Infrared Sensing of Oil Spill

Proposers

Saint Peter's University

Society of Physics Students

SPS Chapter # 6266

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Abstract:

Oil Spill is a major environmental disaster, which is good prevented, best stopped. Infrared (IR) Technology is a new promising technology being introduced in detecting oil spills. IR has advantages over traditional methods because of the distinct thermal contrast between oil and water. While IR has been successfully employed at various instances including the Deep Water Horizon Crisis, the technology has not yet fully matured. At Saint Peter's University, we intend to study in details the thermal properties of oil, particularly its dependence of emissivity of oil on the thickness which will allow us to make a volumetric estimation of the oil. In addition, we plan to employ fluorescence to investigate the spectral response of different oil samples. Numerical simulation would be done in addition to undertaken in addition to experimental investigation.

Introduction:

Every object whose temperature is above absolute zero emits radiation. For the body at the room temperature which is around 300 K, the major part of the radiation lies in the infrared region. Thus, IR due to its ubiquity is a very handy technology in detecting objects under the condition of low visibility. In oil spill detection, the thermal contrast of oil and water [1] allows us to localize the boundary of the oil. Even though the water and oil have about the same temperature, IR camera registers different temperature owing to different emissivity of oil and water. We intend to measure the dependence of emissivity of oil on thickness. Investigation has previously been directed at finding properties of oil, while we will be particularly focusing in using crude oil, which has not been studied extensively.

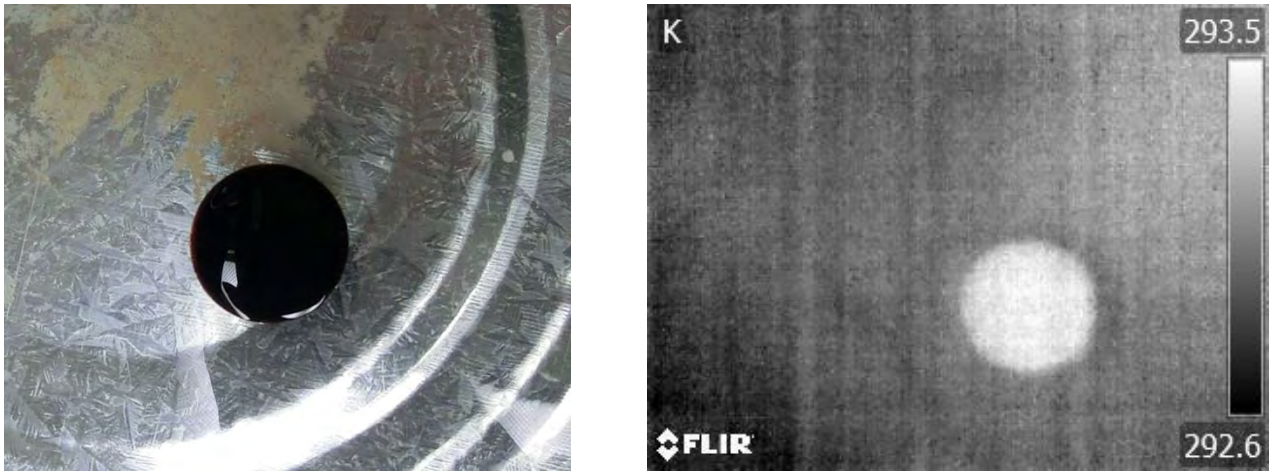


Fig 1. An optical Image (left) and infrared image (right) of oil drop of a crude oil taken at room temperature.

Research Methodology

We will be using crude oil for our research. Initially, the water and oil mixture will be taken at room temperature and the temperature distribution of oil will be recorded with the help of IR

camera. As the volume of the oil remains constant, and the area grows, the thickness of the oil layer decreases. By taking data, we will be able to determine the dependence between oil and water thickness of the oil film. Thermal contrast between oil and water is supposed to transition from positive to negative at about 50 μm and 150 μm [2,3] , and we will be testing if this hypothesis holds for our samples of crude oils. An image analysis software called "ImageJ" will be used to analyze the pictures in detail. In addition, we will be developing programs to analyze temperature variation, such as temperature especially near to the boundary compared to that at the center.

