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Design Modelling and Analysis of Welding Fume Extractor

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ABSTRACT
In Manufacturing and Construction Industries Welding Fume Extractor is a typical device process where constant shifts in welding location and place makes it easier to monitor contacts to gases than in industry where the rules are cannot be changed. Welders can be exposed to many harmful pollutants in the soil, such as hexavalent chromium (CrVI) and manganese (Mn). One of the efficient and reliable technique called Local Exhaust Ventilation (LEV) is a fumes welding engineering system but was not commonly implemented in most of the construction industries.

The recent studies show that Local exhaust ventilation (LEV) can minimize fume exposures to total particulate matter, hexavalent chromium, and manganese to level below current requirements. The possible out comes from our project show that, nearly 35% to 45% of the emission may be minimized compared to natural ventilation with portable or fixed LEV systems as shown in the Fig No. 12.1 and 12.2, provided that proper installation of the sufficient exhaust flow and hood flow levels are important. Installation of flux core arc welding and extraction guns for gas metal arc welding (GMAW) is a feasible technique between shielding gas and extraction airflow to minimize harmful pollutants. Work procedures are an important aspect of effective fume exposure control; in particular, placing the hood along the arc, testing exhaust flow levels and minimizing the plume.

Keyword: *Welding Fume Extractor, Local exhaust ventilation (LEV), emission, Natural Ventilation.*

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I. INTRODUCTION

Welding Fume Extractors are intended to be used as a safety test for manufacturing to shield consumers from the industrial hazards posed in different welding applications. Assuming that the vast majority of reparable particles in the air stream are smaller than 0.4 microns in size, a controlled ventilation system capable of filtering down to that amount is what is needed to ensure the welder's safety and health. While selecting a appropriate ventilation system, it is necessary to make sure you are aware of all the factors that may differ the filtration capacity of welding gases [3]. The particular application of welding is usually the number one variable which helps to decipher what is recommended, but additional configurations such as HEPA or ASHRAE filters, cleanable media, multi-operators or portability are dependent on various elements that are best discussed with a trained specialist.

Thermal Cutting and welding processes produces enormous amount of toxic gasses and airborne consists of ozone, Hexavalent Chromium (CrVI), Nitrogen oxides, Manganese and Carbon Monoxide. The welding technique such as Scarfing, MIG, TIG, GMAW, GTAW, Oxyacetylene Torch Cutting, SMAW, Gas Tungsten Arc Welding are widely used by Construction and automotive Industries [5]. Builders, Carpenters and Glazers use cutting oxyacetylene torch regularly for welding purpose. Specialized worker in welding and can regularly weld (e.g. pipe fitters, boiler makers, sheet metal workers, ironworkers).

II. LITERATURE SURVEY

The literature review provides evidence on the efficiency of a number of building, shipyard and other industries LEV systems for welding fume power. Further research is required to control or reduce fume during welding process while using movable Local exhaust ventilation system, and how to utilize Local exhaust ventilation system in automotive field at maximum level by reducing toxic gasses.

Els, L, Coetzee, C., and Vorster, O. 2017, Latest Mn and psychiatric disease issues reinvigorated attempts to regulate lower rates of welding gases [4]. The primary engineering regulation for external hoods equipped to regulate welding fume is Local Exhaust Ventilation, and design standards are in place, which work minimum velocities within the range of 0.50 to 0.87ms^{-1} i.e (100 to 170 fpm).

Susi et al. (2019), [8] reported during thermal cutting and welding on specific exposure measurements of metal gases to pipefitters, ironworkers, boilermakers separate two exhaust systems were used.

C.B. Solnordal, P.J. Witt, A. Manzoori, H. Namavari, E. Niknejad, M. Davari, the operative engineering measures during the implementation of welding fumes in the automotive industries by recording different level of efficiency of Local exhaust ventilation either in construction field or in different manufacturing industries [3].

Els, L., Cowx, P., Kadkhodabeigi, M., Kornelius, G., Andrew, N., Smith, P., and Rencken, S. 2014, National Apprentice Training School Boilermakers conducted simulation test by using two Local Exhaust Ventilation to observe stainless steel SMAW in simulation test. Three welders carried out the welding work outside of the premises in a semi-entered tank [5]. Flat steel portion which was attached with tank's workhorses a 24cm long flat welds were carried out. The first LEV Machine was 2 meter Arm with a conical roof type flexible duct with 6.30 inch diameter, hood flow was 571-707 cfm i.e. 0.28 – 0.34 m^3s^{-1}. Capture velocity calculations were conducted with each unit in front of the hoods at 6, 9 and 12 inches (14.9, 23.0 and 31.4 cm).

