Evaluating Nitrogen Oxide (NO) Impacts on Misrata Municipality's Ecosystem

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تقييم تأثيرات أكسيد النيتروجين (NO) على النظام البيئي لبلدية مصراتة

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Abstract:
"This study investigates the environmental and health consequences of open waste burning, a prevalent, unsustainable practice in cities like Misrata, due to inadequate waste management. Specifically, it examines the impact of nitrogen oxide (NO) emissions from the Saso Merdoom waste dump yard, located south of Misrata, on the city's air quality and environment. Employing ANSYS software, the research analyzes air flow and gas dispersion to determine the spatial distribution and concentration of NO emissions. The findings reveal that waste burning significantly elevates NO levels, severely degrading Misrata's air quality. Consequently, the study advocates for the implementation of sustainable waste disposal alternatives to mitigate the detrimental environmental and health effects of open waste burning."

Keywords: Waste disposal, waste burning, environmental impact, health impact, nitrogen oxide (NO) emissions, air quality, Misrata, Saso Merdoom, ANSYS, gas dispersion, sustainable waste management.

الملخص:
تبحث هذه الدراسة في العواقب البيئية والصحية لحرق النفايات في الهواء الطلق، وهي ممارسة شائعة وغير مستدامة في مدن مثل مصراتة، نتيجة سوء إدارة النفايات. وتدرس الدراسة تحديدًا تأثير انبعاثات أكسيد النيتروجين (NO) من مكب نفايات ساسو مردوم، الواقع جنوب مصراتة، على جودة هواء المدينة وبيئتها. باستخدام برنامجANSYS ، يُحلل البحث تدفق الهواء وتشتت الغاز لتحديد التوزيع المكاني وتركيز انبعاثات أكسيد النيتروجين. وتكشف النتائج أن حرق النفايات يرفع مستويات أكسيد النيتروجين بشكل ملحوظ، مما يُؤدي إلى تدهور حاد في جودة هواء مصراتة. وبناءً على ذلك، تدعو الدراسة إلى تطبيق بدائل مستدامة للتخلص من النفايات للتخفيف من الآثار البيئية والصحية الضارة لحرق النفايات في الهواء الطلق.

الكلمات المفتاحية: التخلص من النفايات، حرق النفايات، الأثر البيئي، الأثر الصحي، انبعاثات أكسيد النيتروجين(NO) ، جودة الهواء، مصراتة، ساسو مردوم، ANSYS، تشتت الغاز، الإدارة المستدامة للنفايات.

Introduction:

Waste burning is considered one of the most hazardous methods of disposal, with severe negative impacts on the environment and public health.

Main reasons for waste burning:

1. **Lack of waste management systems:** The absence of effective waste management systems drives communities to adopt quick and unsustainable solutions like burning [1].
2. **Rapid waste disposal:** Burning waste is seen as a quick way to dispose of large amounts, especially in densely populated areas [2].
3. **Separation of combustible materials:** Waste is sometimes burned to separate combustible from non-combustible materials for further use [3].
4. **Heating:** In some areas, waste is burned as a means of heating [4].

Negative impacts of waste burning:

1. **Air pollution** [5]**:**
    - Waste burning releases numerous toxic gases, such as carbon dioxide, methane, nitrogen oxides, dioxins, and furans.

- These gases contribute to global warming, climate change, and increase the risk of respiratory diseases like asthma and bronchitis.
- They also cause chronic diseases like cardiovascular disease and cancer.

2. **Water pollution** [6]**:**
   - Pollutants from waste-burning seep into groundwater and surface water, contaminating water sources and making them unfit for drinking and usage.
   - Water pollution affects aquatic life and degrades aquatic ecosystems.
3. **Soil pollution** [8]**:**
   - Toxic ash from waste burning accumulates in the soil, rendering it unsuitable for agriculture and affecting its fertility.
   - Pollutants also seep from the soil into groundwater, worsening water pollution.
4. **Impact on public health** [9]**:**
   - Exposure to air pollutants from waste burning increases the risk of respiratory diseases, cardiovascular disease, cancer, and neurological disorders.
   - Pollution particularly affects children's health, increasing the risk of respiratory diseases and developmental issues.
5. **Environmental impact** [10]**:**
   - Waste burning deteriorates air, water, and soil quality, affecting biodiversity and disrupting ecological balance.
   - It contributes to climate change and global warming.

