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BOARD # 43: Simulation Analysis of Wind Speed Effects on Propylene Storage Tank Leak Addressing Emergency Management

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Simulation Analysis of Wind Speed Effects on Propylene Storage Tank Leak Addressing Emergency Management

Abstract

As energy demand is growing day by day proportionately chemical spill accidents are increasing. Leaks are happening from different stages encompassing extractions to various usages. Giving training with hands on experience to the proper personnels to address these spills are expensive. Computer simulations help saving money as well as user friendly based on trainers' available time. To implement these ideas and to learn hazard involve during chemical spills and effects of wind speed with different time in a day and seasons, an important and widely used chemical propylene chemical spill is considered for this analysis when it leaks from a tank. This analysis will help teaching students how to address chemical spills and evacuate nearby neighborhoods in a prompt manner. The author is not aware of any study related to chemical spill and wind speed effects using an inexpensive software to prepare students in classrooms or trainees in workplaces to control chemical spills.

Keywords: Propylene, Fire ball, Explosion pressure, Wind Speed, Computer Simulation, Emergency.

1. Introduction:

Due to rapid demand of energy, operators and suppliers are facing new challenges to address this energy demand [1]. The major phases of petroleum productions and sells include storing and transporting [2]. Chemical leak from tank can happen for so many reasons including but not limited to mishandling, material degradation like corrosion, even hit by a forklift during operation [1, 3]. When it happens, it can create devastating situations and nearby neighborhoods need to be evacuated when the chemical is hazardous for health of living beings and property.

Literatures indicate these chemical spills are analyzed using experimental, theoretical, and practical understandings [2, 4]. Computer simulation is a cheaper way to simulate this leak, rather than doing it in large scale experimental setup which will cost a lot. Therefore, computer simulation is needed to predict the spread of the chemical so that citizens can escape safely.

Literatures listed a lot of typical accident consequence models that have considered Gaussian, Sutton, BM, FEM3, and P-G model. Some of the simulation softwares are dedicated to certain types of chemicals only. Rather than using commercial softwares, Aloha [5] is an opensource and user-friendly software from Environmental Protection Agency (EPA) [3] that can address this kind of chemical spill simulation properly. In addition to its user-friendly features, it has very good Graphical User Interfaces (GUI).

Wind speed can dictate chemical spills especially in a very windy weather. The dispersion is caused by convection of the gas. Higher wind speed will dictate more heat and mass convection, therefore a faster spreading of gas. Therefore, this study tried to simulate this dispersion with varying Wind Speed. For simulation purposes, a horizontal cracked propylene tank is analyzed. The dimensions of this tank and a base study is conducted following Yang et al. [4] where Aloha software is used to look at potential environmental consequences of the leak. This leads to qualitative and quantitative hazard mitigations and proposes some reasonable risk control measures. This greatly helps on improving the risk forecasts and overall prevention capabilities. This also provides a guideline for potential propylene leak from rescue operations and decision-making.

2. Objectives:

This study aimed to find the effects of propylene leak and dispersions with the variations of wind speed that can happen over the years in various season. This study will help emergency professionals to tackle the leak when wind can cause a big role of spreading the leaks.

3. Literature Review:

Different literatures considered various aspects of chemical spills. Simulation software is used by Yang et al. [4] to conduct simulation on propylene leak. Although their study conducted based on a city in China, however no other city especially wide weather patterns in Houston area is considered. Their study also did not consider wind speed variations effects on propylene chemical spills.

Chen et al. [6] has investigated wind effects on propylene leak from pipeline using a Computational Fluid Dynamics (CFD) software. In their study significance of diameter of a pipe is considered as the amount of leak has a relation of volume of chemical storage. Their study did not show the effects of wind speed on leak from a tank, however explained how diffusion of the chemical with ambient air with wind direction occurs.

Li et al. [7] has investigated chlorine leak from factory equipment using a CFD software. Their study did not show the effects of wind speed on leak, however explained how diffusion of the chemical with ambient wind direction occurs slowly with ground effects that can played a role. Hasan [8] has investigated tank leaks with temperature variations with weather fluctuations, however wind speed effects were not considered.

Horiguchi et al. [9] has investigated ethanol leak from a chemical plant. Their investigation revealed that low concentrations of ethanol will not be bad on health and evacuation and can be done safely. However, wind speed effects on leak and dispersion are not discussed.