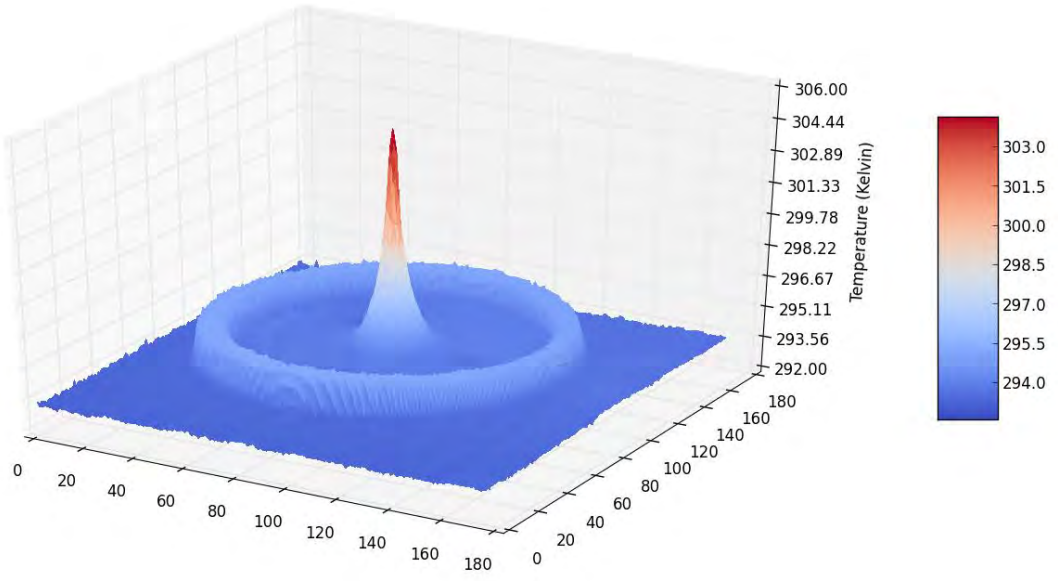
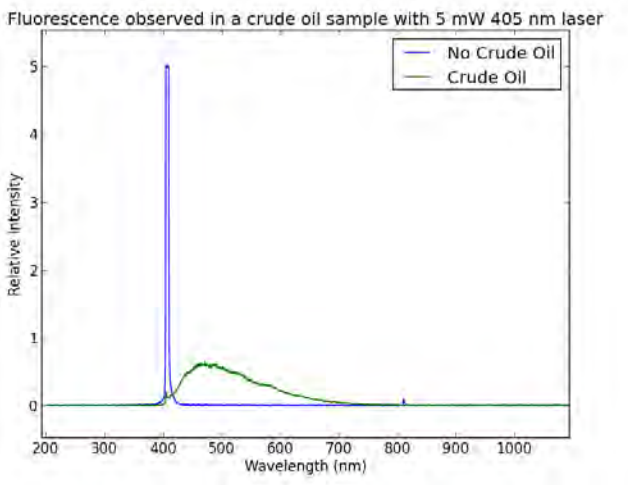


Fig. 2 Plot of spatial variation of temperature of circular oil drop heated centrally with a laser pointer of 405 nm.

As for the fluorescence, we will be using the tunable laser of wavelength 405 nm. The unique spectral response of each oil sample will be recorded and an algorithm based on our record will be developed to recognize different oil sample by scanning them. We will also study the feasibility of using laser stimulated fluorescence in detecting oil spill, particularly the distance over which the signal is still detectable. Besides, the temperature distribution of the will be governed primarily by heat diffusion equation. The data obtained from the experiment will be compared against



the theoretical model. By studying different parameters such as thermal capacity, specific heat capacity, their role in heat distribution will become clearer. This will allow us to determine the feasibility of using the aforementioned physical parameters in distinguishing different types of liquids, in our case water and different types of oil.

Since this project is a joint effort of students from Physics, Biology and Computer Science, we have different sets of interdisciplinary talents required for the completion of the project. Our advisor, Dr. Zeng who has agreed to guide us throughout the completion and allow us to use various equipment needed for the experiments including the infrared camera from FLIR® and spectrometer.

Time Line:

February	Buy all equipment
March – May	Build necessary programs for image processing Take Experimental Data on different data
September - November	Continue taking data Start working on Modeling
November - December	Continue working on experiment Write a report

Conclusion:

The goal of this research project is to develop a mechanism to characterize oil in oil water mixture. By the end of our research, we will have developed an algorithm that will allow us to quantify the amount of oil by processing IR images. By this, we hope to access the reliability of utilizing Infrared Technology in Oil Spill detection.

Bibliography

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