H. Mekky, A. Mohaisen, and Z.-L. Zhang, The study registered an 1824 fpm (927 m s^{-1}) hood face velocity in Unit 2 hood face core and decided the airflow was 391 cfm (0.19 m^3s^{-1}) [10] . The catch velocities calculated 312, 224 and 53 fpm (1.4, 1.3 and 0.24 ms^{-1}). The measures of immediate intake (total fume) suggested by Unit 2 were slightly higher than Unit 1 (P = 0.04) and considerably superior than no ventilation at all (P = 0.007). Unit 2 was slightly higher than almost no ventilation (P = 0.02) for CrVI.

Kadkhodabeigi, M., Tveit, H., and Berget, K.H. Van der Wal (1986) subsequently reported on Dutch plasma welders and cutters with regard to exposures in chromium, nickel and gas. There was some details regarding the effects of Local Exhaust Ventilation [6].

III. METHODS

The Integrated Unit Architecture is built to be lightweight and rational device. A full collection of standards has been created to suit the various work-in-conditions on-site, including large-scale welding or grinding shop or welding centers, production lines for robotic welding, plasma or blanking production lines for laser cutting, you can locate the correct design pattern.

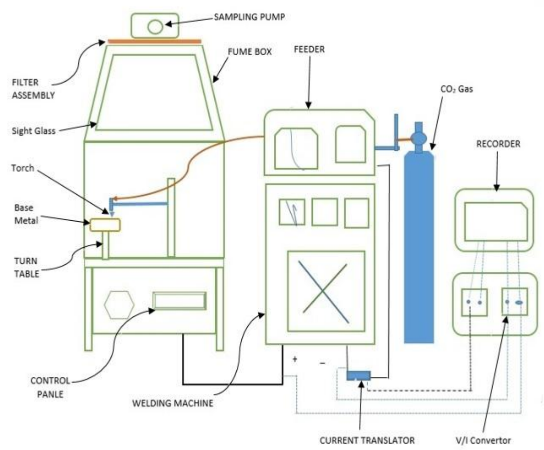

FIG NO. 1 : INTEGRATED UNIT ARCHITECTURE

Central Control Panel provides real-time tracking and examination of a variety of critical parameters of equipment in operation and shows them on display, and it has self-diagnostic function, automatically displaying pathological and malfunction conditions in equipment activity. The output of the central dust & fume purification system is regulated by PLC control system.
Central fume & dust purifier is a set of devices the company has studied, created and built depending on the needs of specific site environments.

The experiments listed below are broadly classified into two categories:
1. Laboratory Research.
2. Field Research.

It is shown in the Fig No.1, effectiveness of the Local Exhaust Ventilation can be calculated from the difference values collected during experiment. The efficiency metrics acted as specific exposures and percentage cuts to separate welding fume constituents. When specific exposure limits were presented, the actual occupational exposure rates know as (OEL's) and OSHA known as Occupational Safety and Health Administration Permissible Exposure Standard, TLV, REL difference can be observed [7]. Manganese, Hexavalent Chromium (CrVI), Nitrogen oxides, Iron Particle, Total particulate matter and Carbon Monoxide are found and OEL's for each material are listed in Table 1.

OEL's calculated values					
	Mg m^{-3}	Hexavalent Chromium µg m^{-3}	Total particulate mg m^{-3}	Iron Oxide mg m^{-3}	Carbon Monoxide (ppm)
NIOSH REL 1.0	1.0	1.0	NILL	5.0	35.0
ACGIH TLV 0.2 50 (soluble)	0.3	10.0	10.0	10.0	25.0
OSHA PEL	4.5	5.0	15.0	10.0	49.0

TABLE NO.1: OEL CALCULATED VALUES

The received Data in final section are less supportive in drawing decisions about conditions that impact the efficacy of Local Exhaust Ventilation in the field but do track reductions in revelation. The final part deals with FEG known as fume extraction weapons and the other sub part that deals with other Local Exhaust Ventilation types [9].