Current literatures lack the findings of the effects of propylene leak and dispersions in the air with the variations of wind speed. Hence, wind speed variations due to different season change as well as in a typical day, and the effects of that on the air dispersion are considered as the primary goals for this study.

3.1 Physicochemical Properties:

Propylene is used as raw materials for acetone, oxides and polymers. Molecular weight of Propylene (C_3H_6) is about 42 g/mol which is heavier than air [10, 11]. At room temperature, propylene is a colorless and slightly sweet gas. It is also an asphyxiated but mildly anesthetic gas. Its boiling temperature is -47.4°C and flash point temperature of -108°C. Its vapor pressure is above atmospheric pressure. Once leak happens from tank, this chemical will evaporate instantly.

4. The Software Information and Base Study:

4.1 Software Introduction and Features:

Emergency leak scenario is analyzed by a widely used ALOHA (Areal Locations of Hazardous Atmospheres) software [5]. It is a user friendly and open-source software. It allows to enter parameters related to leaks and afterwards plot for threat zones. In terms of color, the red threat zone is the worst type of hazard, orange is moderate type of hazard, and yellow threat zone is low type of hazard. Users can modify as well as add new chemical lists, environmental parameters, tank properties, etc. in the software.

This study considered the damage due to explosion that can create very high pressure and toxicity that can be poisonous to human beings.

4.2 Base Study:

For base study the site (altitude of industrial area is 1398 meters.), tank size, and environmental parameters are used for propylene chemical spill. Figure-1 shows different dimensions and parameters of tank and ruptured hole involved with the base line study. As indicated in the figure, the ruptured hole is located above 1.5m from ground, which indicates that the chemical needs to evaporate and turn to vapor to be fully removed from the storage tank.

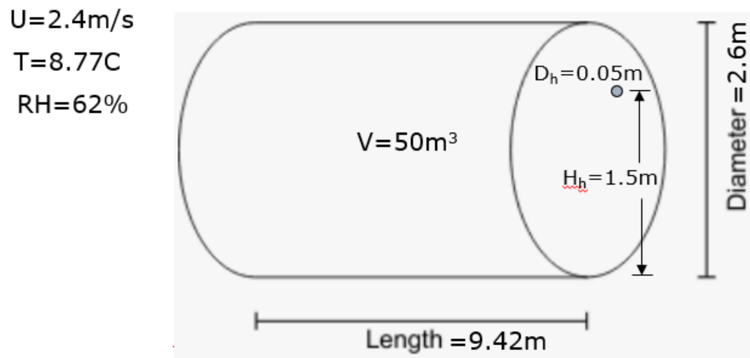

Figure-1: Storage tank in the base line study [4]

5. Methodology:

After completion of base study [4], the model parameters are changed with different site/location (Deer Park area which is near to Houston, Texas) and environmental parameters (wind speed, temperature, humidity etc.) while keeping the same tank data used from baseline study. Yearly wind speed data [12] is obtained from literature, from where the average wind speed is considered 1 to 5 meter/second (2.25 to 11.25 mph) and outside average ambient temperature is considered as -21.2^{o}C (70.17^{o}F). On the other hand, the average Relative Humidity (RH) considered is 75% [13].

Table-1: Atmospheric parameters for the propylene chemical spill simulations

Parameter	**Symbol**	**Value**	**Unit**
Annual Wind Speed	U	1 (2.25) to 5 (11.25)	m/s (mph)
Wind Measuring Height		3	M
Ground Roughness		Open Country	
Cloud cover (Cloudy level)		40	%
Outside/Ambient Air Temperature	T	21.2 (70.17)	C (F)
Stability class		D	
Relative Humidity	RH	75	%

Figure-2 shows different dimensions and parameters of the tank and ruptured hole involved with the current study.

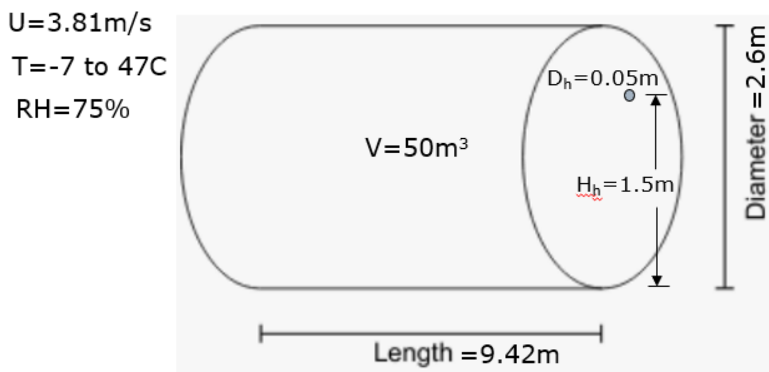

Figure-2: Parameters involved with storage tank for the current study

5.1 Leakage Simulation:

Following the baseline study, this study conducted simulations based on Table-1 parameters. This study looked at pressure rise due to vapor explosion and toxicity.

