changes that have introduced new hazards in the workplace; proliferation of safety and health legislation and corresponding regulation; increase pressure from regulatory body, realization by executives that workers in a safe and healthy workplace are typically more productive; increase pressure from environmental groups; corporate social responsibility and increased pressure from labor organizations and employees in general.[5][6]

Figure 2: The Evolution on OSH (Goetsch, 2010)



2.2 Occupational Health status

DOSH is the government body responsible for administrating, managing and enforcing legislation pertaining to in Malaysia. From DOSH annual report, the industrial accident statistic was tabulated in table 1. The data describes the number of industrial accidents occurred by sector from year 2008 to 2009. It shows that the number of industrial accident is quite high especially for manufacturing sector.

Table 1: Accident Data year 2008 to 2009 base on Sector in Malaysia

Sector/Year	**YEAR 2008**			**YEAR 2009**		
	D	**PD**	**NPD**	**D**	**PD**	**NPD**
Manufacturing	76	134	1564	63	90	1419
Mining and Quarrying	6	0	4	3	1	2
Construction	72	2	55	71	6	38
Agriculture and Forestry	42	7	365	44	8	440
Utility	19	12	82	23	3	116
Transport & Communication	8	1	18	18	0	21
Wholesale and retail	0	0	2	0	0	0
Hotel and restaurant	1	1	13	0	0	18
Financial & Real Estate	4	1	2	1	0	0
Public Services	2	1	3	1	0	0
Total	230	159	2109	224	108	2054

LEGEND: D = Death. PD = Permanent Disability. NPD = Non Permanent Disability.

Table 2: Total Number of Investigation Cases of Occupational Diseases and Poisoning from 2008 - 2009

No.	**Types of Disease**	**2008**	**2009**
1.	Occupational Lung disease (OLD)	56	57
2.	Occupational Skin Disease (OSD)	70	53
3.	Occupational Noise Hearing Loss (NIHL)	169	427
4.	Occupational Muscular Skeletal Disorder (OMD)	31	57
5.	Disease caused by chemical agent (poisoning)	41	61
6.	Disease caused by biological agent	2	3
7.	Occupational Cancer	3	2
8.	Other and Non- Occupational Disease	81	2
TOTAL		453	669

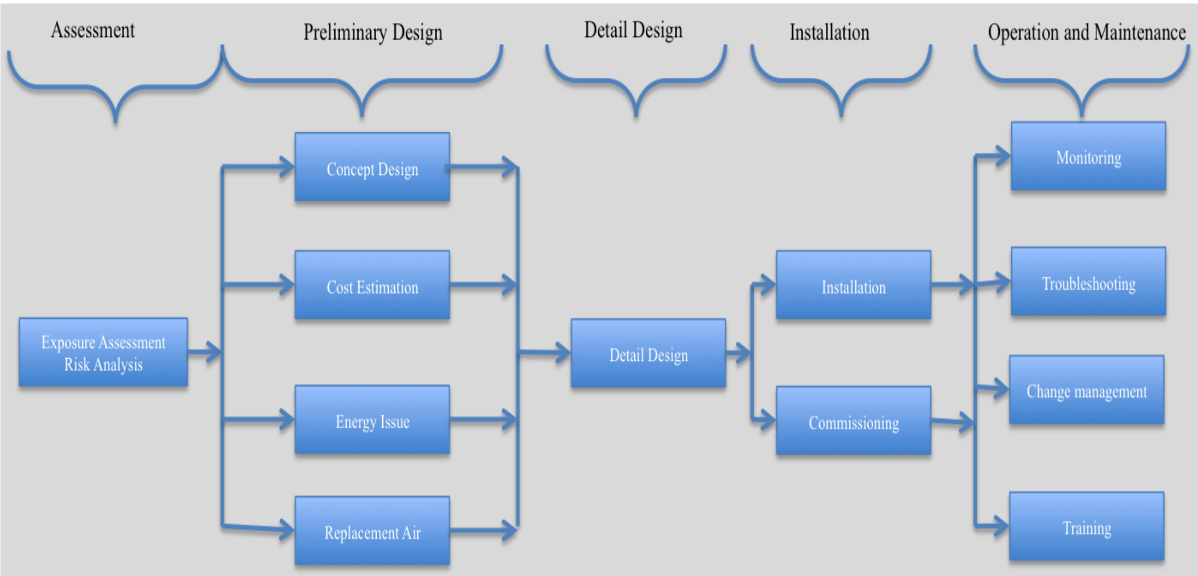
Table 2 present a total number of investigation cases of Occupational diseases and poisoning. For the occupational diseases, The Occupational health Division of DOSH monitors and analyses the data received. For each case of occupational diseases and poisoning that is investigated, the Department will advises to the industries to take corrective measure to prevent from recurrences.