Simulation Model:

A 3D model representing the area where gas dispersion was studied was created with dimensions of 45 km in length, 1 km in width, and 300 m in height, identifying the emission source area. The model was divided into smaller mesh elements with varying sizes (10 meters, 20 meters, and 30 meters) to study the impact of element size on the accuracy of the results [11].

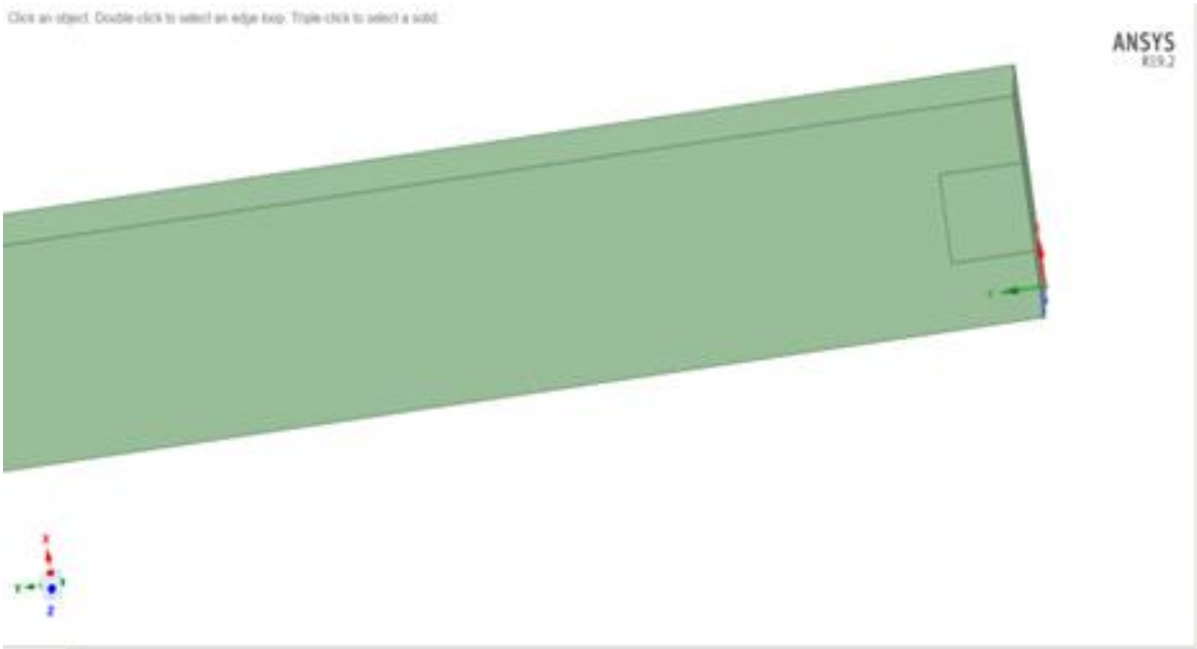

Figure 1: Area of Study**.**

The number of nodes and elements for the three models was as follows:

	Model One	Model Two	Model Three
Nodes	14,089,500	1,836,816	565,565
Elements	13,497,000	1,687,500	499,120

The boundary conditions, such as wind speed and gas concentration at the area's inlet and outlet, were then defined. Additionally, the initial flow conditions, including velocity, pressure, and gas concentration at the start of the simulation, were specified.

The governing equations were solved using the ANSYS computational fluid dynamics (CFD) simulation software, with the (k-epsilon 2eqn) model activated. The solution was iterated until a stable solution was reached [11].