Any time a leak happens from a propylene tank, the emitted liquid will rapidly turn to vapor in the ambient temperature of the designed area (Deer Park) due to its very low boiling temperature. Once turned to vapor, the chemical will disperse in different directions and will form vapor cloud around the tank area, however major distributions will be in the wind or air direction of flow. How fast and slow the chemical will disperse will depend on wind speed.

5.2 Steam Cloud Explosion Distribution Simulation:

This study considered BLEVE (Boiling Liquid Expanding Vapor Explosion) explosion as the chemical propylene leak from the tank and evaporate, which will impact nearby communities and neighborhoods. As shown in Figure-3, pressure distribution from source (tank) containing propylene to nearby areas (neighborhoods) at 3m/s wind speed. Greater than 3.5 to 8 psi pressure distribution (orange color) is observed near to source (range around 126 m along wind direction). Whereas, greater than 1 to 3.5 psi pressure distribution (yellow color) is observed after and surrounding the orange band (range around 113 m along wind direction). Above 8 psi pressure distribution is not expected in this scenario. Different pressure distributions can have different consequences to living beings and properties.

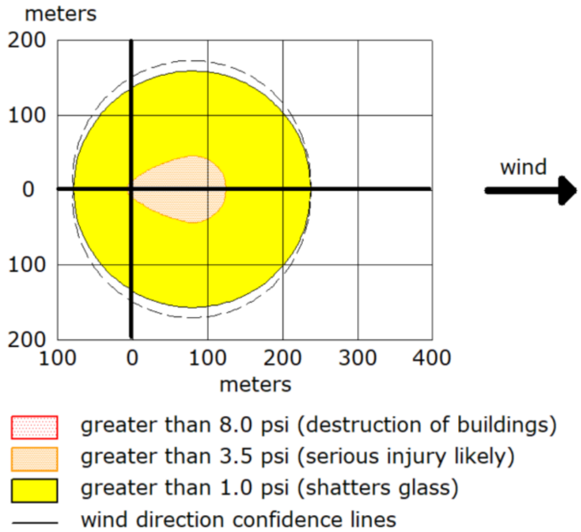

Figure-3: Pressure (psi) distributions contours at wind speed 3m/s after propylene leak

Figure-4 indicates the total time (min) needed for the release of the chemical from the tank at 3 m/s. At first the release due to leak will occur very fast and gradually will decrease the rate of release. The progression of release follows step by step process.

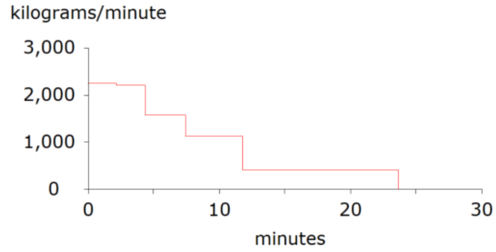

Figure-4: Propylene release rate (kg/min) after the leak at wind speed 3 m/s

5.3 Toxic Chemical Distribution Simulation:

In US threshold limit value of 500 ppm was established for occupational 8-hour TWA-Time Weighted Average exposure [11] for propylene. Therefore, emergency personnel need to look at quantitative data to evacuate neighborhood citizens near to the chemical leak.

As shown in Figure-5, toxicity distribution from source (tank) containing propylene to nearby areas (neighborhoods) at 3m/s wind speed. Greater than 2800 to 17000 ppm toxicity distribution (orange color) is observed near to source (from 186 to 500 m along wind direction). Whereas, greater than 1500 to 2800 ppm toxicity distribution (yellow color) is observed after the orange band (from 500 to 713 m along wind direction). Above 17000ppm toxicity distribution (red color) is located around 186 m in this scenario. Different toxicity distribution can have different consequences to living beings.

