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Elimination of VOC Emissions from Surface Coating Operations with Solvent Management and Waste Disposal In GM Egypt

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1. ABSTRACT

Performance standards for controlling VOC emissions in the air, as well as solvent management and waste disposal in paint operations. For air VOC emission streams frequently associated with standard painting systems, performance parameters are provided.VOCs (volatile organic compounds) are released into the work environment and atmosphere during the vehicle painting process from paint solvents/thinners and paints. The majority of VOC pollutants are produced during the cleaning (purge flushing) and spraying processes of solvent-based paints, as the spray booth air gathers up all gaseous solvent compounds and overspray paint paints. Chemical aromatic and aliphatic esters hydrocarbons, glycolethers, alcohols, and ketones are among the VOCs.

Keywords: Solvent Purge, Paint solvents, Painting, Volatile organic compounds and Vehicle Automotive

الملخص

تستخدم كبائن إعادة طلاء السيارات كمية كبيرة من الطلاء والمذيبات لتنظيف مسدس الرش. غالبًا ما يكون المذيبات المستخدمة جنبًا إلى جنب مع نفايات الطلاء أكبر مجرى نفايات في القسم ويتم إدارتها عن طريق شحنه إلى منشأة إعادة التدوير خارج الموقع أو عن طريق إعادة تدوير النفايات في الموقع. في كل من عمليات إعادة التدوير داخل وخارج الموقع ، يتم تقطير مذيب النفايات لفصل واستخلاص المذيب من طلاء النفايات وخليط المذيبات. قد تساعد إعادة تدوير المذيبات على تقليل المتطلبات التنظيمية والمسؤولية المستقبلية ، وتوفير المال استخدام مواد اخري بدل المذيبات لعمليات الغسيل والتظيف داخل الكبائن النيتروجين هو غاز جاف يشتت الحرارة بسرعة أكبر مما يؤدي إلى تشغيل أنابيب أكثر برودة. هذا يحافظ على سلامة الجوانات هذا الغاز الخامل يؤدي أيضًا إلى إبطاء عملية الاكسدة الكيميائية المرتبطة بالأكسجين بشكل كبير

إدخال غاز النيتروجين إلى دورة التنظيف يوفر من 206 لتر إلى 185 لتر.
أدى استخدام المذيب المعاد تدويره إلى تحسين استهلاك المذيبات من 185 لترًا إلى 135 لترًا.
أدى تغيير تسلسل استخدام المذيبات والنيتروجين إلى تحسين الاستهلاك من 135 لترًا إلى 50 لترًا.
التوفير الكلي في المذيبات المستخدمة في تنظيف مواسير نقا البوية وخزانات البوية هو 75 ٪.
إجمالي التوفير في استهلاك المذيبات هو 25 ٪ بالنسبة لباقي المذيبات
• يقلل المركبات العضوية المتطايرة /• يقلل من تكاليف التشغيل/• من السهل الحصول عليه
• لديه كفاءة نقل عالية/• يقلل من تعرض العمال للأبخرة المذيبات/• غاز N2 متوافق مع الهواء
• يتناقص غاز N2 ولن يسبب أي أكسدة (للصدأ) للحديد في أي آلة أو مواسير أو أدوات أو معدات في المقصورة بدلاً من جسم السيارة عملية جديدة/• تخفيض استهلاك أرق بنسبة 50٪ من خلال:
• استخدام غاز النيتروجين لدورة التنظيف بالطلاء.
• أعد تدوير المذيب لاستخدامه مرة أخرى في دورة التنظيف التالية.

1. Problem Defination

Cairo, Egypt is generally classified as one of the world's "megacities", with an estimated population in excess of 20 million people in the greater Cairo/Giza area. It also suffers from high ambient concentrations of atmospheric pollutants, including particulates (PM), carbon monoxide (CO), oxides of nitrogen (NOx), ozone (O3), and sulfur dioxide (SO2) (Nasralla 1994; Sturchio et al. 1997). [1-2] Specific objectives of the source attribution studies included estimating the spatial and temporal distributions of PM and VOCs, apportioning PM and VOC concentrations to specific source emissions, and providing a baseline against which the impact of CAIP implemented strategies may be evaluated. Source apportionment results for PM in Cairo were presented by (Abu-Allaban et al. 2007). [3] The major sources of PM2.5 (particles with diameters smaller than 2.5 μm) were motor vehicles, open burning, and lead smelters. This paper presents the results of VOC measurements and source apportionment analysis in the Greater Cairo area.

High rate of industrialization/urbanization process, especially in developing countries, leads to an increase in the emission of many types of air pollutants due to fossil fuel combustion. Volatile organic compounds (VOCs) are one of the most important groups of air pollutants in the urban atmosphere because they can cause significant risk to human health. Many VOCs have been reported to be toxic, carcinogenic or mutagenic (Duce et al, 1983; Edgerton et al., 1989; Sweet and Vermette, 1992; Kostiainen, 1995; Mukund et al., 1996). [4-8] In addition, the presence of VOCs in the atmosphere play an important role in the formation of ground level ozone, photochemical oxidants and smog episodes (Monod et al., 2001) [9] and they are harmful to the ecosystem (Derwent, 1995; Kuran and Sojak, 1996; Dewulf and Van Langenhove, 1997; Atkinson, 2000). [10-13] In addition, ozone and photochemical oxidants lead to an increase in the formation and fate of airborne toxic chemicals and fine particles (Finlayson-Pitts and Pitts Jr., 1997). [14]

problem definition, a survey of measurements of VOCs emitted from automotive painting in General Motors Egypt and impacted on the photochemical smog occurs in Greater Cairo atmosphere during the summer season, especially around noon. Therefore, it is very important to evaluate the concentration levels and variation of VOCs in Greater Cairo atmosphere. This will help in setting a proper strategy to control the ground level ozone, photochemical oxidants and smog episodes build up in the future. Therefore, the present study aims to mitigate the levels of generated VOCs in General Motors in 6 October City

The sources of VOCs are both anthropogenic and natural. The major anthropogenic sources in the urban environment are vehicle exhaust, gasoline evapouration, emissions from the use of solvents, (Fujita et al., 1995; Jose et al., 1998; Kourtidis et al., 1999; Derwent et al., 2000; Srivastava et al., 2005). [15-19] The levels of VOCs in the ambient air are related to the fuels used, vehicle types and ages, flow rates and speeds of traffic as well as road and environmental conditions in the city (Paul, 1997). [20]

2. Introduction

The Body in white (metal surface) may be galvanized, galvanneal and iron steel and is painting for both decorative purposes and for corrosion protection. The coating paints consist of organic polymers and thinner /solvents. The solvent emits into air pollution, as volatile organic compounds (VOCs).