Results and Discussion:

After the simulation process, the following graphical plots were obtained:

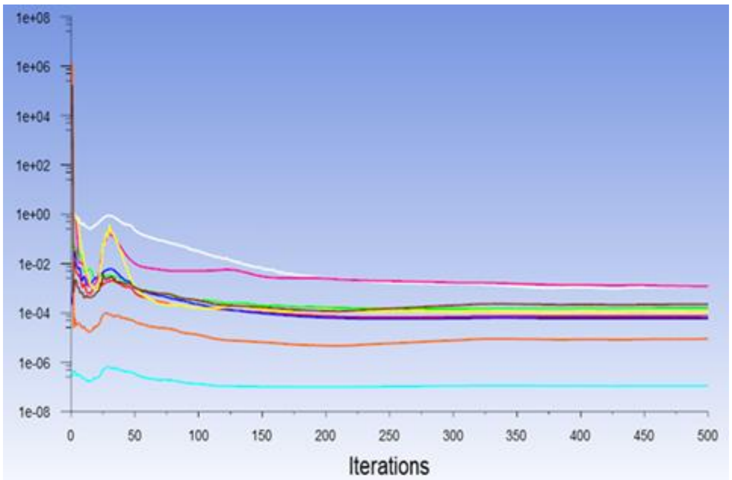

Figure 2: Calculated Values and Residual Values for Model One.

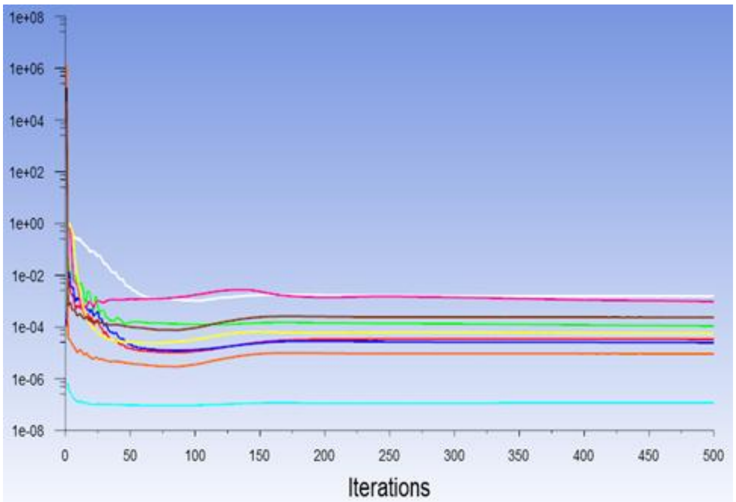

Figure 3: Calculated Values and Residual Values for Model Two.

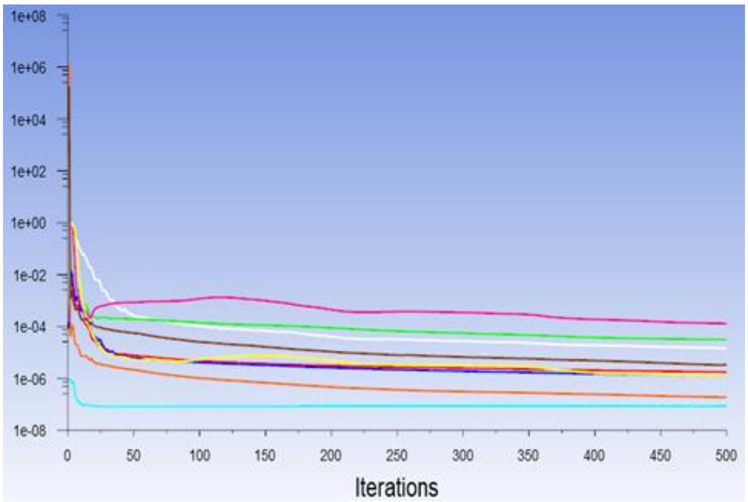

Figure 4: Calculated Values and Residual Values for Model Three.

Three horizontal levels were established at distances of 42 km, 43 km, and 44 km from the waste emission source, along with three vertical levels at heights of 10 m, 20 m, and 30 m above the ground [11]. The following results were obtained:

Firstly, along the horizontal Y-axis:

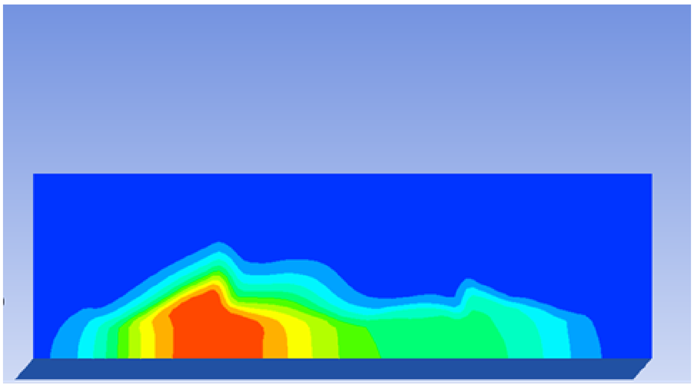

Figure 5: Gas Concentration at the First Level of Model One.