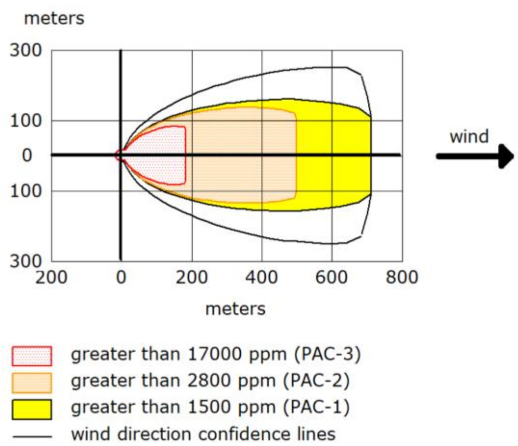

Figure-5: Toxicity concentration (ppm) distribution contours at wind speed 3m/s after propylene leak

6 Results and Discussions:

As shown in Figure-6, different propylene toxicities from 1500 to 17000ppm are distributed from 133 m to 1300 m distance for wind speed of 1 to 5 m/s. For same wind speed, toxicities gradually lower from higher to lower concentrations along the wind speed. Concentration decreases gradually for the same distance, for gradual increase of wind speed.

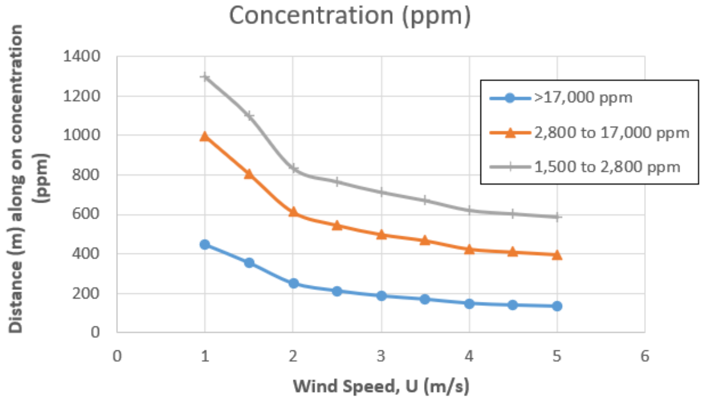

Figure-6: Dispersion distance (m) along wind direction on varying toxicity concentration (ppm) for different Wind Speed (m/s)

As shown in Figure-7, different propylene dispersion pressures from 1 to 8psi are distributed from 89m to 493m distance for wind speed of 1 to 5 m/s. For same wind speed, pressure gradually lower from higher to lower for along the wind speed. Pressure decreases gradually for the same distance, for gradual increase of wind speed.

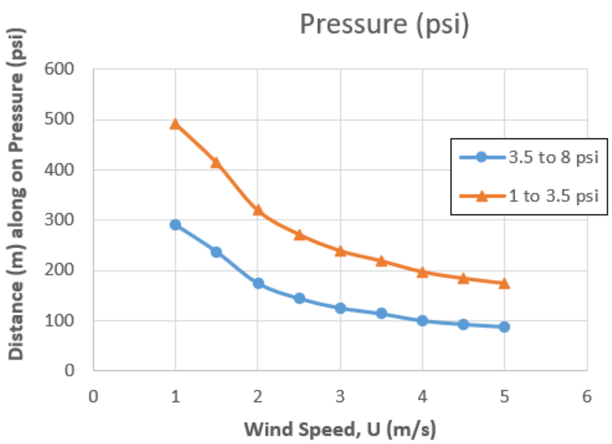

Figure-7: Dispersion distance (m) along wind direction on varying pressure (psi) for different Wind Speed (m/s)

Separate analysis indicated for varying wind speed (m/s) does not have any variation with release rate (kg/min) and release duration (min) of propylene. The release rate is 2240 kg/min for different wind speeds. The duration of release is 24 minutes for different wind speeds. This indicated that propylene can release with same rate and duration as soon as there is a crack which can produce leak. Therefore, neighborhood people need to be cautious and evacuate accordingly, no matter what the wind speed is.

7 Student Surveys and Results using the software:

Students' were assessed before and after using this software to judge their learning improvements. The assessments were conducted with the same questionaires. Appendix (at the end) illustrates questionsaires asked to the students to assess before and after the software was discussed.

Students' outcomes were reported in tabular formats which is shown in Table-2. Each period of assessment had 10 questions. Learning improvement was assessed by difference of Post and Pre-survey scores. 'NA' (Not Available) notation is used if a student did not want to respond or absent during the assessment. Learning improvement is marked as positive (+) sign, whereas improvement needs more time is marked as negative (-) sign.