3. Current Implementation

3.1 Method and references

American Conference of Governmental Industrial Hygienists (ACGIH) and DOSH Guideline is used as reference, in order to design, build and install LEV. Figure 3 shows the life cycle of An Industrial Ventilation System. In ACGIH[1] are suggested as in figure 3 to have an Industrial Ventilation System. Start from early stage in assessment of exposure, preliminary design, detail design, installation and operation and maintenance. A guideline is recommended by the ACGIH, there are 6 parts in compliance and LEV installation in the industry. Assessment the workplace of exposure to the risk analysis must be carried out in initial stage. The next stage is the preliminary design; taking into account several factors, design concepts, cost evaluation, energy issues and the replacement of air and followed by detail design. Manufacturing, installation and commissioning after being satisfied with LEV design to be made. Last part of the cycle is operation and maintenance where the LEV must carry out monitoring, troubleshooting, change of management and training.

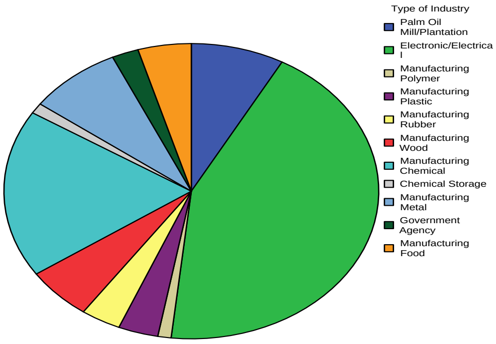
Figure 3: Life Cycle of An Industrial Ventilation System



3.2 Compliance Analysis

Using a form provided by the Division of Industrial Hygiene and Ergonomics of DOSH for analyzing report submitted by industrial in compliance of Regulation of USECHH 2000. The elements observed are Hood, Ducting, and Air Cleaning, Fan/Motor and Comparison design value and tested value for fan/motor. Data collected and analyzed using Statistical Package for Social Science (SPSS Version 12.0).

Figure 4: Type of Industry



Type of Industry

	Frequency	Percent
Electronic/Electrical	38	43.7
Manufacturing Polymer	1	1.1
Manufacturing Plastic	3	3.4
Manufacturing Rubber	3	3.4
Manufacturing Wood	5	5.7
Manufacturing Chemical	16	18.4
Chemical Storage	1	1.1
Manufacturing Metal	7	8.0
Government Agency	2	2.3
Manufacturing Food	4	4.6
Total	87	100.0

Three states involved in taking the data of 87 data, which is Johor, Malacca and Negeri Sembilan with 33 companies, or consultant/competent persons were involved. 10 types of industries were identified as a result of observations on the report and found Industry Electrical/Electrical is the highest at 38, while the percentage was 43.7%. Followed by chemical manufacturers (18.4%) and metal manufacturers (8%), and the other industries are less than 5%.

Table 3 shown that Cross Tab Data Related with type of Industries, type of LEV against result of Design value/Test Value in reported monitoring of compliance data analysis. Design type of LEV involve in a study are fume Hood (27), System of LEV (49) and Spray Booth (11). Three categories of analysis of result finding are OK, Not OK and only provided BHP data. OK means all data shown in table 5 are complete and not OK means no data provided. Another category is the measurement only provided BHP data.