The significant part in VOC from hydrocarbon like toluene and xylene when generated from cleaning (purge flushing) and spraying operations process. The VOCs are hazard pollutant due to the formation of ground-level ozone which hazard effect on human health and respiratory disorders

Exposure for ground-level ozone may increase the risk of death whom already suffering from heart or lung disorders, Exposure for VOCs may cause a variety of health diseases, like irritation to the nose, eyes, and throat; headaches and damage to the liver & kidneys, and/or central nervous system. And in chronic cases VOCs are proven carcinogens.In most proposal for others using only A regenerative thermal oxidizer (RTO) system and/or low emitted VOC thinner/solvent but it good for limited colors

but in multicolor vehicles its useless.Using water base painting system which is high cost and less durability from solvent base paints. In some case using electrostatic powder coating but it has color mismatch defects in repair.But tow categories water base and powder electrostatic paints consume high quantity of water and energy compare with solvent base paints.Therefore, in this paper we introduce, new system for purge flushing and cleaning with using reducing gas and minimal quantity of solvent.

3. Automotive in Egypt

The Egyptian automotive (Vehicles) industry motivated under the policy of country's related to import substitution industrialization. It covered to Egypt's small domestic market. The Open-Door Policy of the 1970 opened the door to joint ventures with imports with further liberalization with the high (ERSAP)Economic Reform and Structural Adjustment Program in the 2000 .

the main features of 1970 import substitution policies were sustained in place. Both assembly and feeder industries sites were protected and saved during relatively high rates of tariff protection and local content requirements. The Vehicles sector faced a series of setbacks and challenges since the January 2011 Egyptian revolution and then again by 2015, the latter including maximum caps on cash dollar withdrawals with deposits imposed by (CBE) the Central Bank of Egypt. The Vehicles sector's influential businessmen improved and developed a draft law for a series of non-tariff trade barriers to protect and save their assembly and manufacturing roles in the industry sites Unable to compete in the international environment, if not protected these bold firms would turn into importers and authorized distributors. Beginning in 1961, all Egyptian vehicles production was monopolized by El Nasr Automotive Manufacturing Company ('NASCO'). NASCO continued its operation during early years of the Sadat era, remaining the sole vehicle assembler in Egypt between 1973 and 1977

Lotfy Mansour, founder of the Mansour and Sons Cotton Company, established in 1952 and later nationalized by Nasser in 1965 (Al-Ahram May 10, 2015). In 1975 the company was revived as the Mansour Group operating in automotive, becoming the sole importer and distributor of Chevrolet vehicles in Egypt via its partnership with the American car company General Motors (GM).

Egypt's first automotive assembly joint venture 'Arab American Vehicles' (AAV) was established in 1977 between the Chrysler Group LCC, which held a 49% share in the company, and the military owned Arab Organization for Industrialization (AOI) with the remaining 51% (AAV 2015). Beginning in 1988, manufacture and assembly of Suzuki vehicles was taken over by Modern Motors, another potentially smaller PCF owned by the Seoudi Investment Group, run by Dr. Abd al-Moneim Seoudi (Seoudi Investment Group 2015). By 2013, AAV was utilizing 30% of its total factory capacity, leasing its excess capacity to KIA Motors and Peugeot (Yehya 2013). The Mansour Group thrived under Sadat's liberalization policy. In 1977, the company established Mantrac, which became the sole distributor of American Caterpillar construction and agricultural products in Egypt, including trucks, engines and forklifts. In 1983, the Mansour Automotive Company went from being a distributor to sole assembler of GM Chevrolet passenger vehicles in Egypt, a position it still maintains (Mansour Group 2015). Over the next 30 years the Mansour Group evolved into an international conglomerate based in London with business interest in 82 countries. (El-haddad, Hodge, & Manek, 2017).[(21)]

4. **Egyptian Air Quality Limits Values**

From the last five years, there were been continuous public concerns and comments related to the degradation and impurities of air quality in the most cities of Egypt and, in particular, in Greater Cairo (Elkalyobia-Giza – Cairo). This concerns and comments were sparked by the occurrence of a "Black Cloud" or Smog. it occurred because of smoke from industrial sites plumes mixing with air fog. This new mixture produces a yellow to brown color near ground level

Figure1 Greater Cairo Climat

It is appearing in the skies of the Greater Cairo (Elkalyobia-Giza – Cairo). since 1999. The cause was a chemical and thermal inversion climatic phenomenon air trapping pollutants from a multiple of sources in with around Cairo and it is generally a problem in major cities. One major root cause attributed this to start the open burning of solid waste in general, and agricultural residues.

Air Quality Limit values are shown in the Egyptian Executive Regulations of the Environmental Law 4/1994. and labor law. 12 / 2003 compared to the (WHO) World Health Organization air quality guideline values

5. VOC Health effects may include

Headaches, nausea, eye, nose and throat irritation and loss of coordination. failed and damage for kidney, liver and central nervous system, some organics causes cancer in animals; and others suspected or known to cause cancer in humans.

«symptoms associated with VOCs exposure include: Eye and respiratory tract irritation ,nose and throat discomfort, headache, conjunctival irritation ,allergic skin reaction, dyspnea, declines in serum cholinesterase levels, nausea, emesis, visual disorders , fatigue, dizziness and memory impairment Role of VOCs in the ground level ozone formation mechanism In Ambient Air.