Table-2: Assessment of students' outcomes

Student no.	**Pre-Survey (10)**	**Post-Survey (10)**	**Difference (=Post-Pre Survey scores)**
1	9	NA	NA
2	5	6	1
3	NA	4	NA
4	8	6	-2
5	8	7	-1
6	7	7	0
7	6	4	-2
8	7	9	2
9	7	9	2
10	6	NA	NA
11	4	8	4
12	8	8	0

13	8	5	-3

Tabular format (Table-2) and Bar chart (Figure-8) are used to assess students' improvements or needed more extra time. Out of 13 students, 4 students' post-assessment scores are higher than pre-assessment. These students' represent 30.77% of the class. This data also indicates importance and success of this training with the way followed. 2 students' (15.39% of all students) post-and pre-assessment scores are equal. Which indicates their learning did not change. 2 students' (15.39% of all students) did not attend post-assessment. Their learning data was not able to be judged. 4 students (30.77% of all students) post-assessment score was lower than pre-assessment. This data indicated that those students needed extra time to learn this kind of technology dependant chemical spill analysis. The students might not be in the right mode to attend this assessment on that particular day. No matter what the scores, students were provided extra sessions to learn this software after the post-assessment so that they can get better understanding related to chemical spill dispersion analysis.

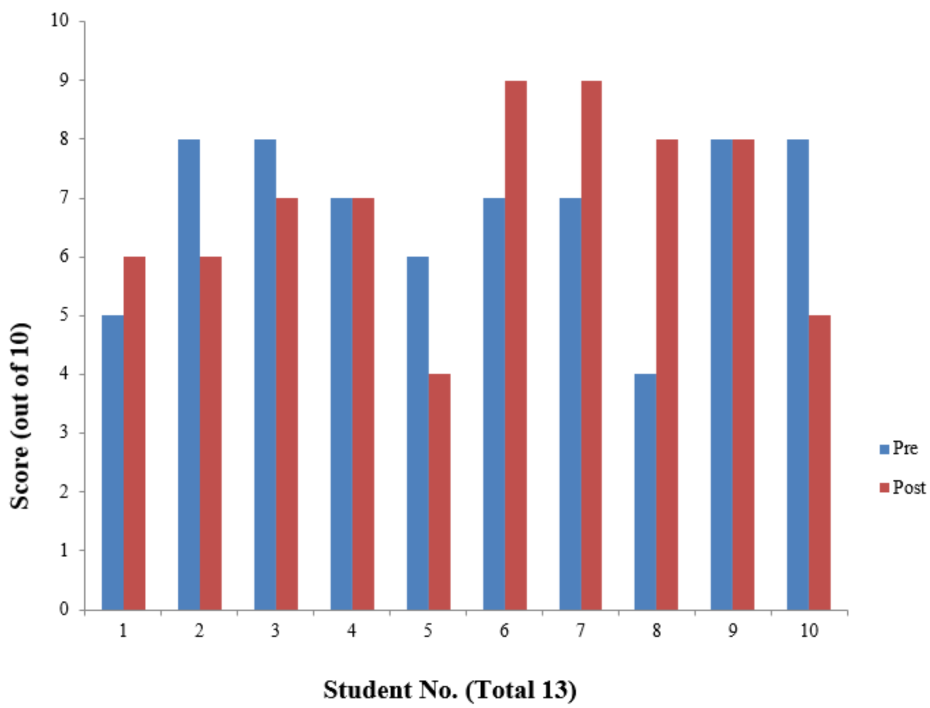

Figure-8: Graphical representation of students' outcomes

Students' outcomes were also assessed by performing statistical analysis. Mean (average) data for pre- and post-assessment were 6.8 and 6.9 respectively. This data indicates a good improvement of knowledge using this simulation software and a success for this type of training.

8 Effects of this Study on Chemical Spill Education or Training:

As Junior (3rd year) and Senior (4th year) students will be graduating soon and will be the future worksite leaders or trainers, therefore this software helped them learning how to tackle chemical spills during the time of emergency. This software is demonstrated in various courses primarily in Engr-4350 (Industrial Loss Prevention) class when the discussion focuses on chemical spill analysis and mitigation techniques. To practice this software, in addition to use classroom computers where the software was downloaded, students also downloaded this software in their personal laptops and desktops. This helped them to learn this software in their own pace. Students also reported that they did several sample chemcial spills for the chemicals they are handling in their worksites and showed the results to their managers. The managements appreciated these students' efforts to analyze chemical spills albeit in a no cost but accurate ideas.