1. *LOCAL EXHAUST VENTILATION IN CONSTRUCTION INDUSTRIES.*

Clinical analyses of exposures to welding fume in the construction industries are limited to determine the efficacy of LEV, with only four listed here. One was in order to achieve High Efficiency Particulate Air component was installed with filter and to movable elbow joint hood was connected. Second, to exhaust and assembly of pollutants a lightweight compact unit is fitted with filtration option. When local exhaust system was used, the mean value of Total Particle was observed 1.98mgm^{-3}; for no ventilation 9.44 mgm^{-3} (n=1); for natural ventilation 5.38mg m^{-3}; for mechanical ventilation 1.71 mgm-3 was observed [6].

In case of Mechanical Ventilation to combine air volume to Local Exhaust Ventilation at the exhaust end hood is installed before releasing in open environment. When we combined Local Exhaust Ventilation with Mechanical Ventilation in no ventilation achieved P=0.0001 difference. In Subsequent experiments with Local Exhaust Ventilation and pipefitter decreasing the Total Particle and Magnesium 12% (0.075 to 0.066 mg m^{-3}) and 21% (3.2 to 2.5 mgm^{-3}) correspondingly [4]. But in case of Iron worker and boiler maker only mechanical ventilation values varied but there was no effect on Local Exhaust Ventilation.

When ventilation was used TLV reached to 5mg m^{-3} in 7 samples out of 10 experiments but efficiency of TLV was insufficient. Our Experiments found that one welder should be in the plume and another one outside of the plume and regularly relocated. Air particles of 21 – 41 fpm may reduce the output of the Local Exhaust Ventilation enclosed tank [4]. Unit 1 obviously had very less airflow, and Unit 2 still seems to be weak, based on the capture velocity measurements performed. In the median results, the inability of the devices to sustain capture velocities over 100 fpm (0.51 ms−1) over the entire length of the base plate where the welding took place is undoubtedly a significant cause.

During indoor welding to test ventilation some light dispersal device and filter samples are used when welding inside the tank. The data received from light dispersal filter had a factor of 5 reduction in Hexavalent Chromium but when compared with Local Exhaust Ventilation it was found zero. In case of fume elimination the reduction factor was 4 and 3 in field control when we used Local Exhaust Ventilation.

The mean value of TP was reduced to 20 percent (5.1 mg m^{-3} versus 4.5 mg m^{-3}) but it was not major difference but it was observed that other activities during welding leads to total dust exposures. But I was observed that, when LEV was in process other field sample did not beaten TLV of Magnesium value 0.2 mg m$^{-3.}$

The following findings are unique to the building industry and include useful details on the efficiency and usefulness of Local Exhaust Ventilation in managing welding gases. The results show that significant decrease are feasible with Local Exhaust Ventilation in complete fume, Mn, which CrVI, and in certain situations result in concentrations below existing OEL's.

2. *LEV WELDING STUDIES IN THE SHIPYARD INDUSRTY.*

Local Exhaust Ventilation usage for the regulation of welding gases have recorded in a number of businesses that have specific activities & welding styles to those in the building industry. That is especially valid in the shipyard sector, because the operating climate increasing be quite close to the activities of building during factory reconstruction and repair.

The impact of ventilation was only investigated for FCAW because of the limited sample sizes for GMAW, GTAW, and SMAW. The seven ventilation systems which are defined during the experiments are as follows.

1. Low Smoke Welding Cables.
2. Fixed Smoke Extraction Units.

3. Low Smoke Welding Cables and General Supply Ventilation.
4. Low Smoke Welding Cables and Portable Smoke Extraction.
5. Low Smoke Welding Cables and Portable Welding Cables.
6. Smoke Extraction Gun (FEG).
7. Portable Smoke Extraction and General Supply Ventilation.

For the FCAW, Table 2 provides the mean value of the specific concentrations calculated with these different control /ventilation devices. Given the low sample size and mitigating variables, the FEG appeared to be performing better than, or equal with, the other options.