6. VOC Environmntal impact

The formation of ground-level ozone is a serious air pollution problem in many areas. Ozone is not emitted directly, but is formed from the photochemical interactions of volatile organic compounds (VOCs) and oxides of nitrogen (NOX) (Carter, 2012) [(22)]

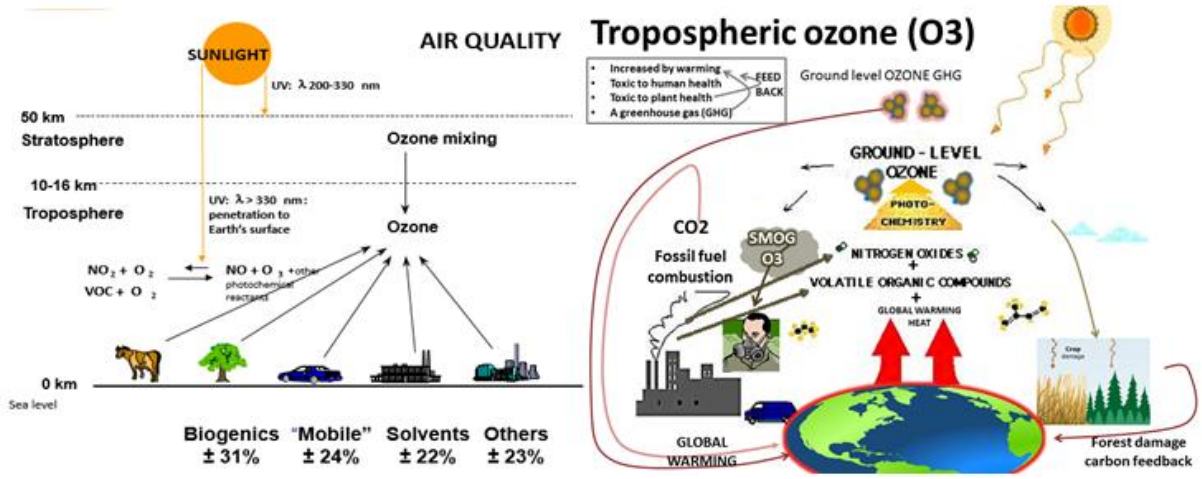

Figure2 Ozone effected on atmospher

The Photochemical Ozone Creation Potential (POCP) scale quantifies the relative abilities of volatile organic compounds (VOCs) to produce ground level ozone. POCP values are usually calculated using atmospheric boundary layer models containing detailed representations of atmospheric VOC degradation chemistry. The sensitivity of POCP values to variation of a number of kinetic and mechanistic parameters has been investigated here. It is shown that POCP values for VOCs can be rationalized in terms of their molecular structure and OH reactivity. As a result, a simple method has been developed and optimized that allows POCP for alkanes, alkenes, aromatic hydrocarbons, and several oxygenated VOC classes without the requirement to construct a detailed chemical mechanism or run an atmospheric mode

7. Aim of the study

VOCs play an important role in the formation of surface ozone) and secondary organic aerosols (SOAs) (Odum et al., 1996) Current practice in painting flushing of coating systems (system clean out) During normal painting cleaning and purging operations for E-coat and primer vehicle bodies are initially, cleaned to remove the dust materials from spot sanding or impurities in air. There are many different processes that to be achieved for VOCs emissions reduction. These processes are basically depending upon on used techniques and classified into two different categories as the following:

- Modification of work processes, equipment, tools and materials for VOC reduction
- Add-on control techniques for limiting emissions of voc.

In the first category, the modification for of VOCs reduction are done by reassess the used process equipment, raw material, and/or management of change, while in the second category an additional administrative- method controls have to be implemented to regulate pollution. The first task in evaluating VOC control techniques is to prepare a comprehensive emissions inventory. The emissions inventory provides the basis for planning, determining the applicability of regulations permitting the selection of control options for further consideration (USEPA, 1986; Kuhn & Ruddy, 1992). [23-24] To reduce emissions. Similarly, process enclosures can be designed to reduce emissions. By enclosing the source, a positive means of collecting the emissions can be provided. However, simply providing an enclosure is not enough to reduce the emissions. If emissions are captured in the enclosures but no additional measures are taken, the pollutants will eventually escape into the environment. Typically, this situation is handled by endof- pipe solutions (Chadha & Parmele, 1993; Ruddy & Carroll, 1993; William & Lead, 1997) [25-26]

Due to that, the Industrial pollutants (of indoor air) can originate from materials produced from manufactures and be emitted by the industry and thus appear in the environment due to the industrial development. Those pollutants can be either volatile organic carbons (VOCs), semi-volatile organic (SVOCs), polynuclear aromatic hydrocarbons (PAHs) or others (Wei et al. 2018) [27].

Exposure to pollutants in the indoor environment has increased with improved insulation and reduced ventilation making many indoor environments act as concentrators of emissions from plastics, paints, and other building materials, while protecting from outdoors contaminants (Lei et al. 2017). [28] The more restricted air quality regulations, as well as safety and health prospective, means that air emissions control from assembly sites is more big business in the vehicle industry. The biggest challenges of concern are in the paint shop, where coating manufacturers have to prevent and reduce the release of VOCs into the outdoor and ambient air in order to eliminate and avoid ground-level ozone formation .

New legislation in European countries and North Africa has meant high and huge investment across the global in waterborne paints not solvent base, but air abatement systems in ovens or curing system are still needed to bring VOC emissions down to acceptable limits. In the united states, requirements vary depending on the region (states). For more sustainability , the world legislation is being considered as the first time.

8. Literature review

The automobile coating process can discharge a variety of harmful pollutants into the air. These pollutants can damage both the environment and people's health through contamination by harmful materials. Air emission released by automobile coating process including volatile organic compounds and heavy metals. "automobile coating process workshops employ a large number of cleaners, paints, and solvents servers which can all release volatile organic compounds. which are organic, carbon-based compounds which easily turn into gases or vapours It has been demonstrated that building materials (i.e., paints; varnishes; solvents; carpets; and furniture, wall, and flooring materials) are major contributors to indoor emission sources of volatile organic compounds (VOCs) (Chang and Guo 1998; You et al. 2007; Matsumoto et al. 2010; Logue et al. 2011). [29-32]

Mixing and coating and cleaning process are responsible for most of the harmful air emissions generated by automobile coating process workshops, so it is of supreme importance for focusing on reducing VOCs by coating and cleaning process in ways that release fewer emissions. Also, downdraft airflow coating booths can be used to eliminate emissions, providing cleaner paint jobs. Paint spray guns can generate Volatile organic compounds VOCs into the atmosphere and expose vehicle manufacturing workers to harmful fumes if they are cleaned improperly. Paint spray gun, piping and paints pressure pot tanks cleaning solutions should fall within a district's Volatile organic compounds VOC limits, and be used in an enclosed proper flushing or washing system. employees should use the proper gloves and respirated tools during cleaning flushing or washing.