The implementation of this software was gradual and in slower pace. First the students were deomonstrated an example from Aloha software. They kept practicing this example for a week time frame. As students knows the basic and buttons of the software, therefore for next example a randomly one student picked up to follow the tutorial and deomostrate this example in the classrooms. Other students were suggested to help that student in case the student needs help. This process of picking randomly different students kept going up to the last example. At the end of the semester, students were asked to pick a random chemcial spill case that happended earlier somewhere in the world, and students were given an assignment to domonstrate the chemical spill dispersions. This helped them to apply the knowledge of the class and finding out analysis process in real life situations.

I have followed two different Learning Management System (LMS) to collect students' feedbacks related to this anlaysis. These two LMS: Canvas and Blackboard were used for course evaluation and students' learning. These LMS gives opportunities to collect students' response/feedback after the end of the semester which can be accessed by instructors after the end of the semester. Between the semester students' verbal comments during class intreactions were also considered as student feedback related to their learning improvements and the software. Students' comments indicated that they really liked this software and will do futture chemical spill simulatiolns in their worksites. At the end, they have been able to co-authors peer reviewed papers which is a very important accomplishment for undergraduate students and helping them to excel in their respective future careers in petroleum companies.

9 Conclusion:

Wind Speed variations and effects on propylene leak and later dispersions with blast force were simulated using Aloha software. The simulations indicated propylene toxic as well as explosion-affected areas. Results from these simulations can help identifying neighborhood citizens who will be susceptible for the effects of propylene leak in different directions and distances for varying wind speed. This analysis will help to identify the neighborhoods in terms of distance who are susceptible to quick evacuation and who can evacuate later. That means evacuation level and preferences can be decided by this analysis. This analysis will help teaching students how to address chemical spills and evacuate nearby neighborhoods in a prompt manner. The author is not aware of any study related to chemical spill and wind speed effects using an inexpensive software to prepare students in classrooms or trainees in workplaces to control chemical spills.

10 Acknowledgments:

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Appendix (Questionsaires asked to the students to assess before and after the software was discussed)

Example-1: A Tank Source (Puddle and Pool Fire) -Modeling a Toxic Vapor Cloud

In a small industrial park outside Baton Rouge, Louisiana, a 500-gallon, 4-foot-diameter, vertical tank contains liquid benzene. On June 20, 2016, at 10:30 p.m. local time, a security guard discovers that liquid is leaking out of the tank through a 6-inch circular hole located 10 inches above the bottom of the tank. He also sees that the liquid is flowing onto a paved area in the industrial park. The guard thinks that the tank has just been filled that evening.

The temperature on scene is 80°F, with the wind from the southwest at 7 miles per hour (as measured at a height of 10 meters by a fixed meteorological tower at the site). The sky is more than half covered by clouds and the humidity is about 75%. A thunderstorm is approaching from the southwest. There is no low-level inversion. There are very few buildings in the industrial park and a large grassy field is located to the northeast of the industrial park.

The Local Emergency Planning Committee has requested that on-scene responders use ERPG-2 concentrations to define the toxic endpoints in their analysis of benzene hazards.

In this example scenario, you'll determine: Distance to the ERPG-2 level if the puddle evaporates and forms a toxic vapor cloud.

Instructions:

*Follow 'ALOHA Sample Examples' file from page-3 to page-14.

*You need to upload your simulation file in Blackboard as attachment

*Your file name need to be this format: "ENGR-4330 Simulation-1 Exp-1 Last name First Name"

*You can submit the Simulation file early, if you want

Example-2: A Tank Source (Puddle and Pool Fire) -Modeling a Pool Fire

In a small industrial park outside Baton Rouge, Louisiana, a 500-gallon, 4-foot-diameter, vertical tank contains liquid benzene. On June 20, 2016, at 10:30 p.m. local time, a security guard discovers that liquid is leaking out of the tank through a 6-inch circular hole located 10 inches above the bottom of the tank. He also sees that the liquid is flowing onto a paved area in the industrial park. The guard thinks that the tank has just been filled that evening.