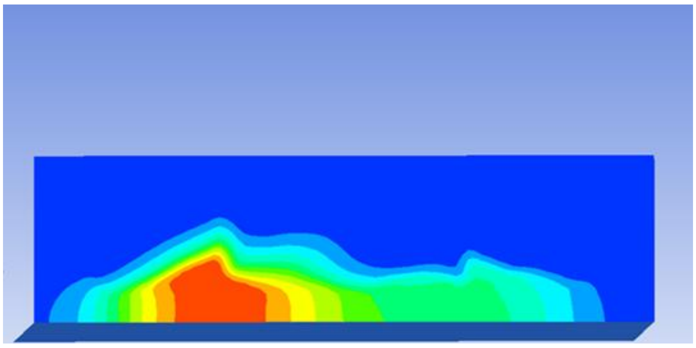

Figure 6: Gas Concentration at the Second Level of Model One.

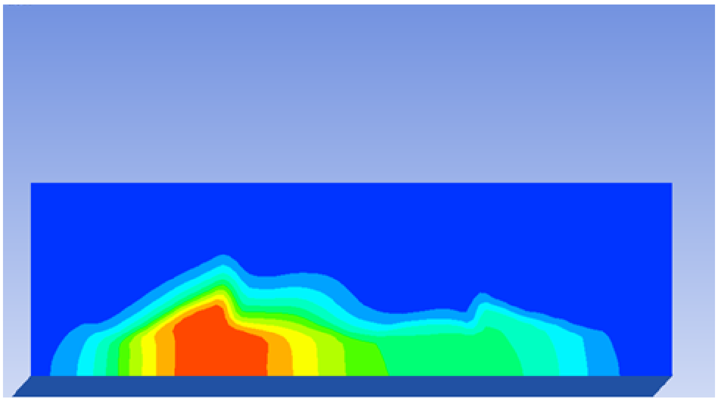

Figure 7: Gas Concentration at the Third Level of Model One.

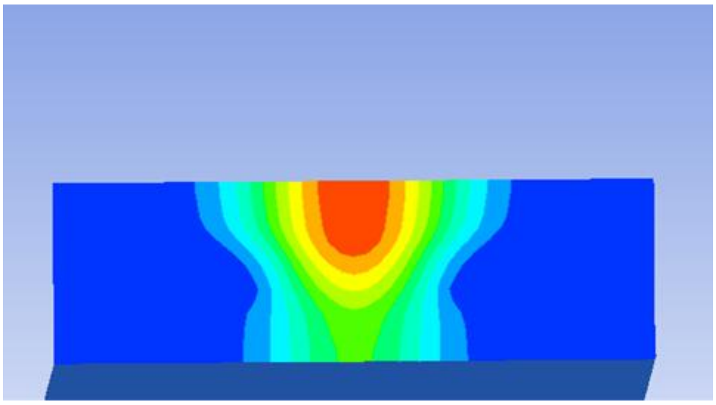

Figure 8: Gas Concentration at the First Level of Model Two.

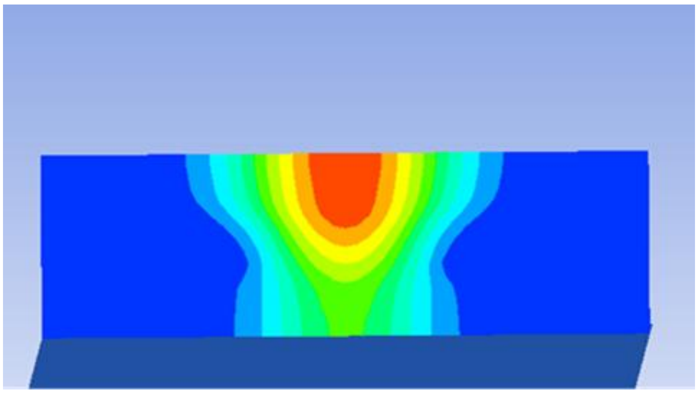

Figure 9: Gas Concentration at the Second Level of Model Two.