Today, paints are being used on a variety of substrates. Past research showed that the substrate has a major effect on the time history of (S)VOC emissions (Gehrig et al. 2004; Krebs et al. 1995; Chang et al. 1997; Sparks et al. 1999; Silva et al. 2003; Fjällström et al. 2003; Lin and Corsi 2007; Corsi and Lin 2009). [33-40]

So, the air pollution problem is released by vehicle industrial expansion, renovation, and excessive quantities of sites that, already existing pollution.

The Egyptian Environmental law (law 4/1994) is issued by Egyptian Environmental Affairs Agency (EEAA), accurate data for monitoring of air pollutants and analysis measurements with standards to prevent air pollution, that some of which effect on the greenhouse. In The vehicle manufacturing industrial the Body in white (metal surface) may be galvanized, galvanneal and iron steel and is painting for both decorative purposes and for corrosion protection. The coating paints consist of organic polymers and thinner /solvents. The solvent emits into air pollution, as volatile organic compounds (VOCs). The significant part in VOC from hydrocarbon like toluene and xylene when generated from cleaning (purge flushing) and spraying operations process.

The VOCs are hazard pollutant due to the formation of ground-level ozone which hazard effect on human health and respiratory disorders. Therefore, in this paper we introduce, new system for purge flushing and cleaning with using reducing gas and minimal quantity of solvent. For many automotive assembling manufacturers, applied volatile organic compound VOC abatement technology may has a significant impact on their processing value and therefore, profitability. regenerative thermal oxidizer (RTO) is energy-saving system, which oxidation process and degraded volatile organic compound VOC at 850°celisious or more. Paints have been widely used in our daily life. They protect the surface of an object as well as provide colorful view for humans. However, the applications of paints also cause environmental problems. A large amount of volatile organic compounds (VOCs) is emitted from various coating processes (Kim et al. 2000; Yu and Crump 2000; Anderson et al. 2006; Kwon et al. 2007; Celebi and Vardar 2008; Chung and Lee 2009; Yuan et al. 2010; Kim 2011; Kim et al. 2011; Katsoyiannis et al. 2012). [41-49]

The metals and plastics used for automobiles have been painted for both decoration and protection against corrosion. The paints used contain organic polymers and solvents. The solvents contribute to air pollution, as volatile organic compounds (VOCs), when emitted during painting operations. VOCs have been the focus of environmental concern and regulated for two basic reasons: human health issues due to some VOCs being toxic and ozone formation through photochemical reactions with NOx. Recently, various efforts have been made to change the nature of paints to reduce VOC emissions (US Congress 1990; Matheson 20th- to 21st). [50-51]

In 1923, E.I. DuPont De Nemours developed nitrocellulose lacquer systems that included many choices of color and offered improved applicability for the use of spray paint guns (Khanna et al 2008). [52]

These lacquer systems required the application of 3–4 coats to achieve the desired surface properties and, because of their chemical makeup, had relatively poor resistance to chemical solvents like hydrochloric acid. This disadvantage hindered the ability of coatings to endure acidic environments with various chemicals. Another significant enhancement in paint technology was the development of "alkyd" enamel paints that were introduced on some car models in the early 1930s (Standeven et al 2006). [53] the painting booths must be purged to remove evapourated solvent, overspray paint particles, and regulated pollutants (like VOCs). Hence, the energy associated with only booth ventilation is significant (Galitsky, C.; Worrel 2008). [54]

1700 tons of solvent was used in Taiwan. It was also observed that the main VOCs, such as toluene, xylene, or ethylbenzene, emitted from paints were very important ozone precursors, which produced ground-level ozone in the presence of NOx and solar energy (Latella et al. 2005; Duan et al. 2008; Ling et al. 2011). [55-57] In the maximum incremental reactivity (MIR) scale, the potential of ozone formation of toluene, m/p-xylene, and ethylbenzene was 4.0, 7.8,and 3.04 g O3/g VOC, respectively. The ground-level ozone caused many adverse effects on human health and human welfare (Schlink et al. 2006; Li et al. 2011; Sousa et al. 2011;Karaca and Ozturk 2012; Paoletti et al. 2014). [58-62]

The automobile coating process involves adding some solvents as thinners and additives to avoid excessive viscosity of the coating materials and to increase facility in working. Conventionally used thinners contain VOCs, such as toluene, xylene, ethyl acetate, and n-butyl acetate, Owing to their low boiling point and high volatility, these thinners can easily seep out of the coating materials during the coating or drying processes, subsequently causing pollution. The impacts of VOCs are largely found in photochemical reaction (smog forming), plant devastation, and pulmonary disorders. Moreover, a high concentration of VOCs causes acute poisoning in humans and even leads to fatal accidents.

9. The automobile coating process

Involves adding some solvents as thinners and additives to avoid excessive viscosity of the coating materials and to increase facility in working. Conventionally used thinners contain VOCs, such as toluene, xylene, ethyl acetate, and n-butyl acetate, Owing to their low boiling point and high volatility, these thinners can easily seep out of the coating materials during the coating or drying processes, subsequently causing pollution. The impacts of VOCs are largely found in photochemical reaction (smog forming), plant devastation, and pulmonary disorders. Moreover, a high concentration of VOCs causes acute poisoning in humans and even leads to fatal accidents.