Impact of Ventilation	Chromium µg m^{-3}	Nickel µg m^{-3}	Mg m^{-3}	Chromium µg m^{-3}
FEG - (n = 4)	0.0	0.59	0.08	0.08
FFES - (n =3)	28.9	6.74	0.07	0.51
PFE and GSV - (n = 2)	1.42	0.67	0.47	0.92
LFWW-(n = 7)	38.1	9.0	1.70	1.70
LFWW and GSV -(n = 4)	2.0	0.0	0.50	0.17
LFWW and PFE - (n = 6)	6.1	2.4	2.20	0.83
LFWW and PSAV- (n= 3)	3.1	2.0	0.58	0.64

TABLE NO.2: FCAW MEAN VALUE

Chromium exposures for different environments, clear, contiguous or enclosed areas, the form of welding and base alloy and for any natural ventilation and Local Exhaust Ventilation were recorded in a draft study (Harris, 2019) on existing shipyard activities [8]. There was a shortage of local fatigue criteria, low sample sizes, and mixture of tests. In only 7 of the 16 comparisons (Table 3), exposure to Local Exhaust Ventilation therapy was lower. The overall Local Exhaust Ventilation concentration was smaller in three of the four instances of at least five tests per ventilation [3].

Values collected of different alloy from shipyard industry.					
Material and Process	Worker Average Value (µg m^{-3}) (N)	Confined Natural	Local Exhaust Ventilation	Natural Local Exhaust Ventilation	General/Natural Local Exhaust Ventilation
Mild Steel	0.31 (8)	0.41 (4)	0.29 (7)	0.8 (1)	0.45 (2)
SMAW HY80 Steel	0.34(10)	1.10 (4)	0.53 (3)	0.75 (4)	0.21 (5)
SMAW HY100 Steel	0.35 (2)	1.3 (1)	16.4 (10)	4.63(8)	0.2 (2)
SMAW Stainless	0.91 (3)	0.94 (4)	1.79 (1)	1.5 (7)	0.6 (10)
GMAW Nickel alloys	0.87 (36)	0.1 (2)	0.15 (4)	0.27(2)	0.1 (2)
GMAW Stainless	0.35 (20)	0.2 (11)	1.0 (20)	0.14 (20)	1.18 (5)

TABLE NO.3: VALUES OF DIFFERENT ALLOY FROM SHIPYARD INDUSTRIES

3. WELDING STUDIES WITH QUALITATIVE LEV INFORMATION.

Different study findings include details on LEV's impact on soldering conditions but not on LEV systems in quantitative terms, showing whether or not they were present. As mentioned above, such evidence generally is insufficient to infer that any specific LEV architecture is successful, while overall studies indicate less than ventilation-related average exposures.

In 1967, researcher called Smith also looked at the exposures of the low hydrogen SMAW welding in a review of plant and shipyards producing pressure vessels and boilers. Research was done at various locations defined as restricted, enclosed or free [3]. Confined revealed a completely sealed compartment with a volume of entry in a man hole less than 76 cm (30 inches) in diameter normally smaller than 2019 feet (56 m^3). Enclosed room, with volumes over 2019 feet (56 m^3); in big shops, opened welding indicated.

During the experiment we received the following data of fume extractor with and without Local Exhaust Ventilation enclosed in a confined areas. The author observed that total no ventilation fume levels within a boiler were 88.4, 57.12, 48.23 mg m^{-3} and Local Exhaust Ventilation rate reduces in between 35.32 mg m^{-3} to 6.4 mg m^{-3}.

Local Exhaust Ventilation in Shipyard Industries			
Conservation condition	Sample size (N) Minimum	Concentrations, mg m^{-3} : Maximum	Median
No Local Exhaust Ventilation	67.0	114.9	21.2
Local Exhaust Ventilation	40.0	44.9	17.6
Enclosed No Local Exhaust Ventilation	76.0	57.6	10.2
Local Exhaust Ventilation	35.0	77.8	5.6

TABLE NO. 4: LEV QUALITATIVE INFORMATION

Steel (1968) also investigated the soldering and flame-cutting shipyard and measured zinc fume breathing area concentrations with or without ventilation for closed processes (note LEV not provided). 19 were tested over TLV from the 48 ventilated processes at the period (5 mg m^{-3}). Approximately 17 non-ventilated and 12 TLV (graphical estimate) cases were examined. The researcher mentioned in the value of Local Exhaust Ventilation as practicable in normal ventilation and recommended the flange extraction of fishtail at each specific point of welding. The maximum allowable distance of one feet (0.30 m), 1000 cfm (0.51 m^3 s^{-1}) and 1500 fpm (7.62 ms^{-1}) hood face velocities for steel is specified [8]. Steel will also be used to specify a cap distance [4].