*Table 3: Type of Industry * Type of LEV * Design Value vs. Test Value*

	Type of LEV													
	Fume Hood						Systems						Spray Booth	
	Design value vs Test value						Design value vs Test value						Design value vs Test value	
	OK		Not OK		Only BHP		OK		Not OK		Only BHP		Not OK	
	Type of Industry		Type of Industry		Type of Industry		Type of Industry		Type of Industry		Type of Industry		Type of Industry	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Palm Oil Mill/Plantation			3	18.75	4	44.44								
Electronic/Electrical			5	31.25	1	11.11	3	42.86	18	69.23	9	56.25	2	18.18
Manufacturing Polymer									1	3.85				
Manufacturing Plastic													3	27.27
Manufacturing Rubber					1	11.11	1	14.29	1	3.85				
Manufacturing Wood			1	6.25					1	3.85	1	6.25	2	18.18
Manufacturing Chemical	2	100	5	31.25			1	14.29	2	7.69	5	31.25	1	9.09
Chemical Storage											1	6.25		
Manufacturing Metal							1	14.29	3	11.54			3	27.27
Government Agency			1	6.25			1	14.29						
Manufacturing Food			1	6.25	3	33.33								
Total	2	100	16	100	9	100	7	100	26	100	16	100	11	100

Table 4: Example data measurement and calculation

Point	Static Pressure, SP (in wg)	Velocity, V (fpm)	Flow rate, Q (cfm)
Fan Inlet	-5.328	2,617	2,795
Fan Outlet	0.079	2,935	3,135

Table 5: Comparison Design and tested value

Description	Speed (rpm)	FSP (in wg)	FTP (in wg)	BHP (HP)	Flow Rate, Q (cfm)
Designed	1900	5.000		7.5	2,650
Tested	1957	4.979	5.516	4.04	2,795

Example of calculation of Fan Static Pressure (FSP) and Total Pressure (FTP) for design value vs. test value is shown in Table 4 and 5. Data available for the design and measurement data can be implemented for comparison purposes. However, results from the calculations are the value of BHP's 50% less than the design value.

Data for the design value cannot be found and also the measurement data cannot be implemented. This is because the area is difficult to carry out the measurements entered. Table 3 shows the three types of LEV is most do not show any data that can be measured for comparison with the design so that the motor performance can be determined. Number of studies have shown 53 of 87 (61%) were indeterminate LEV performance. For which there is only the value of BHP in the design data of 25 (29%). This value cannot reflect the actual performance of the LEV motor. While the number of LEV that is perhaps more to comply with legal requirements is of 9 (10%).

This can be expressed in a preliminary study only 10% of the industry has monitored the design and measurement data. Nevertheless, the ability of the test is part of the design value. Further study and a standard should be recommended to further improve this performance.

3.3 National Legal Requirement

Compliance to the regulation is an approach to reduce and maintain the exposure level of employees to chemicals hazardous to health. The requirements are to the lowest practicable level or below permissible exposure limits.

Engineering Control Equipment (Regulations 2) means any equipment, which is used to control exposure of employees to chemicals hazardous to health and includes local exhaust ventilation equipment, water spray or any other airborne chemical removal and containment equipment? The equipment shall be maintained and operated at all times while any machinery or plant is in operation, and for such time. (Regulation 17)[8].

Regulation 25 (1): Requirement of ventilation in a industry and the required of natural ventilation or mechanical ventilation or both shall be provided.[9] Dilute the concentration of the airborne contaminant before it reaches the worker ventilation, to cool the air, to create adequate air move. Adequate ventilation mention in Regulation 25 (2)[9]: where the number of air changes every hour is not less than ten (10) in the case of processes, which generate little or no heat, smoke or fume, or not less than twenty (20) in the case of processes, which generate heat, smoke or fume, not less than thirty (30) if any fume generated is likely to cause bodily injury.

Mechanical Ventilation Design: Regulation 25 (3): The total free area of any ventilation air inlets shall be at least 50% greater than the total free area of the air outlets. Air inlets shall, so far as practicable, be located at floor level, and air outlets shall be located as high as practicable.[9] Air Cleanliness: Regulation 26 (1): where any process given off any offensive fume or dust which is or is likely to be offensive or injurious to any person or being accumulated, measures shall be taken to protect such persons against inhalation and to prevent it accumulating.[9]