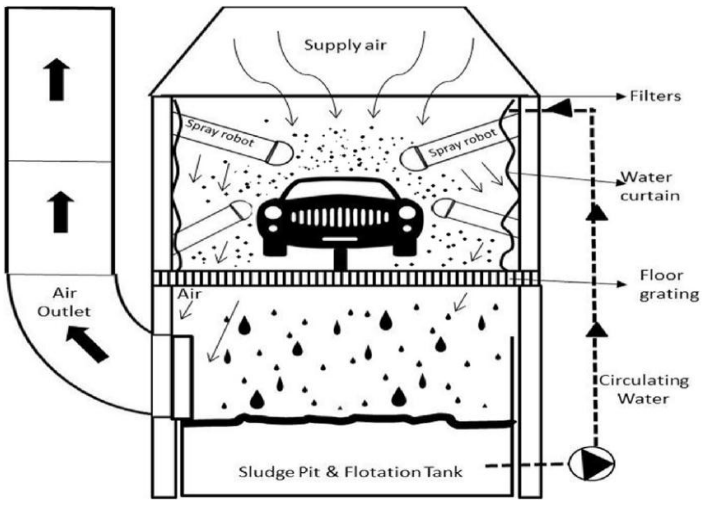

Figure 3: schematic for vehicle coating and VOCs pollutants release

The paint shops are the most damaging area of a car plant from environmental prospective, as per 60 % of an assembly sites' energy use and almost all VOC air emissions. the air abatement and environmental controls in a new paint shops would typically account from 5 and 10 % of the total investment of the facility. The hazardous and dangerous of air pollutants comes from volatile organic compounds (VOCs), which when generated and released into the outdoor and ambient air react with sunlight (photochemically) to create ground level ozone. This can cause respiratory problems. The type of controls varies from proper and effective EIA study depending on the location of the site and the huge quantities of VOCs generated

During automotive painting process, VOCs (volatile organic compounds) are generated from the paint solvents/thinners and paints to the work conditions and atmosphere. Most VOC pollutants come from spraying operations process via the using a solvent-based paints, as the spray booth air picks up all gaseous solvent compounds and overspray paint paints. The VOCs include a variety of chemical aromatic and aliphatic esters hydrocarbons, glycolethers , alcohols, and ketones

And as we mentioned the VOCs are hazard pollutant due to the formation of ground-level ozone which hazard effect on human health and respiratory disorders

Exposure for ground-level ozone may increase the risk of death whom already suffering from heart or lung disorders .

Exposure for VOCs may cause a variety of health diseases, like irritation to the nose, eyes, , and throat; headaches and damage to the liver & kidneys, and/or central nervous system. And in chronic cases VOCs are proven carcinogens.

Air pollution is one of the major problems of different cities in the world. There is a continuous increase in the number of sources of air pollution. Firstly, natural sources (Volcanoes, Earthquakes); secondary, man-made sources (Industrial and Transportation) .

10. VOC Removal technique

There are many different techniques available to control VOCs emissions. These techniques are basically classified into two different groups:

(i) process and equipment modification and

(ii) add-on-control techniques.

In the first group, control of VOCs emissions is achieved by modifying the process equipment, raw material, and/or change of process, while in the other class an additional control method has to be adopted to regulate emissions. Though the former is the most effective and efficient method, its applicability is limited, as usually it is not possible to modify the process and/or the equipment. In the second techniques group are further classified into two sub-groups, namely the destruction and the recovery of VOCs. An organizational tree diagram showing various VOC control techniques is presented in Fig. 9 The emissions inventory provides the basis for planning, determining the applicability of regulations permitting the selection of control options for further consideration (USEPA, 1986; Kuhn & Ruddy, 1992).

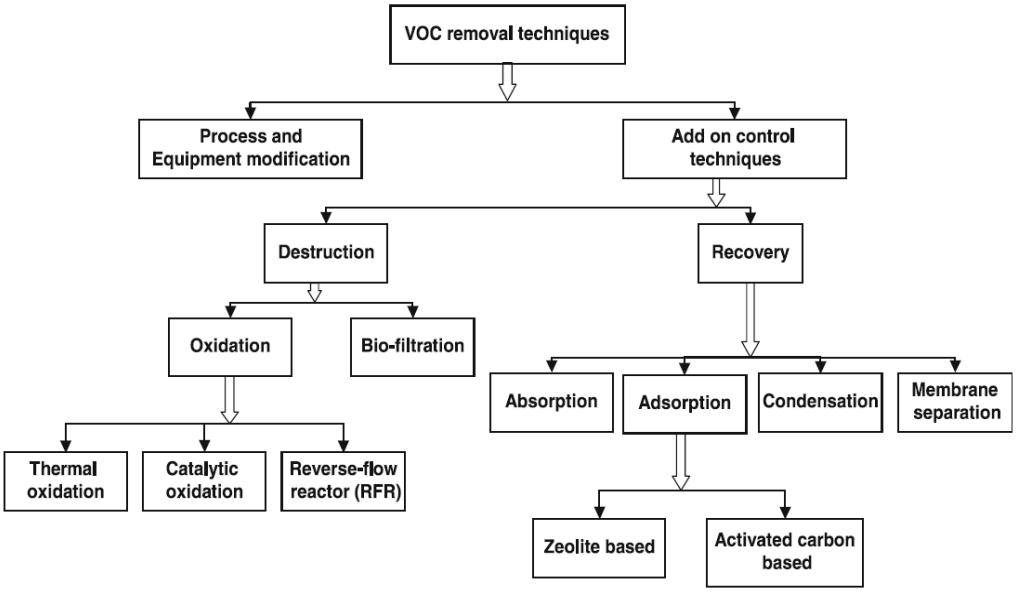

Figure 4: Classification of VOC control techniques (Khan and Ghoshal 2000) [28]

11. Environmental Aspect / Impact for paint process

The purpose of this assessment is to provide guidance for evaluating the environmental aspects and impacts for paint process of the organization's activities, services, and products. The evaluation should result in a determination of whether or not a particular aspect has any significant environmental impacts and if so, whether or not the organization can control or influence those impacts. Those activities, services, and products that are identified through this procedure as having significant and controllable impacts will then be reconsidered in the procedure to determine objectives and targets for

12. Mitigation by Chemical Leasing

GM Egypt awarded by silver certificate of chemical leasing on 2012 .The project for pure (flushing) solvent recycling

Figure 5 Chemical leasing award

CLEANING/PURGING WITH, AND RECOVERY OF, VOC MATERIALS

- Vehicle Body in white Wiping and cleaning
- Coating line flushing or purging emissions

- **Flushing (purging) process of coating systems (system clean out)**
  - ✓ Use high quantity of hydrocarbon solvent for purging the piping line of paint spray during color changing of cars
  - ✓ This solvent has impact on negative environmental and health effect with air pollutant VOC in ambient and atmospheric and high cost
- **Cleaning process for**
  - ✓ Spray booth grates and walls
  - ✓ Spray booth tool and equipment (paint line, robots, hoses, etc.)
  - ✓ External spray booth areas and mix room
- Housekeeping and floor cleaning measures not addressed above