The temperature on scene is 80°F, with the wind from the southwest at 7 miles per hour (as measured at a height of 10 meters by a fixed meteorological tower at the site). The sky is more than half covered by clouds and the humidity is about 75%. A thunderstorm is approaching from the southwest. There is no low-level inversion. There are very few buildings in the industrial park and a large grassy field is located to the northeast of the industrial park.

The Local Emergency Planning Committee has requested that on-scene responders use ERPG-2 concentrations to define the toxic endpoints in their analysis of benzene hazards.

In this example scenario, you'll determine:

1) Distance to the ERPG-2 level if the puddle evaporates and forms a toxic vapor cloud. (Note: Get data from Example-1).
2) Thermal radiation threat if a lightning strike (or other ignition source) ignites the puddle and forms a pool fire.

For this example, you want to assess the threat assuming that the pool fire occurs soon after the puddle forms. Therefore, you don't need to enter new information for time, atmospheric conditions, or puddle size.

Instruction:

*Follow 'ALOHA Sample Examples' file from page-15 to page-19

*You need to upload your simulation file in Blackboard as attachment

*Your file name need to be this format: "ENGR-4330 Simulation-2 Exp-2 Last name First Name"

*You can submit the Simulation file early, if you want

Example-3: A Tank Source (Multiple Scenarios) -Modeling a BLEVE

On June 25, 2016, at 12:30 p.m., a train derails in a highly industrialized section of Columbia, South Carolina. Among the derailed cars is a tank car of propane in a U.S. Department of Transportation (DOT) class 112J400W car with a listed capacity of 33,800 gallons. The tank is approximately 70 feet long and the tank appears to be intact. The propane has been liquefied under pressure.

At the time of the accident, the air temperature is 70°F, with the wind from 360° at 10 miles per hour (measured at a height of 10 meters by the National Weather Service). The sky is completely overcast and the relative humidity is 67%. There is no low-level inversion.

The tank needs to be removed from the tracks and the cargo off-loaded. The tank has already been subjected to significant stress during the wreck and it is conceivable that it could fail during this effort. Possible failure scenarios include: A sudden catastrophic failure leading to a Boiling Liquid Expanding Vapor Explosion (BLEVE);

In order to plan a safe response and ensure public safety, the potential severity of these threats must be evaluated. You'll use ALOHA to predict the threat zone the potential scenario.

Instructions:

*Follow 'ALOHA Sample Examples' file from page-20 to page-27.

*You need to upload your simulation file in Blackboard as attachment

*Your file name need to be this format: "ENGR-4330 Simulation-3 Exp-3 Last name First Name"

*You can submit the Simulation file early, if you want

Example-4: A Tank Source (Multiple Scenarios) -Modeling a Flash Fire or Vapor Cloud Explosion

On June 25, 2016, at 12:30 p.m., a train derails in a highly industrialized section of Columbia, South Carolina. Among the derailed cars is a tank car of propane in a U.S. Department of Transportation (DOT) class 112J400W car with a listed capacity of 33,800 gallons. The tank is approximately 70 feet long and the tank appears to be intact. The propane has been liquefied under pressure.

At the time of the accident, the air temperature is 70°F, with the wind from 360° at 10 miles per hour (measured at a height of 10 meters by the National Weather Service). The sky is completely overcast and the relative humidity is 67%. There is no low-level inversion.

The tank needs to be removed from the tracks and the cargo off-loaded. The tank has already been subjected to significant stress during the wreck and it is conceivable that it could fail during this effort. Possible failure scenarios include:

1) A sudden catastrophic failure leading to a Boiling Liquid Expanding Vapor Explosion (BLEVE). (Note: Get data from Example-3).
2) A leak leading to a flash fire or a vapor cloud explosion;

In order to plan a safe response and ensure public safety, the potential severity of these threats must be evaluated. You'll use ALOHA to predict the threat zones for each of these potential scenarios. For the last scenario, you'll model the release assuming a seam fails on the tank, creating a rectangular hole 40 inches long and 0.1 inch wide.

Now that ALOHA has displayed the thermal radiation hazard from a BLEVE, you want to assess the threat if the tank leaks and a flammable vapor cloud forms instead. If this situation occurs, either a flash fire or a vapor cloud explosion could occur, depending on the scenario specifics. For both of these scenarios, you will need to begin by estimating the flammable area of the vapor cloud. You do not need to enter new information for time, atmospheric conditions, or tank size.