Removal dust laden air: Regulation 26 (2): Dust laden air shall be removed by a settling chamber, water spray, cyclone, filter or any combination of these or other suitable appliance[9]. Hood and Ducting: Regulation 26 (3): Any hood, enclosure, canopy or shall be constructed so as to envelop, as far as practicable, the point of origin of the fume or dust so that a smooth and uninterrupted flow is maintained. In addition to this requirement the hood, enclosure, canopy, or ducting for the extraction of fume shall be constructed so as to maintain the air velocity at the surface thereof at a rate not less than one hundred and fifty (150) feet per minute.[9]

Design, construction and commissioning of local exhaust ventilation equipment. Regulation 18: any local exhaust ventilation equipment installed shall be designed according to an approved standard by a registered professional engineer and constructed according to the design specifications; and tested by a registered professional engineer after construction and installation to demonstrate that the equipment meets the design specifications.[8]

4.0 Future Technology

4.1 Nanotechnology

A number of consumer nano-based products are already available on the market. Not much is known of the risks of Engineered Nanomaterials (ENM) to occupational safety and health. The level of exposure for these materials is usually higher at workplaces than in other environments and workers are likely to be at extra risk. Several issues related to ENM in the workplaces require marked attention. The most topical issues include: (1) improved understanding of ENM metrics associated with ENM toxicity; (2) development of monitoring devices for ENM exposure assessment; (3) understanding the changes of ENM structure and state of agglomeration at different concentrations in aerosols; (4) understanding translocation of ENM in the human body; (5) identifying the key health effects of ENM including pulmonary toxicity, genotoxicity, carcinogenic effects, and effects on circulation; (6) development of tiered approaches for testing of safety of ENM; and (7) utilising these data for health risk assessment, with a special emphasis on occupational environment. [10]

4.2 Computational Fluid Dynamic (CFD)

For control the VOCs exposure to the workers, LEV systems are design and fabricate to remove contaminants. CFD is the solution on preventive method in designing LEV system and before the LEV systems are fabricate.

Flynn & Sills [11]conducted study to simulate breathing-zone concentration for a simple representation of spray-painting a flat plate. The results demonstrate the capability of CFD to track correctly changes in breathing-zone concentration associated with work practices shown previously to be significant in determining exposure.

CFD is the way to determine the efficiency of ventilation systems. Kassomenos et. al.[12] use CFD model PHOENICS to investigate VCM concentration at workplaces. The results showed that the use of a CFD is a promising technique to study the occupational exposure in the known carcinogen VCM and to design the proper ventilation system to reduce the consequences of an accidental release of VCM in a workplace. Measurement also made and found that the computational results are realistic and in good agreement with the experimental measurements.

More efficient in remove contaminant from workplace is using push pull method. A study in Occupational Exposure to VOCs and Mitigation by Push-Pull Local Exhaust Ventilation in Printing Plants conducted by Leung et al [13] evaluate the Occupational VOC exposure, quantitatively, by detailed field measurement and parametric analysis on a proposed mitigation measure; push pull local exhaust ventilation (LEV) was conducted. None was found close to individual 8-h time weighted average (TWA) and push-pull effective identified by CFD.

Kyoungbin & Changhee,[14]using FLUENT V.6 in order to investigate flow characteristic of kitchen hood system with using 3D numerical analysis method and improving the system to expel pollutes more efficiently. The work are divided to 4 different types of separation plates (Case 1 - Case 4) were modeled using Gambit Ver. 2.1.X and Case 3 showed the lowest value of the temperature and CO_2 concentration distribution.

CFD simulation is using as study of the effectiveness of mechanical ventilation systems of a hawker center in Singapore using conducted by Wong et al.[15]The objective is to investigate the effectiveness of the different types of mechanical ventilation systems to alleviate the thermal discomfort in a hawker center using Phoenics v3.5.

In wood processing industry, workers are commonly exposed to mechanical hazard. Inthavong et al[16]conducted study of effect of ventilation design on remove of particles in woodturning workstations. Using five different ventilation designs were considered with the aim of reducing the particle suspension within the breathing zone. The result stated that ventilation R3, where the local outlet emanated from the roof and had an angled outlet, provided greatest total particle clearance and low particles in the breathing plane.