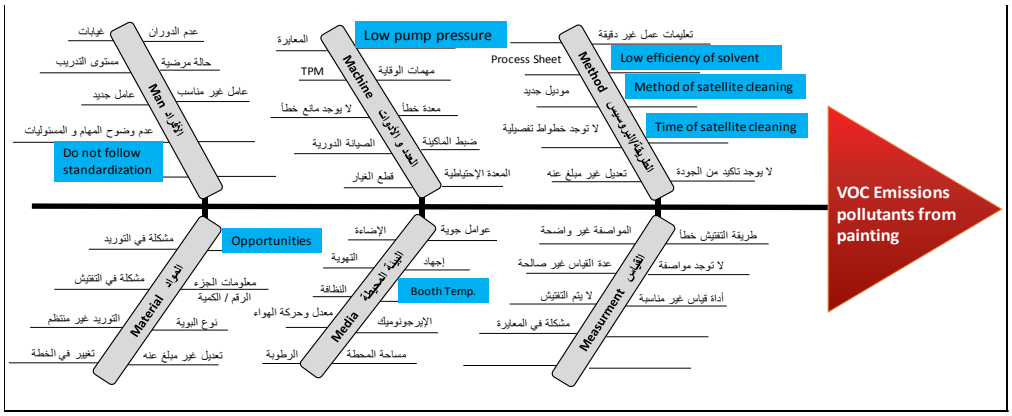

Figure 6 Fishbon analysis

<u>Reduce VOC Emissions:</u>

Cleaning Solvents

- Block Painting
- Solvent management Life cycle
- New opportunities for flushing and Best Practices for Cleaning
- Lower Purge Cycle Times
- Spray Applicator Maintenance
- Increasing Solvent Recovery
- Raise the quality of operator by training

<u>Solvent management Life cycle to reduce VOC emissions</u>

The purpose of the plan is to minimize solvent use and volatile organic compound (VOC) emissions from the management of solvents used in paint shop cleaning operations.

- ✓ Vehicle body in white cleaning and wiping operations;
- ✓ Purging of coating line operations;
- ✓ Flushing of coating lines;
- ✓ Cleaning of spray booth walls, grates, tools, and equipment.

The plan details are identified in the following paragraphs.

I. Identify uses and locations of solvent based cleaning materials subject to the work plan requirements.

reviewed plant operations to identify where the identified materials are stored, mixed, conveyed, and/or used as equipment cleaning or purging solvents. The materials, location, and uses are summarized

II. Work Practices addressing VOC emissions of air pollutants from different areas like paint storage, mix room, and conveyer system of thinners, cleaning & wiping materials, and disposal waste as identified in Paragraph I.

A. Storage Work Practice

The facility has implemented the following storage practices and procedures:

1. Floor personnel are instructed to store materials in closed containers and to close any containers that they observe open.
2. Facility personnel conduct periodic reviews for container status and will close open containers if found. In addition, if containers are found open, personnel in the area will be reinstructed to close containers when not in use.

B. Spill Prevention Work Practice

The facility has implemented the following practices to minimize the risk of spills:

1. Designated areas are established indoors for material storage. This will reduce the potential for container puncture during storage or handling. Example areas are as follows:
    a. Low traffic areas,
    b. Paint mix room
    c. Walled areas
    d. Flammable cabinets
    e. Storage tanks
2. Personnel are instructed to store materials, to the extent practical, indoors in areas with containment, curbing, and / or sloped floors. Signs are posted designating areas for this purpose.
3. Registered Storage tanks will be equipped with high level alarms to prevent overfilling.
4. Load / unload activities are monitored by a GM representative and are stopped immediately should material be leaked or spilled. The environmental response plan will be initiated to clean up the leak or spill.
5. Material transfer operations are conducted according to specific work plans developed for the function or in accordance with good engineering practices.
6. All material handling is conducted according to specific work plans or in accordance with good engineering practices.
7. Employees will be trained pursuant to documented plant procedures as appropriate.

C. Material Conveyance

The facility has implemented the following practices and procedures for material conveyance:

1. Fork truck/Material drivers are instructed to transport only closed containers

The facility will continue utilizing the piping system for the following materials/activates to be conveyed in pipes:

1. Delivery of purge solvent from the paint mix room to the paint booths
2. Recovery of the purge solvent to the reclaimed purge solvent tank
3. Delivery of equipment cleaning solvents to the booth cleaning closets

D. Mixing vessels

The facility has implemented the following practices and procedures for management of mixing vessels

1. Appropriate personnel are trained to keep mixing containers (puts and vessels), other than day puts tank maintained with continuous agitation systems, which keep solvents closed except when need to remove, add, or mix the paint contents.

E. Cleaning of storage, mixing and conveying equipment

The facility has implemented the following practices, procedures and precautions for the cleaning operations, materials storage, paint – solvent or thinner mixing, and conveying equipment system.

The requirement plan to minimize and reduce the emissions of VOCs during cleaning operations, materials storage, paint – solvent or thinner mixing, and conveying equipment system is satisfied by the implementation of some or all of the activities listed below. *it* will implement one or more of these as appropriate for *area*, taking into consideration the particular operation and activities involved.

Examples of practices which will be considered:

1. Use of low VOC cleanup materials.
2. Use of closed loop, recirculating cleaning practices.
3. Minimize the usage of high VOC cleaning materials.
4. Manage materials in closed system containers.

III. Work practices for cleaning and from purging of equipment associated with all coating operations

A. Vehicle body in white wipe emissions

Plant will use one or more of the following techniques for vehicle body wipe processes.

1. Wipes are moistened by solvent or thinner.
2. Solvent or thinner containers should be closed when not in use.
3. Quick moistened wipers disposal in closed waste containers.
4. Use of tack rags or wipes.

B. Coating line purging emissions

Paint shop area will use one or more of the following for coating line purging processes:

1. Using Air (nitrogen) and solvent in push-out.
2. Fix and recycle or recovery of purge solvent or thinner (other than applicator nozzles/tips).
3. Isolate and block the painting process to the optimum extent feasible.

C. Flushing of coating systems

Paint shop area will use one or more of the following for the flushing of coating systems:

1. The pressurized puts, tanks and vessels solvent /thinner must be closed.
2. Implement in solvent and thinner Recovering and recycling.
3. Recovered/recycled thinner/solvent vessels and tanks are closed.