Instructions:

*Follow 'ALOHA Sample Examples' file from page-28 to page-36

*You need to upload your simulation file in Blackboard as attachment

*Your file name need to be this format: "ENGR-4330 Simulation-4 Exp-4 Last name First Name"

*You can submit the Simulation file early, if you want

Example-5: A Tank Source (Multiple Scenarios) -Modeling a Jet Fire

On June 25, 2016, at 12:30 p.m., a train derails in a highly industrialized section of Columbia, South Carolina. Among the derailed cars is a tank car of propane in a U.S. Department of Transportation (DOT) class 112J400W car with a listed capacity of 33,800 gallons. The tank is approximately 70 feet long and the tank appears to be intact. The propane has been liquefied under pressure.

At the time of the accident, the air temperature is 70°F, with the wind from 360° at 10 miles per hour (measured at a height of 10 meters by the National Weather Service). The sky is completely overcast and the relative humidity is 67%. There is no low-level inversion.

The tank needs to be removed from the tracks and the cargo off-loaded. The tank has already been subjected to significant stress during the wreck and it is conceivable that it could fail during this effort. Possible failure scenarios include:

1) A sudden catastrophic failure leading to a Boiling Liquid Expanding Vapor Explosion (BLEVE). (Note: Get data from Example-3).
2) A leak leading to a flash fire or a vapor cloud explosion. (Note: Get data from Example-4).
3) A breach leading to a jet fire from the tank.

In order to plan a safe response and ensure public safety, the potential severity of these threats must be evaluated. You'll use ALOHA to predict the threat zones for each of these potential scenarios. For the last two scenarios, you'll model the release assuming a seam fails on the tank, creating a rectangular hole 40 inches long and 0.1 inch wide.

Now that you've considered the flammable area and the overpressure hazard from a vapor cloud explosion, you want to assess the thermal radiation threat if the tank leaks and the escaping propane is quickly ignited, so that a jet fire occurs instead. Therefore, you don't need to enter new information for time, atmospheric conditions, or tank size.

Instructions:

*Follow 'ALOHA Sample Examples' file from page-37 to page-39

*You need to upload your simulation file in Blackboard as attachment

*Your file name need to be this format: "ENGR-4330 Simulation-5 Exp-5 Last name First Name"

*You can submit the Simulation file early, if you want

Example-6: A Direct Source and a MARPLOT Map

At 3 p.m. on June 4, 2016, a train traveling on the Southern Railway near Manassas, Virginia, collides with a stalled truck at Lee Highway (U.S. Route 29). Three 150-pound chlorine cylinders that were in the truck bed are damaged during the collision and simultaneously release their contents. At the time of the release, winds are out of the east at about 6 miles per hour, measured at a height of 3 meters. One-third of the sky is covered by clouds, the humidity is about 80% and the air temperature is 72°F. There is no low-level inversion.

The land between the accident site and the intersection of John Marshall Highway (State Route 55) with Lee Highway is flat with no obstructions. Two workmen repairing potholes on Lee Highway just west of this intersection are overcome by fumes and treated at a local hospital for chlorine gas inhalation. To what approximate concentration of chlorine might the workmen have been exposed?

You'll evaluate this scenario first by using ALOHA to obtain a source strength estimate and a threat zone estimate, and then by displaying the threat zones on a MARPLOT map in order to obtain a concentration estimate for the location where the workmen were injured.

Instructions:

*Follow 'ALOHA Sample Examples' file from page-40 to page-53

*You need to upload your simulation file in Blackboard as attachment

*Your file name need to be this format: "ENGR-4330 Simulation-6 Exp-6 Last name First Name"

*You can submit the Simulation file early, if you want

Simulation-7, due by 12/6, by 9pm

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Find a historical chemical spill incident (https://en.wikipedia.org/wiki/List_of_industrial_disasters) and evaluate the hazard emission scenario by using ALOHA to obtain a source strength, as well as different threat zones estimates, and then display the threat zones on a MARPLOT map in order to obtain a concentration estimate for the location where the neighborhoods and workmen were in potential hazard zone.

Instructions:
*You need to write a nice report related to that incident: cause, how it could be avoided, lesson learn etc.
*You need to attach your simulation files in that file
*You need to upload your file in Blackboard as attachment
*Your file name need to be this format: "ENGR-3375 Simulation-7 Independent Study Last name First Name"
*You can submit the Simulation file early, if you want

Points 50

Submitting a text entry box or a file upload