5.0 Conclusions and recommendation

Analysis done in early stage show that most of the current Local Exhaust Ventilation is not complying with the standard and design proposed. Based on 87 data collected in southern region of Malaysia most of the LEV reported are not comply with the requirement with fan and motor measurement data are ignoring and only 10% out of measured data are provided. The future contaminants such as from Nanotechnology are seriously to look on consideration to prevent effect on workers health. The issues are the performances of the ventilation to ensure of workers are preventing from exposure contaminant at their workplace. To improve the performance of industrial ventilation, the CFD are recommendation in design stage to ensure the systems are effective and work as per design. CFD recommendation also will cost effectives plan before fabricate and install the LEV.

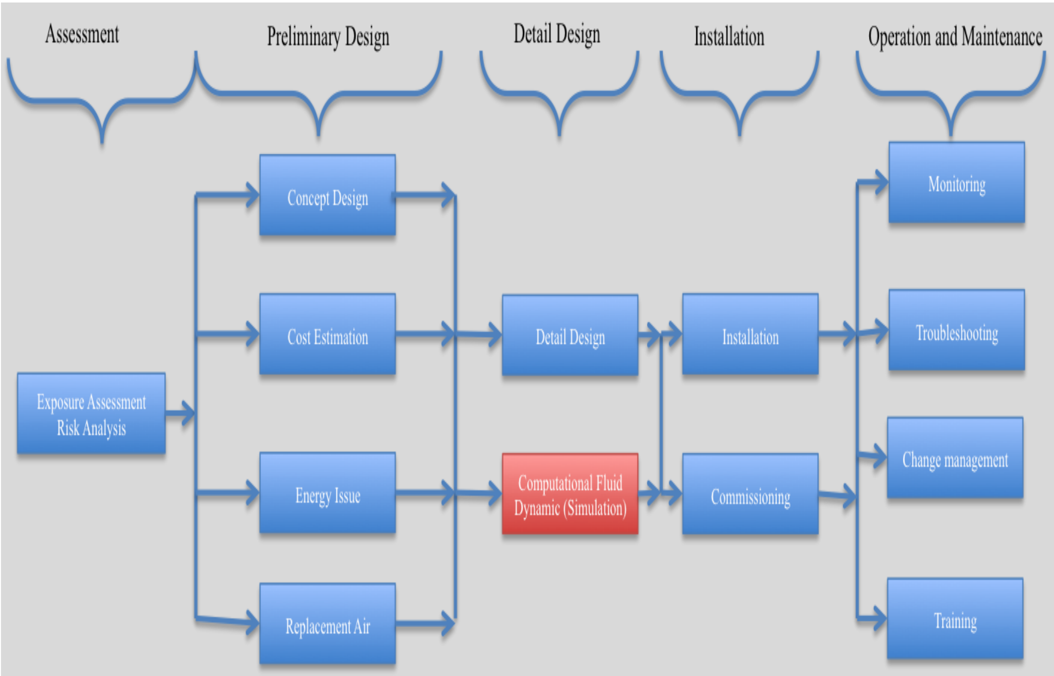


Figure 5: Proposed CFD in Life Cycle of An Industrial Ventilation System

Responsible for manufacturer and designer under OSHA 1994 described that in Part V, to provide general duties of person who design, manufacturers imports and supplies any plant in section 20. This section states: "*It shall be the duty of a person who designs, manufactures, imports or supplies any plant for use at work* " –to ensure, so far as is practicable, that the plant is so designed and constructed as to be safe and without risks to health when properly used;

This subsection required to the designers (engineers) to ensure that a plant for use at work is designed and constructed to be safe and without risk to safety and health. Hence, properly used means that the designer must having being given instructions, employers as well as employees must follow the instructions.

Other is *"to carry out or arrange for the carrying out of such testing and examination as may be necessary for the performance of the duty imposed on him by paragraph (a)".* The designers are required to carry out testing and examination of the plan and running test before the employees use it.

"It shall be the duty of a person who undertakes the design or manufacture of any plant for use at work to carry out or arrange for the carrying out any necessary research with a view to the discovery and, so far as is practicable, the elimination or minimization of any risk to safety or health to which the design or plant may give rise." Designers have a duty to carry out the necessary research to discover and eliminate or minimize any risk to safety or health that there design or plant might cause.

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