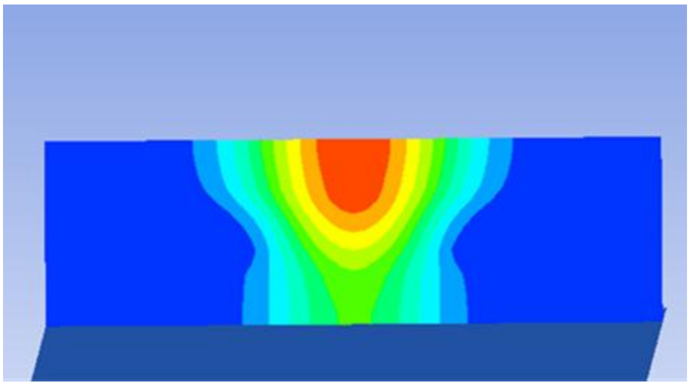

Figure 10: Gas concentration at the third level of the model Two.

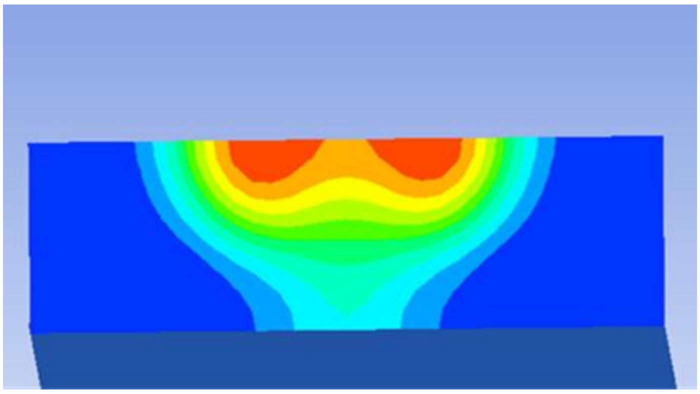

Figure 11: Gas concentration at the first level of model three.

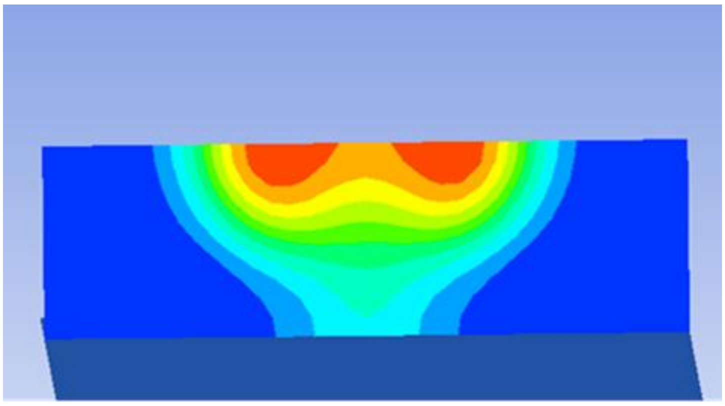

Figure 12: Gas concentration at the second level of the model three.

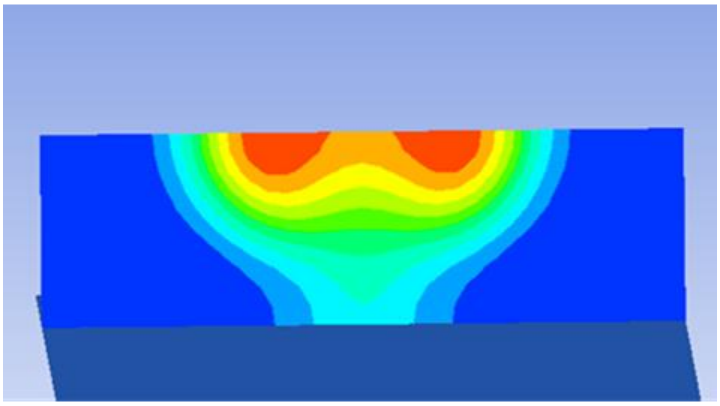

Figure 13: Gas concentration at the third level of the model Three.