IV. DISCUSSION

Due to growing health problems associated with Mn and CrVI exposure, ventilation use is likely to increase in manufacturing to control welding smoke and gases and moveable smoke removal system that can reduce Mn concentrations in the field by 50 percent and below the current TLV for SMAW welding. The smaller 19% drop in TP indicates the value of finding and monitoring certain causes of employee exposure [10]. Similarly, LEV lowered CrVI concentrations on the field to below the 1 µg m^{-3} NIOSH REL.

Technology evolve frequently to designed and operate in absence of the worker's input; nevertheless, working habits remain key to a effective implementation for most welding operations. The research at the boilermakers (NIOSH, 2019) found that one welder tended to move his aspect away from the feather and the other did not. That was clear. Standing oneself exterior the welding pan is an vital job, such that apprentices may in still themselves as quickly as possible. However, the positioning in relation to the soil pen can be difficult in practice because of the usual air arrangements and the degree to which work conditions can be controlled.

The location of the Local Exhaust Ventilation hood comparative to the smoking generation point is an essential factor which employees regulate. For the successful usage of LEV in the construction industries, the requirement for Local Exhaust Ventilation equipment's repositioned at various positions at a workplace as well as for portable exhaust hood repositioning with respect to the weld is difficult. Rapidly air speed falls very in front of local exhaust hood, particularly tiny one, and must therefore be near to the arc in order to succeed. The capture speed at the arc location may be drastically modified for tiny exhaust caps of 2 to 3 inches (5.2cm to 7.8 cm) diameter, for instance. Comparatively short distances (e.g. 0.5 inch to 1 inch). Consider a spherical cap mounted at 1 to 5 inche (3 to 8 cm) diameter with a 3 inch (7 to 6 cm) diameter and a pace of 100 fpm (0.51 s^{-1}). This should cause a catch of the object. The capture speed decreases to around 50 fpm (0.25 m^{-1}) if the hood is repositioned such that the gap is 6.6 cm [1].

V. CONCLUSION

Complex restrictions threaten and rely on job procedures to good control of fumes. Our review work found that the sensitivity of LEV to weld gases during normal or general ventilation may be greatly minimized if correctly used. In FCAW and GMAW operations FEG provides security even though the question of the shielding gas is significant. However, it is possible to minimize this problem by correct airflow balance and location of the nozzle. The data reveal that the capture output of the weapons depends on soldering location, the lowest fumes capture output being vertical or overhead sold. To provide efficient environment and healthy worker, the weight of the extraction gun must be minimized. In case of stick welding more importance should be given on hood which keeps on replacing the electrode due to which utilization of device can be kept minimum as much as possible.

Additional work on the field of mobile fumes extraction systems is required to determine the efficacy of many hood size and Local Exhaust Ventilation systems for different tasks by numerous manufacturing industries. Decreasing the weight, including mobile extraction units, of virtually all equipment is necessary to minimize pressure on the arm and hand, allow kinesis and ease worker approval of inspections. Although Local Exhaust Ventilation can lead to considerable reduction in smoke, work practice is important and training in the right positioning of the hood is necessary and also feather avoidance is needed. Pressure assessment monitoring and testing of equipment for sufficient hood flux. Training in these work practices and procedures among apprentices before their working habits are established is possibly the most successful.

VI. FUTURE SCOPE OF WORK

The welding process presents workers with various risks, such as inhaling the complex mixture of all inorganic, chemical, organic components which spread during fusion and heating of sold components. The structure and absorption of these chemicals is directly proportional to welded material, electrode composition and components. The composition and concentration of the chemical components. Metal solids (dust) or gas (vapors) present the highest risk, and some types of metals or special welding material produces very dangerous waste, such as the fumes produced during soldering in stainless steel

Contain highly harmful gasses of metals, such as Chromium and Nickel, Magnesium welding with light alloys, can spread to several materials.

In future we offer many solutions from movable extractors to centralized systems for the extraction of soldering fumes. Movable filter extractors are fitted with various filtrations: mechanical filtration corrugated filters (SMART or MIDI), mechanical filtration pocket filters (AIR), filtration cartridges (MISTER FILT), or electrostatic filtration (PROF) filters. These are valuable for factories of many remote facilities and limited operators in the facility. To workplaces where there are several working halls and a number of workers, distributed structures are best suitable. In this situation, a device of elevated wall-arms connected to a fan / filter should be fitted, gases collected from working halls should be eliminated and sent out. To find out all our deals, just take a peek at our web catalog or get more details from our commercial team.

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