D. **Cleaning of spray booth grates**

Paint shop area will use one or more of the following for the cleaning of spray booth grates:

1. Controlled fire and explosive proof.

2. Rinsing with spray mist or high- pressurized water (in/off place).
4. Using one of types liquid masking or spray-on masking.
5. Using low VOC content solvents/thinners.

E. **Cleaning of spray booth walls**

Paint shop area will use one or more of the following for the cleaning of spray booth walls:

1. Using masking materials (ex: plastic sheet , contact paper, or other similar type of material) or spray-on masking.
2. Using wipes and rags instead of spray application system during walls cleaning.
4. Using low VOC content solvents/thinners
5. Followed and controlled access for cleaning solvents.

F. Cleaning of spray booth equipment

Paint shop area will use one or more of the following for the cleaning of spray booth equipment:

1. Using covers on tool/equipment (disposable or reusable).
2. Using cleaners' parts (off-line submersion cleaning).
3. Using spray-on masking or others protective coatings.
4. Using low VOC content solvents/thinners.
5. Followed and controlled access for cleaning solvents.

G. **Cleaning of external spray booth areas**

Paint shop area will use one or more of the following for the cleaning of spray booth areas:

1. Using removable floor system coverings
2. Using mechanical and/or manual scrubbers, rags/wipes other than spray application.
3. Using plastic floor matt or shoe cleaners for elimination coating footprint track-out from spray booths.
4. Using shoe wraps , booties or other similar applications.
5. Using low VOC content solvents/thinners.
6. Followed and controlled access for cleaning solvents.

H. Housekeeping measures not addressed elsewhere in the plan

Paint shop area will use one or more of the following for housekeeping measures not addressed elsewhere in the plan:

1. Containers of solvent-laden items (cloths, paper, plastic, rags, wipes, ..etc) are covered when not in use.
2. New and used solvents/thinners are stored in closed containers.
3. Transferring and handlining of thinners/solvents in a manner to reduce the potential of spillage.

IV. Plan Communication

The requirements of this work plan will be communicated to *Paint shop area* employees and contract employees as appropriate to ensure that the elements of the work plan are properly implemented.

Methods of communication include:

1. Work Instructions

2. Hazardous materials communications
3. Team Meetings
4. Employee instruction
5. Work Plans
6. Other communication, such as email

V. Plan Review and Validation

Paint Shop Manager or Designee will perform a review annually at a minimum to ensure that the elements of the work plan are properly implemented. The "Work Practice Plan Check sheet" will be used to document the review and results.

VI. **Plan Updates**

This work practice plan will be reviewed once annually and updated as appropriate by the Paint Shop Manager or Designee.

VIII. Definitions

Closed: A container is "closed" if its top, lid, hatch, or other opening mechanism is in the closed position. Containers requiring pumps or other devices inserted into the container are considered "closed" if the pump or other device is securely installed.

Storage: A container used for the storage of a solvent containing material is one in which no mixing or conveyance takes place. Examples may include totes, drums, and buckets.

Out target improve air quality work condition (indoor) and out let release (outdoor)

13. Characteristic and using of nitrogen gas

Nitrogen is a reducing agent and dry gas heat is rapidly dispersed by it.
generating in cooler running vessels and piping. This maintains the integrity of the bead , rubber and belts. Nitrogen gas is inert so the chemical aging reactions with oxygen significantly slows

- HAPs and VOCs reduction
- decreases the operating costs value
- Using N2 in process support to retrofit
- It has high transfer performance and efficiency
- Minimize the exposure worker for solvent/Thinner vapors
- N2 gas is compatible with air
- N2 gas is reducing and will not cause any oxidation (rusting) for iron in any machine, piping, tools, equipment in booth rather than vehicle body

New process

- Flushing thinner consumption reduction by 50 % through:
- Usage of Nitrogen gas for Paint flushing cycle of satellite tank.
- Recycle the solvent to be used once more in the next cleaning cycle.
- Changing the sequence of satellite cleaning.
- Replacing the currently used solvent (444) with a more efficient solvent (443)