Secondly, along the vertical Z-axis:

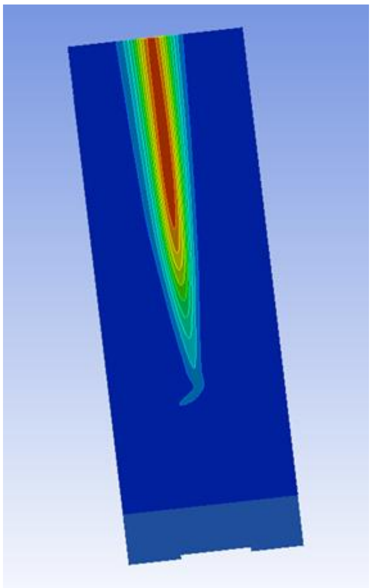

Figure 14: Gas concentration at the first level of Model One.

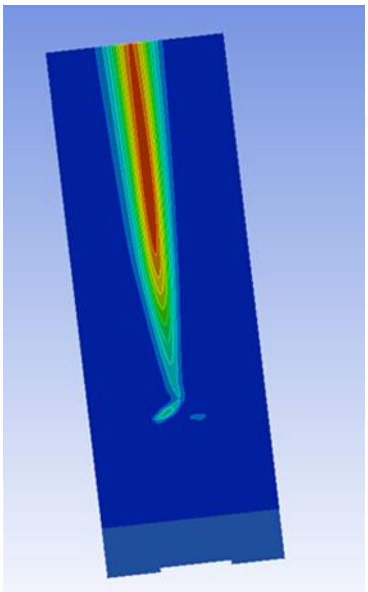

Figure 15: Gas concentration at the second level of the Model One.

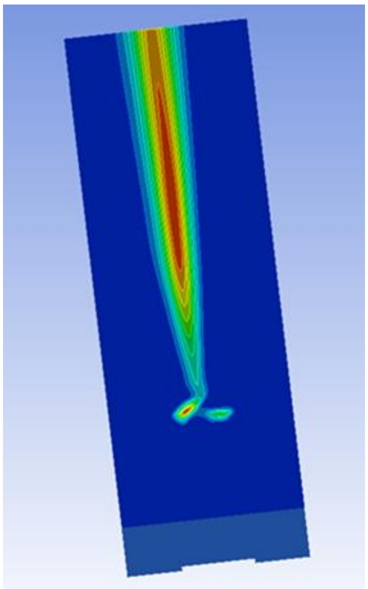

Figure 16: Gas concentration at the third level of the Model One.

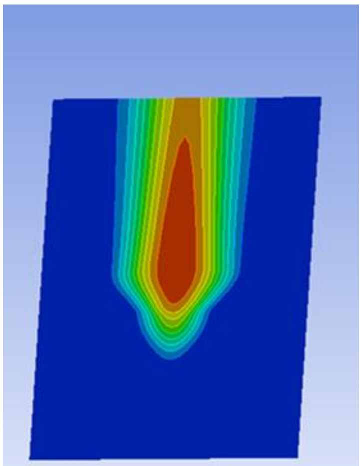

Figure 17: Gas concentration at the first level of Model Two.

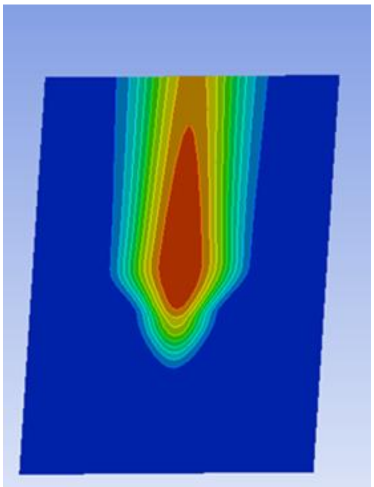

Figure 18: Gas concentration at the second level of Model Two.

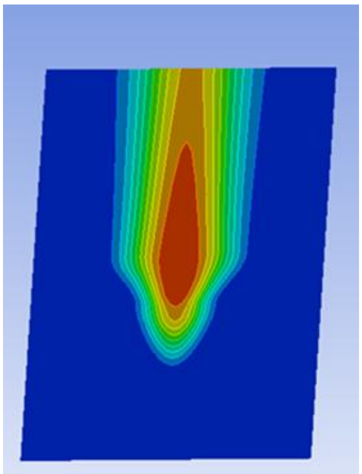

Figure 19: Gas concentration at the third level of the Model Two.

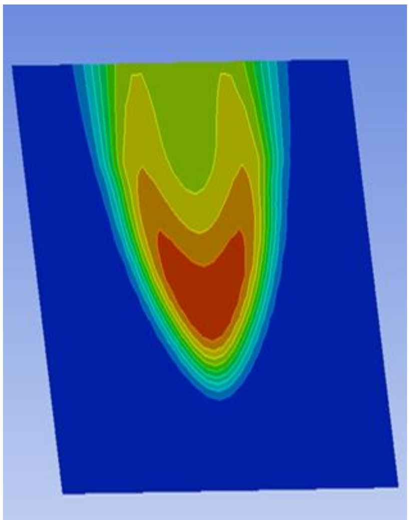

Figure 20: Gas concentration at the first level of the Model Three.

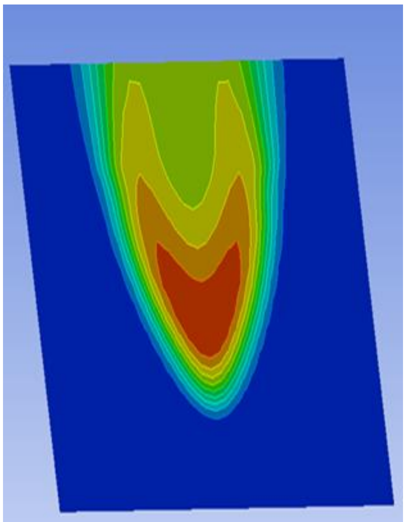

Figure 21: Gas concentration at the second level of the Model Three.

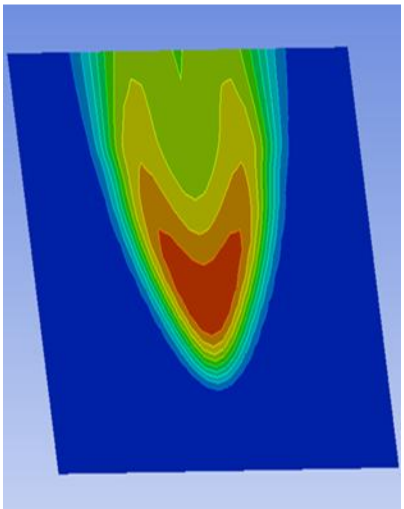

Figure 22: Gas concentration at the third level of the Model Three.

Conclusion

Based on the outcomes from the previous results regarding the concentrations of Nitrogen Oxide (NO), these concentrations were utilized to calculate Dalton's Formula of partial pressures, which states that the total pressure of a gas mixture is equal to the sum of the partial pressures of each component in the mixture.

$$\boldsymbol{\rho} = (\boldsymbol{m\%_{air}} * \boldsymbol{\rho_{air}}) + (\boldsymbol{m\%_{CH_4}} * \boldsymbol{\rho_{CH_4}}) + (\boldsymbol{m\%_{NO}} * \boldsymbol{\rho_{NO}})$$

The concentration of Nitrogen Oxide (NO) under the worst conditions was = 0.0221903% [11]

The results obtained from Dalton's Formula are 53.5 ppm. [11]

Thus

Since the non-harmful and permissible levels of nitrogen oxide gas according to the World Health Organization are 0.02 – 0.03 ppm, we conclude that the impact of the studied gas is significantly higher compared to the levels established by the World Health Organization [7]

Symbols:

Symbol	Geometric Meaning	Unit of Measurement
-	**Nitrogen Oxide Gas**	NO
kg/m^3	**Density**	ρ
kg/m^3	**Air Density**	ρ_{air}
kg/m^3	**Density of Nitrogen Oxide Gas**	ρ_{NO}
kg/m^3	**Density of Methane Gas**	ρ_{CH_4}
-	**Mass Fraction of Air**	$m\%_{air}$
-	**Mass Fraction of Nitrogen Oxide Gas**	$m\%_{NO}$
-	**Mass Fraction of Methane Gas**	$m\%_{CH_4}$
-	**Parts Per Million (ppm)**	ppm
-	**Meter**	m
-	**Kilometer**	Km
-	**Square Meter**	m^2
-	**Meter/Second**	m/s

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