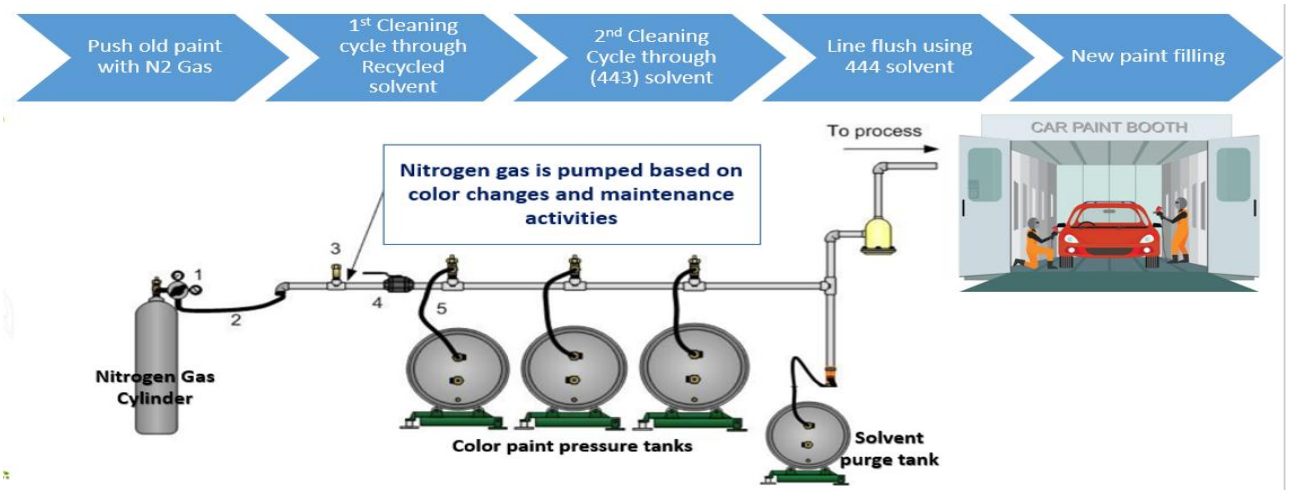

Figure 7 Using layout of Nitrogen gas

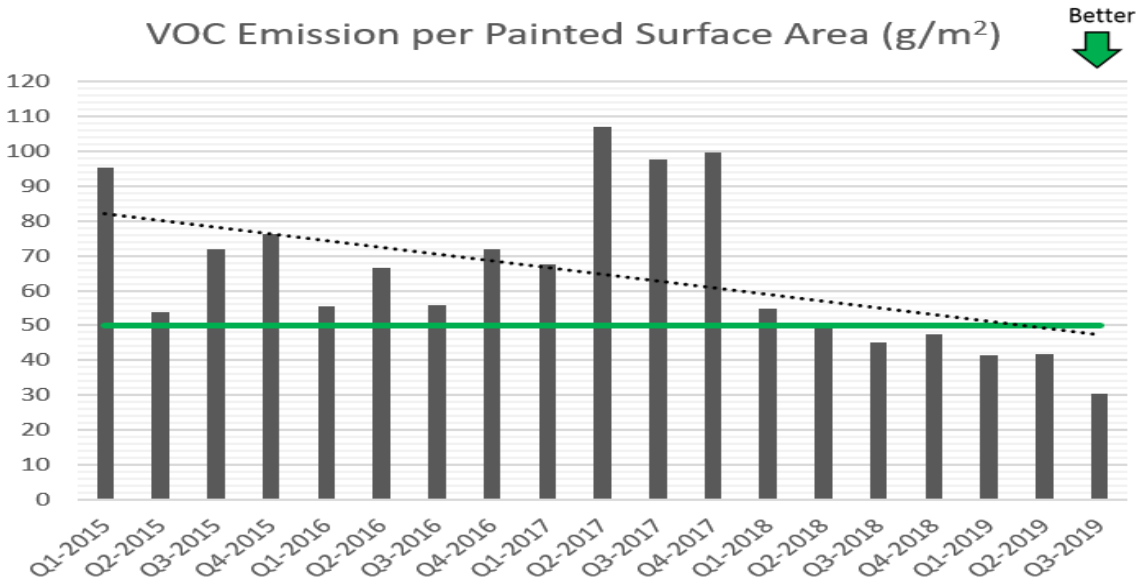

Figure 8 Purge Thinner g/l

14. Waste purge solvent

Previous practices
The waste solvent was disposed for Dr.Badawi company with free cost (old practices). Triggered to change the previous practices to Reuse Practice
In beginning 2017 Dr.Badawi company refused to receive the purge solvent.
Material handling and paint shop request support due accumulation of waste solvent which lead to safety and environmental risk.
communication with Elgammal to review all governmental document.
Request from Elgammal the possibility to reuse the purge solvent waste in others products. Elgammal succeeded to reuse it in producing an economical product (undercoat 705) that used in the refinishing sector to be applying as a protective thick coat for renewing the old vehicles underneath.
negotiation on price, to reach 5 L.E/ kg
Compliance and conformance with environmental laws and regulations associated with waste management at workplace environment.
Reduction of chemicals, raw materials, energy, emissions and waste
Avoid cost (transportation and disposal) in El Nasrya Center.
Eliminate the safety and env. risk due to waste accumulation.

Achieve BPD target by waste reuse and recycle.
Revenue 5 L.E/kilo of waste solvent (31 ton by end May 2015)
The estimated total revenue 80 ton X 5000 = 400,000 L.E (21280$)

15. Conclusion

In today's environmentally conscious society, all finishing operations are searching for ways to minimize their environmental impact while also reducing their costs. One solution that achieves both goals is a reusing- recycling program pioneered by General Motors Egypt, headquartered in united states, the new most for purging allows solvents to be reclaimed and reused instead of wasted, thereby allowing more efficient use of natural and company resources.
Purge solvents are used to clear paint lines between color blocks in automotive finishing operations. However, once the solvents have been flushed through the paint system, they must be disposed of as hazardous waste according to government regulations. For GM Egypt, this used solvents account for 50 to 70% or more of their hazardous waste stream. The solvents also create air emissions, forcing some facilities to limit production or purchase control equipment to remain compliant with increasingly stringent emission rules. Solvent formulations containing reduced volatile organic compounds (VOCs) and hazardous air pollutants (HAPs) have been developed to reduce air emissions, but the used solvent in most cases is still considered a hazardous waste. In today's environmentally conscious society, all finishing operations are searching for ways to minimize their environmental impact while also reducing their costs.

Method technique Basics

The method technique is based on a reduced gas with purge solvent that impact on solvent recovery and emissions reductions. Depending on the paint technology, GM Egypt appropriate purge new method to minimize material use and timing required to change colors. VOC and HAP compliance is considered, along with permit requirements and the type of application equipment used (automated or manual). The company conducts a purge review by measuring the exact consumption of solvents and paints during color change cycles, as well as the corresponding programming and timing. By optimizing both the chemistry and purge cycle time, a more efficient color change becomes possible. The benefits include fewer quality defects such as color carryover, spits and dirt, along with increased throughput through faster line speed or closer job spacing, and a reduction in paint and solvent use through a higher first time through. The spent purge solvent is monitored closely for solids levels, as well as other contaminants like water, and is then sent to GM Egypt for remanufacturing. On average, 70% of the captured solvents are returned to the auto manufacturer for future reusing. Collection systems are evaluated and improved if necessary, to provide the highest possible capture rate, while eliminating potential cross contamination or dumping of incompatible wastes. By fully understanding a manufacturer's waste stream, GM Egypt provide feedback and technical assistance to optimize the entire coating process.
The second phase of the program involves the use of appropriate cleanup materials and processes to ensure a clean spray booth and painting environment without the excessive use of cleaning solvents containing VOCs. Depending on the manufacturer's needs.

A Cost-Effective Solution

The new method technique has substantially reduced both the amount of waste generated and their solvent costs. Comparing Year 2019 Vs Year to date 2020 the reduction in used solvent in purging per vehicle was 41%. GM Egypt has revenue its paint solvent waste by 5 L.E per liter.

Summary of benefits of nitrogen using

- ✓ Comply with legal environmental law and GM requirement
- ✓ HAPs and VOCs reduction (carcinogenic)
- ✓ decreases the operating costs value
- ✓ Using N2 in process support to retrofit
- ✓ It has high transfer performance and efficiency
- ✓ Minimize the exposure worker for solvent/Thinner vapours
- ✓ Conformance with ISO 9001:2015
- ✓ Cost saving by reduction quantity of solvent by 75%

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